MEBS6000 Utility Services
Worked Example on Above and Underground Drainage Pipe Sizing

<u>Question</u>
Consider a residential building having 20 storeys and each storey houses 8 flats. Each flat has a single bathroom (with a basin, a shower and a water closet) and a kitchen (with a sink and a washing machine).

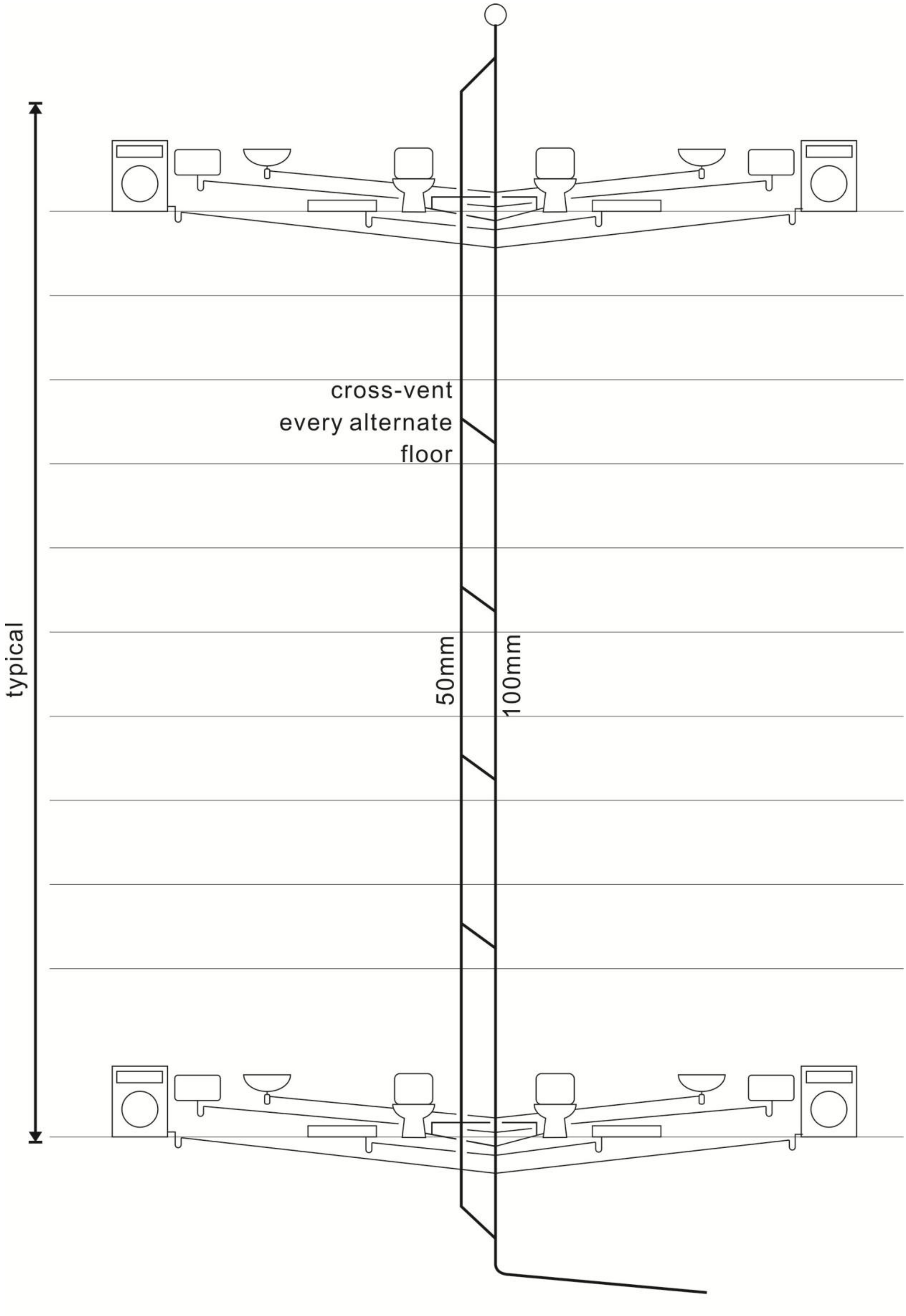
Develop a draft schematic diagram for this building assuming two flats on each floor to share a vertical stack.

<u>Solution</u>
The discharge units (DU) for individual sanitary fitments in one flat are as follows:
Basin – 0.3 L/s
Shower – 0.4 L/s
W.C. – 2.0 L/s (assume 9L cistern)
Sink – 1.3 L/s
Washing machine – 0.6 L/s
Total: 4.6 L/s (for one flat)

Total discharge units for one single stack = 4.6 L/s x 2 x 20 storeys = 184 DU
The design water flow is computed using K-factor
$Q_{ww} = k\sqrt{\sum DU} = 0.5\sqrt{184} = 6.8$ L/s

With secondary ventilated discharge stack, 100mmØ stack + 50mmØ vent → 7.3 L/s
Thus, 100mmØ stack + 50mmØ vent are chosen

The draft schematic diagram for a single stack is shown.
Note:
a) the venting for soil fitment
b) cross vent between vent pipe and soil and waste stack every alternate floors
c) vent pipe connecting the stack at the top and at the bottom of the vertical stack
d) traps provided for all sanitary fitments



Draft Schematic Diagram
for a single stack

Question

Consider a residential district with a population of 2500 residents. What will be the size of the main sewer pipe for the district?

Solution

The common design figure for residential discharge = 230L per person per day
This figure is adopted for designing sewage treatment works.

When handling this data, the design discharge rate per hour is taken as:
½ of the daily discharge is made in a 6 hour period.
i.e. ½ of 230L is discharged into the sewage pipe work within 6 hours.
= ½ x 230L / 6hr = 19.2L/hr for each resident
Thus, total discharge
= 19.2 L/hr x 2500 = 47 917 L/hr = 13.3 L/s (0.0133 m^3/s)

Consider half bore flow for the sewer pipe, and the design flow velocity = 1.5 m/s
Let D = diameter of pipe

$$Q = \frac{\pi D^2}{4} \times \frac{1}{2} \times v$$

$$0.0133 = \frac{\pi D^2}{4} \times \frac{1}{2} \times 1.5$$

$D = 0.15$m

Consider 150mm pipe, the hydraulic mean depth (HMD or m_d) for ½ bore flow = D/4
i.e. m_d= 0.15/4 = 0.0375m

The inclination can be computed using Chezy Formula

$v = c\sqrt{m_d \times i}$

$1.5 = 65\sqrt{0.0375 \times i}$ (Chezy Coefficient is usually taken as 65)
The inclination i = 0.0142 or 1 in 70 (this complies with the Buildings Regulations)

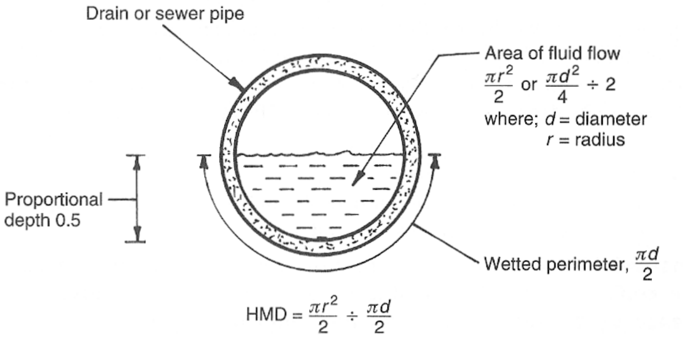
Thus the selected pipe size is Ø150mm and the inclination is 1 in 70.

The full bore carrying capacity Q_o = 2 x ½ bore capacity of pipe (see proportional table or chart)
The full bore flow velocity v_o= ½ bore flow velocity (see proportional table or chart)
Thus, Q_o= 0.0266m^3/s and v_o = 1.5m/s

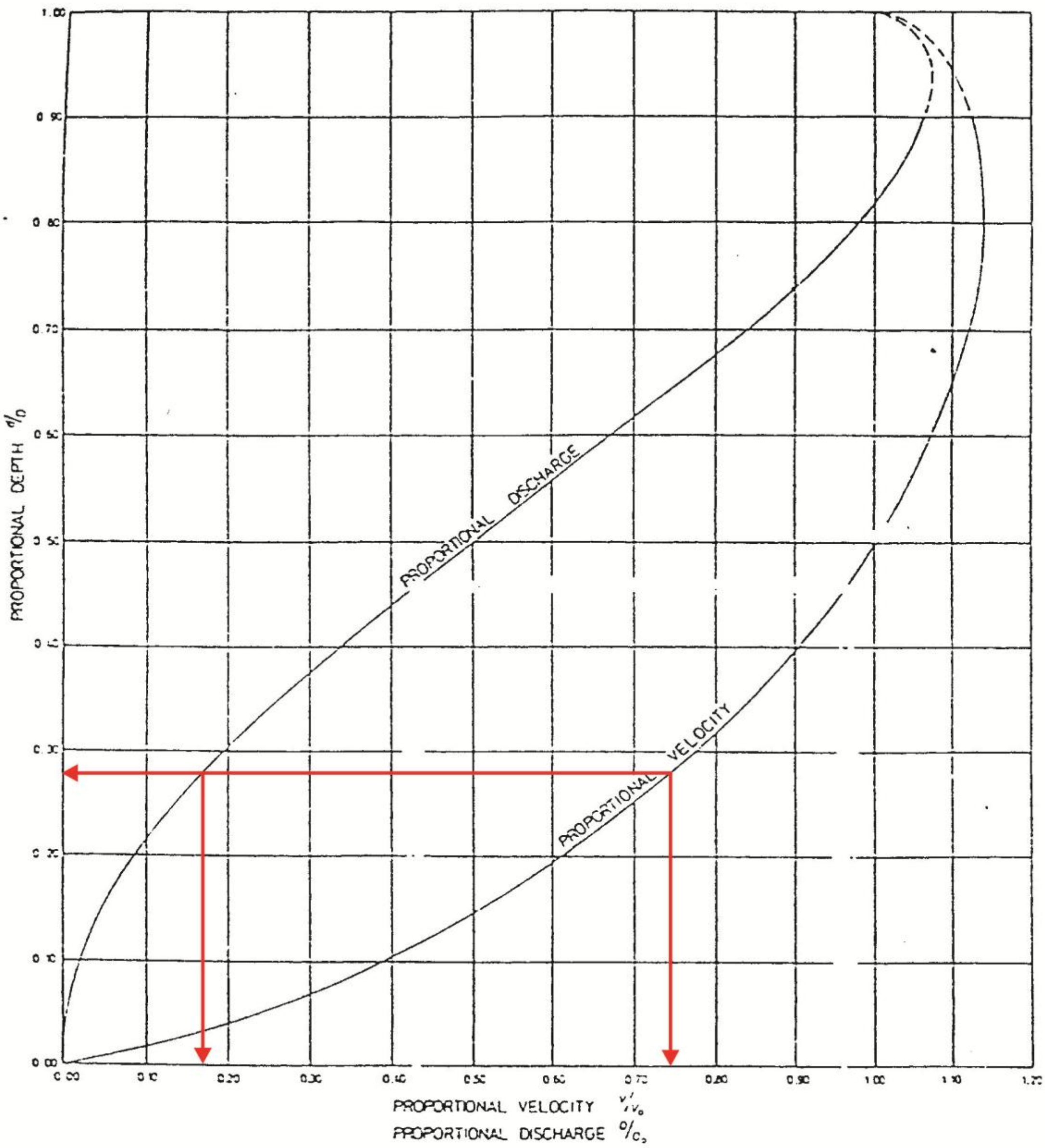
It is necessary to check against minimum flow to ensure that self-cleansing velocity is met.
The minimum flow = 1/6 of design flow = 1/6 x 0.0133m^3/s = 0.00222m^3/s
Thus, the proportional flow $\frac{Q}{Q_o} = \frac{0.00222}{0.0133} = 0.17$
From the proportional table or chart,
The proportional depth $\frac{d}{D}$ = 0.27
The proportional velocity $\frac{v}{v_o}$ = 0.79

Thus, the velocity $v = 0.79v_0 = 0.79 \times 1.5 = 1.2$ m/s (> 0.75m/s self-cleansing velocity) (acceptable)

Proportional Flow Chart Data for Circular Pipes laid to fall



Proportional Depth (d/D)	Proportional Velocity (v/v_0)	Proportional Discharge (Q/Q_0)	Proportional Depth (d/D)	Proportional Velocity (v/v_0)	Proportional Discharge (Q/Q_0)	Proportional Depth (d/D)	Proportional Velocity (v/v_0)	Proportional Discharge (Q/Q_0)
0.01	0.163	0.0003	0.34	0.870	0.2608	0.67	1.080	0.7693
0.02	0.230	0.0011	0.35	0.880	0.2744	0.68	1.083	0.7843
0.03	0.281	0.0025	0.36	0.889	0.2883	0.69	1.086	0.7992
0.04	0.324	0.0043	0.37	0.899	0.3024	0.70	1.089	0.8139
0.05	0.361	0.0067	0.38	0.908	0.3166	0.71	1.091	0.8284
0.06	0.394	0.0097	0.39	0.917	0.3311	0.72	1.093	0.8426
0.07	0.425	0.0131	0.40	0.926	0.3458	0.73	1.095	0.8566
0.08	0.453	0.0170	0.41	0.934	0.3606	0.74	1.097	0.8703
0.09	0.479	0.0214	0.42	0.942	0.3756	0.75	1.099	0.8838
0.10	0.504	0.0262	0.43	0.950	0.3907	0.76	1.100	0.8969
0.11	0.527	0.0316	0.44	0.958	0.4060	0.77	1.101	0.9097
0.12	0.549	0.0373	0.45	0.966	0.4214	0.78	1.102	0.9222
0.13	0.570	0.0436	0.46	0.973	0.4369	0.79	1.103	0.9343
0.14	0.590	0.0502	0.47	0.980	0.4526	0.80	1.103	0.9460
0.15	0.610	0.0573	0.48	0.987	0.4683	0.81	1.103	0.9573
0.16	0.628	0.0648	0.49	0.994	0.4841	0.82	1.103	0.9682
0.17	0.645	0.0728	**0.50**	**1.000**	**0.5000**	0.83	1.103	0.9786
0.18	0.662	0.0811	0.51	1.006	0.5159	0.84	1.102	0.9884
0.19	0.679	0.0898	0.52	1.012	0.5319	0.85	1.101	0.9978
0.20	0.695	0.0989	0.53	1.018	0.5480	*0.86*	*1.100*	*1.0066*
0.21	0.710	0.1083	0.54	1.024	0.5640	*0.87*	*1.099*	*1.0147*
0.22	0.724	0.1182	0.55	1.029	0.5801	*0.88*	*1.097*	*1.0222*
0.23	0.739	0.1283	0.56	1.035	0.5962	*0.89*	*1.095*	*1.0290*
0.24	0.752	0.1389	0.57	1.040	0.6122	*0.90*	*1.092*	*1.0350*
0.25	0.766	0.1497	0.58	1.045	0.6283	*0.91*	*1.089*	*1.0402*
0.26	0.779	0.1609	0.59	1.049	0.6443	*0.92*	*1.085*	*1.0444*
0.27	**0.791**	**0.1724**	0.60	1.054	0.6602	*0.93*	*1.081*	*1.0477*
0.28	0.804	0.1842	0.61	1.058	0.6761	*0.94*	*1.076*	*1.0497*
0.29	0.815	0.1963	0.62	1.062	0.6919	*0.95*	*1.070*	*1.0504*
0.30	0.827	0.2086	0.63	1.066	0.7076	*0.96*	*1.064*	*1.0495*
0.31	0.838	0.2213	0.64	1.070	0.7232	*0.97*	*1.056*	*1.0466*
0.32	0.849	0.2342	0.65	1.074	0.7387	*0.98*	*1.046*	*1.0410*
0.33	0.860	0.2474	0.66	1.077	0.7541	*0.99*	*1.033*	*1.0309*


PROPORTIONAL DEPTH d/D
PROPORTIONAL DISCHARGE
PROPORTIONAL VELOCITY
PROPORTIONAL VELOCITY v/v₀
PROPORTIONAL DISCHARGE Q/Q₀