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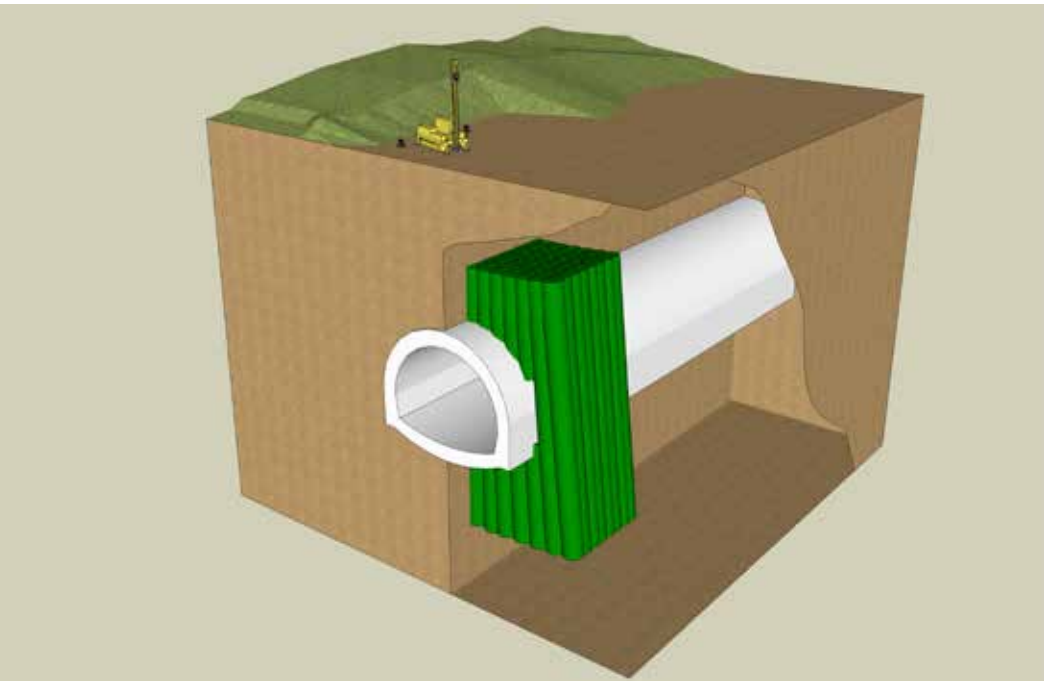
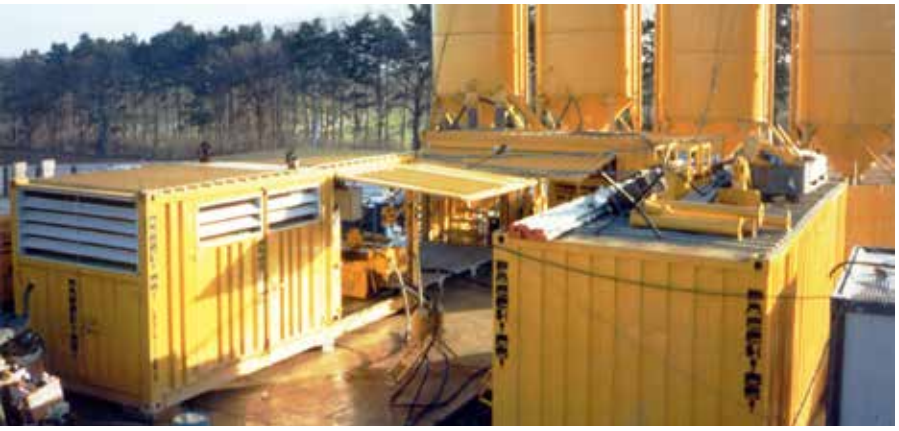
ROCK - SOIL TECHNOLOGY AND EQUIPMENTS

PACCHIOSI DRILL

TUNNEL





BAILLET EN FRANCE (FRANCE)

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PROJECT:

Consolidation for protection of the excavation of a section of the tunnel for access to the subterranean chalk cave in the side of Montmorency (Val d'Oise Region, 20 km north of Paris).

PERIOD OF CONSTRUCTION:

1998/1999

CLIENT:

Borie Sae/Simecsol

Lithology.

Stratigraphic sequence consisting of sub-horizontal layers of sand, marl, calcareous rock, clay, marl, chalk, marl and chalk again (Fig.1).

Purpose of the work, difficulties and solutions applied.

The geological studies made for the design of the tunnel revealed the presence of a much-disturbed volume of rock at about 250 m from the entrance.

The problem, built up over the course of the geological eras by the process of dissolving of the chalk by the water, had caused a partial collapse of the overlaying loam rock layers.

This had created a sinkhole of truncated cone shape; the geotechnical tests performed on samples drawn from this mass of disturbed rock gave readings of deformation that were five times lower than those of the loamy rocks not involved in the collapse.

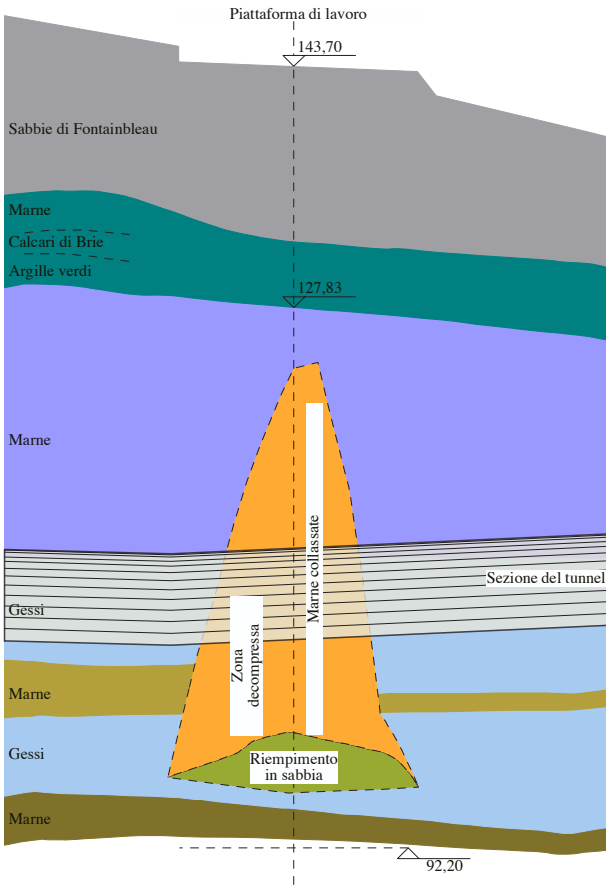

Fig. 1. Geological cross section view of the construction zone Geological cross section view of the construction zone.

The purpose of the works was therefore to consolidate this material, improving its geotechnical features, so as to be able to excavate under conditions of absolute safety.

The original project called for consolidation during the works by means of a series of operations on the cap, front, sides and reverse arch.

In spite of the considerable depth (45-50 meters), Pacchiosi Drill proposed and obtained permission to perform a single treatment from the outside, thereby speeding the construction time.

Description of works.

The method used to perform the work was the **Pacchiosi Triple Jet Grouting System (PS3)**, already applied successfully in other works with similar problems.

Activities.

The work consisted of 13 rows of columns arranged in a quincunx pattern with the following characteristics (Fig. 2):

- Spacing: 0.75 m;
- Diameter: 0.80 m;
- Perforation length: 45 ÷ 46.5 m;
- Angle from vertical: min 0° for the central row, max +/- 10.2° for the two outer rows.

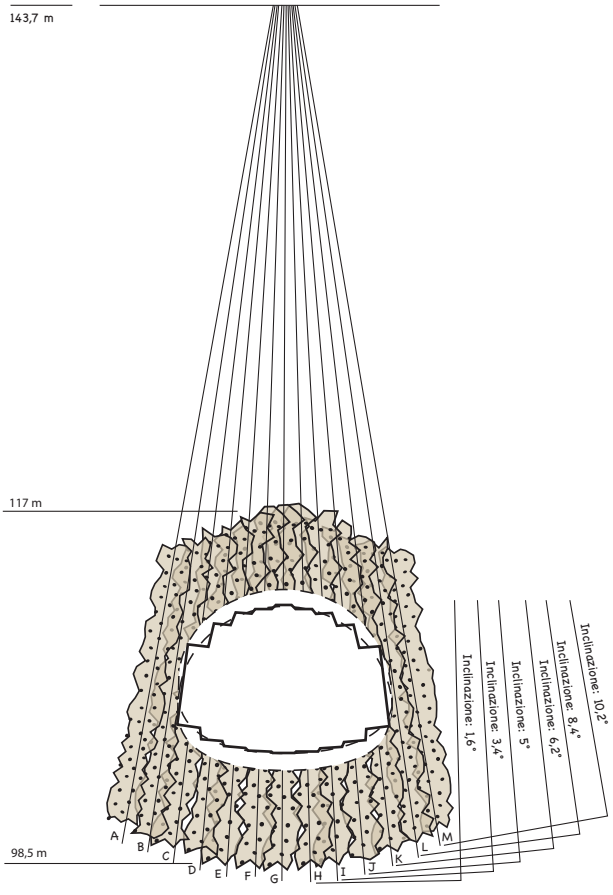

Fig. 2. Cross section of works.

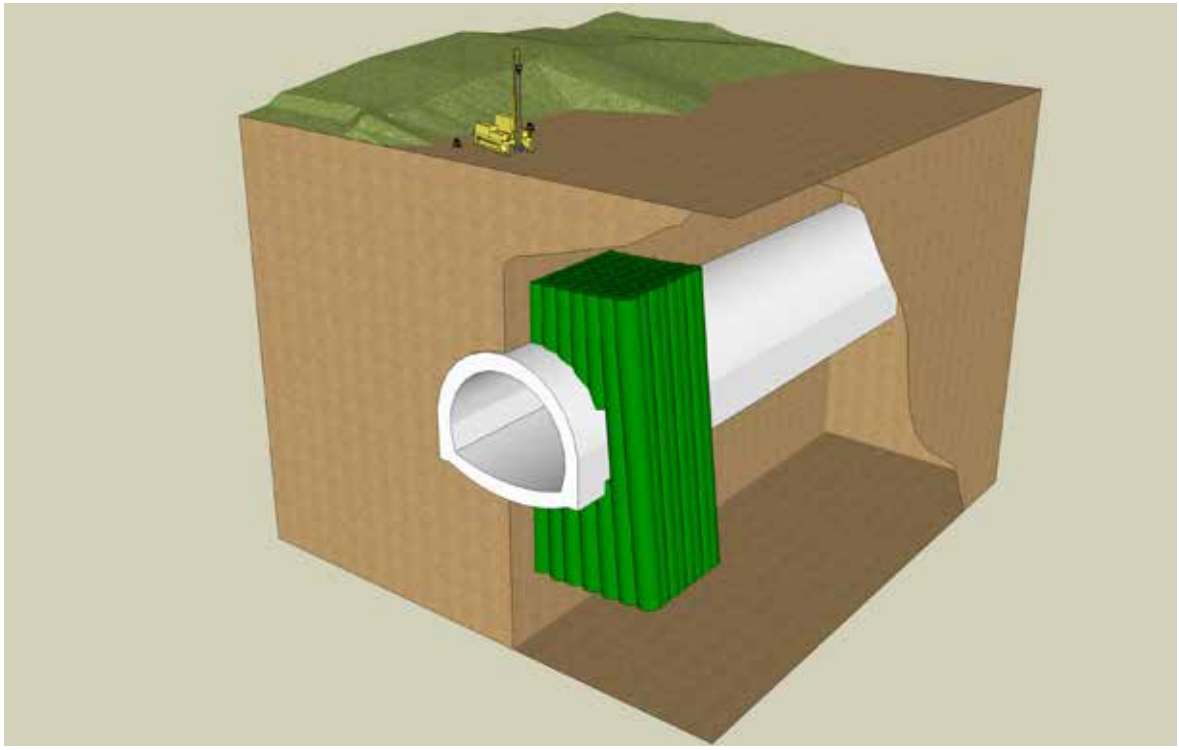

Fig. 3. 3D view of retaining curtains.

The columns in the four outer rows of the excavation section (2+2) were built continuously with an average length of 16 m.

During construction of the 9 inner rows, the treatment was interrupted in the section of the excavation with the maximum injection length of 12 m.

Further treatment became necessary during excavation of the tunnel due to the continuous slipping of the front as works proceeded in the zones not previously consolidated. The works, also carried out from the surface, required construction of two retaining screens with two rows of Jet Grouting columns reinforced with steel beams type HA 27, spaced 6 m from one another and consisted of 11 columns each (Fig. 3) (Fig. 4).

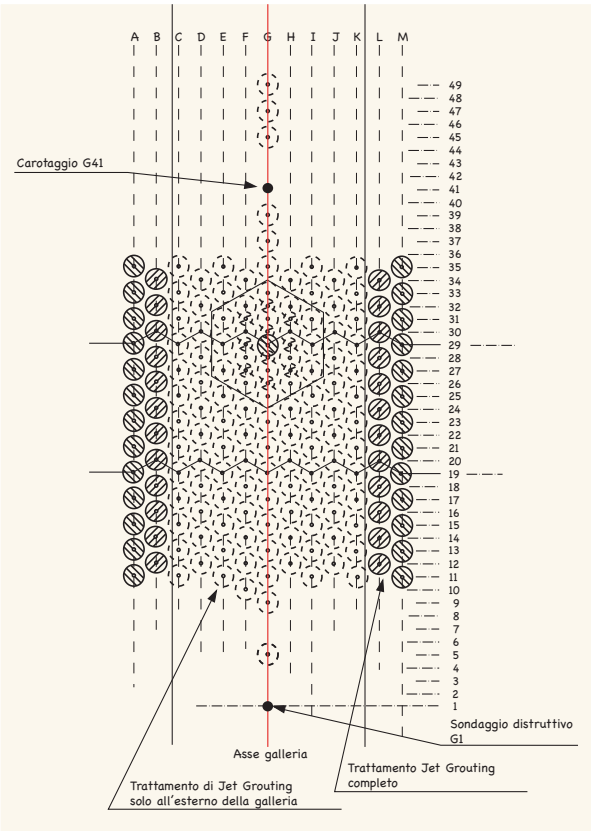

Fig. 4. Drawing of Jet Grouting columns lay-out.

At the end of drilling, done using a special triple-cone cutter, the angle of the hole was systematically checked by inserting an inclinometer probe directly inside the drilling rod. The measurement of the angle made it possible to optimize the injection parameters of every column; moreover, the perforation and injection data were automatically recorded with the PRS3 system. Excavation of the tunnel could then be carried out under conditions of absolute safety as the soil around the columns was dry and very

compact to a distance of 1 meter from its center, and tests of compression of samples of the columns gave readings of average resistance of 4 MPa.

Field tests.

The PS3 system was first tested at the beginning of the works, with field tests in the zone to be treated. 19 columns were built, with slightly angular perforations, using various injection parameters. The control holes for continuous core sampling (Fig. 5 - 6) made it possible to check the effectiveness and choose the most adequate means for this work. The real dimensions of the rock volume to be consolidated where determined by a series of destructive tests, systematically recording the perforation parameters (using the PRS3 system) and thereby providing a reliable measurement of the spatial extent of the zone to be treated.

Fig. 5 - 6. Corings of Jet Grouting columns from the field tests and P 1500 ESCR drill rig employed in the field tests.

Fig. 7. P 1500 ESCR drill rig.

Fig. 8. View of the worksite.

Fig. 9. Laser pump 1700 C.

Fig. 10. MA 500 C mixer and PRS3 data acquisition instrument.

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