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BELVER DAM, PORTUGAL

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The Belver Dam is built on the River Tage and is located approximately 170 kilometers upstream from Lisbon, Portugal.

The works consist of a fixed dam in massive concrete about 80 meters long, a lock 11 meters wide and 70 meters long (to be built later), and a movable dam 260 meters in length, consisting of 12 openings of 17 meters' width, closed by gates 14 meters in height separated by 13 piers. Regarding the two end piers, the first is embodied in the side of the lock and the other is incorporated into the powerhouse structure. The powerhouse building is 74 meters long.

The ensemble of works has a total length of 450 meters, Figures 1, [illegible] and 2,

The movable dam. This dam is made up of concrete piers spaced 22 meters (72.6 feet) center to center. Each pier is 5 meters (16.5 feet) wide and 29 meters (95.7 feet) long, with a height of about 30 meters (99 feet) above the lowest part of the foundation. The concrete is, in the greater part, not reinforced, and the sides of the piers are armored with blocks of granite. In the first pier is incorporated a fish ladder consisting of an inclined tunnel formed of steps, according to the system of Denil; the height of each step, or pool, is about 0.47 meters (1.55 feet). The access to the fish ladder is made by four openings in the side of the pier at different levels.

The aprons of the openings are also of concrete, with a facing of granite. Their foundations are separated from the foundations of piers in order to avoid the formation of cracks in the longitudinal direction of the structure. There are three types of aprons, of which the curves descent to the different levels, according to the depth of the bed in relation to their placement. The upstream level is the same for all of the aprons.

Throughout the length of the dam, the foundation is of precambrian schists, very permeable, in which there has been injected a grout screen of portland cement to insure watertightness. The foundations of the piers and of the aprons have been carried down to 5 to 6 meters below the bed of the stream.

The gates are of the double type, each composed of two movable panels moved by hoists on the service bridge. The framework of the lower panel is formed of two main girders. These girders are of the web and flange type and are built up by welding. The web is a solid flat plate with the upstream edge straight and the downstream edge parabolic. The flanges are shaped and welded to the flat plate web. Vertical uprights connect the two girders and are welded in place. The ends of the main beams rest on the carriages provided for movement of the gate.

The framework of the upper panel is formed of a single horizontal member placed at the upper edge. This member is the same as the members for the lower gate. Seven vertical members extend downward from the main beam. These lower ends of these members are connected to a single light member.

The force on the lower part of the gate is transmitted by rollers (one at the lower end of each vertical member) to the lower gate. The main beam is provided at its extremities with carriages that ride on the same rails that carry the carriages of the lower gate. These rails are cast in the piers. The upper part of the upper gate is fitted with a steel apron formed according to the profile of an ogee crest.

The carriages supporting the gate consist of two bogies of two articulated wheels each, so that the load is balanced on each. The beams of the gate panel are supported on the carriages by means of ball and socket joints. The weight of each gate is 27.4 tons.

For passing small floods up to 5,000 cubic meters per second, only the upper panel is lowered, according to the magnitude of the flood, and the water is passed over the top of the gate. The maximum movement of this gate is 5 meters. If complete lowering of the upper gate is not sufficient, the two panels are then raised simultaneously in a fashion permitting the flow of the water under the lower gate. Finally, in the case of exceptional floods, the entire ensemble of the two gates is raised above the level of the water in a manner to leave the opening between the piers entirely free.

The operation of the gate is always assured by means of electric or hand hoists. With the aid of the electric hoists, the velocity of movement of the gates is 0.4 meters per minute for the upper panel and 0.2 meters per minute for the lower panel. Each opening may be closed by a cofferdam or stop log upstream from the gates to permit the replacement or the repair of any one of the gates.

The set of stop logs is composed of six elements that may be placed in the stop-log slots in the piers by means of a crane moving on the bridge and carrying the hoists for the gates. Each element of the stop log weighs approximately 20 tons.

The gates were manufactured by Neyrpic-Sorefame at Lisbon, Portugal.

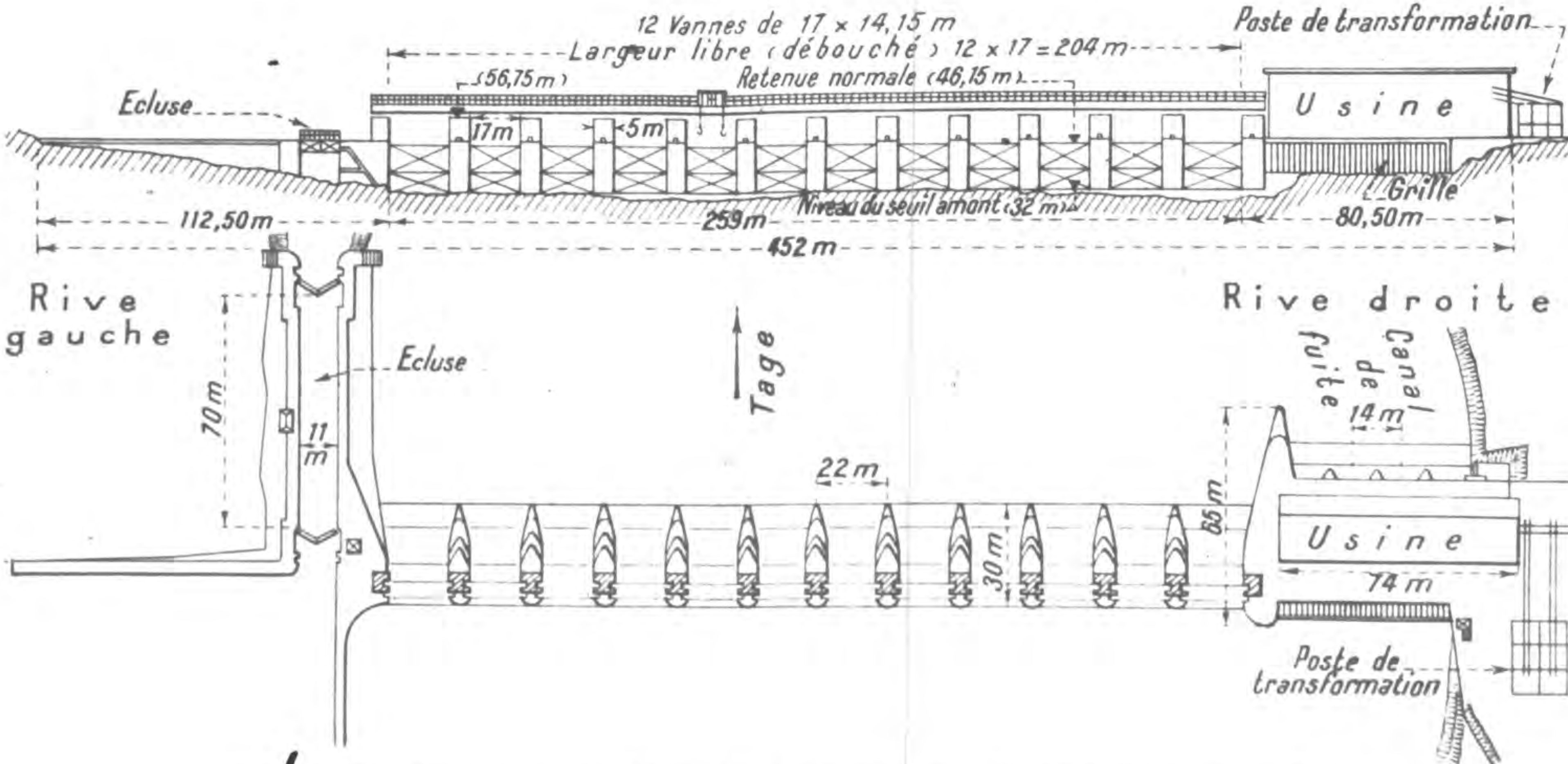

FIG. 1 ~~2 et 3~~. — Elévation et plan schématiques du barrage et de l'usine de Belver, sur le Tage.