SEGMENTAL BLOCK SEwers


This article in the series on various materials used in sewer construction is devoted to one of the newer systems, that using segmental blocks, which differ from bricks in their size, in their material in concrete block sewers, and in the form in which that material is put up in vitrified clay block sewers.

There is a large field for this method of construction and success has been met with almost uniformly in building strong, durable and sanitary sewers and in keeping the cost within reasonable limits. As knowledge of the material and of the sewers built with it increases, the use of the system seems certain to increase.

SEGMENTAL block sewers are those constructed of blocks laid in place to form both invert and arch. Each block occupies a segment of the complete circumference or perimeter. The blocks are made of concrete, sometimes it is a vitrified clay product. The blocks are made and matured before being put in place. As each is of moderate size, it is possible to insure high-class manufacture, whether the material is vitrified clay or ordinary concrete. Ordinarily the blocks need not be larger than one-man size. Thus, in a patented system of concrete blocks the largest block has a weight of 180 pounds. It goes into the ring of a 15-inch sewer. More usual weights of concrete block segments range from 100 to 125 pounds. Weights of vitrified clay segments are, say, one-third of the latter or less.

A considerable advantage of the segmental block system, whether concrete or hollow tile be used, is the fact that the invert may be laid in water. Or we may lay the invert and allow water to run over it at once. In practical construction this may at times be an exceedingly advantageous possibility.

A further practical advantage consists in the fact that it will ordinarily be practicable to go ahead with the backfilling at once upon completion of the arch, or at least with a very inconsiderable delay.

The centering required for segmental block construction need be nothing more than a skeleton. This will be removable after a ring or two have been set in place. There are some special devices for centering for which advantages in handling are claimed.

Still further, in segmental block sewer construction, the difficulties of working in tunnels are reduced from what they would be with the placing of mass concrete.

Some of these advantages make for speed in construction. Some make for quality. Certain of the advantages possessed, no doubt, by other systems. Ordinary brick sewer construction possesses none. But even here the segment block, being much larger than a brick, permits a single handling to produce the equivalent of many bricks. The reduction in joints is another advantage.

The advantages enumerated are possessed in common, the perhaps not to precisely the same degree, by both the concrete block and the vitrified block.

The inventor of a patented concrete block claims the following additional advantages: (1) The steel reinforcement may be placed to great advantage, "the tensional regions of the intradoses may be anchored against those of the extrados of the arch." (2) Minimum weight of steel required to secure effective reinforcement with regard to the quality of the concrete, the manufacture of small blocks above ground permits us to secure a high degree of imperviousness.

The vitrified block for use in segmental construction has been on the market for 5 or 6 years. Each block has partitions parallelizing the axis of the sewer, which divide the hollow inside into two or more channels. When the blocks are assembled it is possible to lay the invert blocks so that a kind of subdrain is formed by the junction of transverse longitudinal passages. The objection has, however, been made that when laid to secure this advantage, if advantage it be, it is difficult to make a water-tight joint where end of block joins end of block. It is said to require especial care to produce an impervious joint. The longitudinal joints are more easily made watertight because of the increased area of surface with which the mortar is in contact and because the longitudinal joints surfaces are corrugated.

Segmental blocks of vitrified clay are made in a multitude of sizes corresponding to sewer diameters, varying from 36 to 168 inches.

The problems in laying segmental block sewers are in part the same as those encountered in laying masonry and brick sewers. There must be an adequate foundation. This will usually be afforded by the natural strata. However, it must be borne in mind that it is very necessary that the support provided be even. Hard and soft spots contribute a poor condition for vitrified pipe and concrete pipe. It will be safest to assume that such a condition will be even poorer for the barrel of a segment-block sewer, for the reason that this barrel is made of many parts and that there are many joints. If the soil does not have good supporting power we may enlarge the base of the sewer by means of a concrete invert having a flat base sufficiently wide to distribute the load.

Vitrified segmental blocks differ somewhat with different ranges of size. All ends are either formed or laid so as to break joint radially as well as longitudinally. The Amco block has an offset at one end fitting into a corresponding recess on the other end. The Natco block for the larger sizes of sewers is made in two layers so that the blocks break joint in all three directions—radially, circumferentially and...
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longitudinally. Corrugations or definite projections on the radial faces coming in contact, aid in making water-tight joints as well as in making the completed sewer more nearly monolithic. Because of the hollow construction we get a very stiff form along with a comparatively light weight.

For a 24-inch Amco sewer each segment will occupy 45 degrees of the circuit and will weigh per linear foot of length 23 pounds. One foot of sewer will contain 184 pounds of segment block. The mortar will add something to this. The overall thickness of the block will be 4 inches. The effective width of the block on the face which is to be on the inside of the sewer will be 9 1/16 inches.

A 72-inch Amco ring will have a radial thickness of 7 7/16 inches and a weight per linear foot of pipe of 938 pounds. Twenty blocks complete the circle. The standard length of vitrified blocks for sizes from 24 to 72 inches, including both extremes, is 24 inches.

For a Natco double-tile, 72-inch-ring sewer the thickness of wall is 8 inches and the weight per linear foot of sewer is 940 pounds. Fifteen double tile are required. The standard length of blocks is 18 inches, but they are also made 2 feet in length.

With concrete blocks the number of blocks in a ring may be less than with the hollow tile segments. For example, a rather large sewer may have only 3 blocks in the half-circle of the invert. But the length of a block may be only 12 inches. A 24-inch sewer may be constructed with 4 blocks to a ring. The thickness of the concrete will be 2 1/4 inches. The bottom block may have a flat under surface which extends 45 degrees to either side of the bottom line of the invert. We have thus a 90-degree invert without longitudinal joint. The top block will be similarly placed immediately overhead. The reinforcing rods are placed partly in the joints between blocks, where they are covered with the mortar, and partly in the body of the concrete of the top and bottom blocks. It is possible to arrange the circumferential rods in the form of an ellipse flattened top and bottom. That is to say, the rods are nearer the inner surface of the concrete tubular shell at top and bottom and nearer the exterior surface at the ends of a horizontal diameter. There is more or less breaking of joints in laying the blocks.

Fifteen hundred feet of sewer of the segmental block type were constructed in Harrisburg, Pa. This tube is 48 inches in diameter. Each block covers 90 degrees of circuit and 1 foot of sewer length. As many as 225 segments were made in 1 working day of 10 hours with a crew of 9 men. Later on the same contractors were able to turn out 250 blocks with 8 men on a job at Johnstown. Apparently, the Harrisburg sewer was laid on the bare soil wherever the ground was considered good. Where the soil was thought had two boards would be laid on the bottom and the space between and to either side of the pair of boards was leveled up with concrete. This formed a kind of bed upon which the flat side of the invert block was laid. However, tar paper 2 inches wide was interposed between bed and block at the end joint. The haunches were then filled in with concrete.

A part of this sewer is above the general surface. This is at the bottom of a partly filled gully. Here tiles were placed in groups, caps put on the groups and longitudinal timbers laid. A thin stratum of concrete was placed on the timbers and the invert blocks put in place upon the bedding thus formed. The bed was completed by filling in the haunches with concrete and bringing it up to the level of the horizontal diameter. The concrete bed was made 4 inches thick at these upper points.

Concrete blocks of a different sort were used in the construction of eleven miles of sewer at Edmonton, Alberta, Canada. The sewer varied in diameter from 4 to 10 1/2 feet. The joints in axial planes were very long for the purpose of placing longitudinal reinforcing rods. Circular reinforcing rods were used to envelop the barrel of the tube. The whole barrel with its exterior reinforcement was enveloped in concrete. All this is equivalent to a sewer of reinforced mass concrete lined with concrete blocks. The ring of reinforcement around the blocks consisted of four pieces. Two of these were rods, enveloping nearly the whole of the arch, and the other nearly the whole of the invert. At the ends of the horizontal diameters of the barrels of blocks special pieces were used to bridge the intervals between the upper and lower rods. These pieces were provided with openings or slots into which the rod ends might be passed. The rod ends were threaded and the form of the connecting pieces was such that the threads could be utilized by means of nuts to draw the ring tight against the barrel of blocks. Including rods and connecting pieces, the reinforcing ring fitted tight to the barrel, throughout nearly the total of the circuit. This arrangement provided circular reinforcement in a definite position and did not involve the complication of casting any of the blocks with reinforcement embedded.

All blocks had a standard circumferential length of 12 inches, a radial thickness of 4 inches and a length (along the sewer axis) of 12 inches. They were made of concrete in

II. PERSPECTIVE OF NATCO DOUBLE-TILE SEWER AND V-BRANCH.

III. SECTION OF NATCO DOUBLE-TILE SEWER AND Y-BRANCH.
The second photograph shows a 45-inch double-tile Nato block drain in Illinois, in which there were a number of constructive difficulties due to the irregularity of the old drainage ditch in which much of the drain was laid. The ability of the sewer to carry a heavy weight is shown by the crane following up the ditch and making the backfill. The loose earth of the fill makes this a particularly heavy test of the strength of the sewer, especially since the filling at the sides of the sewer is unusually broad and the consequent support of the sewer on haunches of invert and against the horizontal thrust of the arch at the springing line is less than is usually expected in sewer construction.

One of the strong points of the segment block sewer is the strength of the construction. In one test of a Natoe single-block sewer of 36 inches inside diameter, 50 inches long and supported only on the invert, the arch being entirely uncovered, 22,040 pounds was loaded on a square 12-inch saddle resting on the center of the top of the sewer before a crack appeared. A 48-inch double-tile sewer carried 20,950 pounds without fracture under the same conditions.

While the segment block is scarcely ten years old made of concrete and is still heavier as made of vitrified clay, its popularity has increased with great rapidity and the indications are that it will displace brick for sewer construction for the larger sizes to a great extent, and will successfully compete with the various methods of building concrete sewers.

(Experient Note.—We are indebted to the National Fireproofing Company, Pittsburgh, Pa., for most of the illustrations used in this article.)

IV. A 48-INCH SEGMENTAL BLOCK SEWER UNDER CONSTRUCTION IN WAUSAU, WIS.

V. A 45-INCH SEGMENTAL BLOCK DRAIN UNDER CONSTRUCTION AT GIBSON, CITY, ILL.

accordance with the formula 1:2:3. The enveloping concrete surrounding the barrel of blocks followed the formula 1:3:6. This envelop had a minimum thickness of 4 inches. It will be understood, perhaps without my saying so, that without this envelop of protecting concrete the exterior circular reinforcement would not have been usable.

The making of connections with segment block sewers has been worked out very completely. The special block used for inserting T or Y branches in the Amico block is shown in one of the accompanying drawings. Another drawing shows a perspective of the construction of a T branch in the Natoe double-tile sewer, and a third shows a section of a Y branch in a Natoe double-tile sewer, and gives an excellent idea of the method of carrying the structure thru the two blocks making up the thickness of the ring.

One of the photographs shows a 48-inch sewer in Wausau, Wis., under construction with the Natoe double tiles. Several interesting details are seen clearly. First, the trench has been excavated to the exact outline of the outside of the invert so that the blocks are laid directly on and beside the earth for the whole of the lower half-circle of the sewer. Second, the simple and inexpensive form used will be noted. Third, the breaking of joints longitudinally and circumferentially is evident in the finished invert. The same longitudinal breaking of joints between the outer and inner blocks is seen in the position of the blocks along the springing line, where part of the first layer of blocks in the arch has been laid preparatory to moving up the forms. The radial breaking of joints is seen in the invert in the foreground, each inner block spanning the joint between two outer blocks. The same is seen in the arch in the background.