

*Concept
of
Pipeline Design
&
Longitudinal Section*

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Design of Pipeline

- Dia. of Pipeline
 $Q = A \times V$
Q = Discharge in terms of public health engineering demand
- Domestic Water Demand
- Industrial water demand
- Institutional water demand
- Public use
- Fire hazard & water theft

In GWSSB it comes to 100 lpcd for villages & 140 lpcd for Cities

- Population – Based on Census
- Factors affecting water demand
 1. size of the city
 2. Climate condition
 3. Habit of people
 4. Quality of supply
 5. Industrial development
 6. Pressure in pipeline
 7. Drainage facility
 8. availability of power
 9. Use of Water metering

So, Variation in demand due to season is also in day hourly variation.

Design Period

Hydraulic Design of Pipe Line

T.E.L.

H.G.L.

Center of Pipe

| Pipe Material | Value of C in New Pipe | Design Purpose |
|----------------------------|------------------------|----------------|
| Unlined Cast Iron, Ductile | 130 | 100 |
| MS | 140 | 100 |
| Metallic Lined Pipe (DI) | 140 | 140 |
| Mortar Lined DI pipe | 130 | 110 |
| PVC | 150 | 140 |

Hazen Williams Formula:

$$V = 0.85 C_H R^{0.63} S^{0.54}$$

C_H = hydraulic capacity of pipe material (Hazen Coefficient)

R = Hydraulic Mean Depth of Pipe (Pipe Running Full)

$$= \text{Area / Wetted Perimeter} = \frac{\frac{\pi}{4}(d)^2}{\pi \times d} = d / 4$$

S = Slope of Energy Line, V = Velocity in m/s

- Limitations in Formula

1) C_H is not dimensionless has the unit $L^{-0.37} T^{-1}$.

$$\left[\frac{m}{s * m_1^{0.63} * m} m \right]$$
$$[m^{1-0.63} \times s^{-1}]$$

- 2) 0.85 constant is calculated by assuming that hydraulic mean depth 0.3 m friction slope $s = 1/1000$ but formula is used for all ranges of pipe dia. & friction slope. So, Error of 30% in velocity & 15% in head loss.
- 3) Hazen William coefficient does not depend on pipe Dia., Velocity of flow & Viscosity that & 65% error in further in C-value & it does not consider laminar or turbulent flow.

Darcy - Weisbach Formula

$$H_L = \frac{F^l L v^2}{2gd}$$

Where,

H_L = Head Loss , V = Mean Velocity

L = Length of Pipe , g = Acceleration due to Gravity

D = Dia. of Pipe , $F^l = 0.02$ to 0.55 depends on Reynold Number (Re)

$$Re = \frac{\rho v d}{\mu}$$

Where, μ = Absolute Viscosity, ρ = Density of Water,

$\frac{\mu}{\rho} = \nu$ = Kinematic Viscosity = 10^{-4} m²/s

Laminar Flow,

$$F^l = \frac{64}{Re}, \text{ For Re more than 2000}$$

$$F^l = 0.05 + \frac{0.3 a^r}{Re^{0.3}}$$

& 20,000 to 32,40,000

$$F^l = 0.032 + \frac{0.221}{R}$$

- Loss of head due to entrance = $KL \frac{v^2}{2g}$
- Loss at Exit = $\frac{v^2}{2g}$
- Loss in sudden contraction = 0 to $0.5 \times \frac{v^2}{2g}$
- Loss in sudden Enlargement = 0.17 to $1 \times \frac{v^2}{2g}$
- Loss due to Elbow = $0.9 \frac{v^2}{2g}$, $1.8 \frac{v^2}{2g}$ (Tee) , $2.2 \frac{v^2}{2g}$ (bend)

| CHAI H | HGL II | GRO | EFFE | STAT | HEAD | Bed Level |
|-----------|--------|--------|-------|-------|------|-----------|
| 0 | 145.00 | 100.00 | 45.00 | 45.00 | 1 | 100.00 |
| 30 | 144.94 | 99.28 | 45.66 | 45.73 | 1 | 99.28 |
| 60 | 144.88 | 97.93 | 46.95 | 47.08 | 1 | 97.93 |
| 90 | 144.81 | 97.93 | 46.88 | 47.07 | 1 | 97.93 |
| 130 | 144.75 | 97.40 | 47.35 | 47.60 | 1 | 97.40 |
| 150 | 144.69 | 97.69 | 47.00 | 47.31 | 1 | 97.69 |
| 180 | 144.63 | 96.02 | 48.61 | 48.99 | 1 | 96.02 |
| 210 | 144.57 | 92.40 | 52.17 | 52.61 | 1 | 92.40 |
| 240 | 144.51 | 93.28 | 51.23 | 51.73 | 1 | 93.28 |
| 270 | 144.44 | 96.33 | 48.12 | 48.68 | 1 | 96.33 |
| 300 | 144.38 | 97.51 | 46.88 | 47.50 | 1 | 97.51 |
| 330 | 144.32 | 98.33 | 45.99 | 46.67 | 1 | 98.33 |
| 360 | 144.26 | 98.82 | 45.44 | 46.19 | 1 | 98.82 |
| 390 | 144.20 | 100.58 | 43.62 | 44.42 | 1 | 100.58 |
| 420 | 144.13 | 101.09 | 43.04 | 43.91 | 1 | 101.09 |
| 450 | 144.07 | 100.77 | 43.30 | 44.23 | 1 | 100.77 |
| 480 | 144.01 | 100.92 | 43.09 | 44.08 | 1 | 100.92 |
| 510 | 143.95 | 101.43 | 42.52 | 43.57 | 1 | 101.43 |
| 540 | 143.89 | 101.62 | 42.27 | 43.38 | 1 | 101.62 |
| 570 | 143.82 | 101.54 | 42.29 | 43.47 | 1 | 101.54 |
| 600 | 143.76 | 101.42 | 42.34 | 43.58 | 1 | 101.42 |
| 630 | 143.70 | 101.32 | 42.39 | 43.69 | 1 | 101.32 |
| 660 | 143.64 | 101.28 | 42.36 | 43.72 | 1 | 101.28 |
| 690 | 143.58 | 100.87 | 42.71 | 44.14 | 1 | 100.87 |
| 720 | 143.52 | 100.51 | 43.01 | 44.50 | 1 | 100.51 |
| 750 | 143.45 | 100.17 | 43.28 | 44.83 | 1 | 100.17 |
| 780 | 143.39 | 99.90 | 43.49 | 45.10 | 1 | 99.90 |
| 810 | 143.33 | 99.82 | 43.52 | 45.19 | 1 | 99.82 |
| 840 | 143.27 | 98.81 | 44.46 | 46.20 | 1 | 98.81 |
| 870 | 143.21 | 98.59 | 44.62 | 46.41 | 1 | 98.59 |
| 900 | 143.14 | 97.84 | 45.31 | 47.17 | 1 | 97.84 |
| 930 | 143.08 | 98.11 | 44.98 | 46.90 | 1 | 98.11 |
| 960 | 143.02 | 101.57 | 41.46 | 43.44 | 1 | 101.57 |
| 990 | 142.96 | 102.93 | 40.03 | 42.08 | 1 | 102.93 |
| 1020 | 142.90 | 104.41 | 38.49 | 40.60 | 1 | 104.41 |
| 1050 | 142.84 | 105.31 | 37.53 | 39.70 | 1 | 105.31 |
| 1080 | 142.77 | 106.08 | 36.69 | 38.92 | 1 | 106.08 |
| 1110 | 142.71 | 105.74 | 36.97 | 39.26 | 1 | 105.74 |
| 1140 | 142.65 | 105.08 | 37.57 | 39.93 | 1 | 105.08 |
| 1170 | 142.59 | 103.95 | 38.64 | 41.06 | 1 | 103.95 |
| 1200 | 142.53 | 103.54 | 38.99 | 41.47 | 1 | 103.54 |
| 1230 | 142.46 | 104.20 | 38.27 | 40.81 | 1 | 104.20 |
| 1260 | 142.40 | 100.02 | 42.38 | 44.98 | 1 | 100.02 |
| 1290 | 142.34 | 98.94 | 43.40 | 46.06 | 1 | 98.94 |
| 1320 | 142.28 | 98.70 | 43.58 | 46.31 | 1 | 98.70 |
| 1350 | 142.22 | 98.83 | 43.39 | 46.17 | 1 | 98.83 |
| 1380 | 142.15 | 99.64 | 43.54 | 46.95 | 1 | 99.64 |
| 1410 | 142.08 | 99.58 | 43.96 | 47.54 | 1 | 99.58 |
| 1440 | 142.01 | 99.58 | 44.37 | 47.95 | 1 | 99.58 |
| 1470 | 141.94 | 99.58 | 44.78 | 48.36 | 1 | 99.58 |
| 1500 | 141.87 | 99.58 | 45.19 | 48.77 | 1 | 99.58 |
| 1530 | 141.80 | 99.58 | 45.60 | 49.18 | 1 | 99.58 |
| 1560 | 141.73 | 99.58 | 46.01 | 49.59 | 1 | 99.58 |
| 1590 | 141.66 | 99.58 | 46.42 | 50.00 | 1 | 99.58 |
| 1620 | 141.59 | 99.58 | 46.83 | 50.41 | 1 | 99.58 |
| 1650 | 141.52 | 99.58 | 47.24 | 50.82 | 1 | 99.58 |
| 1680 | 141.45 | 99.58 | 47.65 | 51.23 | 1 | 99.58 |
| 1710 | 141.38 | 99.58 | 48.06 | 51.64 | 1 | 99.58 |
| 1740 | 141.31 | 99.58 | 48.47 | 52.05 | 1 | 99.58 |
| 1770 | 141.24 | 99.58 | 48.88 | 52.46 | 1 | 99.58 |
| 1800 | 141.17 | 99.58 | 49.29 | 52.87 | 1 | 99.58 |
| 1830 | 141.10 | 99.58 | 49.70 | 53.28 | 1 | 99.58 |
| 1860 | 141.03 | 99.58 | 50.11 | 53.69 | 1 | 99.58 |
| 1890 | 140.96 | 99.58 | 50.52 | 54.10 | 1 | 99.58 |
| 1920 | 140.89 | 99.58 | 50.93 | 54.51 | 1 | 99.58 |
| 1950 | 140.82 | 99.58 | 51.34 | 54.92 | 1 | 99.58 |
| 1980 | 140.75 | 99.58 | 51.75 | 55.33 | 1 | 99.58 |
| 2010 | 140.68 | 99.58 | 52.16 | 55.74 | 1 | 99.58 |
| 2040 | 140.61 | 99.58 | 52.57 | 56.15 | 1 | 99.58 |
| 2070 | 140.54 | 99.58 | 52.98 | 56.56 | 1 | 99.58 |
| 2100 | 140.47 | 99.58 | 53.39 | 56.97 | 1 | 99.58 |
| 2130 | 140.40 | 99.58 | 53.80 | 57.38 | 1 | 99.58 |
| 2160 | 140.33 | 99.58 | 54.21 | 57.79 | 1 | 99.58 |
| 2190 | 140.26 | 99.58 | 54.62 | 58.20 | 1 | 99.58 |
| 2220 | 140.19 | 99.58 | 55.03 | 58.61 | 1 | 99.58 |
| 2250 | 140.12 | 99.58 | 55.44 | 59.02 | 1 | 99.58 |
| 2280 | 140.05 | 99.58 | 55.85 | 59.43 | 1 | 99.58 |
| 2310 | 139.98 | 99.58 | 56.26 | 59.84 | 1 | 99.58 |
| 2340 | 139.91 | 99.58 | 56.67 | 60.25 | 1 | 99.58 |
| 2370 | 139.84 | 99.58 | 57.08 | 60.66 | 1 | 99.58 |
| 2400 | 139.77 | 99.58 | 57.49 | 61.07 | 1 | 99.58 |
| 2430 | 139.70 | 99.58 | 57.90 | 61.48 | 1 | 99.58 |
| 2460 | 139.63 | 99.58 | 58.31 | 61.89 | 1 | 99.58 |
| 2490 | 139.56 | 99.58 | 58.72 | 62.30 | 1 | 99.58 |
| 2520 | 139.49 | 99.58 | 59.13 | 62.71 | 1 | 99.58 |
| 2550 | 139.42 | 99.58 | 59.54 | 63.12 | 1 | 99.58 |
| 2580 | 139.35 | 99.58 | 59.95 | 63.53 | 1 | 99.58 |
| 2610 | 139.28 | 99.58 | 60.36 | 63.94 | 1 | 99.58 |
| 2640 | 139.21 | 99.58 | 60.77 | 64.35 | 1 | 99.58 |
| 2670 | 139.14 | 99.58 | 61.18 | 64.76 | 1 | 99.58 |
| 2700 | 139.07 | 99.58 | 61.59 | 65.17 | 1 | 99.58 |
| 2730 | 139.00 | 99.58 | 62.00 | 65.58 | 1 | 99.58 |
| 2760 | 138.93 | 99.58 | 62.41 | 65.99 | 1 | 99.58 |
| 2790 | 138.86 | 99.58 | 62.82 | 66.40 | 1 | 99.58 |
| 2820 | 138.79 | 99.58 | 63.23 | 66.81 | 1 | 99.58 |
| 2850 | 138.72 | 99.58 | 63.64 | 67.22 | 1 | 99.58 |
| 2880 | 138.65 | 99.58 | 64.05 | 67.63 | 1 | 99.58 |
| 2910 | 138.58 | 99.58 | 64.46 | 68.04 | 1 | 99.58 |
| 2940 | 138.51 | 99.58 | 64.87 | 68.45 | 1 | 99.58 |
| 2970 | 138.44 | 99.58 | 65.28 | 68.86 | 1 | 99.58 |
| 3000 | 138.37 | 99.58 | 65.69 | 69.27 | 1 | 99.58 |
| 3030 | 138.30 | 99.58 | 66.10 | 69.68 | 1 | 99.58 |
| 3060 | 138.23 | 99.58 | 66.51 | 70.09 | 1 | 99.58 |
| 3090 | 138.16 | 99.58 | 66.92 | 70.50 | 1 | 99.58 |
| 3120 | 138.09 | 99.58 | 67.33 | 70.91 | 1 | 99.58 |
| 3150 | 138.02 | 99.58 | 67.74 | 71.32 | 1 | 99.58 |
| 3180 | 137.95 | 99.58 | 68.15 | 71.73 | 1 | 99.58 |
| 3210 | 137.88 | 99.58 | 68.56 | 72.14 | 1 | 99.58 |
| 3240 | 137.81 | 99.58 | 68.97 | 72.55 | 1 | 99.58 |
| 3270 | 137.74 | 99.58 | 69.38 | 72.96 | 1 | 99.58 |
| 3300 | 137.67 | 99.58 | 69.79 | 73.37 | 1 | 99.58 |
| 3330 | 137.60 | 99.58 | 70.20 | 73.78 | 1 | 99.58 |
| 3360 | 137.53 | 99.58 | 70.61 | 74.19 | 1 | 99.58 |
| 3390 | 137.46 | 99.58 | 71.02 | 74.60 | 1 | 99.58 |
| 3420 | 137.39 | 99.58 | 71.43 | 75.01 | 1 | 99.58 |
| 3450 | 137.32 | 99.58 | 71.84 | 75.42 | 1 | 99.58 |
| 3480 | 137.25 | 99.58 | 72.25 | 75.83 | 1 | 99.58 |
| 3510 | 137.18 | 99.58 | 72.66 | 76.24 | 1 | 99.58 |
| 3540 | 137.11 | 99.58 | 73.07 | 76.65 | 1 | 99.58 |
| 3570 | 137.04 | 99.58 | 73.48 | 77.06 | 1 | 99.58 |
| 3600 | 136.97 | 99.58 | 73.89 | 77.47 | 1 | 99.58 |
| 3630 | 136.90 | 99.58 | 74.30 | 77.88 | 1 | 99.58 |
| 3660 | 136.83 | 99.58 | 74.71 | 78.29 | 1 | 99.58 |
| 3690 | 136.76 | 99.58 | 75.12 | 78.70 | 1 | 99.58 |
| 3720 | 136.69 | 99.58 | 75.53 | 79.11 | 1 | 99.58 |
| 3750 | 136.62 | 99.58 | 75.94 | 79.52 | 1 | 99.58 |
| 3780 | 136.55 | 99.58 | 76.35 | 79.93 | 1 | 99.58 |
| 3810 | 136.48 | 99.58 | 76.76 | 80.34 | 1 | 99.58 |
| 3840 | 136.41 | 99.58 | 77.17 | 80.75 | 1 | 99.58 |
| 3870 | 136.34 | 99.58 | 77.58 | 81.16 | 1 | 99.58 |
| 3900 | 136.27 | 99.58 | 77.99 | 81.57 | 1 | 99.58 |
| 3930 | 136.20 | 99.58 | 78.40 | 81.98 | 1 | 99.58 |
| 3960 | 136.13 | 99.58 | 78.81 | 82.39 | 1 | 99.58 |
| 3990 | 136.06 | 99.58 | 79.22 | 82.80 | 1 | 99.58 |
| 4020 | 135.99 | 99.58 | 79.63 | 83.21 | 1 | 99.58 |
| 4050 | 135.92 | 99.58 | 80.04 | 83.62 | 1 | 99.58 |
| 4080 | 135.85 | 99.58 | 80.45 | 84.03 | 1 | 99.58 |
| 4110 | 135.78 | 99.58 | 80.86 | 84.44 | 1 | 99.58 |
| 4140 | 135.71 | 99.58 | 81.27 | 84.85 | 1 | 99.58 |
| 4170 | 135.64 | 99.58 | 81.68 | 85.26 | 1 | 99.58 |
| 4200 | 135.57 | 99.58 | 82.09 | 85.67 | 1 | 99.58 |
| 4230 | 135.50 | 99.58 | 82.50 | 86.08 | 1 | 99.58 |
| 4260 | 135.43 | 99.58 | 82.91 | 86.49 | 1 | 99.58 |
| 4290 | 135.36 | 99.58 | 83.32 | 86.90 | 1 | 99.58 |
| 4320 | 135.29 | 99.58 | 83.73 | 87.31 | 1 | 99.58 |
| 4350 | 135.22 | 99.58 | 84.14 | 87.72 | 1 | 99.58 |
| 4380 | 135.15 | 99.58 | 84.55 | 88.13 | 1 | 99.58 |
| 4410 | 135.08 | 99.58 | 84.96 | 88.54 | 1 | 99.58 |
| 4440 | 135.01 | 99.58 | 85.37 | 88.95 | 1 | 99.58 |
| 4470 | 134.94 | 99.58 | 85.78 | 89.36 | 1 | 99.58 |
| 4500 | 134.87 | 99.58 | 86.19 | 89.77 | 1 | 99.58 |
| 4530 | 134.80 | 99.58 | 86.60 | 90.18 | 1 | 99.58 |
| 4560 | 134.73 | 99.58 | 87.01 | 90.59 | 1 | 99.58 |
| 4590 | 134.66 | 99.58 | 87.42 | 91.00 | 1 | 99.58 |
| 4620 | 134.59 | 99.58 | 87.83 | 91.41 | 1 | 99.58 |
| 4650 | 134.52 | 99.58 | 88.24 | 91.82 | 1 | 99.58 |
| 4680 | 134.45 | 99.58 | 88.65 | 92.23 | 1 | 99.58 |
| 4710 | 134.38 | 99.58 | 89.06 | 92.64 | 1 | 99.58 |
| 4740 | 134.31 | 99.58 | 89.47 | 93.05 | 1 | 99.58 |
| 4770 | 134.24 | 99.58 | 89.88 | 93.46 | 1 | 99.58 |
| 4800 | 134.17 | 99.58 | 90.29 | 93.87 | 1 | 99.58 |
| 4830 | 134.10 | 99.58 | 90.70 | 94.28 | 1 | 99.58 |
| 4860 | 134.03 | 99.58 | 91.11 | 94.69 | 1 | 99.58 |
| 4890 | 133.96 | 99.58 | 91.52 | 95.10 | 1 | 99.58 |
| 4920 | 133.89 | 99.58 | 91.93 | 95.51 | 1 | 99.58 |
| 4950 | 133.82 | 99.58 | 92.34 | 95.92 | 1 | 99.58 |
| 4980 | 133.75 | 99.58 | 92.75 | 96.33 | 1 | 99.58 |
| 5010 | 133.68 | 99.58 | 93.16 | 96.74 | 1 | 99.58 |
| 5040 | 133.61 | 99.58 | 93.57 | 97.15 | 1 | 99.58 |
| 5070 | 133.54 | 99.58 | 93.98 | 97.56 | 1 | 99.58 |
| 5100 | 133.47 | 99.58 | 94.39 | 97.97 | 1 | 99.58 |
| 5130 | 133.40 | 99.58 | 94.80 | 98.38 | 1 | 99.58 |
| 5160 | | | | | | |