curved lines, and thus reduce the cost of formwork. Also, the idea being to make all surfaces as sharp and clean cut as possible.

The general features of the bridge over the penstock are similar to those of the longer bridge, the span being twenty-six feet in width. On the cross section of the bridge submitted herewith the details of the beams and slabs are fully shown. After the embankment connecting the two bridges has fully settled to a solid condition, it is the intention to connect the curbs, sidewalks, and railings on each bridge, and to finish the roadway in a permanent manner.



Cumberland Street Bridges; View of Form Work in Place.

The rails for the street cars were bedded and surrounded with concrete, being held together with tie rods at intervals of four feet. So far, and under traffic conditions, this has proved satisfactory, there being no signs of chipping or cracking of the concrete; in fact, this can be said of the entire work.

Design.—In figuring for the design of the bridges, the calculations were based on the following data:—

Live load, a thirty-ton street car, and an additional live load of one hundred pounds per square foot, with an amount for impact figured at fifty per cent. of the live load.

Ratio of modulus of elasticity of steel to that of concrete, 15.

Allowable working stress of steel in tension, 16,000 pounds per square inch.

Society of Civil Engineers. The sand used was ordinary bank sand, sharp and coarse grained, with a very small percentage of loam. The broken stone called for in the specifications was crushed trap rock, of a size that would pass a one-inch ring. Shortly after the work was commenced the demand for crushed rock was so great that it was impossible for the contractor to secure any, so it was decided to use the lake shore gravel.

This gravel is found on the lake shore, about ninety miles from Port Arthur, and is admirably suited for work of this kind. In size the gravel ranges from the size of a pea up to that which will pass through a one-inch ring, the stones being of various shapes, mostly angular. As the surfaces of the stones are pitted, the cement mortar has a far better chance to bond with them than it has with ordinary gravel, and as the stone is of a granite nature the strength of the concrete was not feared by using this gravel. The proportions for the reinforced concrete were as follows: Columns, 1; 11/2; 3. Slab, 1; 11/2; 3. Beams, 1; 2, and 4, and for the mass concrete in wing walls and abutments, 1; 3; 5; with "plums" placed in the ordinary method. All the concrete was mixed with a "Ransome" concrete mixer. In order to obtain a good surface on the exposed faces of the bridge, the concrete mixture was of a sloppy nature, great care being taken to have the concrete well spaded and worked next to the forms. The results are very good, as may be seen in the accompanying views of the bridge.

Tenders were called for the work on July 10th, 1910, and the contract awarded to Messrs. Seaman and Penniman, of Fort William, on August 2nd. Owing to delays in securing materials the work was slow in progressing, so that it was late in the fall before the concrete work for both bridges was completed. All the forms were left on the bridge through the winter, and early in the spring of 1911 the wood blocks were laid, railing set up, and the bridges properly finished. The contractors are deserving of great praise for the work they did, their methods of working, and the diligent manner in which they attended to all the details of the form work, etc., had a good deal to do with the successful carrying out of the designs.

Construction.—The reinforcing steel used in the construction of the bridges was the "Kahn System of Reinforcing," and was furnished by the Trussed Concrete Steel Co., of Walkerville, Ontario. In order that contractors could tender on the same basis, as regards the reinforcing steel,



Reinforced Concrete Cirder Bridge over Current River, Port Arthur. Section at

Section at Centre Span, Showing Balcony.

Allowable working stress for concrete :--

- (1). The extreme fibre, 750 pounds per square inch.
- (2). Direct compression, 600 pounds per square inch.
- (3). Shear, 50 pounds per square inch.

Concrete.—The cement used in the concrete was Lehigh brand, Portland cement, which, when tested, had to meet the requirements of the cement specifications of the Canadian the city purchased it direct and delivered it f.o.b. the site of works.

After the footings were set in place, the form work was commenced on the columns, girders, and abutments. The steel in the columns was then set in place, and the abutments and columns were poured to the level of the under side of girders. The forming was then constructed for the