Should we have a second look at the design standards of sewerage systems?

(K G Dave)

1.0 Constraint of funds and low priority in planning has resulted in meagre investments in urban sewerage sector in developing countries in general and our country in particular. As a result we have very few engineers and contractors having on-field experience in this field. All earlier systems have been designed and constructed based on standards and practices followed in the developed western world. But our circumstances, life styles, customs, habits, socio-economic parameters, etc are quite different and it is high time that based on our experience in the field we should evaluate the applicability of the western standards in our country and modify the same to suit our needs. A couple of issues are discussed in this presentation only as illustrations.

2.0 In Bhavnagar (one of the corporation cities of Gujarat), the erstwhile princely state constructed and commissioned a full fledged sewer system during thirties. Subsequently sewer systems for newly developed areas have also been constructed. But the old city area system remains untouched. No improvement or upgradation is needed looking to its functioning at present. Now it is almost eighty years since its commissioning. Our normal design period is 30 to 40 years. Then how is it that this system is giving satisfactory service even after eighty years? Such and similar cases have been reported from many other cities also. The answer probably lies in the practice of designing sewers to run half to ninety percent full at peak flow. In this country, water supply is for 2 to 6 hours in a day in most of the towns against 24x7 supply in all developed countries. Our sewers have maximum flow in the morning hours only. For the remaining period the flow is meagre. For a short period even if the flow increases beyond designed capacity, there will be some welling in the manholes that in turn will increase the driving head and will counteract the rising of levels in the manholes. In a short duration of time the inflow will start reducing.

2.1 Then the question arises whether it is possible to design sewers to run either full or nearly full to carry the ultimate design flow. Such a design, if adopted, will reduce pipe sizes considerably and the project cost. Of course the smallest size that is required for the convenience of cleaning and maintenance purposes will remain as per present practice.

3.0 Second issue is that of treatment. While designing the sewage treatment plant for Rajkot underground drainage scheme under World Bank project, the consultant submitted a feasibility report indicating the types and levels of treatment. It was proposed to have primary, secondary and tertiary treatments. When examined further it turned out that the tertiary treatment was recommended because the effluent from secondary treatment was having BOD more than 20, the standard prescribed for effluents to be discharged in water bodies. Initial BOD of raw sewage was assumed as 250 (this is as per CPHEEO manual also) and 90% removal was anticipated up to secondary treatment. That gave secondary effluent having BOD value of 25. Normally in a new sewerage

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system BOD of raw sewage is always very low in the beginning as the work of connecting toilets to the new sewer system takes a long time due to various reasons. Apart from that, it was interesting to ascertain actual BOD of raw sewage in existing sewerage as per Indian conditions. Samples from a few existing old sewerage systems were collected and analysed in the consultant's in-house laboratory. The results were quite surprising. Maximum value of BOD among the samples analysed was 180. Now if we adopted this value of BOD for Rajkot and assuming 90% BOD removal up to secondary treatment, the resultant effluent will have BOD value of only 18 that is well below the prescribed standard. With this result it was possible to eliminate the tertiary treatment at that stage and save substantial investment. However as a precaution, adequate space for insertion of tertiary treatment units at a later date was provided at the plant site.

4.0 Conclusion: From the above two real life examples it is obvious that there is ample scope for having a second look at the present design standards being followed for the designing and construction of sewer systems. Data can be collected about experiences about pumping stations, pumping machinery, various types of treatments, etc and standards suitable to our conditions can be developed. CPHEEO (who have prepared the Manual on Sewerage and Sewage Treatment) can take an initiative in this direction by appointing a committee of experts with specific terms of reference to go into all the related issues and recommend standards to be followed in our country. The guidelines generally being used are given in annexure for ready reference.

ANNEXURE
GUIDELINES GENERALLY BEING FOLLOWED AT PRESENT

POPULATION FORECAST

Average of all the following standard methods of forecast.

- Ø Arithmetical Increase Method
- Ø Geometrical Increase Method
- Ø Incremental Increase Method
- Ø Graphical Method.

Note: If population data are not available, the density method can be adopted.
Recommended Density of Population

Size of town population	Density of population per hactre
Up to 5000	75-150
5000 – 200000	150-250
20000- 50000	250-300
50000-100000	300-350
Above-100000	350-1000

Where there is possibility of vertical development, population density can also be worked out considering:

Use of land	40 %
FSI	1
Area required	9 sqm /person

PEAK FACTOR

Contributory population	Peak factor
Upto 20000	3.0
20000 to 50000	2.5
50000 to 75000	2.25
Above 75000	2.0

Peak factors also depend upon the density of population, topography of the site, hours of water supply and therefore it is desirable to estimate the same in individual cases, if required. In densely populated streets peak factor can be taken on higher side.

GROUND WATER INFILTRATION

Suggested estimates for ground water infiltration into the sewers laid below ground water table are as follows.

	Minimum	Maximum
Litres / ha.d	5000	50000
Litres /km.d	500	5000
Lpd / manhole	250	500

SEWER COLLECTING SYSTEM

Design period	30 years
Rate of water supply	135/140 lpcd
Rate of sewage flow	80 % of water supply
Minimum size of sewer	150 mm
Coefficient of roughness for use in	

Manning's formula

	n
Cement Concrete pipes(with collar joints)	0.013
Spun concrete pipes (RCC & PSC) with S & S joints (design value)	0.011
SW pipes	0.011

Velocity not to exceed 3.0 mps
*Minimum velocity recommended *0.8 mps at design peak flow and 0.6 mps for present peak flow
Max depth of flow in sewer (d/D) 0.8 at ultimate peak flow

Flushing Manholes:

Where it is not possible to obtain self-cleansing velocities due to flatness of the gradient especially at the top ends of branch sewers, which receives very little flow, flushing can be very conveniently accomplished by use of tanker and hose.

MANHOLES

To be provided at

- Ø Start of sewer line
- Ø All sewer junctions
- Ø Change of alignment / gradient / size of sewer

Spacing: Not more than 30 m interval in straight line for sewers upto 300 mm dia and not more than 100 m for larger dia.

Drop Manhole: When drop is more than 0.6 m
Scraper (service) Manhole: at 300 m interval with clear opening of 1200 x 900 mm at top

Fall due to deviation in alignment:

30 degree	25 mm
60 degree	50 mm
90 degree	75 mm
Change in size	(D-d)/2

Ventilating column need not be provided

SCREEN CHAMBER

Compulsorily to be provided before entry of sewage to pumping station.
Size Minimum size 2.0 x 1.5 meters

PUMPING MACHINERY

Number
For small capacity pumping stations - 3
(1 of 1 DWF, 1 of 2 DWF & 1 of 3 DWF)
For large capacity pumping stations - 5
(2 of ½ DWF, 2 of 2 DWF & 1 of 3 DWF)

RISING MAIN

The economical size of rising main should be finalized based on the design flow of 1, 2 and 3 DWF. The size should be selected based on velocity ranging from 0.6 to 1.5 mps.

ARE DUCTILE IRON (D I) PIPES SUITABLE TO USE FOR **PUMPING OF SEWAGE?**

***K. G. Dave & **A. G. Desai**

1.0 INTRODUCTION:

1.1 The Government of Gujarat has taken up a massive programme of providing sanitation facilities to all the towns and large villages of the state.

1.2 Work of preparation of number of sewerage projects is on hand. We came across several sewerage project reports and observed that in many of the projects DI pipes are proposed for pumping mains.

1.3 Projects are designed for a period of 30 years. Hence it is necessary to see that the life of materials provided in the projects is at least 30 years or more and should give trouble free service throughout the life period of the project. Any large scale leakage or break in the line can create many problems due to raw sewage.

1.4 But in our opinion DI pipe is neither of long life nor is trouble free under all circumstances. This paper is an attempt to explain that aspect of DI pipes. Our observations are mainly based on the literature published by the manufacturers of the DI pipe and information on experience in other countries

1.5 Phosphorus and sulphur contents of gray cast iron used for manufacture of DI pipes are reduced to less than 0.1% and 0.01% respectively. This makes the DI pipe material more corrosive then CI pipes. To protect the DI pipes from corrosion inner cement mortar or other such lining is applied. In case the lining of pipes is damaged they become vulnerable to corrosion.

2.0 DI pipes are manufactured by centrifugal process as per IS-8329-2000. It arrived in the Indian market only before few years ago. It possesses high mechanical strength, good impact resistance and casting qualities of gray cast iron. However to achieve these qualities, its phosphorus and sulphur contents are reduced as stated above. DI pipes are usually provided with cement mortar lining applied with centrifugal process at works. This lining affords a smooth inner surface and protect it from corrosion by creating a high pH at the pipe wall. This cement mortar or other lining provides a physical as well as chemical barrier to the water by preventing passage of water to the metal. They have properties like ductility, high tensile strength, machinability and corrosion resistance due to lining. DI pipes are around 30 % lighter than the conventional CI pipes. Pipes are joined by rubber gaskets like CI pipes.

2.1 As stated above the major reasons for applying cement mortar lining is to prevent corrosion of metal as DI is more corrosive than CI. Therefore for any reason, if the lining is damaged, the pipe will become highly vulnerable to corrosion. Particularly during transportation, loading, unloading and handling at site if proper precautions are not taken, lining can be damaged. While drilling a hole in DI pipe for service connection

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or while cutting the pipe also there is a possibility of damaging the lining. Once the corrosion sets in, even at one point all the other advantages of DI pipe are lost. As the wall thickness of DI pipe is less than that of CI pipe the possibility of failure due to corrosion are more in DI pipe than that in CI pipe.

2.2 From literature published by one of the manufacturers of DI pipes some portion is reproduced below.

"Repair of damaged cement mortar lining:

The Cement Mortar Lining may get damaged due to bad handling during transportation / installation. All standard specification recommend repair of lining, if there be any, before laying. The procedure is picturised in the following pages:

a. The damaged area of the mortar lining shall first be properly identified.

b. Then the loose mortar should be carefully chipped out and removed from the damaged area.

c. All dust from the damaged areas to be cleaned using a wire brush exposing bare metal

d. Wet exposed area and the adjoining intact lining by spraying water.

e. Apply fresh mortar consisting 1 part cement to approx. 1.5 parts coarse sand(by mass) by using trowel. Develop the lining maintaining a constant thickness equal to the original thickness.

f. Once the repairing is complete, cover the repaired area with a wet sack. Keep the sack wet for a day to allow curing.

g. To prevent corrosion on outer surface it is recommended to provide a sleeving of polyethylene film.

2.2 Following shall be the problems if lining is damaged:

1. It will not be possible to identify the damaged area of the mortar lining when it is in the middle part of the inside of a small diameter pipe. Hence there is possibility of damage undetected. If it remains unattended pipe inside will start corroding. DI is more corrosive than CI . After a very short time there will be pit holes and leakages. Also due to damage of lining C value will be reduced and thus carrying capacity of pipes will also be reduced considerably.

2. If however damage to lining in the middle part could be identified it will not be possible to repair it as it is not possible to enter the pipe unless the pipe is of very big diameter. Thus the result will be as above if it remained unattended.

3. It is said to keep the sack wet for a day to allow proper curing. No cement mortar can be cured in one day and if it is not cured for adequate time properly it will not get required strength and will get cracked and as a result it will not serve any purpose.

4. It is said to allow adequate slack in the external polyethylene tube at the joint to prevent damage to the film during backfilling. Backfill should be free of cinders, rocks, boulders, nails, sticks, or other materials that might damage the polyethylene. Such precautions are not possible in working conditions in our country. Thus outer surface is prone to corrosion where the soil is of aggressive nature.

3.0 Comnclusion:

1. Number of cases of failure of DI pipes due to corrosion are reported in UK. In India these pipes have come in market only a few years ago only. Therefore we do not enough data on experience of performance of DI pipes. But we should be very cautious in using DI pipes in view of experiences in other countries.

2. In most of the cases pressures required in pumping mains will not be so high to warrant use of high pressure DI pipes.

3. To our opinion non-metalic pipes like RCC, AC, PVC, etc. will be more suitable depending upon site specific conditions.