

must tend to make a foul sewer and lead to the formation of sewer gas, which in itself is prejudicial to concrete and will tend to shorten the life of the sewer.

Charles A. Newhall, of the Charles A. Newhall Co., Inc., chemical and inspecting engineers, of Seattle and Vancouver, had described to the Pacific North-West Society of Engineers, in Seattle, the results of his investigation in several concrete-lined railway tunnels, and the effect on the concrete of the percolation of ground water and the gases from locomotive fuel. He was invited by the writer to examine these sewers to see if the cause of the incrustation could be found, and his report in part is as follows:—

Mr. Newhall's Report

"We herewith submit to you the result of our investigations on concrete sewer pipe laid in Georgia Street and Glen Drive, Vancouver. Concrete pipe in stock and samples removed from sewer were also examined.

The Georgia St. sewer was entered from a man-hole west of Jervis Street. With the aid of a rope and dolly the writer was pulled up through the sewer toward Jervis Street and thus was able to make a personal and thorough examination.

This sewer has been in place about eight years and has been used only to carry storm water. The pipe is 27" diameter inside, smooth finish; pipe said to be machine made, with mix of one volume cement to three of crushed granite, with enough water to give a semi-wet consistency. Judging from the inside appearance, the pipe was of good quality and made with care.

"We found that the lower side of the pipe, through practically the entire length of the sewer examined, was coated to a varying degree with a stiff, firmly adhering scale. (See Fig. 1). In places this scale had formed to a depth of three or four inches, these thick deposits being made up of several layers lying parallel to the surface of any water that would flow through the sewer. In places the thick scale would be cut through along the flow line of the sewer water, and only the edges and lower layer of the scale remained firmly adhering to the concrete pipe. In other places the scale had evidently just started to form or had been mostly scoured away, as only a slight roughness and coating was noticeable on the concrete bottom and sides of the pipe.

"In some sections, especially at the joints of the pipe, a thin scale or encrustation of somewhat different appearance than that just described was noted. This encrustation extended in streaks from the top or sides of the pipe down to the bottom, the surface of the encrustation being parallel to the inner surface of the sewer pipe. This encrustation in places was white in color and in others of a dirty grey color. It adhered very firmly to the surface of the concrete pipe. The concrete of the pipe was firm and hard on the inside surface. There was no softening noticeable under any of the encrustations or scales.

Examination of Glen Drive Sewer

"The Glen Drive sewer was entered by the man-hole at the intersection of 11th Ave. and the examination made on the section extending toward 12th Ave. The pipe carries the sewerage from a residence section and was in use at the time of our inspection. The sewer was rather foul and gassy hence we did not deem it wise to go up into it, but made our examination from the bottom of the man-hole into which the pipe opened. With the aid of a flash light and a long pole we were able to make a thorough examination of the surface for a distance of ten feet up the

sewer. In this ten feet, encrustations and scale similar to those noted in the Georgia St. sewer were observed.

"This sewer has been in the ground about seven years; is 24" inside diameter; said to be machine made, of a one to three mix, but gravel and sand instead of crushed granite.

"A section of the Glen Drive sewer had previously been taken up for examination and one of the pipes removed was examined in the city yard. This pipe was 24" diam., 24" long and 3" wall.

"The inside of the pipe showed a thin coating of scale on the lower or flow side; this scale being similar to the scale noted in the two sewers examined. Also a white encrustation was noted in the pipe, this encrustation extending from the high side of the pipe down toward the flow side.

"The inside of the pipe, aside from the encrustations, showed a good smooth concrete finish. The outside surface of the pipe had been pitted in places and softened to a depth of $\frac{1}{4}$ " to $\frac{1}{2}$ " below the original surface. In these soft places the remaining concrete was so loose that it could be quite easily scraped away from the surface.

"Samples were taken of the thick scale from the Georgia St. sewer, the scale from the bottom of the Glen Drive sewer, and the white encrustation from the Glen Drive sewer.

Scale from the Georgia St. Sewer

"A green-grey scale, quite firm and coherent when wet, but turning dirty white and chalky when dry. The scale when examined under the microscope is found to consist of quartz and rock sand, wood shreds, organic matter and a very fine amorphous material like the "laitance" or scum that forms when portland cement is hydrated with too much water.

"This amorphous material binds the sand grains together. It is strongly alkaline toward phenolphthalein indicator; this further establishing its similarity to hydrated portland cement. Fine clay, very fine sand or organic matter—all substances that might possibly be the binder which holds the sand of the scale together—would not give an alkaline reaction with the above indicator.

"When the scale is thoroughly dried, it becomes quite chalky and it is possible to rub the coarse sand from the amorphous binding material. An analysis of the fine portion (which comprises 53% of the weight of the scale) shows as follows:—

"Silica and sand (insoluble matter) 77.10 per cent.

"Iron and aluminium oxides, 2.48 per cent.

"Calcium oxide, 6.77 per cent.

"Water and carbon di-oxide, 10.52 per cent.

Scale from Glen Drive Sewer

"Similar in general appearance to No. 1227. It contained shreds of lint and paper in addition to the other substances noted above.

"Silica and sand (insoluble matter), 72.74 per cent.

"Iron and aluminium oxides, 5.30 per cent.

"Calcium oxide, 10.50 per cent.

"Water and carbon di-oxide, 11.40 per cent.

Encrustation from Glen Drive Sewer

"This material contained a small amount of very fine sand, together with wood and paper shreds, lint and organic matter.

"Silica and insoluble matter, 21.54 per cent.

"Iron and aluminium oxides, 2.48 per cent.

"Calcium oxide, 30.94 per cent.

"Water and carbon di-oxide, 41.02 per cent.

"In these three samples the point of interest is the