

disadvantages, the pavements, with one or two exceptions, show very few cracks.

[The work is done in accordance with specifications which are given in full in an appendix to the paper. They call for the following general construction: The roadbed is graded and rolled to a depth of 11 in. below the proposed street surface. The curb is placed in trenches graded toward catchbasins and containing at least 6 in. of broken stone below the curb. The roadbed is covered with 3 in. of sand, which is rolled and then covered with 4½ in. of Portland cement concrete. The binder course consists of ¾ in. stone and asphaltic cement, mixed in the proportion of about 15 imp. gal. of the latter to 1 cu. yd. of the former. This is laid hot, rolled and covered with the wearing surface, 2 in. thick at the crown and 1½ in. thick at the gutters. This surface is composed of 10 to 12 per cent. pure bitumen, 75 to 78 per cent. sand, and 5 to 10 per cent. pulverized limestone, the exact composition depending on the character of the asphalt and the fineness of the sand and limestone. The powdered limestone must all pass a No. 80 screen, and 25 per cent. must pass a No. 200 screen. Of the sand, 25 per cent. must pass a No. 200 screen, 25 per cent. a No. 100 screen, 25 per cent. a No. 50 screen, 15 per cent. a No. 20 screen, and 10 per cent. must be retained on the last screen. The contractor is required to give a 10-year guarantee of the pavement, and the city retains 20 cents per square yard of the final estimates as surety.]

Broken stone is used for drains, because tile, if used above the frost line, is destroyed by ice.

The 3 in. of sand and gravel on top of

the clay foundation prevents the concrete from adhering to the clay and being cracked or pulled apart, when frost cracks open in the latter. The frost penetrates to a depth of from 6 to 8 ft., and cracks, sometime 6 in. in width, open on the surface. It has not been found that any of these cracks show through the asphalt.

Apart from the above, the methods are those which prevail in most American cities.

The cost of materials f.o.b. cars Winnipeg, 1904, have been as follows: Portland cement, \$0.74 per 100 lb.; broken stone, \$1.30 per cubic yard; sand and gravel, average about \$1; crushed granite, \$5 per cubic yard; asphalt, \$26.37 per ton; maltha, .12 per imperial gallon.

The cost per square yard of asphalt is as follows: Grading, including cross drains, \$0.15; sand foundation, \$0.15; concrete, 4½ in., \$0.65; binder, \$0.28; surface, \$0.60; plant charges, \$0.05; total for construction, \$1.88; maintenance fund, \$0.20; engineering and collection expenses, 10 per cent., \$0.20; total cost, \$2.28.

This cost is divided in different proportions (depending upon the location and character of the street) between the city funds and property fronting on the improvement. In the residence portions the city contributes, out of the general funds, an amount equal to half the cost of a 24-ft. wide macadam, the property fronting paying the balance. The 24-ft. macadam was adopted some years ago as the standard pavement of the city, the city paying half the cost and the property the remainder.

There are a few special streets, business and leading thoroughfares to which the city contributes out of the general funds, one-third of the whole cost. On

streets occupied by the street railway, the company pays for 8 ft. width of pavement for each track, and in the case of double tracks for 17 ft. width in all.

Twenty-year bonds are issued for the original cost of the pavements, the interest and sinking fund for their payment being collected each year.

[An appendix gives the following information concerning the organization engaged on the asphalt work. At the asphalt plant: 1 superintendent chemist, \$8 per day; 1 foreman, \$3; 1 engineer, \$3.50; 1 night engineer, 25 cents per hour; 1 mixer, 30 cents; 1 tankman, 25 cents; 1 dustman, 25 cents; 1 feeder, 25 cents; 1 miller, 25 cents; 1 temperature man, 20 cents; 1 fireman, 25 cents; 7 laborers wheeling sand and stone, 20 cents; 2 laborers on the tanks, 20 cents; 1 night tankman, 20 cents; 7 laborers unloading sand and stone, 20 cents; 1 sandbox man, 25 cents; 1 dipper, 20 cents; 1 laborer for wood, 20 cents; 1 boy at \$1 a day, and 1 clerk, \$2. The asphalt street gang is organized as follows: 1 racker, \$2.75 per day; 2 rackers, \$2.50; 2 tamper, \$2.50; 1 watchman, \$2; 1 water boy, \$1; 2 smoothers, 22½ cents an hour; 10 laborers, shoveling asphalt, sweeping, etc., 20 cents. The concrete gang has the following organization: 1 sprinkler, 22½ cents an hour; 7 wheelers, 22½ cents; 7 wheelers, 20 cents; 2 tail carrier tenders, 22½ cents; 1 concrete feeder, 22½ cents; 2 track plank carriers, 22½ cents; 2 stone feeders 22½ cents; 1 machine mover, 22½ cents; 2 sand feeders, 22½ cents; 3 concrete levelers, 22½ cents; 4 concrete levelers, 20 cents; 1 hydrant tender, 20 cents; 8 graders, 20 cents; 1 oiler, 20 cents; 1 pounder, 20 cents; 1 water feeder, 20 cents; 1 cement man, 20 cents; 1 machinist, 25 cents; 1 foreman, \$4 per day; 1 water boy, \$1; 1 watchman, \$2. The working day is 9 hours.]

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