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ROCK - SOIL TECHNOLOGY AND EQUIPMENTS

WATERPROOFING

BARRAGE DE PETIT SAUT (GUYANA FRE.)

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PROJECT:

Treatment of the foundations of dams C and D of the Petit Saut power plant in French Guyana.

PERIOD OF CONSTRUCTION:

April 2000 – January 2001

CLIENT:

EDF (Electricité de France)

Fig. 1. Aerial view of the Petit Saut dam and, below, view of the probes in the field.

Purpose of the work, difficulties encountered and solutions applied.

Petit Saut dam (Fig. 1) is a large power plant built by EDF (the French Power Company) in French Guyana, on the Le Sinnamary River. The structure consists of a main dam in concrete, 740 meters long and 47 meters high, and six lesser dams, two of which (A1 and A2) are located on the right bank and four (B, C, D and E) on the left bank. Dams C and D, which were the subject of the works, are respectively 145 and 120 m long and 8 and 15 mt. high. They consist of a uniform nucleus of sandy clay and rest on soil consisting in layers of:

- alteration clay with levels of sand: variable thickness from 3 to 12 meters;
- sand with blocks of granite (diameter up to 3-4 m): variable thickness from 0 to 7 meters;
- altered and fractured granite with variable thickness from 0.5 to 6 meters;
- uniform granite with local cracking at the roof.

These soils were not involved in works of consolidation or waterproofing during construction.

The reservoir generated by damming the Petit Saut began in January 1994 and was completed in 18 months. Dams C and D immediately showed problems of hydraulic seal, with leakages of up to 40-50 liters of water/minute. Subsequent geognostic studies made it possible to develop a model that revealed a zone of high permeabilty near the part of the soil consisting of sand with blocks (K ranging in estimate between 10-4 and 10-5 m/sec) and alteration clay (K ranging in estimate between 10-5 and 10-6 m/sec).

The aim of the project was to create a waterproof screen with a minimum thickness of 0.5 m, standing on uniform rock, to reduce the permeability of these soils to values between K = 2x10-7 and 5x10-7 m/sec.

In the construction of the screen, particular attention was necessary to avoid polluting the draining and monitoring system of the dam

Description of works.

The method used to construct the screen was the Pacchiosi Triple Jet Grouting Pacchiosi System (PS3).

Field tests.

To optimize the perforation and injection parameters, and the choice of the cement mixture, a field test was carried out on the right bank of dam C. It called for the construction of 16 vertical columns with a spacing of 1 m, arranged in a circular pattern, laterally overlapping and standing 6 meters in the solid granite (Fig. 2). After drilling, using a down-the-hole water hammer, verticality was systematically measured throughout the length of the hold, using the Pacchiosi Inclinometer model P 401 (Fig. 3), introduced directly inside the drilling rod.

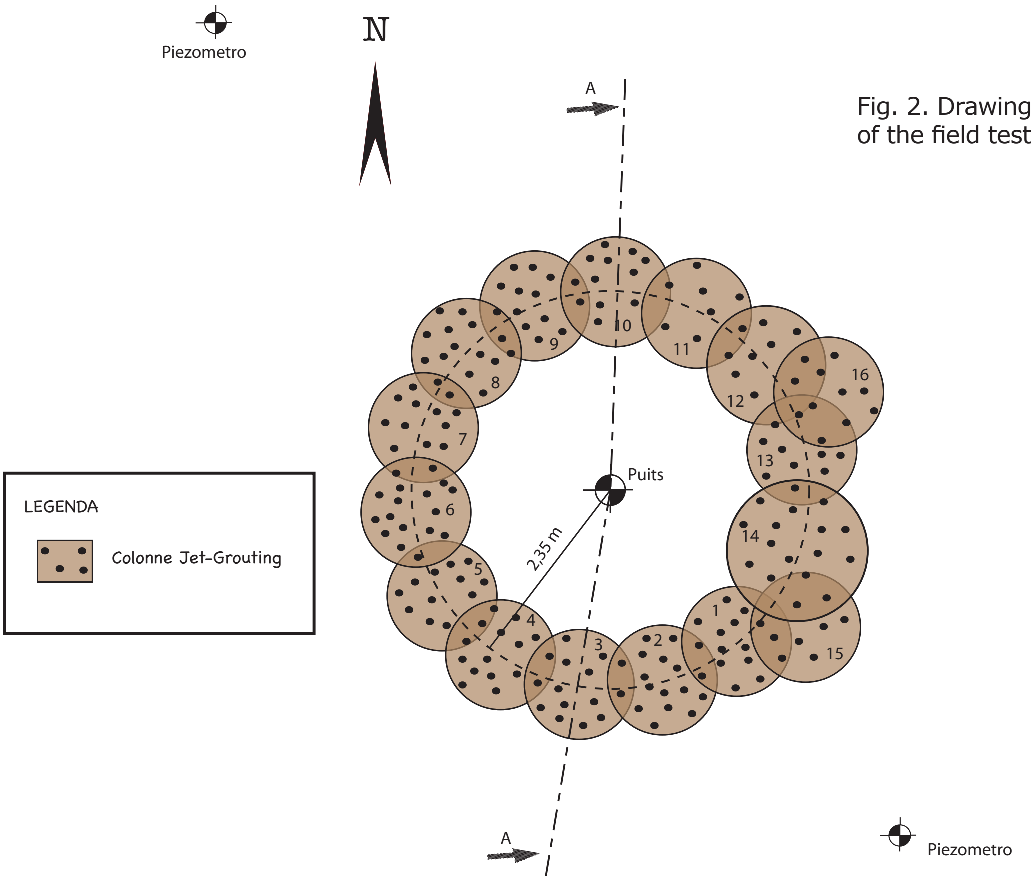

Fig. 2. Drawing of position of the field test columns.

Fig. 3. Pacchiosi P 401 inclinometer.

Fig. 4. P 1500 ECS drill rig for Jet Grouting.

Measurement of the deviation from vertical made it possible to improve the injection parameters to produce a column diameters sufficient to guarantee the minimum thickness required of the screen (Fig. 4). After the columns had set and hardened, 16 holes were drilled to control the zones of overlapping between adjacent columns, including 8 with destruction of the nucleus and 8 with continuous core sampling (Fig. 5), that made it possible to verify the quality of the columns.

Fig. 5. P 1500 ECS and ES drill rig for core sampling.

Fig. 6. Pumping test with measurement of the water table level.

Fig. 7. Column head.

Fig. 8. Excavation of field test columns.

Tests of permeability were performed on all the control holes using the Lefranc and Lugeon methods, that gave readings of K < 2x10-7 m/sec. A shaft was also sunk in the field test for a pumping test which lasted 24 hours (Fig. 6). During the first stage of pumping measurements were made of the lowering of the water table level in the shaft; at the same time, the same measurements were made on the two external piezometers. The same measurements repeated during natural restoration of the water table level (subsequent 24 hours) furnished a value of permeability of the screen of K < 2x10-7 m/sec.

The columns were then excavated (Fig. 7-8), finding that the dimensions varied from a minimum diameter of 135 to a maximum of 180 cm, depending on the injection pa-

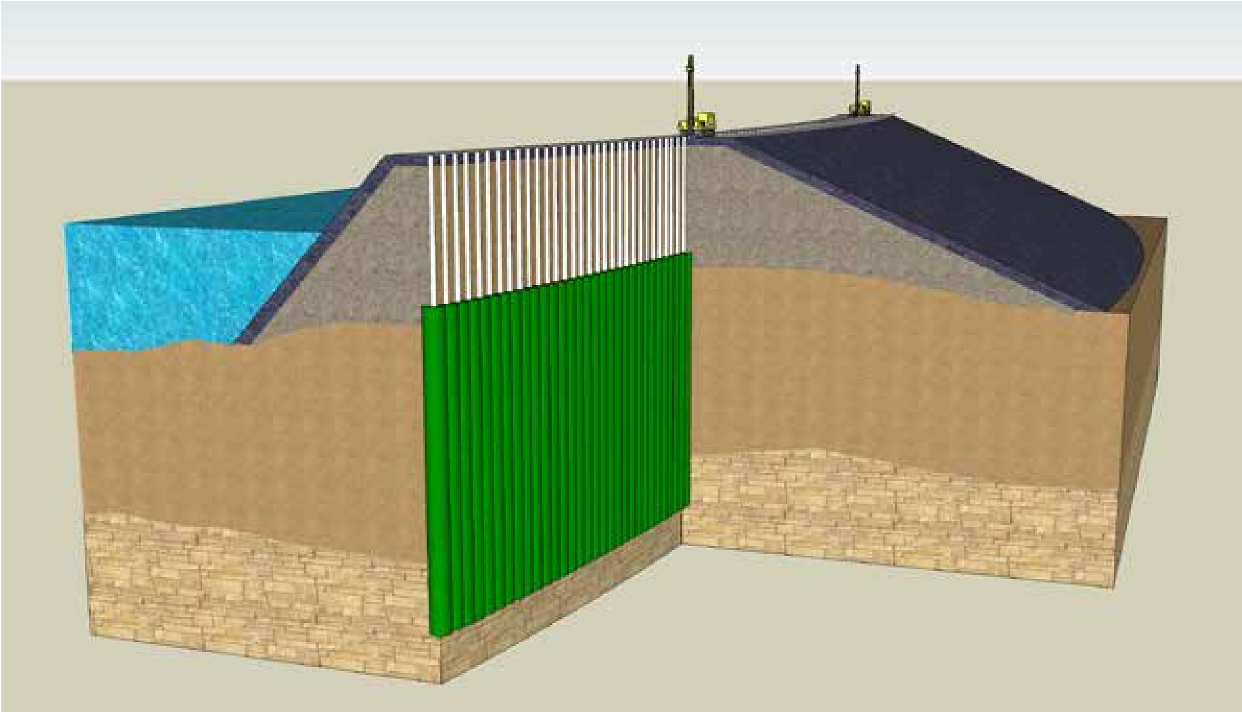

Fig. 9. Cross section of works.

Fig.10. Row of columns.

rameters used and the type of soil treated. It was also possible to ascertain that the thickness of the screen, build in the field test, was greater than the minimum required.

Activities.

The entire plan of works was constructed upstream of the crowning of the dams, after removing a section of artificial cliff face in stone. The works provided for construction of a row of columns, with a spacing of 1 m ; crossing the body of the dam to reach the level where the treatment was to start. This was done by dry drilling with the aid of propeller rods. The preliminary hole thus drilled was fitted with a pipe in pvc , sealed at the opening with injections

Fig. 11. Perforation using propeller rods to lay piping in pvc.

Fig. 12. Laying of pipes in PVC.

Fig. 13. Recovery of waste fluids.

of slurry so as to eliminate the risk of interference with the draining and monitoring system of the dam. Moreover, to prevent drilling and injection waste fluids from contaminating the waters of the reservoir, a device position at the end of the pipes in pvc intercepted the fluids and conveyed them to a collection zone, far from the reservoir waters (Fig. 13). The maximum deviation of the holes with respect to vertical was below the limit value required by EDF (i.e.1%) of the total drilling length. The injection, made with a mixture of water-cement-bentonite (resistance at 28 days = 5.41 Mpa), made it possible to obtain water columns with a diameter up to 180 cm. During performance of the works, control holes were drilled on 50% of the overlapping zones of the columns. The performance of water tests such as the Lefranc test indicated that, in 95% of the cases, the permeability was below 2x10-7 m/sec and in any case below 5x10-7 m/sec in all cases. The drilling and injection parameters were automatically recorded

Fig. 14 - 15. PRS3 recording system.

with the Pacchiosi PRS3 system (Fig. 14-15), capable of displaying them in real time and recording them in graph form. For the duration of the works at the site, a Pacchiosi laboratory was in operation, fully equipped for tests on the cement mixtures with measurement of the density, viscosity, temperature, pH, setting time, mechanical resistance, filter pressure, etc. The screen, built with the Pacchiosi PS3 System, was finally integrated with traditional injections into the granite substratum.

Fig. 16. Probes at work on the dam.

Fig. 17. View of the pumping system.

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