L-5 and L-6
Sewer Design
Theory and Problems

Environmental Engineering - II

Depth of Flow

- The sewers are always designed for the partial flow conditions. The purpose of maintaining partial flow in sewers is to maintain an open channel flow condition and to provide space above surface of sewage for ventilation.
- **Sewers may be designed to run for a depth of flow of d, which should be at least half the diameter, D, i.e., 0.5D but not more than 0.8D at ultimate peak flow conditions.**

Self-cleansing velocity

- Sewage consists of considerable amount of organic and inorganic solids, which remain floating or suspended.
- **If velocity of flow in the sewer is less, these solids get deposited at the invert of the pipe and cause obstruction to the flow of sewage**.
- Hence, it is necessary to maintain a minimum velocity of flow at which no solids get deposited in the sewer.

- The velocity of flow that prevents settlement of solids is known as self-cleansing velocity.
- This velocity should be maintained at least once in a day during the peak flow at all sections of the sewerage system.
- Generally, self cleansing velocity of **more than 0.75 m/s** is useful.

TABLE 4.5. SELF-CLEANSING VELOCITIES.

S.N.	*Nature of material*	*Self cleansing velocity (cm/sec)*
1.	Angular stones	100
2.	Round pebbles (12 mm to 25 mm dia)	50-60
3.	Fine gravel	30
4.	Coarse sand	20
5.	Fine sand and clay	15
6.	Fine clay and silt	7.5

TABLE 4.6. SELF-CLEANSING VELOCITIES.

S.N.	*Diameter of sewer (cm)*	*Self cleansing velocity (cm/sec)*
1.	15 to 25	100
2.	30 to 60	75
3.	Above 60	60

Non-scouring velocity

- Similarly, **the velocity of flow in sewer should not be too high, as the suspended solids will cause wear to contact surface of the pipe and erode the pipe material of sewer.**
- **This will reduce the life of the sewer. The permissible maximum velocity to prevent eroding is termed as non-scouring velocity and it should be limited to 3.0 m/s.**

TABLE 4.7 NON-SCOURING VELOCITIES.

S.N.	*Material of sewer*	*Non scouring velocity (cm/sec)*
1.	Earth channels	60 to 120
2.	Ordinary brick-lined sewers	150—250
3.	Cement Concrete sewers	250—300
4.	Stone ware sewers.	300—450
5.	Cast Iron sewer pipes	350—450
6.	Vitrified tile and glazed bricks	450—500

Grades of Sewers

- The slope or grade of the sewer is selected in such a way that the velocity of flow is maintained between the self-cleansing and non-scouring velocity.
- The sewer sizes and slopes should be such that the velocity of flow increases progressively or steadily from the head section through the entire length of sewers.

- It has been shown that for sewers running partially full, for a given flow and slope, velocity of flow is little influenced by pipe diameter.
- The slopes recommended by the manual (CPHEEO) present peak flows up to 30 Lps are given in Tabular format, which would ensure a minimum velocity of 0.6m/s.

Minimum Sewer Size

- The minimum size of public sewers should not be less than 150 mm.
- However for major towns and cities and where the topography is flat, the minimum size of sewer should be of 200 mm in diameter.

Chezy's Equation

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$$V = C\sqrt{RS}$$

- V = mean velocity of flow in m/sec
- C= a coefficient, its value depends upon the shape and surface of the channel
- R = Hydraulic mean depth in m
- S = Slope of channel

Kutter's Equation for Chezy's Constant

$$C = \frac{23 + \frac{1}{n} + \frac{0.00155}{S}}{1 + \left(23 + \frac{0.00155}{S}\right)\frac{n}{\sqrt{R}}}$$

Manning's Equation

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

- where V = Velocity of flow,
- n = Rugosity coefficient
- R = Hydraulic mean depth
- S = Canal bed slope.
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TABLE 4.1. VALUES OF KUTTER'S OR MANNING'S COEFFICIENT N

Conduit Material	Condition of interior surface	
	Good	Fair
1. Salt glazed stoneware	0.012	0.014
2. Cement concrete	0.013	0.015
3. Cast Iron	0.012	0.013
4. Brick, unglazed	0.013	0.015
5. Asbestos cement	0.011	0.012
6. Plastic smooth	0.011	0.011

Hazen William's Equation

$$V = 0.85\ C\ R^{0.633}\ S^{0.54},$$

where:

V is Velocity in m/s and R is hydraulic radius in meters

S is slope or gradient

TABLE 4.3. HAZEN AND WILLIAM'S COEFFICIENT *C*

S.N.	*Type of material*	C
1.	Steel pipe under future conditions	95
2.	Old C.I. pipes; brick sewers in good condition	100
3.	Stoneware pipes in good condition	110
4.	Cement lined pipes	110
5.	New riveted steel pipe	110
6.	Wood stave pipe	120
7.	New C. I. pipes	130
8.	Pipes with very smooth inside surface	140
9.	Asbestos cement pipes	140

University Exam Objective Questions

1. The value of Hazen William's coefficient C for AC pipe is ______. (110/120/130/**140**)
2. The value of Manning’s N for smooth plastic is ______. (**0.011**/0.010/0.013/0.012)
3. In hydraulic design of sewers Bazin’s constant k in Bazin’s formula for good earth channel is ______. (0.25/**0.50**/0.75/0/92)
4. Sself cleansing velocity for transport of fine sand and clay is _____ cm/s. (5/7.5/**15**/30)

5. Self cleansing velocity for sewer having diameter above 60 cm is ______cm/s. (**60**/75/100/150)

6. For sewer of diameter 15 to 25 cm the self cleansing velocity required is ______cm/s. (75/**100**/125/150)

7. For transport of fine gravel the self cleansing velocity required is _____. (15/20/25/**30**)

8. For circular sewer running full the value of HMD is ______. (**D/4**, D/2, D, 2D)

University Exam Theory questions

Q1. What do you understand by the terms 'Self cleansing velocity' and 'Limiting velocity' in sewers.

Q2. Explain reasons for the following

i. Why sewers should follow slope of ground?
ii. Why should sewer run partially full?