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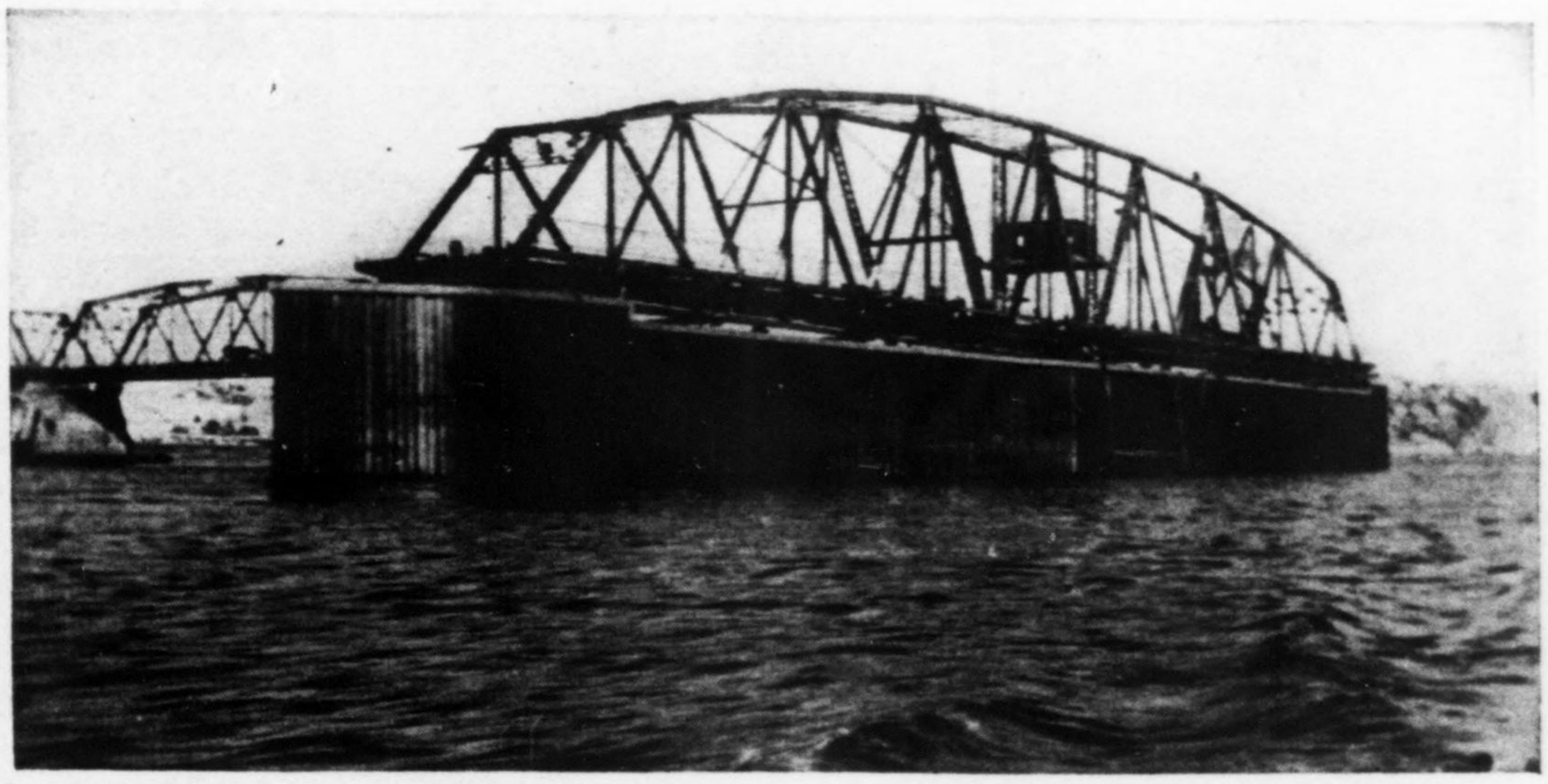

FIG. 1.—PROTECTION PIER 430 ft. long, for swing span of Saguenay River bridge in Quebec, is among largest ever built.

Chicoutimi Swing Span Requires Huge Protection Pier

New seven-span bridge over the Saguenay River at Chicoutimi, Quebec, includes a 375-ft. swing span protected, in open position, by a timber and concrete pier 430 ft. long inclosed in steel sheetpiling

AN UNUSUALLY DIFFICULT foundation operation characterized the consrtuction of the new bridge over the Saguenay River in Quebec joining the city of Chicoutimi on the south shore with the town of Ste. Anne de Chicoutimi opposite. Located about 70 miles from the St. Lawrence River, Chicoutimi nevertheless is subjected to 20-ft. tides and, in addition, is in a territory where flood and ice conditions are always severe. Two attempts were made before the pivot pier of the 375-ft. swing span and its protecting pier were successfully completed. The combined protection and pivot pier, 430 ft. long, with pointed nose upstream and downstream, is so large as to suggest a battleship or a lake boat rather than a bridge pier.

The new bridge, located about 9 miles below the well-known Chute-à-Caron hydro development, fills a vital need, for, prior to its construction, interruption of the ferry service between the two towns necessitated a detour of over 40 miles. And in the late fall and early spring the river often could not be crossed for periods of six weeks at a time.

Superstructure

The superstructure of the Chicoutimi Bridge consists of six through Warren truss spans, each of 185 ft., and the 375-ft. swing span A 20-ft. roadway and two 5-ft. sidewalks are provided; they are of reinforced concrete on the fixed spans and of laminated creosoted timber on the swing span

Contract for the superstructure was awarded to the Eastern Canada Steel & Iron Works, Ltd., Quebec, which fabricated the material for the fixed spans; the fabrication of the swing span and all of the erection was sublet to the Dominion Bridge Co., Montreal. Contract for the substructure was awarded in September, 1931, to A. Janin & Co., Ltd., of Montreal. The bridge is to be operated by the provincial government as a toll structure.

As an unemployment measure, the substructure work was started immediately after the award of the contract, and some work was done before ice conditions became too severe. However, not much could be done until after the normal spring flood of 1932.

Flood records

Floods in the Saguenay are variable and severe. The river is fed mainly from Lake St. John and also by a few minor rivers. According to twenty-year records, the normal spring flood starts about May 12 and ends on June 28, the maximum flood prior to constructing the bridge having been on June 1, 1928, totaling 350,000 sec.-ft. Fall floodflows due to rains are not generally serious and remain on the average under 85,000 sec.-ft. In 1932, in addition to the normal spring floods, there were four other dis-

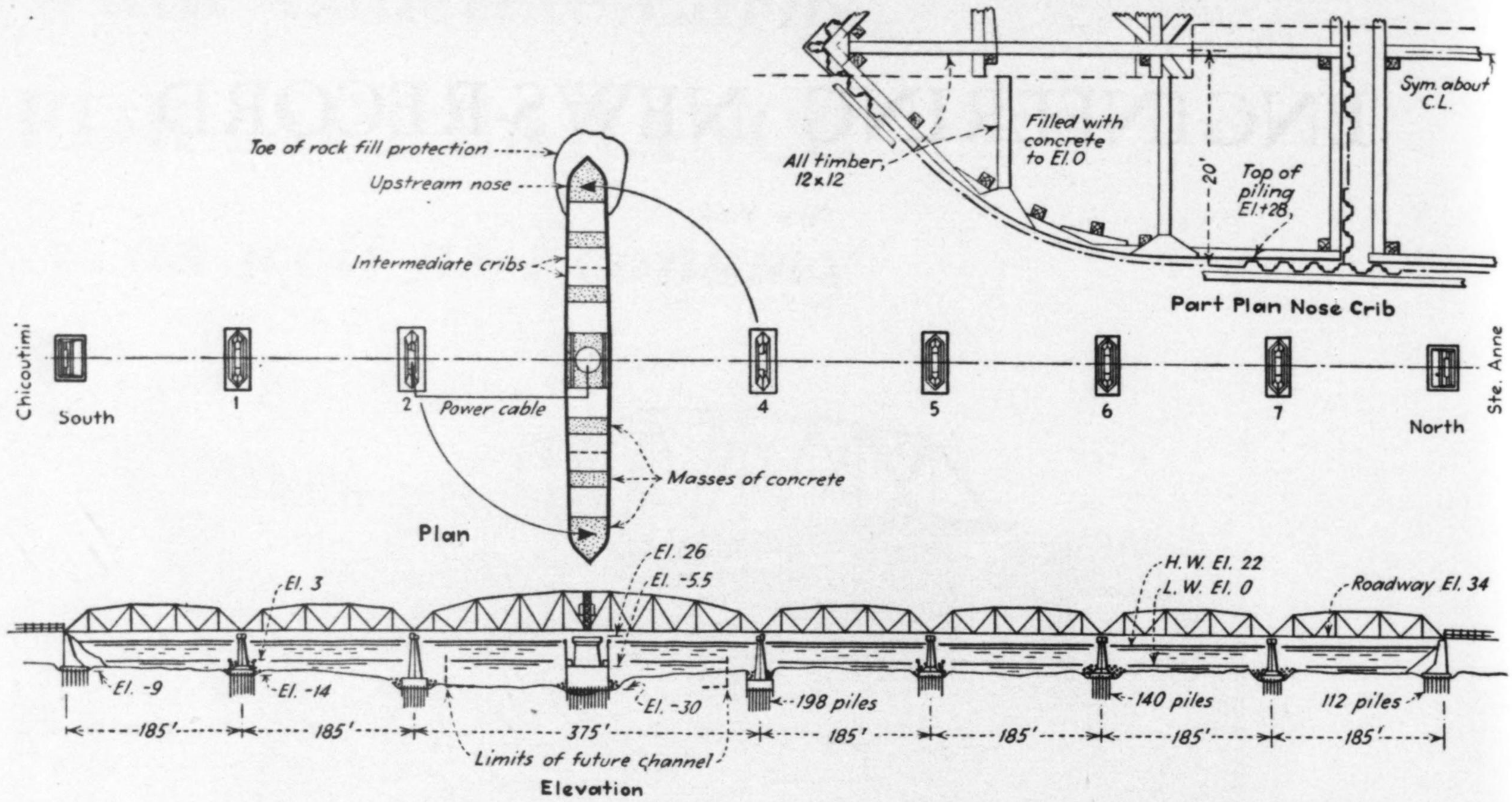

FIG. 2—CHICOUTIMI BRIDGE consists of six simple truss spans and a swing-span of unusual length. Foundation construction was made difficult by the extreme range between low and high water that was experienced several times.

tinct peak flows above 100,000 sec.-ft. The average summer flow was slightly over 90,000 sec.-ft., which was the highest on record. In contrast, the 1933 flow was the lowest on record, varying between 17,000 and 35,000 sec.-ft. Such flow conditions make plain the uncertainty and difficulty that attended foundation construction in the river.

Borings showed clay to a depth of 90 ft. and only sand below that level, making piles necessary. The swing-span pier and the two on either side of it were founded about 50 ft. below high tide, while the other piers are about 36 ft. below this same level. Relatively shallow excavation in the bottom of the river was required.

Progress of work

During eight months of 1932, with average flows about equal to the usual spring flood, floating equipment placed the cofferdams for the fixed-span piers, and these foundations were completed, representing an unusual accomplishment. The construction of the pivot pier for the swing span was the last operation planned for the year. This pivot pier was designed as a cylinder of reinforced concrete about 28 ft. in diameter, hollow on a diameter of 18 ft. and with a 6-ft.-square reinforced-concrete column in the center, connected to the cylindrical shell by two cross-walls. The caisson for this pier therefore was made in the form of a circular frame made up of angles and plates connected vertically by latticed columns. The height of the frame was 49 ft. and the diameter about 50 ft. With the timber bracing, the weight was about 70 tons.

When completely assembled, the structure was towed out to the site and lowered onto the riverbed, anchor cables attached, and driving of the steel sheet-pile inclosure was started.

When about a third of the piles were in place, an unexpected flood occurred, breaking one of the anchor cables and causing the collapse of the latticed columns on the downstream side, which caused the frame to lean about 20 deg. Efforts were made to raise the frame, but flood conditions became worse, and finally the frame completely collapsed and was carried downstream. During this flood period the peak flow reached 250,000 sec.-ft., or about four times the average fall flood. These operations practically completed the work for the 1932 season.

New center-pier design

As a next step, the design of the protection pier, previously conceived as a relatively simple structure, was altered to incorporate the cofferdam for the pivot pier. Independent nose piers up and downstream were also included, to be incorporated into the whole after the upstream nose had served both as deflector and anchorage during the construction of intermediate and center cribs.

The complete protection pier, as thus planned, was 430 ft. long and essentially contemplated the construction of three "islands" formed by steel sheetpil-

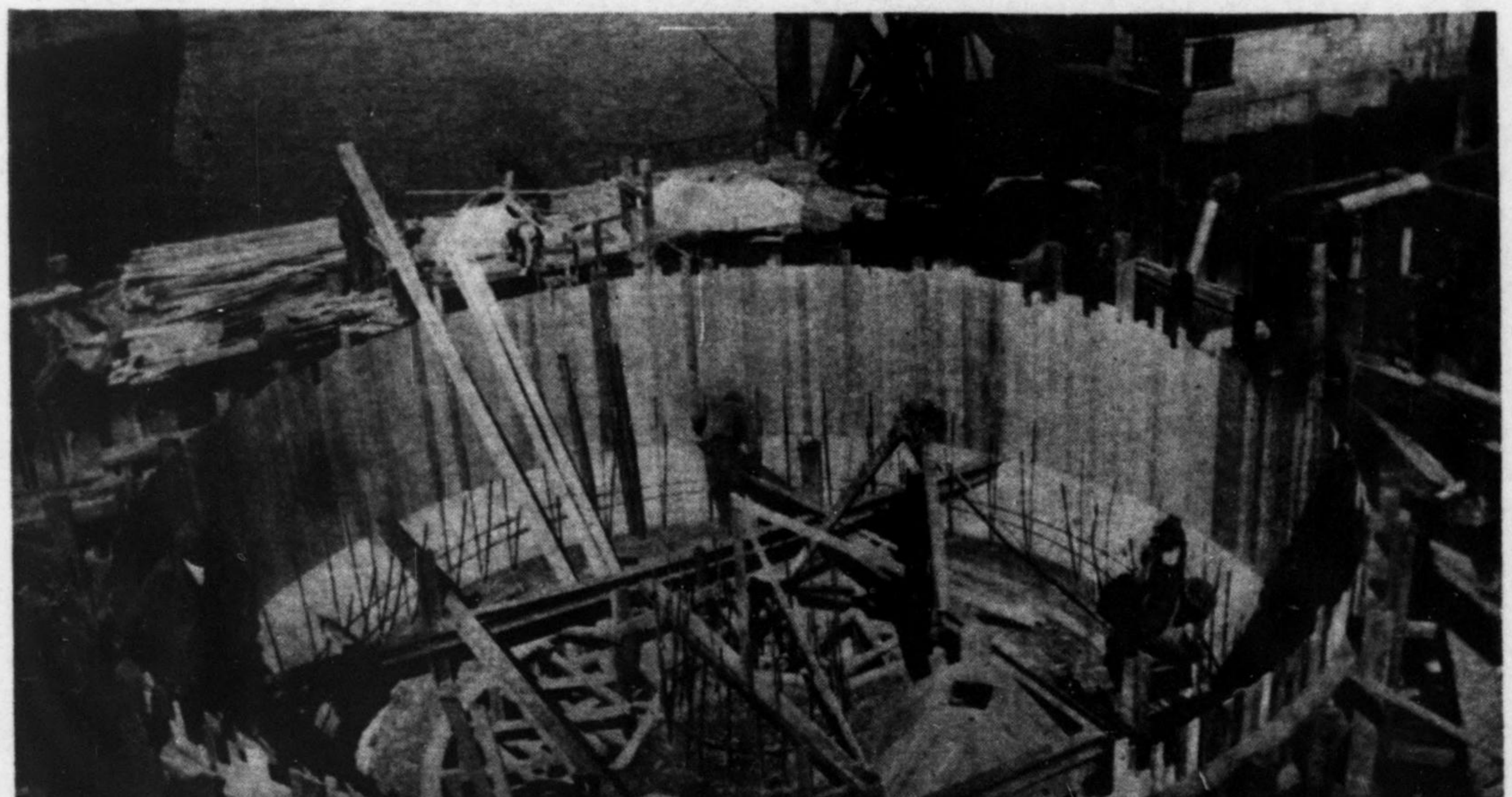

FIG. 3—PIVOT PIER of Chicoutimi Bridge under construction within the cofferdam formed by the protection pier.

ing and connected by steel piling walls suitably braced and anchored, the whole structure presenting the appearance of a single long and narrow pier. The upstream and downstream nose sections (two of the "islands") were filled with concrete cast against the piling from the pre-excavated grade at El. —25 to low tide level at El. 0. The base of the pivot pier (58 ft. long, 44 ft. wide), forming the third unit or island, was formed by concrete from El. —30 to El. —5.5. Between each nose and the center caisson were placed two intermediate cribs, 66 ft. long, each of which contains a transverse pocket of concrete 16 ft. long, also topped off at low-tide level.

The design of the protection pier is such that impact from a ship or from floating ice, regardless of the direction or the elevation of the blow, will be distributed to and absorbed by the masses of concrete. Each one of the steel piles is bolted to the timber framing of the cribs, and occasional piles of the nosings and center cribs are perforated, to admit of the circulation of water. Along the four intermediate cribs the piles alternate in lengths of 65 and 30 ft., the long ones being driven 15 ft. below excavated grade, the short ones extending to only 5 ft. below low tide and being held in that position by bolts. This staggered piling arrangement, besides providing for circulation of water, gave a substantial economy in piling requirements. The piling around the nose and center sections is about 70 ft. long and was driven to 15 ft. below grade.

Construction

The upstream nose was the first section of the pier to be constructed, a timber crib (built to its full height of 46 ft. on the ice during the winter) being accurately set in position by means of derrick scows and tugs and then held in place by means of concrete blocks as ballast. The anchorage system consisted of four 4-ton anchors placed about 700 ft. upstream on a line perpendicular to streamflow, with 200 ft. separating the two center blocks and 50 ft. between the outside and the center anchors. The anchors were linked together by chains and connected to the nose caisson by two 1½-in. and two ⅞-in. steel cables.

Driving started with the nose pile and proceeded thereafter down the two curved sides of the streamlined nose and along the diaphragm end wall. Tee piles, specially riveted, were used at the two corners from which the two long side walls were started. This upstream nose was completely constructed and filled with concrete up to low-water level in the short working period between the break-up of the solid ice and the start of the spring flood—in this case just about three weeks. River work had then to be stopped for five weks until the 100,000-sec.-ft. flood had subsided, when the construction of the long side walls was started. The piles forming these were placed and driven in a similar manner, set against timber cribs resting on the excavated river bottom.

In a similar manner the 70-ft. piles forming the center caisson were placed and driven, the crib supporting them having its center section constructed of steel joists that were later concreted into the body of the pier. The projecting ends of these beams were later cut off so as to isolate the main pier shaft from the steel guard-walls. After the piles had been driven to their penetration of 15 ft. below the dredged level, the entire crib was raised a distance of 15 ft. by means of winches, in order that the concrete for the base of the pier might be placed directly against the piling after the timber bearing piles had all been driven and cut under water to required level.

With the concrete seal complete, the caisson was dewatered followed by form construction and placing of the pivot-pier concrete, the steel sheetpiling for the downstream side guard-walls being placed and driven at the same time. The downstream nose "island" was finally constructed. All the piling was eventually given two coats of special protective tar and capped with an 8x16-in. timber coping.

The work was carried out for the department of public works of the Province of Quebec: J. N. Francoeur, minister, Ivan E. Vallee, deputy minister and chief engineer, and Olivier Desjardins, joint chief engineer. The consulting engineers for the swing span and the protection pier were Monsarrat & Pratley, Montreal. The contractor for the substructure and bridge deck was A. Janin & Co., Ltd., Montreal.

Dirt Streets Surfaced With Slag as Unemployment-Relief Measure

THROUGH the opportunities made available by the Civil Works Administration and the relief works division of the Pennsylvania Unemployment Relief Commission, the city of Pittsburgh has made usable in all weather more than 50 miles of dirt streets in residential districts, at the same time giving employment to as many as 3,000 men. These streets, many of which were completely impassable in winter weather and thoroughly inadequate at all times, have been surfaced with crushed slag; side slopes have been stabilized and drainage facilities have been provided.

There are in Pittsburgh 484 miles of unpaved streets. They are generally found in districts where property values are low and where a first-class paving improvement would involve a cost entirely too high to be borne by the properties so benefited. Many of them are hillside streets on which grades run as

SLAG SURFACE makes dirt street usable. Before improvement this street was only half its present width. A timber-crib retaining wall built along the railroad at the right supports the added width.