tank serves the double purpose of relieving pressure surges and furnishing or storing water during load changes while the velocity in conduit No. 2 is being accelerated or decelerated. It is also equipped with a spillway as an additional safeguard, to prevent spilling over the top at times of abnormal surge, and to limit the height which would have been required without this provision.

No. 3 surge tank is of the same type as No. 2, but has no spillway. Its design is such that full load rejection under the most abnormal conditions will not cause overflow.

During 1913, a series of tests was made to determine the hydraulic characteristics and carrying capacities of conduits Nos. 1 and 2, also of penstocks Nos. 1 to 14, inclusive. The results of these tests indicate some very striking facts regarding the relatively greater carrying capacity of concrete pipe as compared with riveted steel and also the exceedingly smooth surface that can be obtained with concrete if proper and careful construction methods are used.

### Capacity of Wood Stave Pipe

The capacity of No. 3 conduit, which is of wood stave construction, is 2,750 cubic feet per second, giving a velocity of 19.2 feet per second in the pipe on the basis of a coefficient of roughness "C"= 135 in the Williams and Hazen formula. Under such conditions, there will be a total loss in the conduit, from gate house to penstock, of 32 feet, which includes entry losses, friction loss and velocity head: This figure was arrived at by assuming low water elevation in forebay at 554, and the minimum elevation of the gradient at penstock No. 15 at 522, which is eight feet above the top of the conduit. From past experience with conduits Nos. 1 and 2, it was found advisable not to go below elevation 522 in order to prevent the gradient being drawn down below the top of the pipe under operating conditions. Under the above conditions the capacity of the pipe will be approximately 45,000 turbine horse-power. With a coefficient of roughness C= 150 in Williams and Hazen formula, which value is within the limits of possibility, and the same total loss of 32 feet, the discharge capacity would be 2,930 cubic feet per second with a velocity of 20.5 feet per second in the pipe. This quantity of water in turn would give approximately 48,000 turbine horsepower. In comparing the coefficients of roughness of the concrete and steel pipes, as obtained by test, and the assumed coefficients of roughness for the wood stave pipe, based on the tests published by the U. S. Department of Agriculture, it appears that the concrete pipe has the highest coefficient, with the wood stave pipe a good second, and the steel pipe a poor third.

A coefficient of roughness of 100 in Williams and Hazen formula was used in figuring the losses in the steel penstocks. The use of this coefficient was based on the result of tests on the other penstocks.

It was, of course, necessary to design the tank for a drop of full load on No. 3 conduit, under which condition the tank will receive all water without the provision of a spillway, and on the assumption that none of the pressure regulators on the turbines in the power house are in service. The condition of design for load thrown on, was that of an increment of load equivalent to a 20 per cent. velocity change from 80 per cent., up to full capacity of the conduit.

The new construction was carried out under the direction of the technical staff of the Hydro-Electric Power Commission of Ontario, of which Sir Adam Beck is chairman and F. A. Gaby is chief engineer. The technical staff responsible for the design and construction includes H. G. Acres, hydraulic engineer; T. H. Hogg, assistant hydraulic engineer; M. V. Sauer, designing hydraulic engineer; E. T. Brandon, electrical engineer; A. H. Hull, assistant electrical engineer; A. V. Trimble, construction engineer; Walter Jackson, resident engineer; J. F. McGraw, general superintendent of construction; F. A. Burgar, field superintendent.

The contract for the structural steel for the extension was awarded to the Standard Steel Construction Company, Port Robinson, Ontario. The erection of the steel was carried out by the construction department of the commission. The Pacific Coast Pipe Co., Vancouver, B.C., supplied the wood staves for the pipe line. The generators were made by the Canadian General Electric Company and the turbines by the S. Morgan Smith Company, York, Pa. Other materials and equipment were supplied as follows: Bands and washers, Steel Company of Canada, Hamilton; shoes, Malleable Iron Company, Owen Sound, and Pratt and Letchworth Company, Brantford, Ontario; steel distributor, surge tank, penstocks, valve casings and supply pipe, Canadian Des Moines Steel Company, Chatham, Ontario; Johnson valves, Larner-Johnson Valve and Engineering Company, Philadelphia, Pa.; pressure regulators, Wellman-Seaver-Morgan Company, Cleveland, Ohio; turbine governors, the Lombard Governor Company, Ashland, Mass; servo-motors, Canadian Allis-Chalmers Company, Toronto; gate valves, Chapman Valve Manufacturing Company, Indian Orchard, Mass.; blowers, Canadian Blower and Forge Company; potheads, Standard Underground Cable Company, Hamilton; conductors, Eugene Phillips Electrical Works, Montreal; switches and bus bar supports, General Devices and Fittings Company, Chicago, and A. H. Winter-Joyner, Ltd., Toronto.