“BE THE CHANGE YOU WANT TO SEE IN THE WORLD”
COMMON MISTAKES BY CONSULTANTS IN PLANNING OF SEWER NETWORKS AND STP’s

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PROLOGUE

Distribution of Earth’s Water

- Oceans: 96.5%
- Surface water and other freshwater: 1.3%
- Lakes: 20.1%
- Ice and snow: 73.1%
- Rivers: 0.46%
- Swamps and marshes: 2.53%
- Soil moisture: 3.52%
- Groundwater: 30.1%
- Freshwater: 2.5%
- Saline groundwater: 0.93%
- Saline lakes: 0.07%


0.006682% fresh water!!
**PROLOUGE**

**PER CAPITA WATER AVAILABILITY IN INDIA**

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (Million)</th>
<th>Per capita water availability M³/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>361</td>
<td>5177</td>
</tr>
<tr>
<td>1955</td>
<td>395</td>
<td>4732</td>
</tr>
<tr>
<td>1991</td>
<td>846</td>
<td>2209</td>
</tr>
<tr>
<td>2001</td>
<td>1027</td>
<td>1820</td>
</tr>
<tr>
<td>2025</td>
<td>1394</td>
<td>1341</td>
</tr>
<tr>
<td>2050</td>
<td>1640</td>
<td>1140</td>
</tr>
</tbody>
</table>

(Source: Govt. Of India, Ministry of Water Resources(2009))

"WATER STRESSED NATION"

WATER SCARCE NATION
PROLOUGE

SEWAGE GENERATION IN THE COUNTRY

- Sewage generated: 42,510 MLD
- Untreated Sewage: 38,791 MLD
- Sewage Treatment Capacity: 22,963 MLD

62.82% UNTREATED
80% of human diseases are water borne and water related due to water pollution and poor sanitation. (WHO Report)

India lost about 4.7% of GDP($ 105.797 billion) in 2016 due to poor sanitation.
DO YOU KNOW .................

- Total length of sewers in Mil Stns is about 16,000 Km
- Total cost of sewers in Mil Stns is approx 4,000 Crore
- About 50% - 80% cost of a Sewage related project is for sewers.
STAGES OF SEWAGE MGMT

1. Generation
2. Collection
3. Transmission
4. Treatment
5. Disposal
6. Reuse
PECULIAR ISSUES - Mil Stations

- LOW POPULATION DENSITIES
- REMOTE LOCATIONS
- EXTREME CLIMATE
  - COLD: -30 deg C
  - HOT: +50 deg C
  - WET: Highest to minimal Rainfall regions
- HIGH FLOW VARIATIONS

- VARYING BOD
- HIGH TURBIDITY
- HIGH INFILTRATION
- STRINGENT STANDARDS

- MBBR TECH
- STP SIZES- 100 KLD ONWARDS
- STRESS ON ZLD

ZONAL CEs hire consultants who normally work for civil set up and do not understand peculiarities of military establishments
• Consultants tend to ignore importance of contours and layout plans for planning of network of sewers.

• Cases have been reported where sewers have been proposed from lower invert levels to higher invert level without any engineering application.

• Preferably layout plans should be prepared on scale 1:2000. Zoomed up detailed plans at scales 1: 250 to 1: 500 on A3 sheets may be prepared along with key plans for ease of understanding and readability.

• Contours, existing networks, water supply lines, UG cables and other services should be marked. Details of existing sewers including size, load and invert level are essentially required for synchronization with new schemes.
Erosion of sewer.

GRAVITY SEWERS-SCV

Too little or too much slope isn't good

V < 0.6 m/s

V > 0.6 m/s

Preferable 0.8 m/s

V > 3.0 m/s
- Steeper slopes require deep excavation and hence costly.
- Slope should be made milder as soon as discharge permits.
- Sewers flow partially full at peak flow.
- Space for ventilation is required.
LOW INITIAL DISCHARGE

• CENTRAL SEWAGE SYSTEMS ARE AUTHORIZED FOR ALL.

• AT MANY SITUATIONS LOW DISCHARGES ARE RECEIVED
  • BUNGALOW TYPE ACCN
  • AMMUNITION DUMPS
  • REMOTE SECURITY /OUT POSTS etc

• AUTOMATIC FLUSHING TANK IS SUGGESTED TO CONSULTANTS

• SOMETIMES MORE THAN 100 AFTs ARE SUGGESTED WITHOUT REALIZING ADDL WATER REQMT AND MAINT ISSUES !!
CPHEEO Para 3.4.3.1, it is mentioned that for small discharges upto 30 l/s diameter of sewer does not have much effect on velocity.

This 30 l/s of peak ~ population more than 2500.

This value is considered as good discharge in Military Stations.

Computer simulation was done for very low discharges. (<100 population).
Discharge required to generate SCV

(At slope 1 in 100 and Manning's constant = 0.010)
The flow in sewers varies from hour to hour and seasonally. However, for the purpose of hydraulic design estimated peak flows are adopted. The peak factor or the ratio of maximum to average flows depends upon contributory population.

Hitherto, maximum peak flow in Mil Stn was 4 (against 3 in civil) but now it is being raised to 6 for small populations as per actual on ground and as per literature available in its support.

Economical designs of gravity sewers.
## PEAK FACTOR AS RECOMMENDED IN MIL STN

<table>
<thead>
<tr>
<th>POPULATION</th>
<th>As per CPHEEO</th>
<th>As per Metcalf &amp; Eddy</th>
<th>Hitherto in Mil est</th>
<th>Being proposed for CANTTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 500</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>501 - 5,000</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5,001 - 20,000</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>20,001 - 50,000</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>50,001 - 7,50,000</td>
<td>2.25</td>
<td>2.25</td>
<td>2.25</td>
<td>2.25</td>
</tr>
<tr>
<td>Above 7,5001</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*Based on actual ground experience and literature from IIT, Kharagpur*
• The importance of material of sewer is sometimes ignored by consultants.

• Tend to follow the traditional choice of SWG sewers for small diameters and NP-2 sewers for 200 mm and above.

• SWG sewers due to their inherent limitations:
  • Short length
  • High roughness coefficient
  • Cumbersome jointing procedure (now banned in Mil establishments).

• NP-2 pipes also been replaced by NP-3 due requirement of stronger sewers to minimize in-situ concreting for bedding or cradle.
• Double Walled Corrugated Polyethylene (DWCPE) are available as per BIS 16098 (Part 2) : 2013. These are smooth, light weight and 6m long hence faster laying. These sewers require safeguards against uplifting.

• A comparison of carrying capacity of various types of sewers has been made. It can be seen that DWCPE sewers are 50% more efficient than SWG sewers.
RELATIVE EFFICIENCY OF GRAVITY SEWERS

- SWG: 100%
- CI Unlined: 115%
- Concrete: 136%
- CI Lined: 136%
- DWCPE: 150%
AUTOMATIC FLUSHING TANKS FOR VERY SMALL POPULATIONS

• Consultants find it difficult to decide when AFT are to be provided.

• Suggestions - AFTs at all locations where SCV is not achieved.

• In certain cases more than 100 AFT have been suggested in a small station.

• Such high numbers of AFTs are undesirable due to demand of additional water apart from maintenance issues.

• Gravity sewers be designed optimally taking full advantage of flows.

• Once inescapable requirement of AFTs is obtained- one of the following approach can be used.
  • Provide AFT for very small populations.
  • Reuse of treated waste water for direct flushing.
## AFTs - VARIOUS SLOPES AND POPULATIONS

<table>
<thead>
<tr>
<th>Population</th>
<th>Slope of 160mm OD, DWCPE (SN8) Sewer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 in 50</td>
</tr>
<tr>
<td>&gt;50 and &lt; 80</td>
<td>YES</td>
</tr>
<tr>
<td>&gt;80 and &lt; 100</td>
<td>NO</td>
</tr>
<tr>
<td>&gt;100 and &lt; 120</td>
<td>NO</td>
</tr>
<tr>
<td>&gt;120 and &lt; 150</td>
<td>NO</td>
</tr>
<tr>
<td>&gt;150 and &lt; 170</td>
<td>NO</td>
</tr>
<tr>
<td>&gt;170</td>
<td>NO</td>
</tr>
</tbody>
</table>
New concept proposed for the first time in MES (may be first time in the country) to use treated sewage for flushing of sewers to replace AFTs.

Being provided at three stations, under CE(AF) Gandhinagar. In the original work treated sewage was to be reused for arboriculture.

Lateral sewers close to point of reuse were not getting enough discharge to maintain SCV. To ensure that accidental cross connections with drinking water pipes do not take place violet or red coloured HDPE pipes are used and detachable spindles are provided.

Ensured that only one point control of valves is provided close to pumping points. Only 10 – 15 min flow is required for flushing.
Since in Military establishments, the diameters of sub-main gravity sewers are small, it is difficult to provide maintenance to such sewers at deeper depths.

Hence depth of gravity sewers has been restricted to 6.0m.
Minimum Velocity for Preventing Hydrogen Sulphide.

(HOT CLIMATES)

• Avoid formation of foul gas H₂S, the velocity shall be not only be self-cleansing but also be sufficient to keep the submerged surfaces of the sewer free from slimes and prevent the generation gas which can attack the cement concrete sewers.

• Stations which are located in warm areas should preferably be designed to have velocity of 0.8 m/s at least once in a day. However this should not be the criteria for providing AFTs.
Extreme cold conditions.

- **Consultants ignore** extreme cold climatic conditions when proposals are given for extreme cold areas although IS code exists since 1986.
- Sewers and manholes **insulated**.
- Sewers should run **below frost line**
- Manholes should have **double opening** for insulation.
- Building sewers from toilets to UG sewer be **specially insulated**.
- Detailed drawings for these have been developed and are being included in next TI’s.
- Draft for the same has been uploaded on MES web site.
THERMAL INSULATION OF SEWER SYSTEM

MANHOLE COVER 500 X 500

EARTH FILL

ROPE TIED WITH BOTH THE MANHOLE COVERS

INTERNAL MANHOLE COVER 500 X 500

FIBRE GLASS INSULATION

POLYTHENE FILM WRAPPED AROUND

FIBRE GLASS INSULATION

SEWER PIPE

SEWER PIPE

HEAT INSULATION FOR MANHOLE

WOODEN BOX WITH REMOVABLE LID

FLEXIBLE HOSE WITH ALL TEMPERATURE GREASE

FLEXIBLE PIPE

METALLIC PIPE OR EMPTY BITumen DRUM

PVC PIPE

FIBRE GLASS INSULATION

FIBRE GLASS INSULATION

BUILDING WALL

BUILDING FLOOR

INSULATION BOX

GROUND LEVEL

150 Ø PIPE TO BUILDING TRAP

INSULATION OF SERVICE CONNECTION THROUGH WALL
THERMAL INSULATION OF SEWER SYSTEM

Steep slope Pan

Waterless Seal

P-Trap

Ceramic Pan with 25° to 28° slope – it needs only 1.5 litres of water per flushing due to slope and P-trap.

PVC P-trap having 20 mm water seal which does not allow the smell from the pit to enter the toilet.
• IL reaches 6.0 m - provide lift well.

• Sewage should not stagnate in lift well for more than 15 min to avoid development of septic conditions.

• Consultants do provide small lift wells but they ignore the fact that pumps should also be provided with the same logic.

• Capacity of pumps should be such that with in all three conditions i.e. peak, average and lean flow conditions there is no stagnation for more than 15 min and pumps are running at least for 2 min at a stretch. For this number of pumps may be 3-5 and level sensors and timer switches may be provided.
Decentralized STPs

- CBA for all options must be done by consultant to facilitate selection of most efficient system.
- Cost per MLD increases inversely with reduction of size of STP
Suggestions have been made to minimize these mistakes.

• Higher factor; 4 to 6 for peak flows
• Restrictive use of flushing tanks
• Reuse of treated wastewater for flushing
• Use of energy efficient DWCPE sewers
• Restrictions on depth of sewers for all stations
• For extreme cold conditions insulation of sewers and manholes is a must.
• For hot climates higher velocities; > 0.8 m/s
• Conditions for efficient lift wells have also been reiterated.
• STP selection must be judiciously worked out.
WE DON’T PRACTICE ENGG, WE ‘DO’ ENGG