REINFORCED CONCRETE PIPES.*

By Arch. Currie, C.E., City Surveyor, Westmount.

To a French gardener, M. Monier, must be given the credit of having first employed reinforced concrete, for in 1867 he constructed large flower pots of cement concrete with a reinforcement of metal.

Reinforced concrete was undoubtedly known before that date; a patent having been taken out in England for a suspension reinforcement in 1854, an exhibit of this material being shown at the Paris Exhibition of 1855, and several methods of its application having been proposed by a French engineer, M. Francis Coignet, as early as 1861.

No further progress seems to have been made till about 1855, when German and Austrian engineers took the question up. England and America quickly followed, but it is only in very recent years that the problem of the construction of reinforced concrete pipes has been seriously taken in hand.

In this age of improvement of all kinds, but more especially with regard to those of sanitation and water supply, improvements that are necessarily of a costly character, municipal bodies are frequently debarred from carrying out such owing to:—

(1) The initial cost; (2) The cost of repairs owing to corrosion in iron or steel pipes; and (3) The additional burden placed upon the taxpayers. But it can be claimed that reinforced concrete pipes have the following advantages:

(1) Reduced initial cost; (2) There being no corrosion or leakage, repairs are reduced practically to nothing; and (3) The tax rate under these conditions would be considerably less.

The above advantages appeal largely to the public, but there are other advantages which commend themselves to the engineer who acts as advisor to the public.

As is well known, the principal duty of the metal in a water main is to withstand the tensile stress set up in it by the internal water pressure. Now, if a cast iron main is designed simply to resist this stress, the result is that a thin cylinder of cast iron is designed which is almost too thin to cast with accuracy, and iron being a metal adapted to resist compressions and not tension the result does not instill confidence, and a certain percentage of metal is boldly added to cover irregularities in manufacture, unequal bedding in trench, water hammer, road traffic, etc., and, after all, a metal has been used which is not well adapted for its duty, but is used almost universally, being both cheap and convenient. If a sheet steel main is designed simply to withstand the internal pressure, the result would probably be a sheet so thin as to cause doubt as to its power to resist collapse from the weight of the material filled in the trench or from road traffic; the thickness of metal is therefore increased to cover this and the weakness of joints; and this addition to an expensive metal is costly, and although the body of the pipe is of an excellent material and well adapted for its duty and would give more confidence than the more uncertain cast iron pipes, yet both of them are subject to corrosion, which will in time destroy them, the steel pipe first because it is thinner, and the rate of decay practically the same for both metals with pure water. It is therefore necessary to protect both the cast iron and the steel main from corrosion, and for this purpose the pipes are treated with an application of bitumen or other preventive. How long this preventive coating will last under the best conditions it is not possible to say, but it is probable that its effect is simply to defer the time of commencement of the attack by corrosion for a few years, and that once this sets in little assistance is obtained by the coating.

It is only during the past few years that the various valuable properties of cement in combination with steel have been thoroughly realized; it has been vaguely known that when the space between the outer and the inner skins of the hull of an old iron or steel ship have been filled with liquid cement and a portion of this structure is cut into after 30 or 40 years, the metal is found to be perfectly preserved; this experience of ship builders was not generally or widely known by engineers or architects, or if known has not been acted upon. It is on record that a bar of iron after being embedded in concrete for about 400 years was perfectly preserved.

The principal features of value in adopting reinforced concrete for pipes that are to be put under pressure are: (1) Strength—this can be made sufficient to deal with any pressure to which the pipe may be subjected; (2) If steel is well surrounded by cement the metal is protected for a very long period, much longer than any rust preventive will increase the life of a metal pipe. The adhesion of cement to metal excludes all air and prevents rust, thereby allowing the metal to maintain its original strength. As to the cement covering it is well known that cement concrete increases in durability with age and particularly so when impregnated with water.

The following description of the manufacture, laying and jointing of one of the many systems of reinforced concrete pipe, and carried out under the writer's supervision may be of interest:

The pipe consists of an interior tube or sheet of mild steel, varying in thickness from 1/32 in. to 1/8 in. according to the pressure to which the pipe is to be subjected, built up in sheets manufactured locally. The jointing of the steel tube sheets is effected by means of oxy-hydrogen blow pipes, which make autogenous welds. The oxygen and the acetylene, or other heating gas, may be so regulated at the blow pipe as to give either a fusing flame or a burning or oxydizing flame. With this latter flame iron or steel can be cut to any shape; with the former it can be fused or welded together with no waste.

The circumferential joints in the tube are made by turning up the edges of the sheets and welding the adjoining edges, whereas the longitudinal joints are butt joints. The ends of each tube are turned up and a collar made of sheet steel is turned up to form a stop and for the external cement coating.

Outside this steel tube is placed the external reinforcement consisting of bars of the section of a Latin cross wound in helical form around longitudinal parallel bars of smaller cross section, all the crossings of the tube being wired together.

The external reinforcement and the steel tube only are taken into consideration in calculating the strength of the pipe, and the distance apart of the helices is varied to suit the pressure in the main. An internal reinforcement constructed with a lighter section of bar is constructed in the same manner. The only duty of this internal reinforcement is to support the inner portion of the cement, and is not taken into account in the calculations of the strength of the pipe. When the three portions of the steel skeleton are completed, the inner reinforcement is placed inside the tube and the outer reinforcement outside; they are then placed vertically on curved wooden curbs made to the shape necessary to centre them and preserve the correct thickness of the cement coating.

The next operation is the moulding or casting of the pipe. A collapsible core made much on the principle of an

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