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(Reaffirmed 1996)

Indian Standard

CODE OF PRACTICE FOR ANCILLARY STRUCTURES IN SEWERAGE SYSTEM

PART 3 INVERTED SYPHON

(First Revision)

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(*Continued on page* 2)

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(*Continued on page* 9)

Indian Standard

CODE OF PRACTICE FOR ANCILLARY STRUCTURES IN SEWERAGE SYSTEM

PART 3 INVERTED SYPHON

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 29 November 1985, after the draft finalized by the Water Supply and Sanitation Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Inverted syphon is an ancillary structure in sewerage system. The term inverted syphon is applied to a portion of a sewer which dips below the hydraulic gradient line to avoid such an obstruction as a railway cut, a stream or a subway. Inverted syphon should be preceded with bar screen and a grit chamber.

0.3 The standard (IS : 4111) was prepared to cover ancillary structures in sewerage system. This standard (Part 3) was first publihsed in 1967 with a view to giving guidance on proper design and construction of inverted syphon and reducing the risk of operational and maintenance difficulties. The major changes made in this revision are given below:

a) Design considerations for size and arrangement of pipes have been dealt in detail, and

b) Design of inlet and outlet chambers have been given in detail.

0.4 The other parts of the standard (IS : 4111) are given below:

IS : 4111 (Part 1)-1985 Code of practice for ancillary structures in sewerage system: Part 1 Manholes (*first revision*)

IS: 4111(Part 2)-1985 Code of practice for ancillary structures in sewerage system: Part 2 Flushing tanks (*first revision*)

IS : 4111 (Part 4)-1968 Code of practice for ancillary structures in sewerage system: Part 4 Pumping stations and pumping mains (rising mains)

0.5 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.

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1. SCOPE

1.1 This standard (Part 3) covers the require ments of design considerations, materials, construction, safety measures to be adopted, etc, for inverted syphon in sewerage system.

2. TERMINOLOGY

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

2.1 Hatch Box — It is a chamber at the lowest level of the inverted syphon system to clean out the pipes should they become silted up.

2.2 Inverted Syphon — A section of sewer constructed lower than adjacent stretch, to pass beneath a valley, watercourse, or other obstruction. It runs full at greater than atmospheric pressure because its crown is depressed below the hydraulic grade line.

3. DESIGN CONSIDERATIONS

3.1 Variation of Rates of Flow — The following fundamental data are very important:

a) The lowest rate of flow during the day in dry weather during the design period,

b) The highest rate of flow during the day in dry weather during the design period, and

c) The maximum rate of flow to be discharged through the syphon in times of storm if partially separate or combined system is made.

3.2 Hydraulic Calculations — An inverted syphon is actually a pipe running full under pressure. The velocity producing head for the syphon is equal to the difference in level between water levels just upstream of

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

the fore-bay and downstream of the outlet, less the losses of head at entry, at bends, etc, and at the outlet, which may be considerable.

3.3 Desirable Velocities — For trouble, free working of an inverted syphon, as high velocity as possible should be maintained and it should be never less than self cleansing velocity. Velocity should not be generally less than 1·2 m/sec.

3.4 Size and Arrangement of Pipes — In the pipe syphon the fore-bay should be so designed that the various pipes come into action successively. This may be arranged by the provision of distribution weirs.

3.4.1 If there is sufficient head to permit good velocities, single pipe of appropriate size can be used with little trouble. Where very little head and a widely varying flow make it difficult to obtain favourable velocities, a pipe large enough to carry the maximum flow will have the sewage barely moving through it during low flow. Several pipes in parallel will normally overcome this difficulty.

3.4.2 A separate sewerage system carrying only sewage may have two parallel pipes — one pipe large enough to take the minimum dry-weather flow at a good velocity with second pipe to take the difference between the minimum and maximum dry weather flow.

3.4.3 The partially separate or combined sewers will generally have three parallel pipes; one of the pipes of inverted syphon large enough to take the minimum dry weather flow at a good velocity. With a second pipe to take the difference between the minimum and maximum dry weather flow and a third to carry storm water.

3.4.4 Where the fluctuation in flow of storm water in a combined sewer is too large, more than three pipes will often give better result.

3.4.5 In the multiple pipe system the fore-bay should be so designed that various pipes come into action successively. This is arranged by the provision of distribution weirs.

3.4.6 The outlet end of the syphon should be designed to correspond to a great extent more or less with the fore-bay to the syphon so that reverse eddies will not carry solids back into the pipes which are in use. Deposits are prone to form at bends and the smaller the radius the greater the likelihood of any deposit. For this and other reasons easy bends should be used where possible.

3.5 Inlet and Outlet Chambers — The design of inlet and outlet chambers should allow sufficient room for entry by service personnel for cleaning and maintenance of the syphon.

3.5.1 The inlet chamber shall have as many channels as are the number of pipes in syphon system. In Fig. 1 channel '*a*' is for minimum dry weather flow, channel '*b*' for the difference of minimum and maximum of dry weather flow and channel '*c*' for storm water. The channel '*a*' is in continuation of the main sewer entering into the inlet and it discharges into the pipe provided for conducting minimum dry weather flow. On one side of the channel '*a*' is a weir set at an elevation equal to the water height in the sewer when only a minimum dry weather flow is running into the sewer. When flow exceeds its capacity the excess will spill into channel '*b*' which discharges into the second pipe provided for carrying the difference of minimum and maximum dry weather flow. The weir on the other side of channel '*a*' is likewise set at water depth that will fill the two pipes mentioned above and the excess above this is discharged into channel '*c*' which connects with the third and the largest pipe provided for carrying storm water.

Since the loss of head or fall in pipes is to be kept to a minimum, the pipes shall be designed for a velocity of 1·2 m/sec when full. Loss of head at the entrance must be considered. It will be at least one velocity head that is $v^2/2g$. It is 'however' advisable to allow more than this.

In consideration of above as also considering the channel size of pipe, the size and slope for the first pipe (pipe '*a*') shall be decided and the total fall in the inverted syphon shall be worked out which shall be equal to total length of inverted syphon multiplied by the gradient of the first pipe (pipe '*a*') plus the various accountable head losses.

3.5.2 The outlet chamber is so arranged that the inverts of all the pipes merge into single channel which becomes the invert of outlet sewer. Because of greater velocities in the other larger pipes, their outlet should be higher than that of the first and smallest pipe (pipe '*a*') to avoid eddies and possible accumulation of solids during the period when they are not in operation.

3.5.3 Grooves for stop planks should be provided in outlet chambers to close off pipes whilst being cleaned.

3.5.4 Where space is restricted prohibiting the construction of ramps these may be replaced by vertical pipes constructed in access shafts for both inlet and outlet to the syphon, but this is not recommended if it can be avoided.

4. CONSTRUCTION

4.1 A typical construction of an inverted syphon with all the connections is shown in Fig. 1.

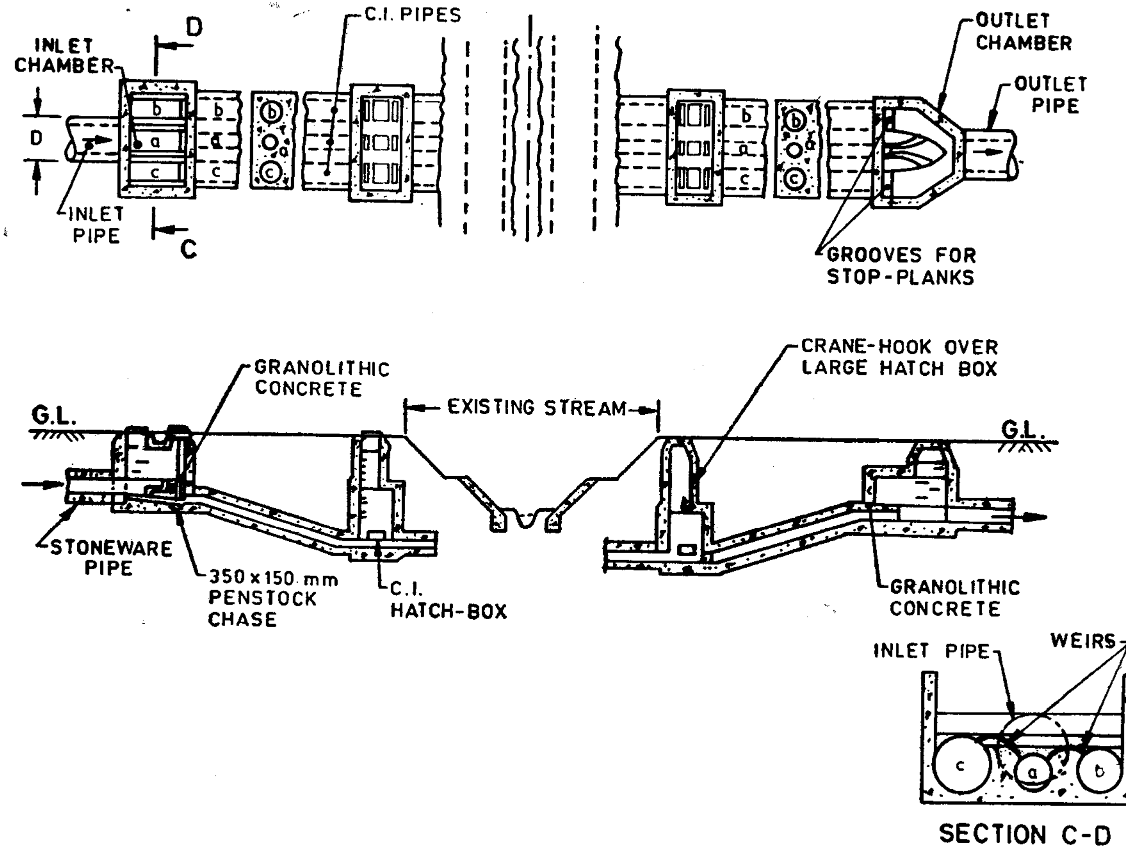

FIG. 1 TYPICAL INVERTED SYPHON

4.2 Provision of Access for Cleaning Purposes — Arrangement should exist whereby any individual pipe in a syphon may be isolated for cleaning. This may be arranged by providing suitable penstocks or stop-planks at the inlet and outlet of each pipe and by providing a draw-off valve at its lowest point if this is acessible; if not accessible, there should be a wash out to drain into a manhole from where contents may be pumped out. On very large syphons, it is often convenient to enable the suction of a portable pump to be connected to this draw-off, and to connect the pump delivery to the draw-off valve on one of the other pipes, so that the contents of the one pipe may be pumped direct into another.

4.2.1 The location of the Hatch-boxes should be decided in such a way that it should take care of bends responsible for silt deposits. Hatch-boxes of adequate size in manholes should be provided on the pipes so as to give access into the pipes for rodding. If hatch-boxes are ommitted the manholes should be watertight and capable of withstanding the internal bursting pressure exerted on them. After a short time so much floating matter usually becomes trapped in manhole openings that objectionable conditions are set up in them.

4.3 Bye-Pass — Proper bye-pass arrangements shall be provided from inlet chamber to nearby stream as available for preventing breakdowns.

4.4 Syphons Under Rivers — Inverted syphons built on or under river beds should have sufficient weight to prevent flotation, when empty. This may usually be done by surrounding the pipes with reinforced cement concrete of appropriate thickness.

4.4.1 An inverted syphon laid on or just under the river bed should be protected from undermining by currents and from movement by shifting bottoms or channels. Where such movements are possible positive flexible type joints should preferably be used. In navigable channels the position of the syphon should be marked by notice boards or other suitable means. Any special requirements of the appropriate river authority should be ascertained.

5. MATERIALS

5.1 Inverted syphon shall be constructed of cast iron pipe or of reinforced pressure pipe (*see* IS : 458-1971*). Where a stream is crossed, cast iron pipe shall preferably be used and lowered into the place in the same method used for water mains in accordancc with IS : 3114-1985†.

*Concrete pipes (with and without reinforcements) (*second revision*).

†Code of practice for laying of cast iron pipes (*first revision*).

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s(s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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