SCIENTIFIC—SANITARY ENGINEERING.

Lectures by Professor H. T. Bovey, of McGill College.

ANSWERS TO QUESTIONS IN LECTURE No. VIII.

1. A long sewer of circular section has a uniform slope; show that if the water is to attain the greatest velocity the stream must only partially fill the channel; and if A be the supplement of the angle subtended at the centre of the section by the unwetted portion of the circumference, then $\pi + A = \tan A$.

Ans.—The angle subtended at the centre is $180° - A°$. The sectional area of the water-way is therefore $\frac{R^2}{2}(\pi + A + \sin A)$, and the wetted perimeter is $R(\pi + A)$, where R is the radius.

Then the mean hydraulic depth H is equal to $\frac{\frac{R^2}{2}(\pi + A + \sin A)}{R(\pi + A)}$

Now, the velocity varies directly as the mean hydraulic depth, and therefore will be a maximum when H is a maximum.

Putting the differential co-efficient of H with respect to A equal to zero, we obtain finally $\frac{2R(1 + \cos A)(\pi + A) - 2R(\pi + A + \sin A)}{4(\pi + A)^2} = 0$, which reduces to $\pi + A = \tan A$.

"Hence, too, we see that the velocity of the stream is greatest when the sewer is not quite full." JOHN S. O'DWYER, (3rd year).

2. A low-level sewer of circular section recently constructed in Torquay is seven feet in diameter, and is capable of discharging 8,000 cubic feet per minute; will it be a sewer of deposit?

Find the fall, and also the "head," which would be sufficient to maintain the velocity of discharge, the length of the sewer being about 2,000 feet.

If the sewer were constructed of brickwork, what should be its thickness?

Ans.—The velocity of discharge in feet per minute is equal to $\frac{8{,}000}{\text{sectional area of sewer}} = 208$ nearly.

Therefore the sewer will not be one of deposit, as the velocity is quite sufficient to keep it clear.

Again, the fall in feet per mile is given by the equation $V = 55(2FD)^{\frac{1}{2}}$, or $208 = 55(2F1\frac{3}{4})^{\frac{1}{2}}$, whence F, the fall in feet per mile, is 4.1 nearly. Hence the fall for a length of 2,000 feet is 1.86 feet, nearly,

To find the head of water necessary to maintain the discharge of 8,000 cubic feet per minute, we have the equation $Q = 2356\left(\frac{h}{l}.d^5\right)^{\frac{1}{2}}$, where Q denotes the discharge, h the head, l the length, and d the diameter, all in feet. Hence h = 1.4 ft. nearly.

The depth of excavation being twenty feet, the thickness of the sewer is given by $t = \frac{d.r}{100} = \frac{20.(1 + 3\frac{1}{2})}{100}$. Hence t = 10½ inches; so that the sewer will require to be three rings thick of 4-inch bricks.

T. DRUMMOND (2nd year).

LECTURE IX.

MATERIALS.

Portland Cement is composed of chalk and clay burned at a high temperature, and ground to a very fine powder. The heavier it is, the stronger it becomes and the longer it takes to set; it must therefore be protected from running water. It does not deteriorate from age, if kept dry. The amount of cement required is not less than the interstice space of the sand used.

SPECIFICATION.—It is to be of the best quality, ground extremely fine, and weighing not less than 112 lbs. to the Imperial striked bushel. It is to be brought upon the works in a state fit for use, but it is not to be used therein until it shall have been upon the works, at least three weeks. It shall be capable of bearing 350 lbs. per square inch after seven days immersion in water, and shall be tested as the engineer may direct. It shall be mixed in the proportion of one of cement to one of sand, and shall not be used after it has begun to set.

Roman Cement is manufactured from "Septaria," and is cheaper than Portland Cement, but not so strong. It sets quickly, and is therefore useful as an inside rendering. Its tensile strength does not exceed 100 to 125 lbs. per square inch after seven days immersion. It should not weigh more than 75 lbs. to the striked bushel, and should be used in the proportion of one of cement to one of sand.

Medina Cement is also manufactured from "Septaria," and sets very quickly, but has less strength than either Portland or Roman Cement.

Blue Lias and Hydraulic Limes may be used, but they must be of the best possible quality, and should "invariably" be carefully tested. They are to be ground sufficiently fine to pass through a sieve with 1,600 meshes to the square inch.

SPECIFICATION.—The lime (say blue lias) shall be obtained from the lowest and hardest beds of the blue lias formation, and shall be brought in lumps fresh from the kiln and ground upon the works in mills under edge runners.

Lime Mortar:

SPECIFICATION.—The mortar shall be mixed in the proportion of one of lime to two of sand; it shall be well tempered, and ground in similar mills for 30 minutes at least, adding the necessary quantities of water from time to time.

Many other cements are in use (*e.g.*, Keene's Parian, Plaster of Paris, &c.) but are only suited for the interior fittings of public and private buildings.

Sand should be of a pure silicious character, free from nitrogenous and some saline matters, and of various degrees of fineness. It dilutes the cement, so to speak.

SPECIFICATION.—The sand shall be very clean, sharp, washed river sand.

Water.—Fresh or sea water may be used for mixing with Portland cement, and according to Grant's experiments the sea water rather augments the strength of the cement. Only sufficient water should be used to bring the mortar into a thick paste.

Concrete (or Beton) is a mixture of mortar, usually hydraulic, with some coarse material, as broken stone, brick, shells or gravel. The material used should be perfectly clean, and of irregular sizes. The proportion of cement should be such as to form good mortar with the sand alone; and the mortar thus made should be somewhat in excess of the interstices to be filled, so that the coarse material may be quite surrounded. The material must be thoroughly saturated with water. No more than is to be quickly used should be mixed at one time.

SPECIFICATION.—(1) Lime concrete shall be composed of clean ballast or stone chippings of sizes, and ground hydraulic lime, fresh burned, mixed in the proportion of six by measure of the former to one by measure of the latter.

(2.) The Portland cement concrete for the sewers and shafts shall be composed of four measures of hard clean limestone, broken into angular pieces so as to pass in any direction through a ring 2 inches in diameter, two measures of sharp clean sand, and one equal measure of cement. The concrete shall be turned over once dry, twice wet, and thoroughly mixed up on a clean floor, placed in the work, and rammed where directed.

Timber, for permanent work, should be free from injurious shakes, large and loose knots, and sap wood. The best kinds are alder, beech, elm, larch, oak and teak. Processes for preservation are sometimes resorted to.

Iron:

SPECIFICATION.—The castings shall be clean and sound, free from porous places, sand and air-holes, and they, as well as the wrought iron work, shall be free from hammer marks and all other imperfections. The whole shall be delivered on the works free from paint or other coatings. All iron sent with plugging or stopping in any part will be rejected, and must at once be removed. Patterns of all castings are to be approved by the Engineer before being run.

TESTS.

Brick.—(1.) Soak a sample brick in water, and expose it to frost.

(2.) Weigh the brick, then leave it immersed for a week in a strong solution of sulphuric acid, and weigh it again when dry.

(3.) The brick should also be subjected to a crushing test.

Earthenware and Stoneware.—For Impermeability.—(1.) Dry the pipe till it ceases to lose weight, submerge it in water for 24 hours, then wipe it dry and re-weigh.

(2.) Tie a bladder over the end, reverse and fill with water, and carefully observe the tendency to sweat.

Cement.—Mechanical.—(1.) Mould the material into blocks of a suitable form, allow them to remain under water for seven days, and then subject them to crushing and tensile strains.

Chemical.—(2.) Subject a portion of it to a standard solution of nitric acid, say distilled water with 10 per cent. of the acid.

Portland Cement.—(3.) In an emergency, make two parts, and keep one in the water and the other dry. If clay preponderates, the part in the water will assume a buff color. If the cement is over-chalked or over-burned to the point of danger, little cracks will be perceptible all round the edge of the wet cake, and if the latter of these indications are found the cement must be laid aside.

Test equally applicable to brick, stone, mortar, &c.—Prepare a cold saturated solution of sulphate of soda, then bring it to the boiling point, and suspend by a string for 30 minutes the sample under trial; then pour the liquid, free of sediment, into a flat vessel, and suspend the stone over it in a cellar. When efflorescences appear on the specimen, it must be dipped in the solution two or three times a day for, say, a week; the quantity of earthy sediment in the vessel collected on a filter and weighed will indicate the effect to be expected from frost on the same sample.

Questions.

1. Explain the method of jointing stoneware pipes. What are the objections to the use of clay as a jointing material?

2. A line of sewer is constructed as follows:—From A to B, a distance of 367 ft., it is 1 ft. 6 in. in diameter; from B to C, 1,720 ft., 2ft. 3 in. in diameter; from C to D, 2,200 ft., 4 ft. 6 in. in diameter; and from D to outlet, 11,387 ft., 7 ft. in diameter. At B its direction turns through a right angle, with a radius of 200 feet, and at C through an angle of 135°, with the same radius. Find the requisite falls to be given to each length, so that the line from A to D may be running full, and the main sewer half full and discharging at the rate of 3,000 feet per minute.

H. TAYLOR BOVEY.

28th November, 1878.

WITTICISMS.

For wit, in the combat, as gentle as bright,
Ne'er carried a heart-stain away on its blade.—MOORE.

WATER in motion, is water still.

WHAT is the exact width of a broad grin?—*Reveille.*

SARCASM is a keen weapon, but in handling it many people take hold of the blade instead of the handle.—*Josh Billings.*

"SANDY, what is the state of religion in your town?" "Bad, sir; very bad! There are no Christians except Davie and myself, and I have my doubts about Davie."

CLASS IN ZOOLOGY.—Prof.: "Do fowls have teeth?" Mr. P.: "Yes, sir." Prof.: "Name one that has." Mr. P.: "Goose." Prof.: "Yes; I know *some* that have."

"A YOUNG DOCTOR in —— spends his leisure hours practising on the violin, and passers-by, thinking an amputation is going on inside, are deluded as to the number of the man's patients."

"Be ever ready to acknowledge a favour," says a writer. We are, sir; we are. What troubles us is, that on one side we are completely loaded down with readiness, while on the other side opportunity is painfully scarce.

THE wise man who writeth to another for information for his own behoof, encloseth a postage stamp for reply, and is informed; but the fool discerneth not the value of a governmental adhesive plaster, and remaineth in ignorance.