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Metropolitan Sewers.

Experiments of Mr. Edward Gotto in respect to Tubular Back Drainings, at Dover.

February, 1849.

My first experiment with stoneware egg-shaped pipes was, in substituting a small sewer of that description, one foot three inches high and nine inches wide, instead of an eighteen-inch barrel drain, which had two years previously been constructed; and in that short time, the joints had been so entirely destroyed by the chemical action of the decomposed deposit as to allow the sewage to penetrate into the basements adjoining. Finding, however, that the depth occupied by the greatest amount of sewage was only two inches: in my next operation, I deemed it sufficient to lay down pipes nine inches by six inches to a fall of $1\frac{3}{4}$ inches in ten feet to drain twice as many houses, a plan of which is annexed. This sewer was laid in a lane at the back of the houses in Limekiln Street at my recommendation, and by order of the Dover Pavement Board. The house-drains were laid with 6-inch pipes. A short time since I conducted, during a very heavy fall of rain, the surface drainage from ten chains in length of street averaging thirty feet wide, with the roof water making an area together of 8066 yards superficial, through this sewer (six inches by nine inches); and found the depth occupied by the volume of water to be $1\frac{3}{4}$ inches, and the mean velocity twenty-eight inches in a second, increasing gradually as it approached the outfall. How did he find this out

This experience will lead me for the future in a similar case to prefer a 6-inch pipe; and from what I have observed with regard to their action, I am of opinion that house-drains may be reduced to four inches for the main branch out of the sewer to the water-closet, and to two inches for minor branches to the sink and yard grating.

The two detailed estimates subjoined shew the cost of house-drainage, water supply, &c. for two houses respectively rented at £25 and £10 per annum, under the circumstances, and in the position shewn in the plan and the enlarged drawings, and upon the assumption that the work is done at cost price, as would be the case under a local Board of Health; providing also the sewer and main for water are laid in the adjoining street.

COST OF DRAINING A HOUSE £25 A-YEAR.

		£	s.	d.
2 Cubic yards, emptying and filling up, with rough beach or rubbish, the cesspool		0	18	0
1 Water-closet pan, with syphon trap		0	7	6
Taking up and re-fixing water-closet, seat, and riser		0	2	0
8 Feet run 4-inch stoneware glazed pipe, laid in clay and jointed in cement,	at 8*d.*	0	5	4
26 Feet run 2-inch as above for roof, yard, and two sinks	at 6*d.*	0	13	0
1 Length 4-inch junction-pipe		0	2	0
2 Lengths 2-inch junction-pipe		0	3	0
2 Plain syphon traps		0	4	6
2 Sink traps fixed		0	4	6
Extra expense of junction with the sewer		0	3	4
8 Cubic yards digging and filling	at 7*d.*	0	4	8
Labour in making good the yard and street-paving, 2 labourers ½ day		0	3	3
		3	11	1
Credit for two loads night-soil (clear of cartage)		0	10	0
Total cost of drainage		3	1	1

COST OF LAYING ON WATER FOR A HOUSE £25 A-YEAR.

		£	s.	d.
38 Feet ¾-inch iron pipe, including bends, screwed joints and hooks to water-closet, and two sinks	at 6*d.*	0	19	0
1 Stop-cock and fixing		0	2	6
2 Taps and fixing		0	3	0
Total cost of laying on water		1	4	6
Total cost of drainage		3	1	1
Total for water and drains		4	5	7
Interest at 5 per cent on 4*l.* 5*s.* 7*d.*		0	4	3½
Yearly instalment, during 30 years, to pay off principal		0	2	9½
Water-rate		0	6	6
Annual Expense		0	13	7

COST OF DRAINING A HOUSE £10 A-YEAR.

		£	s.	d.
2 Cubic yards, emptying and filling up cesspool with beach, &c.		0	18	0
Water-closet pan, with syphon trap		0	7	6
Taking up and re-fixing seat and riser		0	2	0
7 Feet run 6-inch stoneware pipe main drain-pipe, laid in clay and jointed in cement	at 10*d.*	0	5	10
1 Cubic yard digging and filling	at 7*d.*	0	0	7
2 Feet run 4-inch in water-closet	at 8*d.*	0	1	4
1 Length 4-inch junction-pipe		0	2	0
16 Feet run 2-inch pipe from yard, roof, sink, and fall-pipe in front to sewer in the lane	at 6*d.*	0	8	0
1 Sink syphon trap and fixing		0	4	6
1 Plain syphon trap and fixing		0	2	3
3½ Cubic yards digging and filling	at 7*d.*	0	2	0½
Labour making good the yard and street-paving, two labourers ½ day ...		0	3	3
		2	17	2½
Credit two loads night-soil		0	10	0
Total cost of draining		2	7	2½

COST OF LAYING ON WATER TO A HOUSE £10 A-YEAR.

		£	s.	d.
16 Feet ¾ iron pipe (including bends and screwed joints) to water-closet and sink	at 6*d.*	0	8	0
1 Stop-cock and fixing		0	2	0
2 Taps and fixing		0	3	0
Total cost of laying of water		0	13	0
Total cost of drainage		2	7	2½
Total cost of laying on water and drainage		3	0	2½
Interest at 5 per cent on £3 0 2½*d.*		0	3	0
Yearly instalment during 30 years to pay off principal		0	2	0
Water-rate		0	6	6
Annual Expense		0	11	6

The foregoing estimates are made upon the present prices of materials, but it is expected that drain-pipes may be produced at two-thirds the existing prices at least.

In reference to the form of sewers, it appears to me that preference should be given to the egg-shape upon the following principles:—

The parts of the bed of a stream, acted upon most forcibly by the current, and presenting the greatest resistance to it, are the lowest, as may be seen by the contracted channel wrought out in the bottom by running water; and therefore, if the bed of a stream be narrowed by bringing the sides more upright, it follows that the energy of the current will be concentrated on the bottom, and the sides will experience, comparatively, little friction, and so offer the less resistance: there being thus less obstacle to the flow, the same quantity of water will pass more rapidly and, of course the sectional area in such contracted parts will be in proportion diminished. This point can be more satisfactorily determined by experiment than by calculation, for the genius of all calculations on the velocity of running waters, like these on the motion of solid bodies, lies in the degree of resistance (or friction) they meet with. In the instance of sewer pipes, this friction varies according to the *shape*—and, therefore, no fair comparative calculation can be made between *circular* and *egg-shape sewers;* yet, even upon the supposition that the sectional area occupied by the same quantity of water passing through sewers of both shapes and uniform in capacity and declination, and that every part of the frictional surface of both descriptions presents the same resistance (which hypothesis cannot however be maintained, but as before shewn, the egg-shape pipes possess great advantages) nevertheless it can then be shewn that within the limits ordinarily occupied in sewers by the united streams from house-drains, the velocity must be greater in the egg-shape than in the circular :—

NINE-INCH CIRCULAR PIPE.

Declination, 1 inch in 10 feet = 1055 inches in two miles.

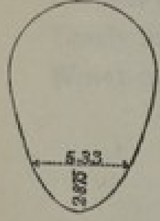
Sectional area $= \frac{2(7.25 \times 2)}{3} + \frac{2^3}{2(7.25)} = 10.21$.

Frictional line = 8.5.

Hydraulic mean depth $= \frac{10.21}{8.5} = 1.213$.

Mean velocity $= \frac{10(\sqrt{1.213 \times 1055})}{11} = 35.6$ inches in a second.

EGG-SHAPE.



Declination as above = 1055 inches in two miles.

Sectional area $5.33 \times \frac{2 \times 2.875}{3} = 10.20$.

Frictional line = 8.

Hydraulic mean depth $= \frac{10.21}{8} = 1.276$.

Mean velocity $= \frac{10(\sqrt{1.276 \times 1055})}{11} = 36.73$ inches in a second.

But if this comparative calculation be prosecuted without a due regard to the various points of friction on the sides and bottom of the section, it will be unfairly to the prejudice of the egg-shape, because in proportion as the volume of water is augmented in each description, beyond the limit alluded to, the length of frictional surface will be greater in the egg-shape than in the circular, *but the amount of friction will not be so great.*

Although, it must be admitted, that experiments upon a large scale are essential to demonstrate the real proportion due to the several points of channels of various forms, in the way of friction, and to exhibit the precise influence of gravity upon that friction; and how far both these elements affect velocity, yet our present limited experience, and I submit, the foregoing observations, shew, that velocity is materially affected by the form of the sewer; and that, although on extraordinary occasions, when the sewers are more full than usual, the circular form may present less frictional surface than the egg-shape, yet the amount of friction is not so great; and again, that there is more friction upon a circle than on the parts of an elipse, which has been shown from a very unfavourable hypothesis to be the case.

(Signed) EDWARD GOTTO.

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EXPERIMENTS

OF

MR. EDWARD GOTTO

IN RESPECT TO

TUBULAR BACK DRAINA

AT DOVER.

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