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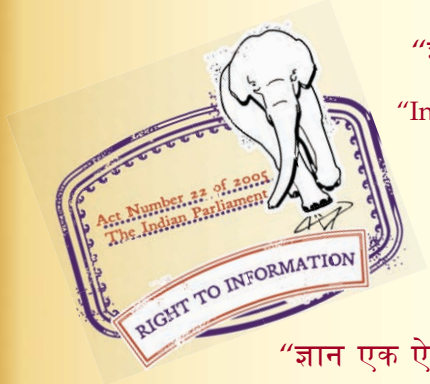

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"Knowledge is such a treasure which cannot be stolen"

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IS : 1742 - 1983
(Reaffirmed 2002)

Indian Standard

CODE OF PRACTICE FOR BUILDING DRAINAGE

(Second Revision)

Second Reprint JULY 1995

UDC 696·12/·13 : 006·76

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 10

August 1984

Indian Standard

CODE OF PRACTICE FOR BUILDING DRAINAGE

(Second Revision)

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(*Continued on page* 50)

Indian Standard

CODE OF PRACTICE FOR BUILDING DRAINAGE

(Second Revision)

0. FOREWORD

0.1 The Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 30 November 1983, after the draft finalized by the Water Supply and Sanitation Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This standard, published in 1960 and subsequently revised in 1972 was intended to bring out a long felt uniformity in the variety of drainage practices followed by various Municipal Corporation, Municipalities and other bodies in the country in efficient drainage of surface and subsoil water and sewage from buildings to public sewers. It is being revised to incorporate improvements found necessary in the light of the usage of the standard.

0.3 This code of practice represents a standard of good practice and, therefore, takes the form of recommendations.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This code gives recommendations for the design, layout, construction and maintenance of drains for waste water, surface water and subsoil water and sewage together with all ancilliary works, like connections, manholes, inspection chambers, etc, used within the building and from the building to the connection to a public sewer or to treatment works, a cesspool, a soakaway or a water course.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Authority — An individual, an official, a board, a department or an agency established and authorised by Union or State Government or any statutory body created by law who undertakes to administer and enforce the provisions of this code as adopted or amended.

2.2 Barrel — That portion of a pipe in which the diameter and wall thickness remain uniform throughout.

2.3 Bedding — The material on which the pipe is laid and which provides support for the pipe. Bedding can be concrete, granular material or the prepared trench bottom.

2.4 Benching — Sloping surfaces constructed on either side of channels at the base of a manhole or inspection chamber for the purpose of confining the flow of sewage, avoiding the accumulation of deposits and providing a safe working platform.

2.5 Chair — A bed of concrete or other suitable material on the trench floor to provide a support for the pipes at intervals.

2.6 Channel — The open waterway through which sewage, storm water or other liquid waste flow at the invert of a manhole or an inspection chamber.

2.7 Cleaning Eye — An access opening in a pipe or pipe fitting arranged to facilitate the clearing or obstructions and fitted with removable cover.

2.8 Connection — The junction of a foul water drain, surface water drain or sewer from building or buildings with public sewer treatment works cesspool, soakaway or other water courses.

2.9 Cover —

a) A removable plate for permitting access to a pipe to a fitting vessel or appliance.

b) The vertical distance between the top of the barrel of a buried pipe or other construction and the surface of the ground.

2.10 Depth of Manhole — The vertical distance from the top of the manhole cover to the outgoing invert of the main drain channel.

2.11 Diameter — The nominal internal diameter of a pipe.

2.12 Drain — A conduit or channel for the carriage of storm water, sewerage or other used water.

2.13 Drainage — The removal of any liquid by a system constructed for the purpose.

2.14 Drainage Work — The design and construction of a system of drainage.

2.15 Drop Connection — A length of conduit installed vertically immediately before its connection to a sewer or to another drain.

2.16 Drop Manhole — A manhole installed in a sewer where the elevation of the incoming sewer considerably exceeds that of the outgoing sewer; a vertical waterway outside the manhole is provided to divert the waste water from the upper to the lower level so that it does not fall freely into the manhole except at peak rate of flow.

2.17 Formation — The finished level of the excavation at the bottom of a trench or heading prepared to receive the permanent work.

2.18 French Drain or Rubble Drain — A shallow trench filled with coarse rubble, clinker, or similar material with or without field drain pipes.

2.19 Gully Chamber — The chamber built of masonry round a gully trap for housing the same.

2.20 Gully Trap — It is a trap provided in a drainage system with a water seal fixed in a suitable position to collect waste water from the scullery, kitchen sink, wash basins, baths and rain water pipes.

2.21 Haunching — Outward sloping concrete support to the sides of a pipe or channel above the concrete bedding.

2.22 Highway Authority — The public body in which is vested, or which is the owner of a highway repairable by the inhabitants collectively; otherwise the body of persons responsible for the upkeep of the highway.

2.23 Inspection Chamber — A water-tight chamber constructed in any house-drainage system which takes wastes from gully traps and disposes of to manhole with access for inspection and maintenance.

2.24 Interceptor Manhole or Interceptor Chamber — A manhole incorporating an intercepting trap, and providing means of access thereto.

2.25 Invert — The lowest point of the internal surface of a pipe of channel at any cross section.

2.26 Junction Pipe — A pipe incorporating one or more branches.

2.27 Manhole — An opening by which a man may enter or leave a drain, a sewer or other closed structure for inspection, cleaning and other maintenance operations, fitted with a suitable cover.

2.28 Manhole Chamber — A chamber constructed on a drain or sewer so as to provide access thereto for inspection, testing or the clearance of obstruction.

2.29 Pipe Systems — The pipe systems as defined in IS : 5329-1983*.

2.30 Rest Bend or Duck-Foot Bend — A bend, having a foot formed integrally in its base, used to receive a vertical pipe.

2.31 Saddle — A purpose made fitting, so shaped as to fit over a hole cut in a sewer or drain and used to form connections.

2.32 Sewer — A pipe or conduit, generally closed, but normally not flowing full for carrying sewage or other waste liquids.

2.33 Soak-away — A pit, dug into permeable ground lined to form a covered perforated chamber or filled with hard-core, to which liquid is led, and from which it may soak away into the ground.

2.34 Slop Hopper (Slop Sink) — A hopper-shaped sink, with a flushing rim and outlet similar to those of a WC pan, for the reception and discharge of human excreta.

2.35 Soffit — The highest point of the internal surface of a sewer or culvert at any cross section.

2.36 Soil Waste — The discharge from water closets, urinals, slop sinks, stable or cowshed gullies and similar appliances.

2.37 Soil Pipe

a) In plumbing, a pipe that conveys the discharge of water closets or fixtures having similar functions, with or without the discharges from other fixtures.

b) A standard type of bell-and-spigot cast iron pipe of limited strength.

2.38 Subsoil Water — Water occurring naturally in the subsoil.

2.39 Subsoil Water Drain

a) A drain intended to collect and carry away subsoil water.

b) A drain intended to disperse into the subsoil the effluent from a septic tank.

2.40 Surface Water Drain — A drain conveying surface water including storm water.

2.41 Systems of Drainage

2.41.1 *Combined System* — A system of drains or sewers in which foul water and surface water are conveyed by the same pipes.

*Code of practice for sanitary pipe work above ground for buildings (*first revision*).

2.41.2 *Separate System* — A system of drains or sewers in which the foul water and surface water are conveyed by separate pipes.

2.41.3 *Partially Separate System* — A modification of the separate system in which part of the surface water is conveyed by the foul sewers and drains.

2.42 Trade Effluent — Any liquid either with or without particles of matter in suspension therein, which is wholly or in part produce in the course of any trade or industry, carried at trade premises. It includes farm wastes but does not include domestic sewage.

2.43 Vent Pipe — An open ended pipe, in a hot water apparatus, for the escape of air and for the safe discharge of any steam generated.

2.44 Ventilating Pipe — A pipe in a sanitary pipework system which facilitates the circulation of air within the system and protects trap seals from excessive pressure fluctuation.

2.45 Waste Water (Sullage) — The discharge from wash basins, sinks and similar appliances which does not contain human excreta.

2.46 Waste Pipe — In plumbing, any pipe that receives the discharge of any fixtures, except water closets or similar fixtures and conveys the same to the house drain or soil or waste stack. When such pipe does not connect directly with a house drain or soil stack, it is called an indirect waste pipe.

2.47 Puff Ventilation — The ventilation provided for waste traps in two-pipe system, in order to preserve the water seal.

3. MATERIALS, FITTINGS AND SANITARY APPLIANCES

3.1 Standards — All materials and fittings used in the construction of any of the works or any of the appliances described in this code shall conform to the latest editions of the relevant Indian Standard specifications where available in so far as these standards are applicable. Where no such standards exist, the materials, fittings and appliances shall be of the best quality and workmanship, and shall be open to inspection by the purchaser at the manufacturer's works before despatch.

4. DESIGN CONSIDERATION

4.1 Aim — In designing a drainage system for individual building(s), the aim shall be to provide a system of self-cleansing conduits for the conveyance of soil, waste, surface or sub-surface waters, and for the removal of such wastes speedily and efficiently to a sewer or other outlet without risk of nuisance and hazard to health.

4.1.1 To achieve this aim, a drainage system shall satisfy the following requirements:

a) Rapid and efficient removal of liquid wastes without leakage;

b) Prevention of access of foul gases to the building and provision for their escape from the system;

c) Adequate and easy access for cleaning and clearing obstructions;

d) Prevention of undue external or internal corrosion, or erosion of joints and protection of materials of construction; and

e) Avoidance of air locks, siphonage, proneness to obstruction, deposit and damage.

4.1.2 The realization of an economical drainage system is aided by compact grouping of fitments in both horizontal and vertical directions. This implies that if care is taken and ingenuity brought into play when designing the original building or buildings to be drainage, it is possible to group the sanitary fittings and other equipment requiring drainage, both in vertical and horizontal planes as to simplify the drainage system and make it most economical.

4.2 Preliminary Data for Design

4.2.1 *General* — Before the drainage system for a building or group of buildings is designed and constructed, accurate information regarding the site conditions is essential. This information may vary with the individual scheme but shall, in general, be covered by the following:

a) *Site plan* — A plan of the site to scale 1 : 500 (*see* IS : 965-1963*) with reduced levels preferably related to Great Trigonometrical Survey Datum indicating the position and lowest floor level of the proposed buildings, formation level, level of the outfall, location of wells, underground sumps and other drinking water sources.

b) *Detailed plans* — Plans and sections of the proposed buildings to scale 1 : 100 showing the positions and types of all sanitary fittings and other equipment requiring drainage, the location and extent of all paved areas and the position of all rain-water down pipes.

c) *Use* — A description of the use for which the building is intended and periods of occupation, in order that peak discharge may be estimated.

d) The availability of sewers or other outlets and their levels.

*Equivalent metric units for scales, dimensions and quantities in general construction work (*revised*).

e) *Bye-laws* — The requirements of local bye-laws in regard to the drainage and sewerage.

f) The nature of the sewage to be carried. While dealing with sewage from domestic premises or schools, special problems under this head may not arise; however, note shall be taken of any possibility of trade effluents being discharged into the pipes at a future date.

g) *Cover* — The depth below ground of the proposed sewers and drains and the nature and weight of the traffic on the ground above them.

h) *Subsoil conditions* — Except for such minor works as house drains, the fullest possible information shall be obtained as to the physical and chemical nature of the ground to be excavated. Subsoil conditions govern the choice of design of the sewer or drain and the method of excavation. The approximate level of the subsoil water, and any available records of flood levels shall be ascertained, as also the depth of the water table relative to all sewer connections, unless it is known to be considerably below the level of the latter. In the case of deep manholes this information will influence largely the type of construction to be adopted. The probable safe bearing capacity of the subsoil at invert level shall always be ascertained in the case of a deep manhole. Where work of any magnitude is to be undertaken, trial pits or boreholes shall be put at intervals along the line of proposed sewer or drain and the data therefrom tabulated together with any information available from previous works carried out in the vicinity. In general, the information derived from trial pits is more reliable than that derived from boreholes. For a long length of sewer or drain, information derived from a few trial pits at carefully chosen points may be supplemented by that obtained from a number of intermediate boreholes. Much useful information is often obtained economically and quickly by the use of a soil auger. The positions of trial pits or boreholes shall be shown on the plans, together with sections showing the strata found and the dates on which water levels are recorded.

j) *Location of other services* — The position, depth and size of all other pipes, mains, cables, or other services, in the vicinity of the proposed work may be ascertained from the authority, if necessary.

k) *Reinstatement of surfaces*— Information about the requirements of the highway authority is necessary where any part of the sewer or drain is to be taken under a highway. Those responsible for the sewer or drain shall be also responsible for the maintenance of the surface until permanently reinstated. The written consent of the highway authority to break up the surface and arrangement as to the charges thereof and the method and the type of surface reinstatement shall always be obtained before any work is commenced.

m) *Diversion and control of traffic* — In cases where sewers cross roads or footpaths, co-operation shall be maintained with the police and administration authorities regarding the control and diversion of vehicular and/or pedestrian traffic as may be necessary. Access to properties along the road shall always be maintained, and adequate notice shall be given to the occupiers of any shops or business premises, particularly if obstruction is likely.

n) During the period of diversion, necessary danger lights, red flags, diversion boards, caution boards, watchmen etc., shall be provided as required by the authority.

p) *Wayleaves* (*easements*) — The individual or authority, carrying out the work is responsible for negotiating wayleaves where the sewer crosses land in other ownership. The full extent and conditions of such wayleaves shall be made known to the contractor and his employees, and prior notice of commencement of excavation shall always be given to the owners concerned and co-operation with them shall be maintained at all stages.

Where sewers run across fields or open ground, the exact location of manholes shall be shown on wayleave or easement plans. The right to maintain the sewer shall be specifically included in any wayleave or easement arrangements which may be made with the owner of the land.

q) *Damage to buildings and structures* — When sewer trenches have to be excavated near buildings or walls a joint inspection with the owners of the property shall be made to establish whether any damage or cracks exist before starting the work, and a properly authenticated survey and record of the condition of buildings likely to be affected shall be made. Tell tales may be placed across outside cracks and dated, and kept under observation. Unretouched photographs taken by an independent photographer may provide useful evidence.

4.2.2 *Drainage into a Public Sewer* — Where public sewerage is available the following information is particularly necessary and may be obtained from the Authority:

a) The position of the public sewer or sewers in relation to the proposed buildings;

b) The invert level of the public sewer;

c) The system on which the public sewers are designed (combined, separate or partially separate), the lowest level at which connection may be made to it, and the authority in which it is vested;

d) The material of construction and condition of the sewer if connection is not to be made by the authority;

e) The extent to which surcharge in the sewer may influence the drainage scheme;

f) Whether the connection to the public sewer is made, or any part of the drain laid by the authority, or whether the owner is responsible for this work; if the latter, whether authority imposes any special conditions;

g) Whether an intercepting trap is required by the authority on the drain near the boundary of the curtilage; and

h) Where manholes are constructed under roads, the approval of the highway authority to the type of cover to be fitted shall be obtained.

4.2.3 *Other Methods of Disposals of Sewage*

4.2.3.1 Where discharge into a public sewer is not possible, the drainage of the building shall be on the separate system. Foul water shall be disposed of by adequate treatment approved by the authority at the site. The effluent from the plant shall be discharged into a natural water course or on the surface of the ground or disposed of by subsoil dispersion, preferably draining to a suitable outlet channel.

4.2.3.2 In the case of dilution into a natural stream course, the quality of effluent shall conform to the requirements of authority controlling the prevention of pollution of stream. For guidance IS : 4764-1973* and IS : 4733-1972† may be followed.

4.2.3.3 In the case of subsoil dispersion, the requirements of the authority for water supply shall be observed to avoid any possible pollution of local water supplies or wells.

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*Tolerance limits for sewage effluents discharged into inland surface waters (*first revision*).

†Methods of sampling and test for sewage effluents (*first revision*).

4.2.3.4 The general subsoil water level and the subsoil conditions shall be ascertained including the absorptive capacity of the soil.

4.2.3.5 A subsoil dispersion is not desirable near a building or in such positions that the ground below the foundations is likely to be affected.

4.2.3.6 Where no other method of disposal is possible, foul water may be collected and stored in impervious covered cesspool and arrangements made with the authority for satisfactory periodical removal and conveyance to a disposal works.

4.2.3.7 Under the separate system, drainage of the building shall be done through septic tank of different sizes or by stabilization ponds or by any other methods as approved by the authority.

4.2.4 *Disposal of Surface and Subsoil Water* — All information which may influence the choice of methods of disposal or surface and/or subsoil waters shall be obtained. In the absence of surface water drainage system and if practicable and permissible, disposal into a natural water course or soakaway may be adopted. The location and flood levels of the water course as also the requirements of the authority controlling the river or the waterway shall be ascertained.

4.3 Layout

4.3.1 *General* — Generally, rain water shall be dealt with separately from sewage and sullage. Sewage and sullage shall be connected to sewers. Storm water from courtyard may be connected to the sewer where it is not possible to drain otherwise after obtaining permission of the authority.

4.3.1.1 The layout shall be as simple and direct as practicable. Considerations shall be given to alternative layouts so as to ensure that the most economical and practical solution is adopted. The possibility of alterations shall be avoided by exercising due care and forethought.

4.3.1.2 The requirements of sanitary appliances and fitments as well as the basic requirements for water supply, drainage and sanitation shall be in accordance with IS : 1172-1983*.

4.3.2 *Protection Against Vermin and Dirt* — The installation of sanitary fittings shall not introduce crevices which are not possible to inspect and clean readily. Pipes if not embedded shall be run well clear of the wall. Holes through walls to take pipes shall be made good on both sides to prevent entry of insects. Materials used for embedding pipes shall be rodent-proof. Passage of rodents from room to room or from floor to floor shall be prevented by suitable sealing. The intermediate lengths of ducts

*Code of basic requirements for water supply, drainage and sanitation (*third revision*).

and chases shall be capable of easy inspection. Any unused drains, sewers, etc. shall be demolished or filled in to keep them free from rodents.

4.3.3 *Choice of Plumbing System* — Sanitary pipe work in buildings shall conform to the requirements given in IS : 5329-1983*.

4.3.4 *Additional Requirements* — The pipes shall be laid in straight lines as far as possible and with uniform gradients. Anything that is likely to cause irregularity of flow, such as, abrupt changes of directions shall be avoided. No bends and junctions whatsoever shall be permitted in sewers except at manholes and inspection chambers.

4.3.4.1 Where it is not possible to avoid a change of direction in the case of drains, access shall be provided through manholes and inspection chambers. Necessary terminal bends at junctions shall be 1/8 or preferably 1/16 bends.

4.3.4.2 All junctions shall be oblique and the contained angle shall not be more than 60°.

4.3.4.3 Drains may be laid under the buildings only when unavoidable and when it is not possible to obtain otherwise a sufficient fall in the drain.

4.3.4.4 Where it is necessary to lay a drain under a building or exposed locations within the building, the following conditions shall be observed:

a) Pipes shall be of cast iron (*see* IS : 1536-1976† and IS : 1537-1976‡);

b) The drains shall be laid in a straight line and at a uniform gradient;

c) Means of access in the form of manholes/inspection chambers shall be provided at each end, immediately outside the building;

d) In case the pipe or any part of it is laid above the natural surface of the ground, it shall be laid on concrete supports the bottom of which goes at least 150 mm below the ground surface; and

e) It is desirable that drains should not be taken through a living room or kitchen and shall preferably be taken under a staircase room or a passage.

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*Code of practice for sanitary pipe work above ground for buildings (*first revision*).

†Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage (*second revision*).

‡Specification for vertically cast iron pressure pipes for water, gas and sewage (*first revision*).

4.3.4.5 *Surcharge of sewers (precautions)* — Where there is a risk of the sewer becoming surcharged under storm conditions all gullies and sanitary fittings shall be located above the level of maximum surcharge of the sewer. Where this is not practicable, an anti-flood valve shall be provided in the manhole nearest to the junction of the drain and sewer. Parts exposed to wear in anti-flood valves shall be of non-corrodable metal and easily accessible. The cross-sectional area of flow through the valve shall not be less than that of the pipe connected. In extreme cases, pumping may have to be considered.

4.3.4.6 The distance between inspection chamber and gully chamber shall not exceed 6 m.

4.4 Preparation and Submission of Plans

4.4.1 No person shall install or carry out any water-borne sanitary installation or drainage installation or any works in connection with anything existing or new building or any other premises without obtaining the previous sanction of the authority.

4.4.2 Before the drainage work of any building is undertaken, a drainage plan drawn to a scale of not smaller than 1 : 200 shall be prepared and furnished along with the building plan. The plans shall show the following:

a) Every floor of the building in which the pipes or drains are to be used;

b) The position, forms, level and arrangement of the various parts of such building including the roof thereof;

c) All new drains as proposed with their sizes and gradients;

d) Invert levels of the proposed drains with corresponding ground levels; and

e) The position of every manhole, gully, soil and waste pipe, ventilating pipe, rain-water pipe, water closet, urinal, latrine, bath, lavatory, sink, trap or other appliances in the premises proposed to be connected to any drains and the following colours are recommended for indicating sewers, waste water pipes, rainwater pipes and existing work:

	Colour
Sewers	Red
Waste water pipes and rain-water pipes	Blue
Existing work	Black

Provided that in the case of an alteration or addition to an existing building this clause shall be deemed to be satisfied if the plans as furnished convey sufficient information for the proposals to be readily identified with the previous sanctioned plans and provided that the location of tanks and other fittings are consistent with the structural safety of the building.

4.4.3 In addition, a site plan of the premises on which the building is to be situated or any such work is to be carried out shall be prepared drawn to a scale not smaller than 1 : 500.

4.4.3.1 The site plan of the building premises shall show:

a) the adjoining plots and streets with their names;

b) the position of the municipal sewer and the directions of flow in it;

c) the invert level of the municipal sewer, the road level, and the connection level of the proposed drain connecting the building in relation to the sewer;

d) the angle at which the drain from the building joins the sewer; and

e) the alignment, sizes, and gradients of all drains and also of surface drains; if any.

A separate site plan is not necessary if the necessary particulars to be shown on such a site plan are already shown in the details plan.

4.4.4 In respect of open drains, cross-sectional detail shall be prepared to a scale not smaller than 1 : 50 showing the ground and invert levels, level of outfall and any arrangement already existing or proposed for the inclusion of any or exclusion of all storm water from the sewers.

4.4.5 The plans for the building drainage shall in every case be accompanied by specifications for the various items of work involved.

4.5 Estimation of Maximum Flow of Domestic Sewage

4.5.1 The maximum flow in a building drain or a stack depends on the probable maximum number of simultaneously discharging appliances. For the calculation of this peak flow certain loading factors have been assigned to appliances in terms of fixture units, considering their probability and frequency of use. These fixture unit values are given in Table 1.

4.5.1.1 For any fixtures not covered under Table 1, Table 2 may be referred to for deciding their fixture unit rating depending on their drain or trap size.

TABLE 1 FIXTURE UNITS FOR DIFFERENT SANITARY APPLIANCE OR GROUP

(*Clause* 4.5.1)

TYPE OF FIXTURE	FIXTURE UNIT VALUE AS LOAD FACTORS
One bath room group consisting of water closet, wash basin and bath tub or shower stall:	
a) Tank water closet	6
b) Flush-valve water closet	8
Bath tub*	3
Bidet	3
Combination sink-and-tray (drain board)	3
Drinking fountain	½
Floor traps†	1
Kitchen sink, domestic	2
Wash basin, ordinary‡	1
Wash basin, surgeon's	2
Shower stall, domestic	2
Showers (group) per head	3
Urinal wall lip	4
Urinal stall	4
Water closet, tank-operated	4
Water closet, valve-operated	8

*A shower head over a bath tub does not increase the fixture value.
†Size of floor trap shall be determined by the area of surface water to be drained.
‡Wash basins with 32 mm and 40 mm trap have the same load value.

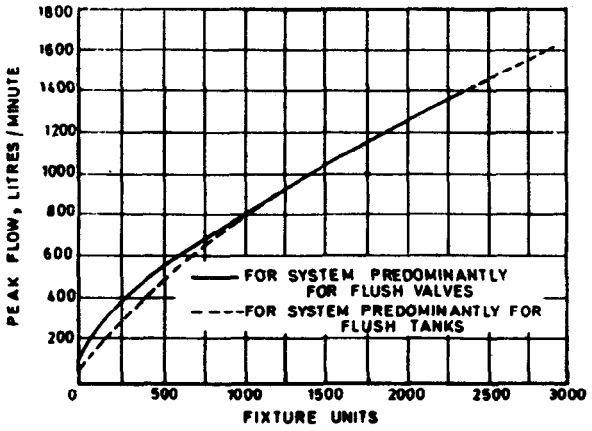
TABLE 2 FIXTURE UNIT VALUES FOR FIXTURES BASED ON FIXTURE DRAIN OR TRAP SIZE

(*Clause* 4.5.1.1)

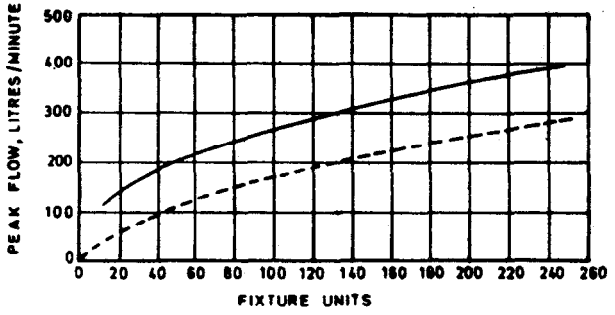
FIXTURE DRAIN OR TRAP SIZE (mm)	FIXTURE UNIT VALUE
30 and smaller	1
40	2
50	3
65	4
75	5
100	6

4.5.1.2 From Tables 1 and 2, the total load on any pipe in terms of fixture units may be calculated knowing the number and type of appliances connected to this pipe.

4.5.1.3 For converting the total load in fixture units to the peak flow in litres per minute, Fig. 1 is to be used.



1A Estimate Curves



——— For system predominantly for flush valves

- - - - - - - - For system predominantly for flush tanks

1B Enlarged Scale Curves

FIG. 1 PEAK FLOW LOAD CURVES

4.5.1.4 The maximum load in fixture units permissible on various recommended pipe sizes in the drainage system are given in Tables 3 and 4.

4.5.1.5 Results should be checked to see that the soil, waste and building sewer pipes are not reduced in diameter in the direction of flow. Where appliances are to be added in fixture unit, these should be taken into account in assessing the pipe sizes by using the fixture units given in Tables 1 and 2.

TABLE 3 MAXIMUM NUMBER OF FIXTURE UNITS THAT CAN BE CONNECTED TO BRANCHES AND STACKS

(*Clause* 4.5.1.4)

Diameter of Pipe mm	Maximum Number of Fixture Units* That may be Connected to			
	Any Horizontal Fixture Branch†	One Stack of 3 Storeys in Height or 3 Intervals	More Than 3 Storeys in Height	
			Total for stack	Total at one storey on branch interval
(1)	(2)	(3)	(4)	(5)
30	1	2	2	1
40	3	4	8	2
50	6	10	24	6
65	12	20	42	9
75	20	30	60	16
100	160	240	500	90
125	360	540	1 100	200
150	620	960	1 900	350
200	1 400	2 200	3 600	600
250	2 500	3 800	5 600	1 000
300	3 900	6 000	8 400	1 500
375	7 000	—	—	—

*Depending upon the probability of simultaneous use of appliances considering the frequency of use and peak discharge rate.

†Does not include branches of the building sewer.

TABLE 4 MAXIMUM NUMBER OF FIXTURE UNITS THAT CAN BE CONNECTED TO BUILDING DRAINS AND SEWERS

(*Clause* 4.5.1.4)

Diameter of Pipe mm	Gradient			
	1/200	1/100	1/50	1/25
100	—	180	216	250
150	—	700	840	1 000
200	1 400	1 600	1 920	2 300
250	2 500	2 900	3 500	4 200
300	3 900	4 600	5 600	6 700
375	7 000	8 300	10 000	12 000

Note 1 — Maximum number of fixture units that may be connected to any portion (see Note 2) of the building drain or the building sewer is given.

Note 2 — Includes branches of the building sewer.

4.6 Gradients and Pipe Sizes

4.6.1 *Gradients*

4.6.1.1 The discharge of water through a domestic drain is intermittent and limited in quantity and, therefore, small accumulations of solid matter are liable to form in the drains between the building and the public sewer. There is usually a gradual shifting of these deposits as discharges take place. Gradients shall be sufficient to prevent these temporary building up and blocking the drains.

4.6.1.2 Normally, the sewer shall be designed for discharging three times the dry-weather flow flowing half-full with a minimum self-cleansing velocity of 0·75 m/s. The approximate gradients which give this velocity for the sizes of pipes likely to be used in building drainage and the corresponding discharges when flowing half-full are as follows:

Diameter	*Gradients*	*Discharge*
mm		m^3/min
100	1 in 57	0·18
150	1 in 100	0·42
200	1 in 145	0·73
230	1 in 175	0·93
250	1 in 195	1·10
300	1 in 250	1·70

4.6.1.3 In cases, where it is practically not possible to conform to the ruling gradients, a flatter gradient may be used but the minimum velocity in such cases shall on no account be less than 0·61 m/s.

NOTE — Where gradients are restricted, the practice of using pipes of larger diameter than is required by the normal flow in order to justify laying at a flatter gradient does not result in increasing the velocity of flow but reduces the depth of flow and for this reason is to be deprecated.

4.6.1.4 On the other hand, it is undesirable to employ gradients giving a velocity of flow greater than 2·4 m/s. Where it is unavoidable, cast-iron pipes shall be used. The approximate gradients which give a velocity of 2·4 m/s for the various sizes of pipes and the corresponding discharge when flowing half-full are as follows:

Diameter	*Gradient*	*Discharge*
mm		m^3/min
100	1 in 5·6	0·59
150	1 in 9·7	1·32
200	1 in 14	2·4
230	1 in 17	2·98
250	1 in 19	3·60
300	1 in 24·5	5·30

4.6.1.5 The discharge values corresponding to nominal diameter and gradient given in **4.6.1.2** and **4.6.1.4** are based on Manning's formula ($n = 0{\cdot}015$).

4.6.2 *Pipe Sizes* — Subject to the minimum size of 100 mm the sizes of pipes shall be decided in relation to the estimated quantity of flow and the available gradient.

4.7 Choice of Materials

4.7.1 *Salt Glazed Stoneware Pipes* — For all sewers and drains in all solids, except where supports are required as in made-up ground, glazed stoneware pipe shall be used as far as possible in preference to other type of pipes, they are particularly suitable where acid effluents or acid subsoil conditions are likely to be encounterd. Salt glazed stoneware pipes shall conform to IS : 651-1980* or IS : 3006-1979†.

4.7.2 *Cement Concrete Pipes* — When properly ventilated, cement concrete pipes with spigot and socket or collar joints present as alternative to glazed ware sewers over 150 mm diameter. These shall not be used to carry acid effluents or sewage under condition favourable for the production of hydrogen sulphide and shall not be laid in those subsoils which are likely to affect adversely the quality or strength of concrete. Cement concrete pipes may be used for surface water drains in all diameters. These pipes shall conform to IS : 458-1971‡. Where so desired the life of cement concrete pipe may be increased by lining inside of the pipe by suitable coatings like epoxy/polyester resin, etc.

4.7.3 *Cast Iron Pipes* — Cast iron pipes (*see* IS : 1536-1976§ and IS : 1537-1976¶) shall be used in the following situations:

a) In bad or unstable ground where soil movement is expected;
b) In made-up or tipped ground;
c) To provide for increased strength where a sewer is laid at insufficient depth, where it is exposed or where it has to be carried on piers or above ground;
d) Under buildings and where pipes are suspended in basements and like situations;
e) In reaches where the velocity is more than 2·4 m/sec; and
f) For crossings of water courses.

*Specification for salt-glazed stoneware pipes and fittings (*fourth revision*).
†Specification for chemically resistant glazed stoneware pipes and fittings (*first revision*).
‡Specification for concrete pipes (with and without reinforcements) (*second revision*).
§Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage (*second revision*).
¶Specification for vertically cast iron pressure pipes for water, gas and sewage (*first revision*).

4.7.3.1 It shall be noted that cast iron pipes even when given as protective paints are liable to severe external corrosion in certain soils. Among such soils are:

a) soils permeated by peaty waters; and

b) soils in which the subsoil contains appreciable concentrations of sulphates. Local experiences shall be ascertained before cast iron pipes are used where corrosive soil conditions are suspected. Where so used, suitable measures for the protection of the pipes may be restored to as an adequate safeguard.

4.7.4 *Asbestos Cement Pipes* — Asbestos cement pipes are commonly used for house drainage systems and they shall conform to the requirements specified in IS : 1626 (Part 1)-1980*. They are not recommended for underground situations. However, asbestos cement pressure pipes conforming to the requirements specified in IS : 1592-1980† may be used in underground situations also, provided they are not subjected to heavy superimposed loads. These shall not be used to carry acid effluents or sewage under conditions favourable for the production of hydrogen sulphide and shall not be laid in those subsoils which are likely to effect adversely the quality or strength of asbestos cement pipes. Where so desired, the life of asbestos cement pipes may be increased by lining inside of the pipe by suitable coatings like epoxy/polyester resins, etc.

4.7.5 *Lead Pipes* — Branch soil pipes from fittings to main soil pipes and branch waste pipes from fittings to main stack and branch anti-siphonage pipes may be of lead and shall conform to IS : 404 (Part I)-1977‡.

4.7.6 *PVC Pipes* — Unplasticized PVC pipes may be used for drainage purposes; however where hot water discharge is anticipated, the wall thickness should be at least 3 mm irrespective of the size and flow load. UPVC pipe shall conform to IS : 4985-1981§.

NOTE — Where possible, high density polyethylene pipes (HDPE) and UPVC pipes may be used for drainage and sanitation purposes, depending upon suitability. HDPE pipes shall conform to IS : 4984-1978‖.

4.8 Drainage Pipes — Drainage pipes shall be kept clear of all other services. Provisions shall be made during the construction of the building for the entry of the drainage pipes. In most cases this may be done conveniently by building sleeves or conduit pipes into or under the structure in appropriate positions. This will facilitate the installation and maintenance of the services.

*Specification for asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings: Part 1 Pipes and pipe fittings (*first revision*).

†Specification for asbestos cement pressure pipe (*second revision*).

‡Specification for Lead pipes: Part 1 for other than chemical purposes (*second revision*).

§Specification for unplasticized PVC pipes for potable water supplies (*first revision*).

‖Specification for high density polythylene pipes for potable water supplies sewage and industrial effluents (*second revision*).

4.8.1 Where soil and ventilating pipes are accommodated in ducts, access to cleaning eyes shall be provided. Any connection to a drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow. Trenches and subway shall be ventilated, preferably to the open air.

4.8.2 All vertical soil, waste ventilating and anti-siphonage pipes shall be covered on top with a copper or heavily galvanized iron wire dome or cast iron terminal guards. All cast iron pipes which are to be painted periodically shall be fixed suitably to the wall to give a minimum clearance of 50 mm.

NOTE — Asbestos cement cowls may be used in case asbestos cement pipes are used as soil pipes.

4.8.3 Drainage pipes shall be carried to a height above the buildings as specified for ventilating pipe (*see* IS : 5329-1983*).

4.9 Manholes — At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manholes as far as possible. The spacing of manhole pipe may be in accordance with IS : 4111 (Part I)-1967†.

4.9.1 Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at a lower level but in such cases the peak flow level of the two sewers should be kept the same.

4.9.2 Chambers shall be of such size as will allow necessary examination or clearance of drains. The sizes of manholes shall be adjusted to take into account any increase in the number of entries to the manhole. The minimum internal sizes of chambers (between faces of masonary) shall be as follows:

a) For depths of 1 m or less	0·8 × 0·8 m
b) For depths between 1 m and 1·5 m	1·2 × 0·9 m
c) For depths more than 1·5 m	Circular chambers with a minimum diameter of 1·4 m or rectangular chambers with minimum internal dimensions of 1·2 × 0·9 m are recommended.

*Code of practice for sanitary pipe work above ground for buildings (*first revision*).
†Code of practice for ancillary structures in sewerage system: Part 1 Manholes.

NOTE 1 — In adopting the above sizes of chambers, it should be ensured that these sizes accord with full or half bricks with standard thickness of mortar joints so as to avoid wasteful cutting of brick.

NOTE 2 — The sizes of the chambers may be adjusted to suit the availability of local building materials and economies of construction.

4.9.3 The access shaft shall be corbelled inwards on three sides at the top to reduce its size to that of the cover frame to be fitted or alternatively the access shaft shall be covered over by a reinforced concrete slab of suitable dimensions with an opening for manhole cover, and frame.

4.9.4 The manhole shall be built on a base of concrete of a thickness of at least 150 mm for manholes up to 1 m depth, at least 200 mm for manholes from 1 to 2 m in depth and at least 300 mm for manholes of greater depth unless the structural design demands higher thickness.

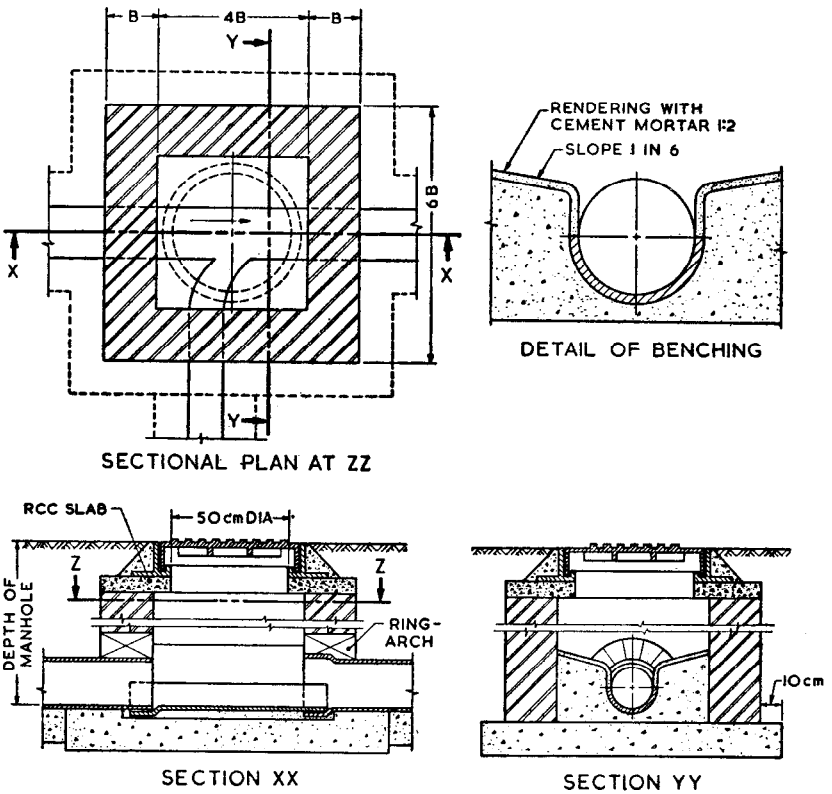
4.9.5 Thet hickness of walls shall not be less than 200 mm (or one brick) up to 1·5 m in depth and 300 mm (or one and a half brick) for depths greater than 1·5 m. The actual thickness in any case shall be calculated on the basis of engineering design. Typical sections of the manholes are illustrated in Fig. 2, 3 and 4.

4.9.6 *Drop Manholes* — Where it is uneconomic or impracticable to arrange the connection with 600 mm height above the invert of the manhole, the connection shall be made by constructing a vertical shaft outside the manhole chamber as shown in Fig. 5. If the difference in level between the incoming drain and the sewer does not exceed 600 mm and there is sufficient room in the manhole, the connecting pipe may be directly brought through the manhole wall and the fall accommodated by constructing a ramp in the benching of the manhole.

4.9.7 *Channels* — These shall be semi-circular in the bottom half and of diameter equal to that of the sewer. Above the horizontal diameter, the sides shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channel shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given.

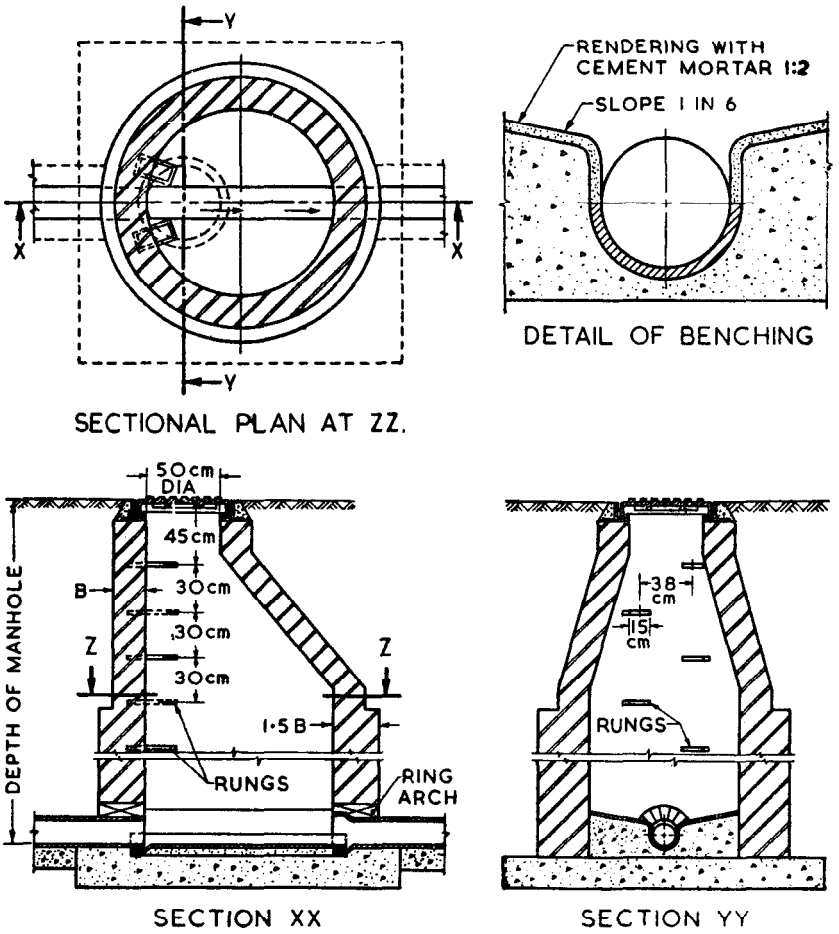
4.9.8 Rungs shall be provided in all manholes over 0·8 m in depth and shall be of cast iron conforming to IS : 5455-1969*. These rungs may be set staggered in two vertical runs which may be 380 mm apart horizontally. The top rung shall be 450 mm below the manhole cover and the lowest not more than 300 mm above the benching. The size of manhole cover shall be such that there shall be a clear opening of at least 500 mm in diameter for manholes exceeding 0·9 m in depth. Circular cover are considered desirable. Manhole covers and frames shall conform to the requirements given in IS : 1726-1967†.

*Specification for cast iron steps for manholes.
†Specification for cast iron manhole covers and frames.



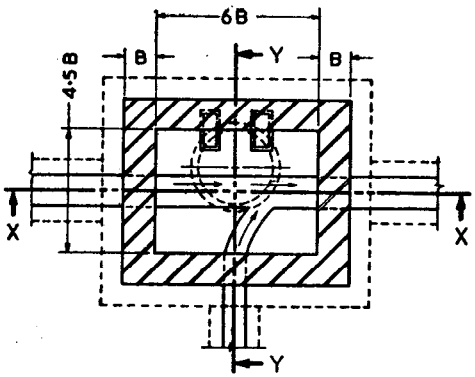
NOTE — Wall thicknesses have been indicated in brick lengths to provide for use of modular bricks [*see* IS : 1077-1966 ' Specification for common burnt clay building bricks (*first revision*).'] or traditional bricks. In the figure, B = one brick length, $1{\cdot}5\ B$ = one and a half brick length, etc.

FIG. 2 DETAILS OF MANHOLE (DEPTHS 1 m AND BELOW)

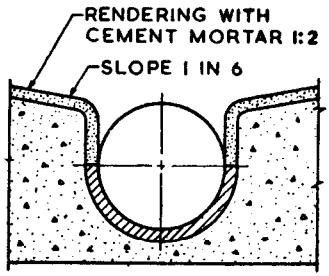


NOTE — Wall thicknesses have been indicated in brick lengths to provide for use of modular bricks [*see* IS : 1077-1966 ' Specification for common burnt clay building bricks (*first revision*) '] or traditional bricks. In the figure, B = one brick length, 1·5 B = one and a half brick length, etc.

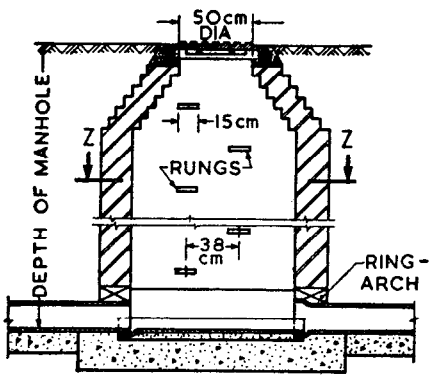
FIG. 3 DETAILS OF MANHOLE (DEPTHS BETWEEN 1 AND 1·5 m)



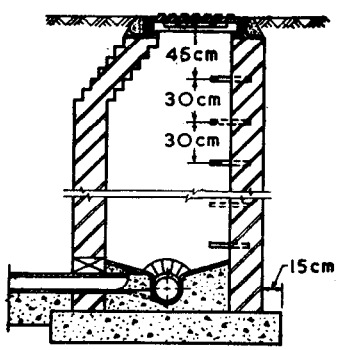
SECTIONAL PLAN AT ZZ



DETAIL OF BENCHING



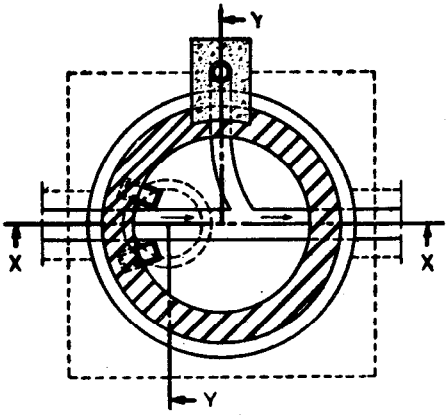
SECTION XX



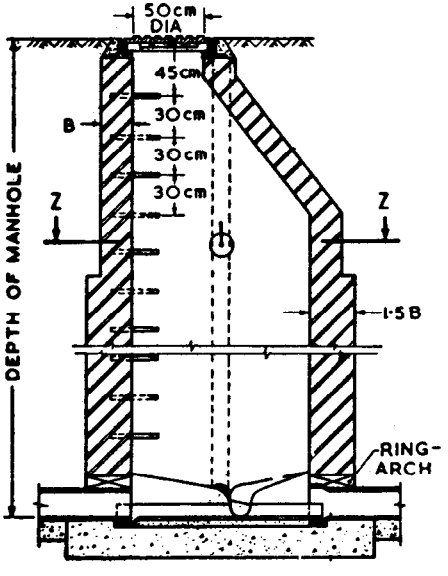
SECTION YY

NOTE — Wall thicknesses have been indicated in brick lengths to provide for use of modular bricks [*see* IS : 1077-1966 ' Specification for common burnt clay building bricks (*first revision*) '] or traditional bricks. In the figure, B = one brick length, 1·5 B = one and a half brick length, etc.

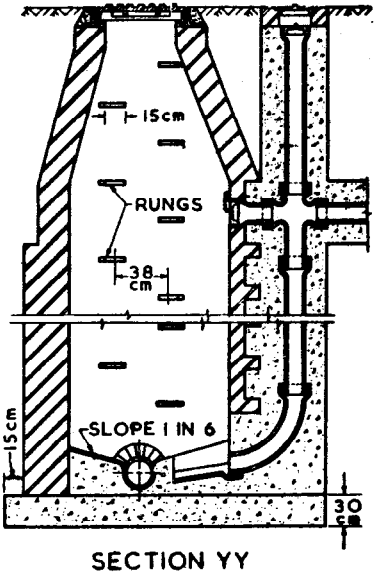
FIG. 4 DETAILS OF MANHOLE (DEPTHS 1·5 m AND ABOVE)



SECTIONAL PLAN AT ZZ



SECTION XX



SECTION YY

NOTE — Wall thicknesses have been indicated in brick lengths to provide for use of modular bricks [*see* IS : 1077-1966 ' Specification for common burnt clay building bricks (*first revision*) '] or traditional bricks. In the figure, B = one brick length, $1{\cdot}5\ B$ = one and a half brick length, etc.

FIG. 5 DROP MANHOLE

4.9.8.1 All manholes shall be constructed so as to be watertight under test. No manhole or inspection chamber shall be permitted inside a building or in any passage therein. Ventilating covers shall not be used for domestic drains.

4.9.9 All brick work in manhole chamber and shaft shall be carefully built in English bond. The jointing face of each brick being well 'buttered' with cement mortar before laying, so as to ensure a full joint. The construction of walls in brick work shall be done in accordance with IS : 2212-1962*. The cement mortar used shall not be weaker than 1 part of cement to 3 parts of sand (*see* IS : 2250-1981†).

4.9.10 The wall shall be plastered (15 mm, *Min*) both inside and outside with cement mortar 1 : 3; where sub-soil water conditions exist, a richer mix may be used for both masonry and plaster. All angles shall be rounded to 7·5 cm radius and all rendered internal surfaces shall have hard impervious finish obtained by using a steel trowel.

4.9.11 The channel or drain at the bottom of the chamber shall be plastered with cement mortar of 1 : 2 proportion and finished smooth, to the grade (where required). The benching at the side shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flooding of the chamber.

4.10 Storm Water Drainage — The object of the storm water drainage is to collect and carry, for suitable disposal, the rain water collected within the premises of the building.

4.10.1 *Water Precipitation and Run-off* — Rainfall statistics for the areas under consideration shall be studied to arrive at a suitable figure on the basis of which the storm water drains could be designed. Consideration shall be given to the effects of special local conditions and to the intensity and duration of rainfall.

4.10.2 *Permeability of Surface* — The impermeability factor, that is, the proportion of the total rainfall discharging to a surface water drain after allowing for soakage, evaporation and other losses, varies with the frequency and duration of rainfall. These factors shall be taken into account in design.

4.10.2.1 The whole of the rainfall on impervious areas shall be assumed to reach the drains, no allowance for evaporation or time of concentration being made in domestic drainage work. The roof area shall be taken as the horizontal projection of the area.

*Code of practice for brickwork.

†Code of practice for preparation and use of masonry mortars (*first revision*).

4.10.3 *Rain Water Pipes for Drainage of Roofs*

4.10.3.1 The roofs of a building shall be so constructed or framed as to permit effectual drainage of the rain water therefrom by means of a sufficient number of rain-water pipes of adequate size so arranged, jointed and fixed as to ensure that the rain-water is carried away from the building without causing dampness in any part of the walls or foundations of the building or those of an adjacent building.

4.10.3.2 The rain-water pipes shall be fixed to the outside of the external walls of the building or in recesses or chases cut or frame in such external wall or in such other manner as may be approved by the authority.

4.10.3.3 A rain-water pipe conveying rain water shall discharge directly or by means of a channel into or over an inlet to a surface drain or shall discharge freely in a compound, drained to surface drain but in no case shall it discharge directly into any closed drain.

4.10.3.4 Whenever it is not possible to discharge a rain-water pipe into or over an inlet to a surface drain or in a compound, drained to a surface drain or in a street drain within 30 m from the boundary of the premises, such rain-water pipe shall discharge into a gully trap which shall be connected with the street drain; such a gully trap shall have a screen and a silt catcher incorporated in its design.

4.10.3.5 If such street drain is not available within 30 m of the boundary of the premises, a rain-water pipe may discharge directly into the kerb drain and shall be taken through a pipe outlet across the foothpath if any, without obstructing the path.

4.10.3.6 A rain-water pipe shall not discharge into or connect with any soil pipe or its ventilating pipe or any waste pipe or its ventilating pipe nor shall it discharge into a sewer unless specifically permitted to do so by the authority in which case such discharge into a sewer shall be intercepted by means of gully trap.

4.10.3.7 Rain-water pipes shall be constructed of cast iron, asbestos cement, galvanized sheet or other equally suitable material and shall be securely fixed.

4.10.3.8 Rain-water pipes shall be normally sized on the basis of roof areas according to Table 5. A bell mouth inlet at the roof surface is found to give better drainage effect provided proper slopes are given to the roof surface. The spacing of pipes depends on the position of the windows and arch openings but 6 m apart is a convenient distance. The strainer area shall be $1\frac{1}{2}$ to 2 times the area of pipe to which it connects.

4.10.3.9 The storm water shall be led off in a suitable open drain to a water course. The open drain, if not of pucca masonry throughout, shall be constructed in pucca masonry as at least where there is either a change in direction or gradient.

TABLE 5 SIZING OF RAIN-WATER PIPES FOR ROOF DRAINAGE

Sl No.	Dia of Pipe mm	Average Rate of Rainfall in mm/h					
		50	75	100	125	150	200
		Roof Area, Square Metres					
i)	50	13·4	8·9	6·6	5·3	4·4	3·3
ii)	65	24·1	16·0	12·0	9·6	8·0	6·0
iii)	75	40·8	27·0	20·4	16·3	13·6	10·2
iv)	100	85·4	57·0	42·7	34·2	28·5	21·3
v)	125	—	—	80·5	64·3	53·5	40·0
vi)	150	—	—	—	—	83·6	62·7

4.10.4 *Size and Gradients of Pipes* — The pipes shall be so designed as to give a velocity of flow of not less than 1 m/s when running half-full. The maximum velocity shall not exceed 2·5 m/s.

4.10.5 *Disposal* — Surface water may be disposed of in one or more ways specified in **4.10.5.1** to **4.10.5.5** but preferably by the method given in **4.10.5.1**.

4.10.5.1 *Separate system* — All courtyards shall be provided with one or more outlets through which rain-water shall be diverted into the storm water drains and away from any opening connecting with any sewer.

Where storm water drains are necessary for the discharge of rain-water to a public storm water drain, such drains shall be designed for the intensity of rain based on local conditions but in no case they shall be designed for intensity of rainfall of less than 13 mm/h. Usually, each separate plot shall have a separate drain connection made to a covered or open public drain. Such connection to a covered drain shall be made through a pipe at least 3·5 m in length, laid at a gradient of not less than that of the connecting drain. The storm water from the plot should discharge into the storm water drain directly and not through a trap.

4.10.5.2 *Combined or partially separate system* — Where levels do not permit connection to a public storm water drain, storm water from courtyard may be connected to the public sewer provided it is designed to convey combined discharge. In such cases, the surface water shall be admitted to the soil sewer through trapped gullies in order to prevent the escape of sewer air.

4.10.5.3 *To a water course* — It may often be convenient to discharge surface water to a nearby stream or a water course. The invert level of the out-fall shall be about the same as the normal water level in the water course. The out-fall shall be protected against floating debris by a screen.

4.10.5.4 *To storage tanks* — Water from the roof of a building may be led straight from the down pipes to one or more watertight storage tanks. Such storage tanks shall be raised to a convenient height above ground and shall always be provided with ventilating covers, and have draw-off taps suitably placed so that the rain water may be drawn off for domestic washing purposes or for garden water. A large impervious storage tank is sometimes constructed underground, from which rain water is pumped as required to the house. All storage tanks shall be provided with an overflow.

4.10.5.5 An arrangement shall be provided in an rain-water leader to divert the first washings from the roof or terrace catchment as they would contain much undesirable material. The mouth of all pipes and openings shall be covered with mosquito-insect proof wire net.

4.10.5.6 French drains may be employed as surface water drains and are useful in the drainage of unpaved surface, such as playfields and certain types of roads. When used for this purpose in addition to the drainage being filled with rubble, it is often advisable to include a field drain in the trench bottom.

4.11 Subsoil Water Drainage

4.11.1 *General* — Subsoil water is that portion of the rainfall which is absorbed into the ground and the drainage of subsoil water may be necessary for the following reasons:

a) To increase the stability of the surface;

b) To avoid surface flooding;

c) To alleviate or to avoid causing dampness in the building, especially in the cellars;

d) To reduce the humidity in the immediate vicinity of the building; and

e) To increase the workability of soil.

4.11.2 *Depth of Water Table* — The standing level of the subsoil water will vary with the season, the amount of rainfall and the proximity and level of drainage channels. Information shall be obtained regarding this level by means of boreholes or trial pits preferably the latter. It is desirable though not always practicable to ascertain the level of the standing water over a considerable period so as to enable the seasonal variation to be recorded and in particular the high water level. The

direction of the flow of subsoil water may usually be judged by the general inclination of the land surface, and the main lines of the subsoil drains shall follow the natural falls wherever possible.

4.11.3 *Precautions* — Subsoil drains shall be sitted so as not to endanger the stability of the buildings or earthwork. In some portions of the drain, it may be necessary to use non-porous jointed pipes.

4.11.3.1 No field pipe shall be laid in such a manner or in such a position as to communicate directly with any drain constructed or adapted to be used for conveying sewage except where absolutely unavoidable and in that case a suitable efficient trap shall be provided between subsoil drain and such sewer.

4.11.4 *Systems of Subsoil Drainage*

4.11.4.1 *Field drain pipes* — Clay or concrete porous pipes may be used and shall be laid in one of the following ways:

a) *Natural* — The pipes are laid to follow the natural depressions or valleys of the site, branches discharging into the main as tributaries into a river.

b) *Harringbone* — A system consisting of a number of main drains into which discharge, from both sides, smaller subsidiary branches parallel to each other but at an angle to the mains forming a series of herringbone patterns.

c) *Grid* — A main or mains near the boundaries of a site into which branches discharge from one side only.

d) *Fan shaped* — The drains are laid converging to a single outlet at one point on the boundary of a site, without use of main or collecting drains.

e) *Moat or cut-off system* — Sometimes drains are laid on one or more sides of a building to intercept the flow of subsoil water and thereby protect the foundations.

4.11.4.2 The choice of one or more of these systems will naturally depend on the local conditions of the site. For building sites the mains shall be not less than 75 mm in diameter and the branches not less than 65 mm in diameter but normal practice tends towards the use of 100 mm and 75 mm respectively. The pipes shall generally be laid at 600 to 900 mm depth or to such a depth to which it is desirable to lower water table and the gradients are determined rather by the fall of the land than by considerations of self-cleansing velocity. The connection of the subsidiary drain to main drain is best made by means of a clayware or concrete junction pipe. The outlet of a subsoil system may discharge into a soakaway or through a catchpit into the nearest ditch or water course. Where these are

not available the subsoil drains may be connected, with the approval of the authority, through an intercepting trap to the surface water drainage system.

NOTE — Care shall be taken that there is no backflow from subsurface drains during heavy rains.

5. CONSTRUCTIONS RELATING TO CONVEYANCE OF SANITARY WASTES

5.1 Pipe Lines and Jointing — All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas-tight. All sewers and drains laid below ground shall be watertight.

5.2 Jointing Lead and Iron Pipes — Where any lead waste pipe, ventilating pipe or trap is connected with an iron pipe or drain communicating with a sewer these shall be inserted between such lead waste pipe and such iron pipe or drain an ordinary thimble of copper or brass, which shall be connected to such lead waste pipe by means of a wiped joint. The thimble shall be connected with such cast iron pipe by means of a joint (*see* Fig. 6) made with molten lead, properly caulked, a sufficient quantity of lead being melted at a time to finish each joint at one pouring.

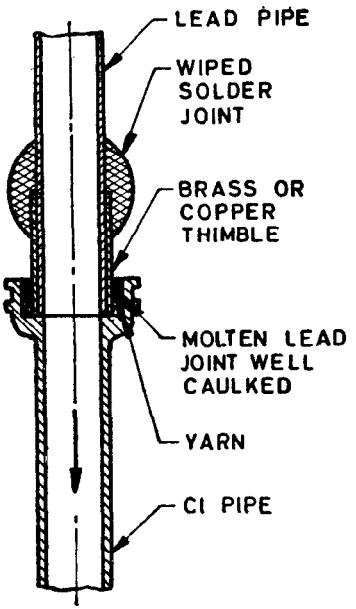


FIG. 6 JOINTING LEAD PIPE TO CAST-IRON PIPE

5.3 Jointing Stoneware with Lead Pipes — Where any stoneware or semi-vitrified ware trap or pipe is connected with a lead soil pipe, waste pipe or trap communicating with a sewer, these shall be inserted between such stoneware or semi-vitrified ware trap or pipe and such lead soil pipe, waste pipe, or trap a socket of copper, cast brass or other suitable alloy, which shall be connected with such stoneware or semi-vitrified ware trap or pipe by means of a joint made with mortar consisting of one part of cement and one part of coarse sand with the lead soil pipe, waste pipe or trap by means of wiped metallic joint (*see* Fig. 7).

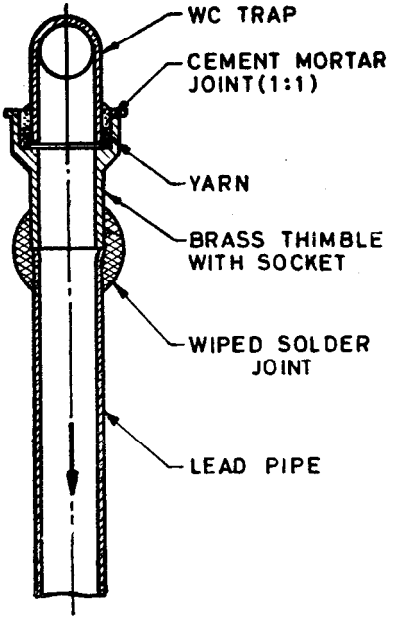


FIG. 7 JOINTING STONEWARE OR SEMI-VITRIFIED WARE PIPE OR TRAP TO LEAD PIPE

5.4 Jointing Cast Iron Pipes with Stoneware Pipes (*see* **Fig. 8**) — Where any cast iron soil pipe, waste pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste pipe, ventilating pipe, or trap shall be inserted into a socket of such stoneware of semi-vitrified ware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean coarse sand after placing a tarred gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

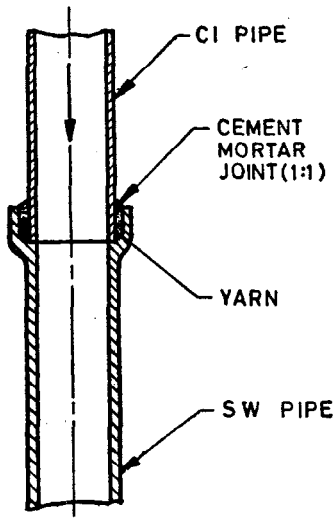


FIG 8 JOINTING C I PIPE TO STONEWARE PIPE

5.4.1 *Jointing Stoneware with Cast Iron Pipes* — Where any water closet pan or earthenware trap connected to such pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible (non-rigid) nature. Such joint shall be made preferably with a mixture of bitumen and chopped asbestos fibre (not dust).

5.5 Jointing Lead Pipes — The joints in lead pipes shall be made as wiped solder joints (*see* Fig. 9). The minimum and the maximum length of the wiped solder joints shall be 80 mm and 90 mm respectively. The solders shall generally consist of two parts of lead and one part of tin.

5.6 Jointing Glazed Stoneware Pipes (***see* Fig. 10**) — Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed well home into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as not to fill more than 1/4 of the total depth (or 13 mm in depth) of the socket.

5.6.1 The remainder of the socket shall be filled with a stiff mixture of cement mortar in the proportion of one part cement and one part sharp sand. When the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45° with the barrel of the pipe.

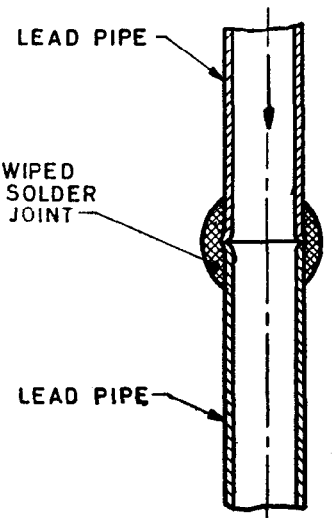


FIG. 9 JOINTING LEAD PIPE TO LEAD PIPE

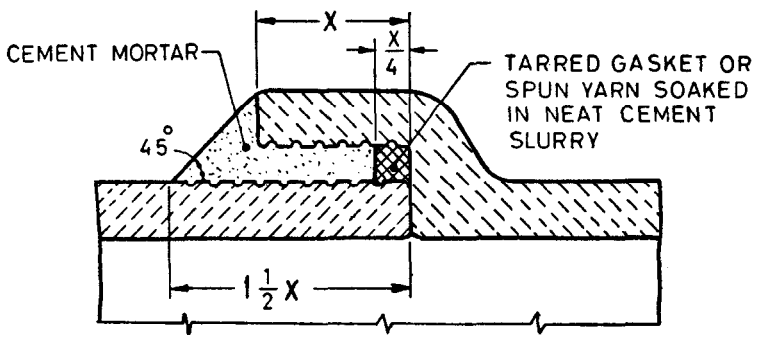


FIG. 10 TYPICAL DETAILS OF CEMENT JOINTS FOR GLAZED STONEWARE PIPES

5.6.2 Mortar shall be mixed as wanted for immediate use and no mortar shall be beaten up and used before it has begun to set.

5.6.3 After the joint is made, any extraneous material shall be removed from the inside of the joint with a suitable scraper or 'badger'. The newly made joints shall be protected, until set, from the sun, drying winds, rain or frost. Sacking or other suitable materials, which shall be kept damp, may be used for the purpose.

5.7 Jointing Concrete Pipes — Concrete pipes shall be jointed as described in IS : 783-1959*. The spigots and sockets shall be thoroughly wet before the joints are made.

5.8 Jointing Cast Iron Pipes

5.8.1 *Lead Run Joints (Cast-Lead Joints)* — The spigot shall be centred in the adjoining socket by tightly caulking in sufficient turns of tarred gasket or hemp yarn to leave unfilled half the depth of socket for lead. When gasket or hemp yarn has been caulked tightly home, a jointing ring shall be placed round the barrel and against the faces of the socket. Molten pig lead shall then be poured in to fill the remainder of the socket. The lead shall then be solidly caulked with suitable tools and hammers of not less than 3 kg weight, right round the joint to make up for the shrinkage of the molten metal on cooling and shall be preferably finished 3 mm behind the socket face. Lead for caulking shall conform to IS : 782-1978†.

5.8.1.1 It is essential that the pipes be perfectly dry before lead run joints are made, otherwise blow holes may occur in the lead and injury may result to the pipe jointer. This method, therefore, requires special care in wet trenches.

5.8.2 *Lead-Wool or Lead-Fibre Joints* — These joints are suitable for wet conditions. Special attention is necessary in caulking. The socket shall be caulked with tarred gasket or hemp yarn as described in **5.8.1** and the lead fibre inserted into the socket and tightly caulked home skein by skein with suitable tools and hammers of not less than 2 kg weight, until the joint is filled. Lead-wool used for caulking shall conform to IS : 782-1978†.

5.8.3 *Cement Joints* — The following procedure is recommended:

a) The joint is first yarned with hemp yarn dipped in the cement slurry. The yarn is first inserted to slight depth and well pressed in the same manner as for lead jointing,

b) Cement mortar of ratio 1 : 1 with a water cement ratio not exceeding one part of water to 5 parts of cement (by weight) should be rammed into the joint by caulking tools,

c) The filling to complete and caulked again,

d) Joints should be kept wet for 24 h after making, and

e) Use of lead joint at intervals is recommended.

5.8.4 *Flanged Joints* — If a drain be constructed of flanged pipes, the joints shall be securely bolted together with a rubber or other suitable insertion.

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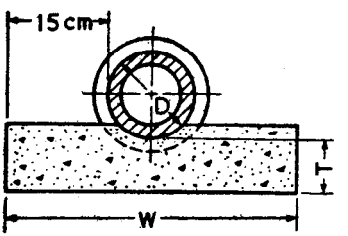
*Code of practice for laying of concrete pipes.
†Specification for caulking lead (*third revision*).

5.9 Concrete Support or Protection for Pipes — It may be necessary to support or surround pipe sewers or drains by means of concrete in certain circumstances and any of the methods given in **5.9.1** to **5.9.7** may be adopted.

5.9.1 *Bedding* — Bedding (*see* Fig. 11) shall be rectangular in section and shall extend laterally at least 150 mm beyond and on both sides of the projection of the barrel of the pipe. The thickness of the concrete below the barrel of the pipe shall be not less than 100 mm for pipes under 150 mm diameter and 150 mm for pipes 150 mm and over in diameter. Where bedding is used alone, the concrete shall be brought up at least to the invert level of the pipe to form a cradle and to avoid line contact between the pipe and the bed.



$W = D + 30$ cm, where D is external diameter of the pipe

$T = \begin{cases} 10 \text{ cm for pipes under 150 mm nominal dia,} \\ 15 \text{ cm for pipes of 150 mm nominal dia and over.} \end{cases}$

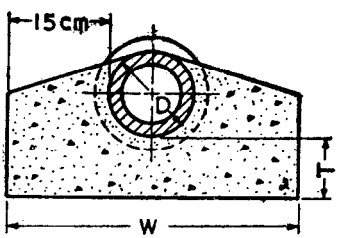
FIG. 11 BEDDING

5.9.2 *Haunching* — Concrete haunching (*see* Fig. 12) shall consist of:

a) A concrete bed as described for bedding (*see* **5.9.1**).

b) The full width of the bed carried up to the level of the horizontal diameter of the pipe; and

c) Splays from this level carried up on both sides of the pipe, from the full width of the bed to meeting the pipe barrel tangentially.

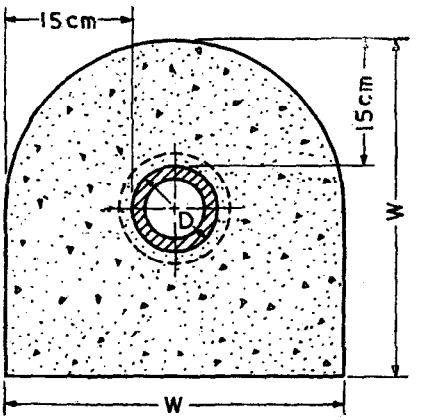


$W = D + 30$ cm, where D is external diameter of the pipe

$T = \begin{cases} 10 \text{ cm for pipes under 150 mm nominal dia.} \\ 15 \text{ cm for pipes of 150 mm nominal dia and over.} \end{cases}$

FIG. 12 HAUNCHING

5.9.3 *Surround or Encasing* — The surround or encasing (*see* Fig. 13) shall be similar to haunching up to the horizontal diameter of the pipe and the top portion over this shall be finished in a semi-circular form to give a uniform encasing for the top half of the pipe.



$W = D + 30$ cm, where D is the external diameter of the pipe.

FIG. 13 SURROUND OR ENCASING

5.9.4 *Piers for Cast Iron Pipes* — Where supporting piers are specified for cast iron pipes, they shall be not less than 30 cm in length (parallel to the axis of the pipe) and at least equal in section to that described for haunching in **5.9.2.** Pipes shall be built just behind the pipe sockets, intermediate piers being provided where necessary.

5.9.5 *Glazed Ware Pipes* — The minimum support or protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 1 m below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete;

b) Where the pipes are laid on a soft soil with the maximum water table lying at the invert of the pipe, the pipe sewer shall be bedded on concrete;

c) Where the pipes have to be laid in a soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewers shall be haunched;

d) Where the maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid in soft soil, the pipe sewers shall be completely encased or surrounded with concrete; and

e) Where the sewers are to be laid adjacent to growing trees, the pipe sewers shall be encased or surrounded with concrete to avoid damage to the pipes likely to be caused by the roots of the trees.

5.9.6 *Cast Iron Pipes* — In normal ground, no concrete support or protection to cast iron pipes need be provided. Where concrete haunching surrounds or piers are required, these shall be in accordance with the details given in **5.9.5.**

5.9.7 *Support of Pipes in Unstable Ground* — In certain subsoils, rise and fall of the subsoil water level may be the cause of considerable earth movement. This and other conditions of unstable ground call for additional support to the pipes in the form of piles or trestles or other suitable means.

5.10 Excavation

5.10.1 Turf, topsoil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

5.10.2 Excavated material shall be stacked sufficiently away from the edge of the trench and the size of the spoil bank shall not be allowed to become such as to endanger the stability of the excavation. Spoil may be carried away and used for filling the trench behind the work.

5.10.3 Excavation shall proceed to within about 75 mm of the finished formation level. This final 75 mm being trimmed and removed as a separate operation immediately prior to the laying of the pipes or their foundations.

5.10.4 The sides of the trench shall be properly propped, where necessary.

5.10.5 The width of the trench at bottom between faces of sheeting shall be such as to provide not less than 200 mm clearance on either side of the pipe.

5.10.6 Where the subsoil is unstable, a foundation for the pipes shall be formed by piling and bridging, earth consolidation or other efficient means.

5.10.7 Excavation in roads shall be so arranged, in agreement with the proper authority, as to cause the minimum obstruction to traffic. The method to be adopted shall depend on local circumstances.

5.10.8 All suitable broken surface material and hard-core shall be set on one side for use in subsequent reinstatement.

5.10.9 Adequate warning lights shall be placed at night to indicate all obstructions in the highway. Red flags shall be displayed along the trenches during day time.

5.10.10 A sufficient number of men shall be employed to guard the work and attend to the lamps.

5.10.11 Blasting may be necessary in hard rock. It shall only be carried out under thorough and competent supervision and with the written permission of the appropriate authorities, taking all precautions connected with blasting operations.

5.10.12 All pipes, ducts, cables, mains or other services exposed in the trench shall be effectively supported by timbers and/or chain or ropeslings.

5.10.13 Excavations below water table shall be done after dewatering the trenches.

5.10.14 All drainage sumps shall be sunk clear of the work outside the trench or at the sides of manholes. After the completion of the work, any pipes or drains leading to such sumps or temporary subsoil drains under permanent work shall be filled in properly with sand and consolidated.

5.11 Concreting — The work shall generally be done according to IS : 456-1978*.

5.12 Laying of Pipes — The pipes shall be laid with the sockets leading uphill and shall rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep, to allow sufficient space for the pipe jointer to work right round the pipes and as short as is practicable to accommodate the socket in proper position and allow the joint to be made.

5.12.1 Where pipes are not bedded on concrete, the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm and undisturbed ground. If the excavation has been carried too low, any packing done shall be in concrete.

5.12.2 If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to a smooth surfaces the pipes shall be laid on a cradle of fine concrete floor or a floor of gravel and crushed stone overlaid with concrete or on a well-consolidated gravel and crushed stone bed only so as to ensure even bearing.

5.12.3 Each separate pipe shall be individually set for line and for level using one of the following methods:

a) Where long lengths of sewer or drain are to be constructed in trench with glazed stoneware or concrete pipes, properly painted sight-rails shall be fixed across the trench at a height, equal the length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight rail is fixed. There shall be minimum three sight-rails in position on each length of sewer or drain under construction at a particular gradient.

*Code of practice for plane and reinforced concrete (*third revision*).

Properly out wooden or iron pegs shall be driven into the floors of the trenches at intervals of at least one metre less than the length of the straight-edge which is to be used. With the aid of a boning rod, equal in length to the height of the sight-rail above the required invert level, each peg shall be driven until its top is at the exact level required for the invert of the pipeline at that point; this will have occurred when a true bone is obtained over boning rod and sight-rails. The underside of a straight-edge resting on the tops of those pegs will give level and gradient of the invert. The pegs shall be withdrawn as pipe laying proceeds.

To obtain a true line along the grade, a sideline shall be used strung tautly at half-pipe level between iron pins firmly driven in the floor of the excavation for the manhole at each end of the proposed pipe line, and the pipes shall be laid in such a way that the sockets are fixed just free of this side line. For long lengths of drain, the side line may require intermediate support. The practice of laying to a top line is not recommended.

b) In the case of short lengths of branch drain where it is inconvenient to fix sight-rails, pegs shall be driven into the floor of the trench and their tops boned in with the aid of three equal boning rods, one of which is used on the pegs to be driven and the other two held at the invert level of the pipes or fittings to be connected. A side line shall be used to obtain a true line in the horizontal plane.

c) In the case of cast iron pipes, it is impracticable to use a straight-edge and the invert of each pipe shall be fixed to a true bone over the sight-rails by means of a boning rod, which in such cases shall be provided with a bottom shoe to rest on the invert of the pipe being laid.

d) Where it is necessary to cut pipes, this shall be done with a suitable wheel type pipe cutter so as to leave a clean and square to the axis of the pipe.

5.13 Connection to an Existing Sewer — The connection to an existing sewer shall, as far as possible, be done at the manholes. Where it is unavoidable to make connection in between two manholes, the work of breaking into the existing sewer and forming the connection shall be carried out by the authority or under its supervision.

Breaking into the sewer shall be effected by the cautious enlargement of a small hole and every precaution shall be taken to prevent any material from entering the sewer. No connection shall be formed in such a way as to constitute a projection into the sewer or to cause any diminutions in its effective size.

5.14 Back-Filling

5.14.1 Filling of the trench shall not be commenced until the length of pipes therein has been tested and passed (*see* **8.2**).

5.14.2 All timber which may be withdrawn with safety shall be removed as filling proceeds.

5.14.3 Where the pipes are unprotected by concrete haunching, the first operation in filling shall be carefully done to hand-pack and temp selected fine material around the lower half of the pipes so as to buttress them to the sides of the trench.

5.14.4 The filling shall then be continued to 150 mm over the top of the pipe using selected fine hand-packed material, watered and rammed on both sides of the pipe with a wooden rammer. On no account shall material be tipped into the trench until the first 150 mm of filling has been completed. The process of filling and tamping shall proceed evenly so as to maintain an equal pressure on both sides of the pipeline.

5.14.5 Filling shall continue in layers not exceeding 150 mm in thickness, each layer being watered and rammed.

5.14.6 In roads, surface materials previously excavated shall be replaced as the top layer of the filling, consolidated and maintained satisfactorily till the permanent reinstatement of the surface is made by the authority.

5.14.7 In gardens, the topsoil and turf, if any, shall be carefully replaced.

6. CONSTRUCTION RELATING TO CONVEYANCE OF RAIN OR STORM WATER

6.1 Roof Gutters — Roof gutters, shall be of galvanized iron sheets not less than 1·25 mm in thickness and shall conform to IS : 277-1977*. The gutter shall be semicircular in section with a width at top about twice the diameter of the down pipe. The gutters shall be fixed 25 mm below the edge of the roof.

6.1.1 MS brackets 25 × 6 mm shall be used to support the gutter at about 1·2 m intervals. A convenient method will be to fix the brackets to every alternate after with three 50 mm screws.

6.1.2 All junctions and joints shall be thoroughly water-tight-riveted, bolted or soldered. All joints between successive length of gutters shall have an overlap of at least 50 mm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of guttering shall be

*Specification for galvanized steel sheets (plain and corrugated) (*third revision*).

closed with galvanized sheets not less than 1·25 mm in thickness, to fit the section and made water-tight. Junctions with down-fall rain-water pipes or leaders shall be made water-tight. Gutters shall have a general minimum fall of 1 in 120.

6.2 Rain-Water Pipes

6.2.1 *Cast Iron Pipes* — Rain-water pipes or leaders if of cast iron shall be with socketed joints having lugs cast on for fixing and shall conform to the requirements specified in IS : 1230-1979*. The shoe may be fixed 150 mm above ground level. Bends and offsets are to be avoided as far as possible.

6.2.2 *Galvanized Iron Pipes* — Galvanized iron pipes shall conform to IS : 1239 (Part I)-1979†. The work will be similar to cast iron pipes except that they are fixed with straps or dogs one for each 2-m length of pipe. Joints between successive lengths of pipes will be by collars at least 10 cm deep riveted tightly and securely to the pipes, and the straps or dogs be riveted or bolted through this collar by 9·5 mm galvanized iron bolts.

6.2.3 *Asbestos Cement Pipes* — Rain-water pipes and gutters shall conform to IS : 1626 (Part 1)-1980‡. Only the pipes will be fixed with straps or clips.

6.2.3.1 All rain-water leaders from roofs or terraces shall be screened off by gratings at the top to prevent leaves, rodents, etc, entering the pipes.

6.2.3.2 The laying of pipes underground and the construction of chambers and manholes shall be carried out as in the case of sewers for foul water.

7. CONSTRUCTION RELATING TO CONVEYANCE OF SUBSOIL WATER

7.1 Subsoil Drains

7.1.1 *Field Drain Pipes* — Suitable pipes for this purpose are plain cylindrical glazed stoneware pipes, or concrete porous pipes though the latter may prove unsuitable where subsoil water carries sulphates or is acidic owing to the presence of peat. Trenches for these pipes need be just wide enough at the bottom to permit laying the pipes, which shall be laid with open joints to proper lines and gradients.

*Specification for cast iron rainwater pipes and fittings (*second revision*).

†Specification for mild steel tubes, tubulars and other wrought steel fittings: Part 1 Mild steel tubes (*fourth revision*).

‡Specification for asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roof fittings: Part 1 Pipes and pipes fittings.

7.1.1.1 It is advisable to cover the pipes with clinker free from fine ash, brick ballast or other suitable rubble, or a layer of inverted turf, brush-wood or straw before refilling the trench, in order to prevent the infiltration of silt through the open joints. Where the subsoil drain is also to serve the purpose of collecting surface water, the rubble shall be carried up to a suitable level and when required for a lawn or playing field, the remainder of the trench shall be filled with previous topsoil. When refilling the trenches, care shall be taken to prevent displacemet of pipes in line of levels. When they pass near trees or through hedges, socket pipes with cement or bitumen joints shall be used to prevent penetration by roots.

7.1.2 *French Drains* — A shallow trench is excavated, the bottom neatly trimmed to the gradient and the trench filled with broken stone, gravel or clinker, coarse at the bottom and finer towards the top.

8. INSPECTION AND TESTING

8.1 Inspection

8.1.1 All sanitary appliances and fitments shall be carefully examined for defects before they are installed and also on completion of the work.

8.1.2 Pipes are liable to damage in transit and, not withstanding tests that may have been made before despatch, each pipe shall be carefully examined on arrival on the site. Preferably, each pipe shall be rung with a hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stored to prevent damage. Any defective pipes shall be segregated, marked in a conspicuous manner and their use in the works prevented.

8.1.3 Cast iron pipes shall be carefully examined for damage to the protective coating. Minor damage shall be made good by painting over with hot tar or preferably bitumen. But if major defects in the coating exists, the pipe shall not be used unless re-coated. Each pipe shall be carefully re-examined for soundness before laying.

8.1.4 Close inspection shall be maintained at every stage in the work, particularly as to the adequacy of timber supports used in excavation and the care and thoroughness exercised in filling.

8.1.4.1 Careful note shall be kept of the condition of any sewer, manhole or other existing work which may be uncovered and any defects evident shall be pointed out immediately to the appropriate authority.

8.1.4.2 No work shall be covered over or surrounded with concrete until it has been inspected and approved by the authority.

8.2 Testing

8.2.1 Comprehensive tests of all appliances shall be made by simulating conditions of use. Overflows shall also be examined for obstructions.

8.2.2 *Smoke Test* — All soil pipes, waste pipes, and vent pipes and all other pipes when above ground shall be approved gas-tight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

8.2.3 *Water Test*

8.2.3.1 *For pipes other than cast iron* — Glazed/stoneware and concrete pipes shall be subjected to a test pressure of at least 1·5 m head of water at the highest point of the section under test. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of ten minutes. The test shall be carried out by suitably plugging the low end of drain and the ends of connections, if any, and filling the system with water. A kunckebend shall temporarily be jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. Subsidence of the test water may be due to one or more of the following causes:

a) Absorption by pipes and joints,

b) Sweating of pipes or joints,

c) Leakage at joints or from defective pipes, and

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased after which the test proper should commence. Any leakage will be visible and the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

NOTE — This test will not be applicable to sanitary pipe work aboveground level.

8.2.3.2 *For cast iron pipes* — Cast iron sewers and drains shall be tested as for glazed stone ware and concrete pipes. The drain plugs shall be suitably strutted to prevent their being forced out of the pipe during the test.

8.2.4 *Tests for Straightness and Obstruction* — The following tests shall be carried out:

a) by inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball should roll down the invert of the pipe and emerge at the lower end; and

b) by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. If the pipeline is not straight, this will be apparent. The mirror will also indicate obstruction in the barrel.

8.2.5 *Test Records* — Complete records shall be kept of all tests carried out of sewers and drains both during construction and after being put into service.

9. MAINTENANCE

9.1 General — Domestic drainage systems shall be inspected at regular intervals. The system shall be thoroughly cleaned out at the same time and any defects discovered shall be made good.

9.2 Cleaning of Drainage System

9.2.1 Sewer maintenance crews, when entering a deep manhole or sewer where dangerous gas or oxygen deficiencies may be present, shall follow the following procedures:

a) Allow no smoking or open flames and guard against sparks.

b) Erect warning signs.

c) Use only safety gas-proof electric lighting equipment.

d) Test the atmosphere for noxious gases and oxygen deficiencies.

e) If the atmosphere is normal, workmen may enter with a safety belt attached and with two men available at the top. For extended jobs, the gas tests shall be repeated at frequent intervals depending on circumstances.

f) If oxygen deficiency or noxious gas is found, the structure shall be ventilated with pure air by keeping open at least one manhole cover each on upstream and downstream side for quick exit of toxic gases or by artificial means. The gas tests shall be repeated and the atmosphere cleared before entering. Adequate ventilation shall be maintained during this work and the tests repeated frequently.

g) If the gas or oxygen deficiency is present and it is not practicable to ventilate adequately before workers enter, a hose mask shall be worn and extreme care taken to avoid all sources of ignition. Workers shall be taught how to use the hose equipment. In these cases, they shall always use permissible safety lights (not ordinary flash lights), rubber boots or non-sparking shoes and non-sparking tools.

h) Workmen descending a manhole shaft to inspect or clean sewers shall try each ladder step or rung carefully before putting the full weight on it to guard against insecure fastening due to corrosion of the rung at the manhole wall. When work is going on in deep sewers, at least two men shall be available for lifting workers from the manhole in the event of serious injury; and

j) Portable air blowers, for ventilating manhole, are recommended for all tank, pit or manhole work where there is a question as to the presence of noxious gas, vapours or oxygen deficiency. The motors for these shall be of weatherproof and flameproof types; compression-ignition-diesel type (without sparking plug) may be used. When used, these shall be placed not less than 2 m away from the opening and on the leeward side protected from wind so that they will not serve as a source of ignition for any inflammable gas which might be present. Provision sholud be made for ventialation and it should be of the forced type which can be provided by blower located at ground level with suitable flexible ducting to displace out air from the manhole.

9.2.2 The following operations shall be carried out during periodical cleaning of a drainage system:

a) The covers of inspection chambers and manhole shall be removed and the side benchings and channels scrubbed,

b) The intercepting trap, if fitted, shall be adequately cleaned and flushed with clean water. Care shall be taken to see that the stopper in the rodding arm is securely replaced.

c) All lengths of main and branch drains shall be rodded by means of drain rods and a suitable runner or leather plunger. After rodding, the drains shall be thoroughly flushed with clean water. Any obstructions found shall be removed with suitable drain cleaning tools and the system thereafter shall be flushed with clean water.

d) The covers and access plates to all gullies shall be removed and the traps plunged and flushed out thoroughly with clean water. Care shall be taken not to flush the gully deposit into the system.

e) Any defects revealed as a result of inspection or test shall be made good.

f) The covers or inspection chambers and gullies shall be replaced, bedding them in suitable grease or other materials.

g) Painting of ladders/rings in deep manhole and external painting of manhole covers shall be done with approved paints.

9.3 All surface water drains shall be periodically rodded by means of drain rods and a suitable rubber or leather plunger. After rodding, they shall be thoroughly flushed with clean water. Any obstruction found shall be removed with suitable drain cleaning tools.

9.4 All subsoil drains shall be periodically examined for obstruction at the open joints due to the roots of plants or other growths.

(*Continued from page* 2)

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Printed at Simco Printing Press, Delhi, India