Sewage Collection System in India – Addressing the Gaps

-by- N.Purnachandra Rao and Dr. S.Sakthivel

This paper is to enable better understanding of the sewage network systems & it's management in India. The reasonable gaps / challenges at broad level in this sector are identified and addressed with proper techno-economic approach and design criteria to enable this sector to develop on a sustainable basis.

Sewer Network – The Present Indian Scenario

The proper sewerage system includes collection of sewage from source of generation through sewer network, treatment using appropriate available economical technology to the prescribed disposal standards and safe disposal to natural water bodies.

There are two systems available in general for Waste Water Collection and Disposal, viz. (i) Separate System – sewage and storm water are collected separately & sewage is treated for safe disposal and (ii) Combined System – sewage and storm water are collected together in same drain & treated together. Presently the separate system is preferred due to its technical and economical advantages. Hence, in India also, nowadays almost all the sewer networks are designed for separate systems.

Almost 80% of India's population does not have proper sewer systems[1]. As many as 55% of rural households defecate in the open and about 12.6% of urban households defecate in the open. This number is higher for slums, with 18.9% of households defecating in the open[2]. Even under the Swatch Bharath Mission also it is observed that as per the 2011 census around 8 million households of the 4,041 statutory towns in India have no access to toilets and continue to practice open defecation. Sanitation facilities are almost absent in rural areas, where around 69% of India's population resides.

Approximately 45 percent of the population (8.1 million people) in urban Delhi (total population of 18 million) which is world's second populist city, has no access to a centralized sewerage system. There are around 2,200 unsewered colonies in the capital region until recent years.

As per the census 2011, only about a third of urban India households covered with piped sewer network.

The above all facts clearly show the pathetic situation of rural and urban areas in terms of basic requirement of sanitation. Hence two third urban population is not having proper sewer network systems and rural folk is almost away from sewer collection system.

The following are the major disadvantages or challenges being faced due to lack of proper sanitation facilities.

i. Population affected with health issues and ultimately affecting GDP of the country

ii. The ground and surface water sources are being polluted and hence water supply is becoming costly & inadequate

The major reasons for inadequate sewer networks / sanitation facilities are as follows.

i. Insufficient funds

ii. Improper design approaches & management of sewer network systems

Various gaps in the design criteria and management of sewer networks observed during the 50 years experience of TCE in various sewerage projects is discussed below.

- **Peak Factor as per Babbit's formula for PE<10,000**

Peak factor plays a vital role in design of both sewer network and sewage pumping stations either intermediate or terminal pumping stations. Consideration of appropriate peak factor would lead to techno economical solutions coupled with optimum provisions in design and operation of sewer networks and pumping stations. At present in most of the cases networks in India are designed adopting Central Public Health Environmental Engineering Organization (CPHEEO) manual as reference statutory guide line. In India, the CPHEEO Manual specifies that the maximum peak factor be adopted as 3 for a population range up to 20,000[3]. i.e., for the population of 1 to 20,000 , the same peak factor of 3 must be considered as per the manual. But due to less diversity factor in small communities the occurrences of sewage generation in shorter duration is high and the same principle has been considered by Babbit and concluded that the peak factor of maximum 6 to 3 for population equivalent 1 to 10,000 is appropriate for sustainable design of sewer network and pumping stations. Accordingly the Babbit's empirical formula is being used for population equivalent less than 10,000 in majority of countries in the world, hence the same shall be considered in India also on priority since major part of sewer network in any project would become more economical. Because of around 70% of any sewer network (estimated based on the DPRs of ongoing projects in TCE) of any project in general is loaded with population equivalent of less than 10,000 PE (population equivalent), there would be considerable saving in the Sewer network cost (i) Capital Cost – less slope requirement lead to considerable reduction in sewer depth & (ii) O&M Cost – requirement of flushing on regular basis will come down drastically. Hence technically it is appropriate to consider the Babbit's formula by amending CPHEEO manual on priority for making our sewer networks cheaper.

However the following are two disadvantages which can be outweighed in few folds with the above benefits.

i. The Intermediate Pumping Stations (IPS) or Terminal Pumping Stations (TPS) or Lifting Stations having capacity of PE < 10,000 in the network will become costly since they need to be designed for higher peak factor, but this additional cost will be compensated with the expected benefits as the estimated benefits are in few folds more than this additional cost. Further considering of higher peak factor for pumping stations, following the actual scenarios, will automatically addressing the issues of controlling frequent overflow/submergence.

ii. Issue of higher size of network against consideration of higher peak factor: The design criteria of providing minimum dia of 150 mm will almost absorb this issue of our sizing due to higher peak factor.

Finally, adopting of Babbitt's formula for PE < 10,000 at par with international design standards will give a substantial techno economical advantage and sewer networks become cheaper. TCE studied in one of sewerage projects in the state of Jharkhand that the adoption of above Babbit's formula would save around 75 Kms of pipe line (around 70% of total network) has been avoided for subjecting to regular flushing as these sewer pipe lines would not with self cleaning velocity if Babbit's formula is not considered.

- **Selection of appropriate pipe material and usage**

The following are the various parameters need to be considered while selecting pipe material for sewer networks.

- Load bearing capacity of the particular class of pipes

- Various loads transferred on the pipes
- Least life cycle cost (LCC) of pipe
- Internal pressure to be withstood
- Requirement of proper bedding
- Frictional losses or roughness coefficient etc.
- Type of soil and it's characteristics, presence of any chemicals.

Based on the above considerations, the required type of pipe shall be selected out of the commonly available pipes – Vitrified Clay Pipes (VCP), Reinforced Cement Concrete (RCC) pipes, High Density Poly Ethylene (HDPE) pipes, Double Wall Corrugated (DWC)-HDPE, Ductile Iron (DI) Pipes, Mild Steel (MS) pipes etc. At present, although VCP pipes upto 380 mm dia. are cheaper and suitable for gravity sewer application upto certain depths, and in any project the requirement of lower diameters upto 380 mm laid at reasonable depth is around 70% of the total network, the usage of these pipes is being reduced (almost nill) under wrong perceptions of less load carrying capacity, O &M issues, etc. But in fact, these pipes are suitable for carrying common loads in a major part of any network and hence are in general usage in a number of sewer network projects around the world. Therefore a proper techno-economic analysis on project to project basis is a must in selecting the best techno economical pipe material for sewer networks. As discussed above, the share of smaller diameter pipes upto 250 mm dia to 300 mm dia in any network is around 70 to 75% and these pipes in general can be VCP pipes in majority of locations. Hence scientific analysis with techno economical basis in selection of pipe material would save lot of network cost.

While designing of all sewer network projects in TCE, the above techno economical comparison between various pipes is being carried out and the best /least life cycle cost (LCC) pipe material is selected for making the sewerage projects more cost effective.

- **Spacing of Manholes**

In any sewer network system, manholes are a costly item and it is advantageous, costwise, to reduce the number of manholes to the extent possible. As per CPHEEO (2013), provision of manhole spacing along the street sewers (which are directly connected to households) must not be more than 30 meters[3]. This guide line was based on manual cleaning for desilting of sewers, but the same criteria of spacing between manholes is being continued even though mechanical high tech cleaning systems are now being deployed. In some of the countries provision of manhole spacing is around 100m for street sewer network where the networks are with minimum dia. Hence relooking into the criterion of manhole spacing with support of technical study is must for making the overall network systems affordable. Accordingly the CPHEEO manual on sewerage and sewage treatment systems is to be revised.

However based on the existing code and CPHEEO manual on sewerage, the maximum manhole spacing for higher diameters is judiciously considered in TCE and considerable saving on provision of manholes is observed in several projects.

- **Optimization of Intermediate Pumping Stations (IPS)**

Based on the topography of catchment of network, the necessity of either IPSs or lifting stations generally arises for reducing the overall depth of sewers or meeting the restricted depth criteria due to high ground water table etc. But the provision of these pumping requirements shall be justified with base of comparison of life cycle cost of options with or without IPS/ Lifting Stations in the network, so that the final provisions would said to be optimized effectively. This kind of approach will lead for saving to the project on both capex and opex on more sustainable basis.

The above practice of network optimization along with inclusion of IPSs in every sewerage projects in TCE is very much common for making the projects more cost effective and the savings can be spent for provision of sewer networks in needy areas.

Conclusion & Recommendation

Any sewer network system will become affordable for countries like India provided all the shortfalls/ gaps discussed above are addressed with greater technical considerations and incorporating them by the statutory bodies into the manuals /guide lines. Ultimately more projects can be taken up with less funds thus sanitation facilities in the country will be improved at the earliest.

References

[1]National Family Survey -3: 2005 – 2006

[2]Data tabled in the Lok Sabha on May 7, 2015.

[3]CPHEEO Manual on Sewerage and Sewage Treatment Systems (2013)

[4]CPHEEO Manual on Water Supply & Treatment (1999)

[5]CPCB (2005a,2007a,2009) – Parivesh Sewage Pollution, Evaluation of Operation and Maintenance of Sewage Treatment Plants in India, Status of Water Supply, Wastewater Generation & Treatment in Class I cities and Class II towns of India.