Reprint ISSN 1923-7766 (Web Version)

International Journal of Experimental Agriculture

(Int. J. Expt. Agric.)

Volume: 10 Issue: 2 July 2020

Int. J. Expt. Agric. 10(2): 22-32 (July 2020)

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An International Scientific Research Publisher

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ISSN-1923-7766 (Online)
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HYDRAULIC PROPERTIES OF BURIED PIPE DISTRIBUTION SYSTEM IN DIFFERENT SCHEMES

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Accepted for publication on 7 July 2020

ABSTRACT

Hossain MZ, Hasanuzzaman KM, Islam MA, Rahman MA, Bary SZ, Pranto MRBH (2020) Hydraulic properties of buried pipe distribution system in different schemes. *Int. J. Expt. Agric.* 10(2), 22-32.

A research work was conducted on buried pipe distribution systems in four different DTW irrigation schemes that's one conducted in the experimental field of the Department of Irrigation and Water Management in Bangladesh Agricultural University, Mymensingh and another three located in the villages of Alokdia, Dhitpur and Chongachain the sadarupazilla of Sirajganj district. The main objectives of the study were to determine the hydraulic properties of flow through buried pipes made of different materials and diameters. In Mymensingh scheme, two piezometers; were fitted to the buried pipe system and in Sirajganj schemes, air vents of the buried pipe were used as piezometers to calculate hydraulic gradient line along the length of the pipe. The flow rate was measured by a cutthroat flume, placed in the open channel several meters away from the outlet of the buried pipe. The study shows that hydraulic properties of buried pipe such as frictional, entrance and exit losses, as well as friction factor are nonlinearly related to velocity of flow. Frictional, entrance and exit losses, as well as friction factor are significantly smaller in PVC pipe compared to CC pipes for the same velocity of flow. Exit loss is greater than the entrance loss except very low flow rates. As the loss of head in PVC pipe is significantly smaller than that in CC pipe, the PVC pipe is recommended for long buried pipe lines.

Key words: *buried pipe, head loss, open channel, velocity, entrance loss, exit loss*

INTRODUCTION

Agriculture is the largest user of water and covers about 70 percent of the worldwide consumption. Irrigated agriculture plays a vital role in increasing crop production in Bangladesh. The performance of an irrigation system depends on engineering, agronomic, organizational and management practices. Minor irrigation technologies namely deep tube well (DTW), shallow tube well (STW) and low lift pump (LLP) have been spreading rapidly in Bangladesh for the last four decades. In fact, these technologies of irrigation have always been considered as one of the major primary contributors to agricultural development in this country. Obviously, various types of studies are carried out for addressing the issues and problems associated with both the operation and management of irrigation systems. Amongst these, Improvement of performance of water distribution system is the prominent one.

Proper water distribution system and its efficient management play very important role in the command area development of any irrigation project. In Bangladesh, use of earthen open channel for water distribution is common in the minor irrigation sector. These earthen open channel distribution systems generally have very low conveyance and distribution efficiencies, resulting in less irrigated area (Sattar *et al*. 1988; Sanjit and Tareq, 1996; Hasan *et al*. 1992) and high maintenance cost. It is fact that, traditional earthen channel distribution systems confront some physical obstructions and canals suffer from high seepage, leakage and evaporation losses.

Field open channels in surface water distribution systems in Bangladesh generally originate from a DTW or a STW, or even from a major canal outlet, run in a random manner with a little consideration of topographical features of the areas (BARI 1988). Seepage and evaporation losses are high in such systems. Besides these, Michael (1987) reported that about 2 to 4 percent of the cultivable land area is taken up by open channels in these systems. Plausible economic solutions of some of these problems, in the areas with plain topography and having heavy to medium textured soils, include construction of improved (compact) earth channel with necessary water control structures and strengthen operation and maintenance to improve performance of the system. However, the buried pipe distribution system (BPDS) may be the best solution to these problems (Bentum and Smout, 1993), especially for uneven topography and light textured soils (Jenkins 1983).

In a buried pipe distribution system, the pipelines are placed underground and cultivation can be done above the pipelines without interference to farming operations. If the pipelines are properly installed, they are very durable, and the maintenance cost is low (MacDonald 1992). Their placement below ground surface prevents any damage and eliminates water loss by evaporation. The systems are operated under pressure. Therefore, they can be laid uphill and downhill, thus permitting the delivery of water to areas not accessible when open channels are used. They do not become clogged by vegetation and windblown materials. With an underground pipeline system, the DTW need not be located at the highest point of the farm but may be at a location that provides the best water supply (Gisselquist 1989). No land needs to be reserved for right-of-way in the BPDS. This is not only an economic advantage, but also a practical benefit when many field plots belong to different individuals are not required to be crossed to distribute water from a pumping well.

Despite the clear advantages and benefits of the buried pipe, some problems have been observed in the systems. For instance, unsatisfactory connecting methods and techniques, frequent leaks, faulty outlet valves, poor hydraulic design (using trial and error method), spill from air vents, higher initial cost and so on.

Since BPDS uses low-pressure pipes, maximum pressure in the buried pipes should not exceed a limiting value (Bentum 1992).Therefore, the rate of head loss is an important parameter to be considered in the design of BPDS. For a given pipe, the head loss per unit length of pipe also depends on discharge through the pipe.

Hence the main objective of this work was to determine major and minor losses in buried pipe distribution systems having different pipe diameters and pipe materials. The specific objectives were:

a) to study the friction loss parameters of selected schemes for different flow rates,
b) to compare the hydraulic properties of buried pipe distribution system (BPDS) of different pipe diameters and pipe materials

MATERIALS AND METHODS

The study schemes

To study the hydraulic properties of buried pipe with different diameters and pipe materials, four DTW irrigation schemes were selected.

BPDS in Mymensingh

This work was conducted in the experimental field at the Department of Irrigation and Water Management in Bangladesh Agricultural University, Mymensingh. A deep tubewell having a buried pipe and an open channel distribution system existed in the experimental site. The deep tubewell discharged into a storage tank, the tank was made of bricks and having vertical walls. There were two exit openings at the bottom of the storage tank. One leaded to a buried pipe system, and the other to an open channel system. The exit opening, provided for water entrance to the buried pipe, was considered as the inlet of the BPDS. Both the exit openings could be closed by cap plates. Water from the storage tank might be allowed to flow either through the buried pipe of through the open channel, or through both of these simultaneously, as required. The buried pipe was made of cement concrete (CC) and had a diameter of 25.4 cm. The length of the pipe was 58.12 m and it discharged into an open channel through a vertical exit system, hereby mentioned as the outlet. Fig. 1 show a schematic diagram of the BPDS available a t the experimental site.

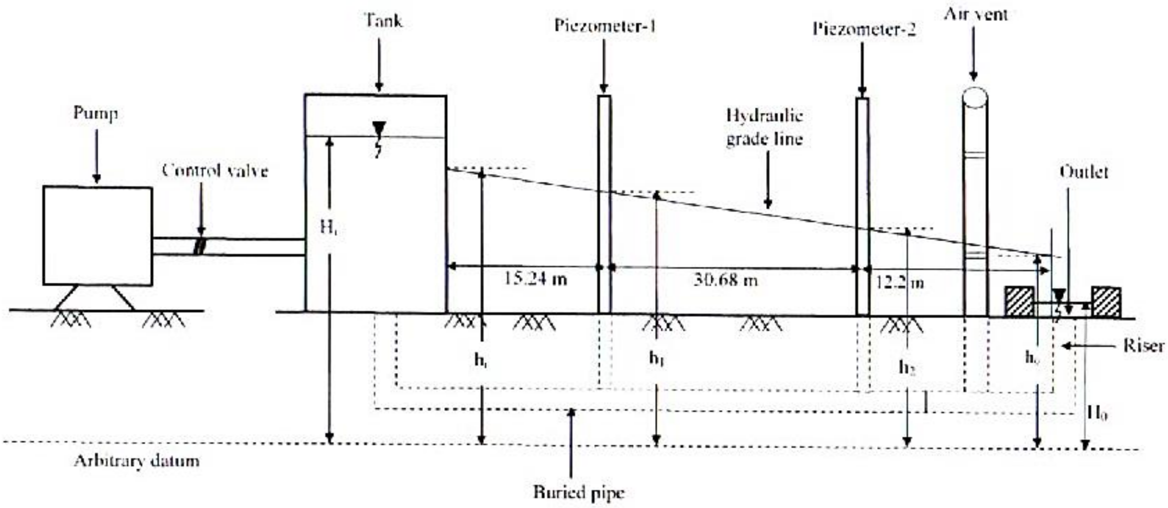

Fig. 1. Schematic diagram of BPDS in Mymensingh Scheme

BPDS in Sirajganj

Another three sites were located in the villages of Dhitpur, Chongachaand Alokdiain the sadarupazilla of Sirajgonj district about 10 km west of the upazilla headquarter. The diameters and materials of the buried pipes were 20 cm CC, 25 cm CC and 25 cm PVC respectively.

In each of the experimental schemes, electricity is used as the source of power supply. Each deep tube well discharges into a circular storage tank, made of RCC, to develop necessary head for water to flow through the buried pipe.

There are three exit openings on the floor of storage tank of each deep tube well. The exit opening, at the floor of storage tank, through which water enters into the buried pipe, is called the inlet of the buried pipe system. Each opening can be controlled by a cap plate. Before switching on the motor, the cap plate is left closed or open as required. In each of the schemes, there are three buried pipe lines in three different directions, starting from the storage tank, in each of the buried pipelines, air vents, risers, outlets are set up where required. Water from the buried pipe is discharged into an open channel through a vertical exit system, called the outlet. At the end of the buried pipeline, an end plug is used to block the pipe. A schematic diagram showing the hydraulics of flow in a buried pipe system is presented in Fig. 2.

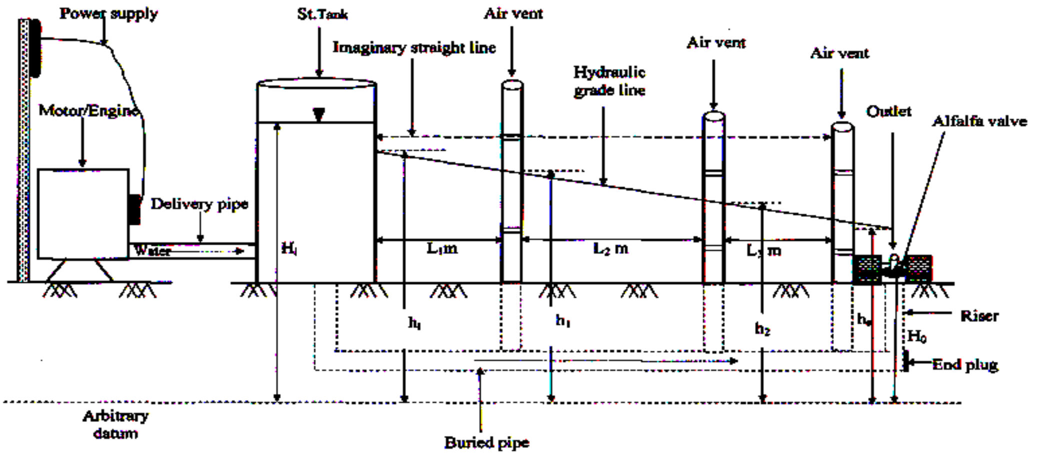

Fig. 2. Schematic diagram of (BPDS) in Sirajganj Schemes

Discharge measurement by cutthroat flume

The flow rate was measured by a cutthroat flume, placed in the open channel at the beginning of the inlet and the end of the BPDS. The flume was installed with its floor horizontal, length wise and breadth wise.

The relationship between flow rate Q and upstream depth of flow h_a in a cutthroat flume under free flow conditions is given by the flowing experimental relationship:

$$Q = c_1 h_a^n \text{.........................(1)}$$

Where, Q = flow rate, in cubic feet per second, C_1 = free flow coefficient, which is the value of Q when h_a = 1.0 foot, i.e., the slope of the free flow rating when plotted on logarithmic paper, n = exponent, whose value depends only on the flume length, L. The value of n is a constant for all cutthroat flumes of the same length, regardless of the throat width, W.

Head loss in pipe

Loss of head in feet of fluid depth, meaning loss of energy expressed in foot-pounds per pound of fluid, occurs in any flow of fluid through a pipe. The loss is caused by: (1) "pipe friction" along the straight sections of pipe of uniform diameter and uniform roughness and (2) changes in velocity or direction of flow. Losses of these two types are ordinarily referred to respectively as major losses and minor losses.

Frictional losses in a pipe are considered to be a major loss. From Darcy-Weisbach formula, loss of head h_f is given by:

$$h_f = f \frac{L}{D} \frac{V_2}{2g} \text{ ………………………………………..(2)}$$

Where,
f = coefficient of friction for pipe, dimensionless
L= length of pipe, m
g = acceleration due to gravity, m/s^2
V= velocity, m/s
D= diameter of pipe, m
h_f= head loss, m

This formula is inconvenient form since it expresses the loss of head in terms of the velocity head in the pipe. Moreover, it is dimensionally correct since *f* is a numerical factor, L/D is a ratio of lengths, and h_f and $V_2/2g$ are both expressed in units of length.

Value of *f* depends on pipe materials and velocity of flow. Value of *f* for different pipe materials and velocities are available in relevant textbooks (Michael 1978, 1986).

Field works

The flow control valve was opened fully to ensure maximum flow to be discharged to the storage tank and then the pump was started. Water from the storage tank was allowed to flow only through BPDS. After starting the pump, sufficient time was allowed to elapse to stabilize the flow through the buried pipe. When the flow through the pipe became steady, piezometric heads, h_1 and h_2 were measured with reference to an arbitrary datum as shown in Fig. 1. Inlet water head in the storage tank, H_i, causing flow through the pipe and the total outlet water head H_0 (Fig. 1 and Fig. 2) at the outlet were also measured.

Loss of head in the pipe between the two piezometers was calculated by subtracting h_2 from h_1. From this, loss of head in m per 100 m length of pipe was calculated. The hydraulic gradient line passing through h_1 and h_2 was extended backward and forward. From this line, potential head h_i, in the pipe, just outside the storage tank, was estimated in order to calculate the entrance loss. Similarly, potential head h_0 in the pipe just before the outlet was estimated from this hydraulic gradient line for the calculation of exit loss.

Entrance loss h_f, in m at the inlet was calculated from,

$h_{fi} = H_i - h_i - V^2/2g$ ………………………………… (3)

Exit loss at the outlet h_{fo} in m was calculated from,

$h_{fo} = h_0 - H_0 + V^2/2g$ ……………………………….(4)

Where, V is the velocity in meter per second through the buried pipe. H_i, h_i, H_o and h_0 are in m.

For the estimation of discharge, the upstream flow depth h_a and the downstream flow depth h_b were measured from the scales attached to the flume. The flow condition was determined from submergence ratio h_b/h_a.

After taking these measurements, flow to the storage tank was reduced by partially closing the flow control valve. Sometime was allowed to elapse in order to stabilize the flow in the buried pipe. When the flow in the pipe became steady, H_i; h_1; h_2, H_o were measured for calculation of head losses and h_a and h_b for discharge. The work was repeated for several variations of discharge.

RESULTS AND DISCUSSION

Discharge measurement by cutthroat flume

Table 1, Table 2, Table 3, and Table 4, represents the measurement data of the upstream head (h_a) and the downstream head (h_b) of the cutthroat flume, the calculated discharge values from these data as well as inlet head (H_i), inlet potential head (h_i), outlet potential head (h_o), piezometric heads (h_1 and h_2), outlet head (H_o). Coefficient values of C and n represent in Fig. 1(a).

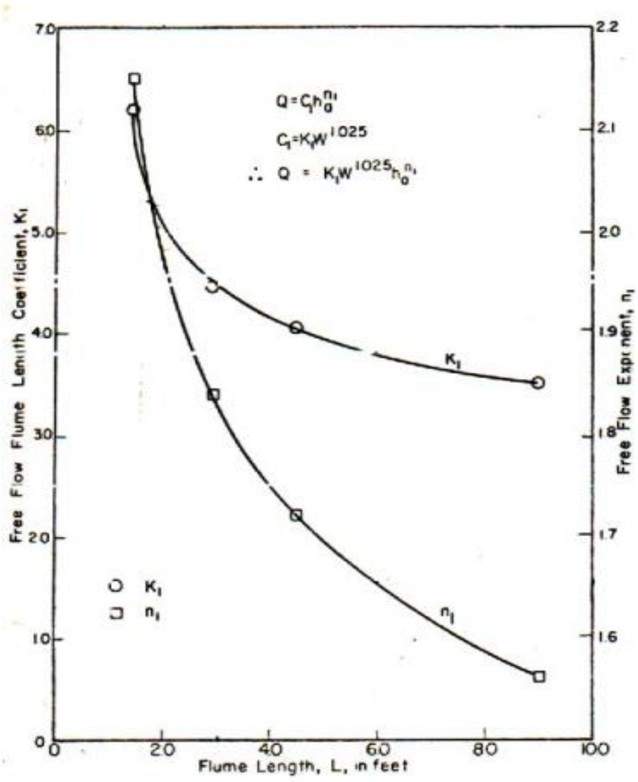

Fig. 1(a). Generalized free flow ratings for cutthroat flumes

Table 1. Measurement of discharge data by cutthroat flume and pressure head at different points of Alokdia 25 cm diameter PVC buried pipe

Test No.	h_a(cm)	h_b(cm)	S= h_b/ h_a	Flow condition	Q(m^3/s)	V^2/2g	H_i(m)	h_i(m)	h_1(m)	h_2(m)	h_0(m)	H_0(m)
1	21.27	6.52	0.31	**Free flow**	0.0524	0.058	0.835	0.656	0.639	0.559	0.496	0.327
2	20.16	5.98	0.30		0.0496	0.047	0.721	0.571	0.558	0.493	0.443	0.303
3	18.45	5.41	0.30		0.0415	0.037	0.631	0.510	0.499	0.447	0.406	0.286
4	17.24	5.10	0.29		0.0363	0.028	0.548	0.453	0.450	0.407	0.374	0.264
5	16.94	4.88	0.29		0.0325	0.022	0.453	0.401	0.393	0.359	0.333	0.237
6	14.60	4.28	0.29		0.0260	0.014	0.385	0.348	0.323	0.323	0.307	0.228
7	13.34	3.85	0.29		0.0204	0.009	0.355	0.314	0.296	0.296	0.285	0.213
8	10.95	2.95			0.0153	0.005	0.322	0.271	0.260	0.260	0.253	0.192

Table 2. Measurement of discharge data by cutthroat flume and pressure head at different points of Chongacha 25 cm diameter CC buried pipe

Test No.	h_a(cm)	h_b(cm)	S= h_b/ h_a	Flow condition	Q(m^3/s)	V^2/2g	H_i(m)	h_i(m)	h_1(m)	h_2(m)	h_0(m)	H_0(m)
1	20.80	6.17	0.30	**Free flow**	0.0496	0.050	1.337	1.130	1.040	0.843	0.761	0.425
2	19.53	5.79	0.30		0.0445	0.042	1.205	1.030	0.956	0.783	0.710	0.405
3	18.89	5.54	0.29		0.042	0.038	1.130	0.970	0.896	0.734	0.667	0.396
4	17.30	5.11	0.29		0.037	0.029	0.925	0.786	0.728	0.602	0.548	0.346
5	17.10	5.05	0.29		0.035	0.026	0.865	0.747	0.693	0.574	0.524	0.337
6	15.87	4.57	0.29		0.03	0.020	0.763	0.678	0.634	0.537	0.497	0.325
7	15.28	4.4	0.29		0.027	0.05	0.640	0.575	0.537	0.453	0.418	0.272
8	13.34	3.87	0.29		0.023	0.011	0.516	0.505	0.473	0.403	0.373	0.255
9	12.07	3.32	0.27		0.09	0.008	0.474	0.393	0.365	0.304	0.278	0.215

Table 3. Measurement of discharge data by cutthroat flume and pressure head at different points of Mymensingh 25.4 cm diameter CC buried pipe

Test No.	h_a(inch)	h_b(inch)	S= h_b/h_a	Flow condition	Q(m^3/s)	$V^2/2g$	H_i(m)	h_i(m)	h_1(m)	h_2(m)	h_0(m)	H_0(m)
1	8.35	2.56	0.31	Free flow	0.043	0.043	1.92	1.787	0.93	0.708	0.657	0.344
2	7.68	2.28	0.30		0.038	0.038	1.02	0.901	0.79	0.618	0.578	0.323
3	7.40	2.17	0.30		0.035	0.035	0.95	0.85	0.754	0.594	0.547	0.317
4	7.08	2.09	0.30		0.033	0.035	0.84	0.77	0.701	0.5460	0.507	0.307
5	6.14	1.77	0.29		0.024	0.024	0.60	0.55	0.596	0.441	0.426	0.279
6	6.41	1.78	0.28		0.013	0.013	0.49	0.46	0.321	0.291	0.283	0.237

Table 4. Measurement of discharge data by cutthroat flume and pressure head at different points of Dhitpur 20 cm diameter CC buried pipe

Test No.	h_a(cm)	h_b(cm)	S= h_b/h_a	Flow condition	Q(m^3/s)	$V^2/2g$	H_i(m)	h_i(m)	h_1(m)	h_2(m)	h_0(m)	H_0(m)
1	19.20	5.70	0.30	Free flow	0.0435	0.098	1.938	1.577	1.423	1.070	0.8700	0.4580
2	18.097	5.31	0.29		0.039	0.078	1.690	1.410	1.270	0.9560	0.7760	0.4260
3	16.750	4.83	0.29		0.032	0.053	1.35	1.135	1.035	0.808	0.676	0.394
4	15.24	4.39	0.28		0.028	0.040	1.120	0.9495	0.8708	0.6940	0.5933	0.366
5	13.97	4.05	0.29		0.025	0.033	0.929	0.7910	0.7260	0.5768	0.4910	0.3340
6	12.065	3.38	0.27		0.0204	0.022	0.6595	0.5555	0.5130	0.4160	0.3600	0.2610
7	11.589	3.10	0.27		0.017	0.015	0.5455	0.4565	0.4240	0.3490	0.3061	0.2350
8	10.319	2.80	0.27		0.0139	0.0097	0.4922	0.3955	0.3730	0.3213	0.2916	0.2275
9	9.684	2.62	0.27		0.0122	0.0077	0.4542	0.3545	0.3357	0.2926	0.2678	0.2085

Values of submergence ratio were less than 0.65 in all discharge. These indicated that free flow occurred through the flume.

Hydraulic properties

Frictional loss in m per 100 m length of pipe, friction factor and entrance and exit losses for different flow rates are presented in Table 1, Table 1, Table 3, and Table 4 respectively. These were calculated from the measured values of H_i, h_1, h_2 and H_o of each pipe.

Table 1.1. Hydraulic properties for different discharge values of Alokdia 25 cm diameter PVC buried pipe

Discharge Q (m^3/s)	Velocity V (m/s)	Frictional loss h_f (m/100 m)	Friction factor, f	Entrance loss h_{fi} (m)	Exit loss h_{fo} (m)
0.0524	1.07	0.292	0.0125	0.121	0.227
0.0496	0.96	0.235	0.0125	0.103	0.187
0.0415	0.85	0.190	0.0128	0.084	0.157
0.0363	0.74	0.155	0.0130	0.067	0.138
0.0325	0.66	0.123	0.0130	0.031	0.118
0.0260	0.53	0.075	0.0130	0.023	0.093
0.0204	0.42	0.053	0.014	0.032	0.081
0.0153	0.312	0.032	0.0160	0.046	0.067

Table 2.1. Hydraulic propertiesfor different discharge values of Chongacha 25 cm diameter CC buried pipe

Discharge Q (m^3/s)	Velocity V (m/s)	Frictional loss h_f (m/100 m)	Friction factor, f	Entrance loss h_{fi} (m)	Exit loss h_{fo} (m)
0.0496	0.98	0.61	0.031	0.157	0.386
0.0445	0.91	0.54	0.032	0.133	0.347
0.042	0.86	0.51	0.034	0.122	0.309
0.037	0.75	0.40	0.034	0.110	0.232
0.035	0.71	0.37	0.036	0.092	0.213
0.031	0.63	0.30	0.037	0.065	0.192
0.027	0.55	0.26	0.042	0.050	0.161
0.023	0.47	0.22	0.049	0.058	0.129
0.019	0.39	0.19	0.061	0.073	0.071

Table 3.1. Hydraulic properties for different discharge values of Mymensingh 25.4 cm diameter CC buried pipe

Discharge, Q (m^3/s)	Velocity, V (m/s)	Friction factor, f	Friction loss, h_f (m/100 m)	Entrance loss, h_{fi} (m)	Exit loss, h_{fo} (m)
0.043	0.85	0.0499	0.724	0.09	0.356
0.038	0.75	0.0499	0.564	0.081	0.293
0.035	0.69	0.0546	0.522	0.065	0.265
0.033	0.65	0.0597	0.505	0.036	0.235
0.024	0.47	0.0678	0.212	0.026	0.171
0.013	0.26	0.0722	0.098	0.017	0.059

Table 4.1. Hydraulic properties for different discharge values of Dhitpur 20 cm diameter CC buried pipe

Discharge Q (m^3/s)	Velocity V (m/s)	Frictional loss h_f (m/100 m)	Friction factor, f	Entrance loss h_{fi}(m)	Exit loss h_{fo} (m)
0.0435	1.39	1.23	0.0249	0.263	0.510
0.039	1.24	1.09	0.027	0.202	0.448
0.032	1.02	0.79	0.029	0.165	0.335
0.028	0.890	0.61	0.030	0.131	0.267
0.025	0.80	0.52	0.031	0.105	0.190
0.0204	0.65	0.34	0.032	0.082	0.121
0.017	0.54	0.26	0.035	0.074	0.086
0.0139	0.44	0.18	0.037	0.084	0.074
0.0122	0.39	0.15	0.039	0.092	0.067

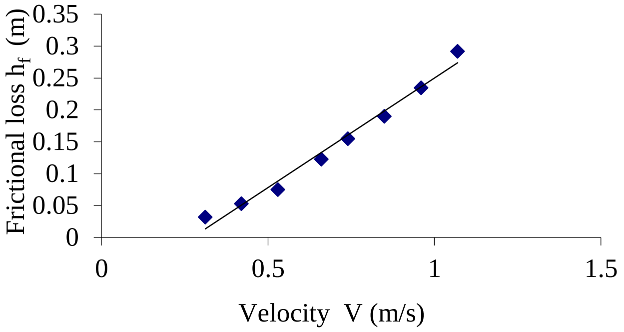

Fig. 1.1: Relationship between velocity and frictional loss for 25 cm PVC buried pipe

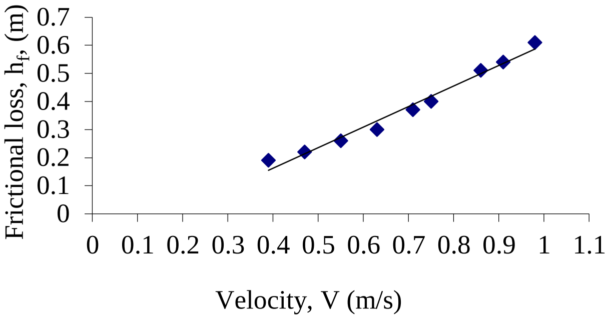

Fig. 2.1: Relationship between velocity and frictional loss for 25 cm CC buried pipe

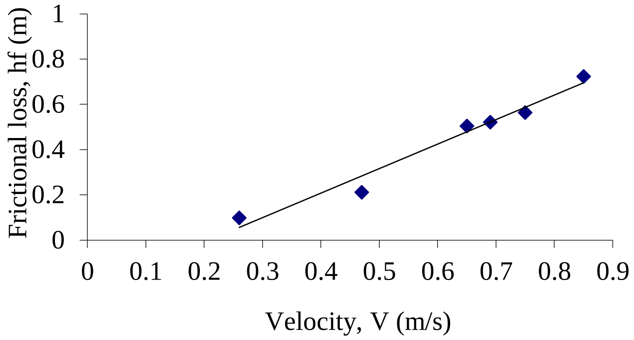

Fig. 3.1: Relationship between velocity and frictional loss for 25.4 cm CC buried pipe

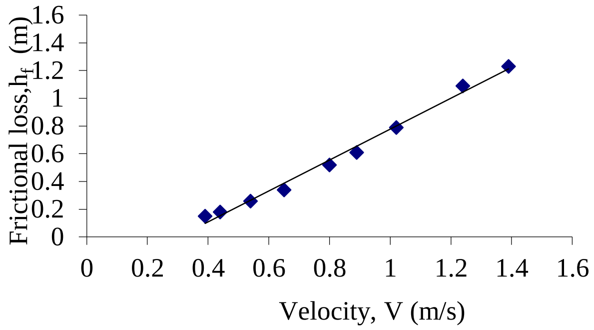

Fig. 4.1: Relationship between velocity and frictional loss for 20 cm CC buried pipe

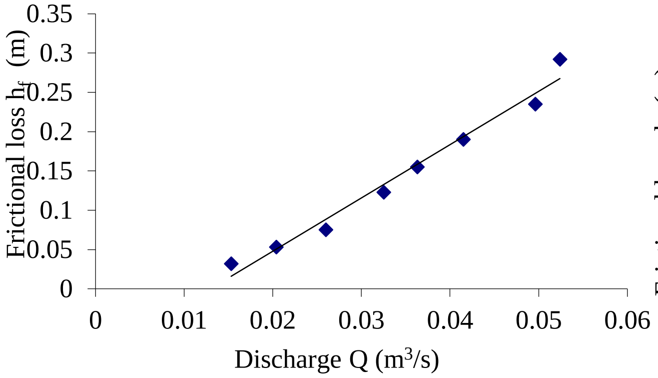

Fig. 1.2: Relationship between discharge and frictional loss for 25 cm PVC buried pipe

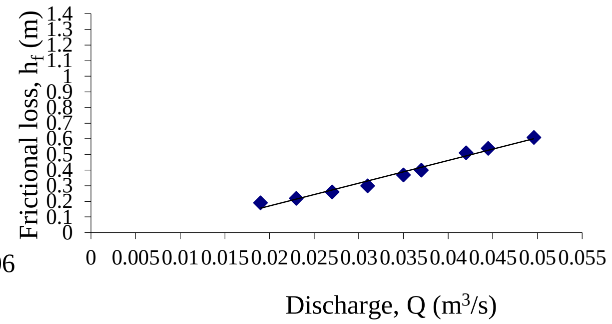

Fig. 2.2: Relationship between discharge and frictional loss for 25 cm CC buried pipe

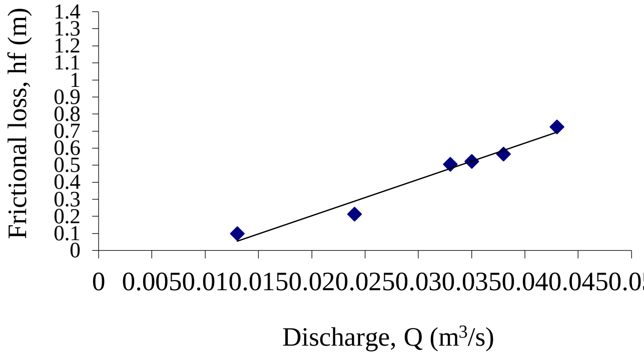

Fig. 3.2: Relationship between discharge and frictional loss for 25.4 cm CC buried pipe

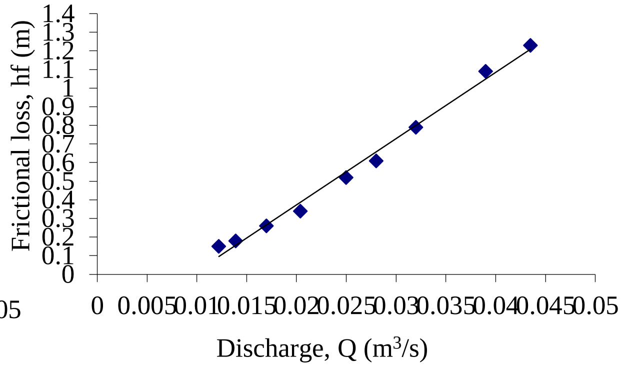

Fig. 4.2: Relationship between discharge and frictional loss for 20 cm CC buried pipe

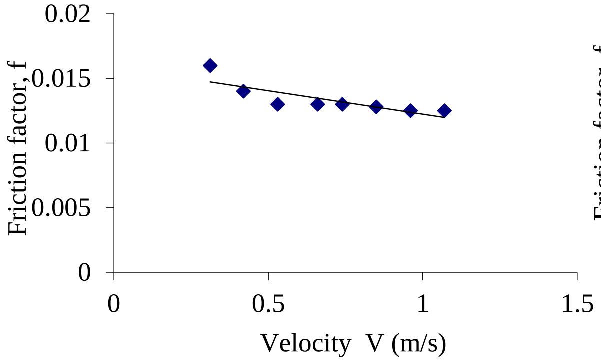

Fig. 1.3: Relationship between velocity and friction factor for 25 cm PVC buried pipe

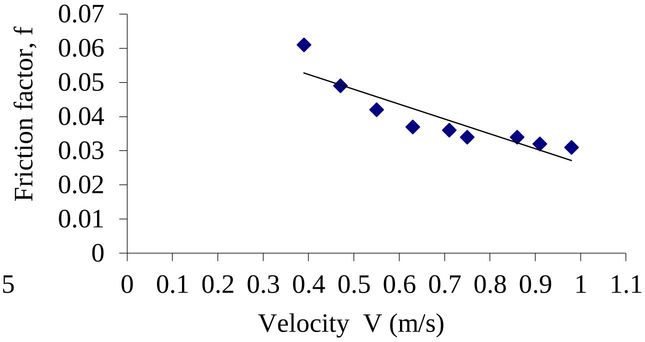

Fig. 2.3: Relationship between velocity and friction factor for 25 cm CC buried pipe

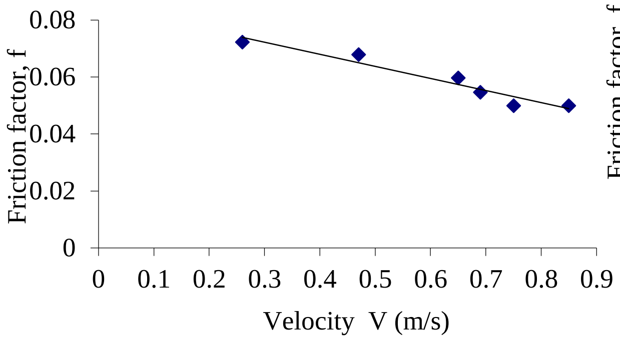

Fig. 3.3: Relationship between Velocity and Friction factor for 25.4 cm CC buried pipe

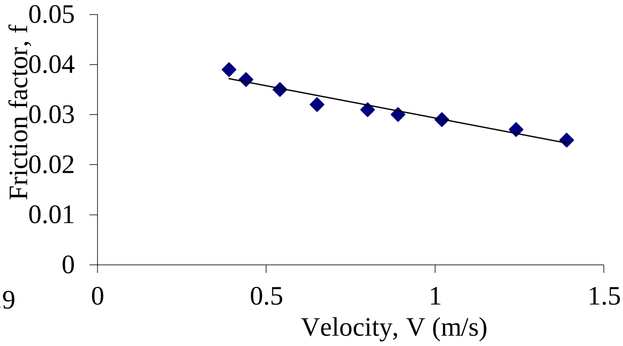

Fig. 4.3: Relationship between velocity and friction factor for 20 cm CC buried pipe

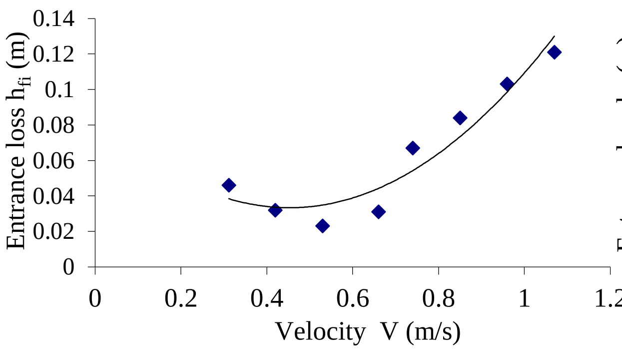

Fig. 1.4: Relationship between velocity and Entrance loss loss for 25 cm PVC buried pipe

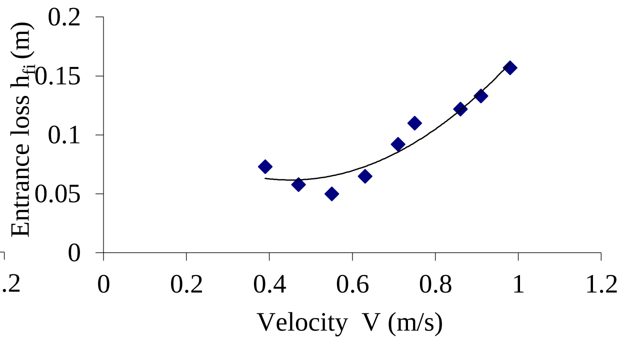

Fig. 2.4: Relationship between velocity and Entrance loss for 25 cm CC buried pipe

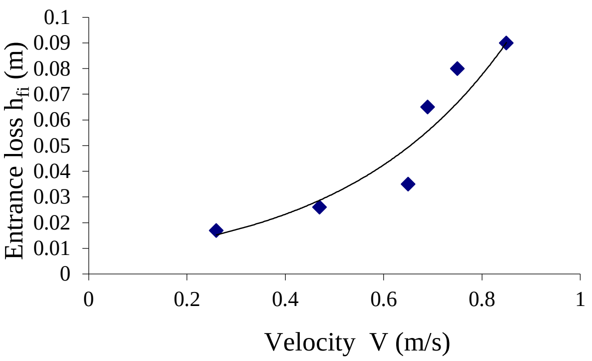

Fig. 3.4: Relationship between Velocity and Entrance loss for 25.4 cm CC buried pipe

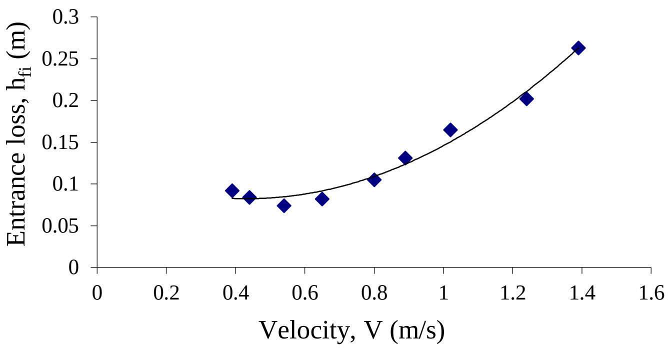

Fig. 4.4: Relationship between velocity and Entrance loss loss for 20 cm CC buried pipe

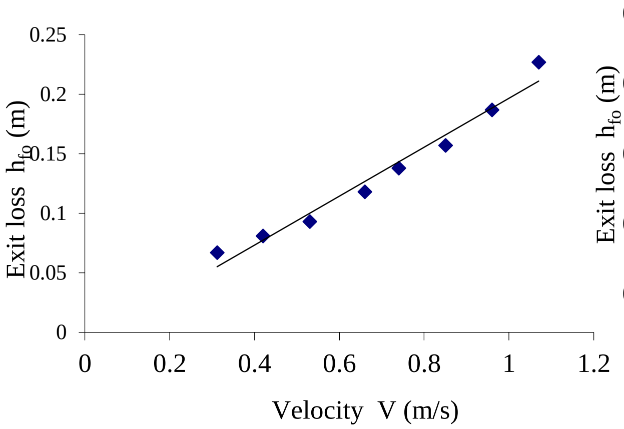

Fig. 1.5: Relationship between velocity and Exit loss for 25 cm PVC buried pipe

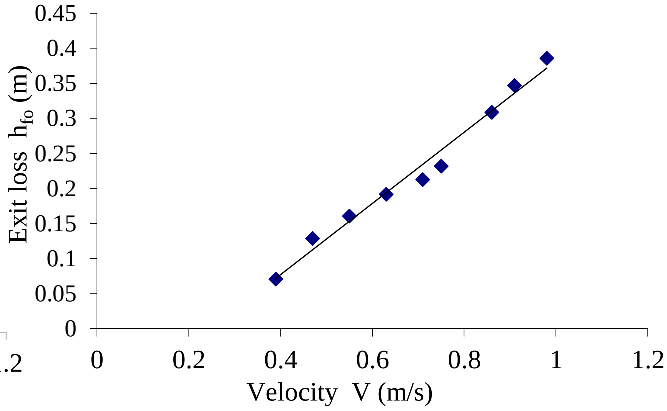

Fig. 2.5: Relationship between velocity and Exit loss for 25 cm CC buried pipe

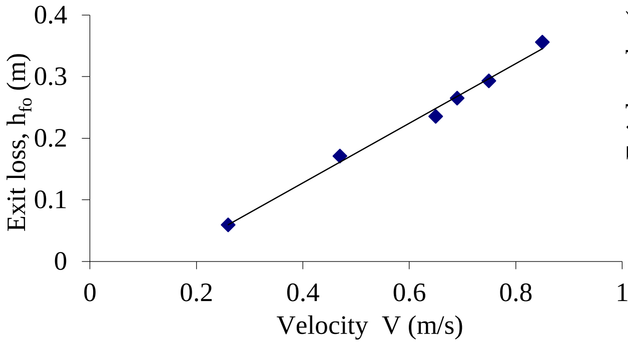

Fig. 3.5: Relationship between velocity and Exit loss for 25.4 cm CC buried pipe

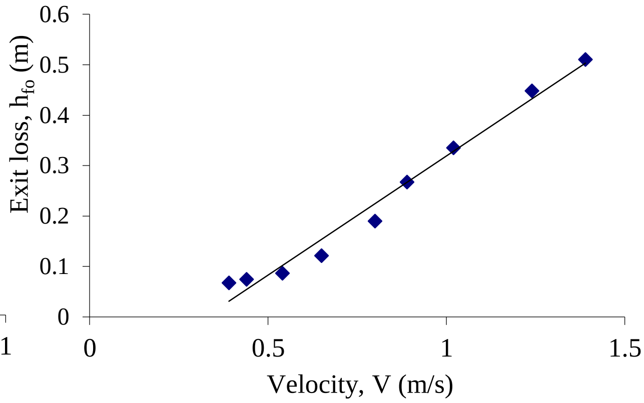

Fig. 4.5: Relationship between velocity and Exit loss loss for 20 cm CC buried pipe

Comparisons of hydraulic properties

Frictional loss

The study shows that for the same velocity and same discharge, the frictional losses were different for different pipe diameters and pipe materials. As indicated in Figs. 1.1, 2.1, 3.1 and 4.1, the frictional loss for a velocity of 0.8 m/s is the lowest in 25 cm PVC buried pipe of the three CC buried pipes, frictional loss is greater in 20 cm pipe than that in 25.4 cm pipe against the same velocity of 0.8 m/s. Similarly, for the same discharge of 0.03 m^3/s, frictional loss is the lowest in 25 cm PVC pipe compared to the CC pipes (Figs. 1.2, 2.2, 3.2 and 4.2). For This discharge, frictional loss is again greater in the 20 cm CC pipe than that in 25.4 cm CC pipe.

Friction factor

For the same velocity of flow, friction factor varies for different pipe diameters and pipe materials (Figs. 1.3, 2.3, 3.3 and 4.3). The friction factor for a velocity of 0.8 m/s is the lowest in the lowest in 25 cm PVC buried pipe of the three CC buried pipes, friction factor is greater in 25.4 cm pipe than that in 20 cm pipe against the same velocity of 0.8 m/s.

Entrance loss

For the same velocity of flow, entrance losses vary for different pipe diameters and pipe materials (Figs. 1.4, 2.4, 3.4 and 4.4). The entrance loss for a velocity of 0.8 m/s is the lowest in 25 cm PVC buried pipe of the two CC buried pipes, entrance loss is greater in 20 cm pipe than that in 20 cm pipe against the same velocity of 0.8 m/s.

Exit loss

For the same velocity of flow, exit losses vary for different pipe diameters and pipe materials (Figs. 1.5, 2.5, 3.5 and 4.5). The exit loss for a velocity of 0.8 m/s is the lowest in 25 cm PVC buried pipe of the three CC buried pipes, exit loss is greater in 25.4 cm pipe than that in 20 cm pipe against the same velocity of 0.8 m/s.

From these results and discussion, it can be said that, the frictional loss nonlinearly related to both velocity and discharge. For the buried pipes of same material, frictional loss decreases with the increase of pipe diameter for the same velocity of flow. Frictional loss in PVC is observed to be significantly smaller than that in CC pipe.

The friction factor decreases nonlinearly with the increase of velocity of flow in a given buried pipe. For the pipes of same material, friction factor increases with the increase of pipe diameter. Friction factor is significantly smaller in PVC buried pipe than in CC pipe for the same velocity of flow.

The entrance loss initially decreases up to a certain level of velocity and then it increases with the increase of velocity. For the pipes of same material, entrance loss increases with the decrease of pipe diameter for constant velocity. Again, for the same velocity, entrance loss is smaller in PVC pipe than that in CC pipe.

Exit loss varies nonlinearly with the velocity of flow. For the buried pipes of same material, it increases; it increases with the decrease of the pipe diameter. For the same velocity, exit loss is smaller in PVC pipe than in CC pipe. Exit loss is greater than the entrance loss except very low flow rates. All types of losses are smaller in PVC pipe compared to CC pipe for the velocity of flow.

CONCLUSION

From this study on cement concrete and PVC pipes, the following conclusions could be made.

- Hydraulic properties of buried pipe, such as frictional, entrance and exit losses as well as friction factor are nonlinearly related to velocity of flow;
- Frictional, entrance and exit losses as well as friction faction factor are significantly smaller in PVC pipe compared to CC pipes for the same velocity of flow;
- Exit loss is greater than the entrance loss except very low flow rates;
- As the loss of head in a PVC pipe is significantly smaller than in CC pipe, the former is particularly suitable for long buried pipe lines.

RECOMMENDATIONS

PVC pipe is found to be superior to CC pipe in terms of hydraulic properties. However, economic analyses need to be carried out to determine which of these is profitable to use in buried pipe distribution system.

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