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ROCK - SOIL TECHNOLOGY AND EQUIPMENTS

PACCHIOSI DRILL

PIPE-JACKING

ORTONA (CHIETI -ITALY)

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PROJECT:

preparatory works for construction of the new “Castello” tunnel between km 370+930 and km 371+520 of the Ancona – Bari railroad line, consisting of construction of a minitunnel and filling of the abandoned Sangritana tunnel.

PERIOD OF CONSTRUCTION:

April 1998 – February 2000

CLIENT:

Italian State Railroad Company – Italferr

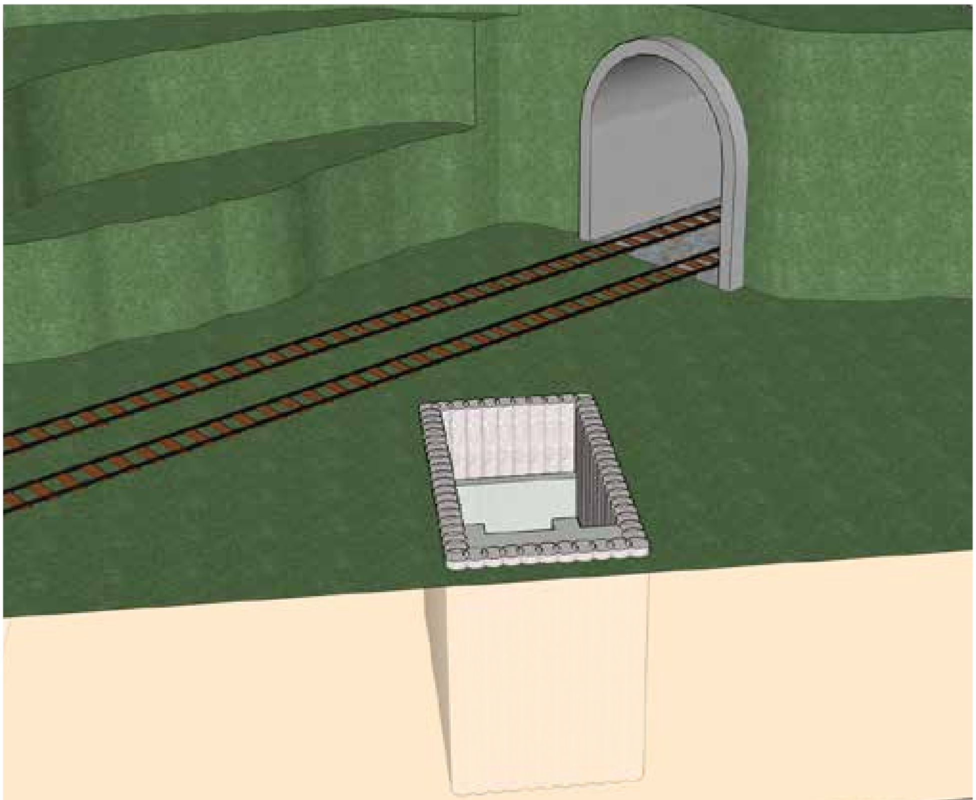

Fig. 1. 3D and schematic view of works including construction of the pipe pusher shaft.

Purpose of the works, problems encountered and solutions applied.

The zone involved in the works is a promontory on which the town of Ortona, in Chieti province, is located. There are two railroad tunnels on this promontory, one of which is in use and the other abandoned (this latter is known as the "Sangritana" tunnel). A new railroad tunnel is also scheduled to be built on the promontory ("Castello" tunnel).

This is the setting in which works were assigned to Pacchiosi Drill S.p.a. All the works, of varying types, served to stabilize the zone, subject to the presence of large quantities of water and consequently tending toward instability.

To drain the water, a minitunnel was built, while an "A-frame" of micropiles served the function of "securing" the slope on which one of the openings of the "Castello" tunnel will be placed.

The presence of the tunnel in use places some limitations on the works, such as not interrupting railroad traffic and, above all, made it impossible to perform any operations on the roadbed. To meet these needs, and considering that the minitunnel passes un-

Fig. 2. Insertion of the supporting piles in the roof of the minitunnel.

derneath the tracks, an umbrella of steel piles was built to support the roof of the new construction (Fig. 2) with constant control of the alignment of its axis in accordance with the project specifications.

The "Sangritana" tunnel also creates a major discontinuity that intersects with the intended position of the "Castello" tunnel. To prevent possible problems during construction, the client ordered the closure and filling of the unused tunnel. The operation to close the ends was carried out by two pumping stations, one directly over the tunnel and one diagonal to it, due to the presence of the Aragonese Castle, where access with the construction equipment was not possible.

Description of the works.

The project consisted of construction of the following works:

- Construction of the starting shaft for the drilling station and construction of works for channeling and drainage around the shaft;
- Construction of a minitunnel, with a diameter of about 2m and length of about 275m, with a draining function, produced using the "pipe pusher" technique;
- Consolidation and filling of the abandoned "Sangritana" tunnel;
- Construction of the "A-frame" of micropiles for protection of the railroad tunnel to be built in the future.

Fig. 3. Position of the drilling shaft with respect to the tracks of the Ancona – Bari rail line.

Construction of the drilling shaft.

Construction of the drilling shaft (Fig. 3), which will house the pipe pusher drilling rig necessary for the minitunnel, was preceded by construction of the accessory works necessary to ensure that it would be waterproof, such as:

- a perimetral diaphragm consisting of intersecting Jet Grouting columns, reinforced with steel pipes (Fig. 4);
- "bottom cap" produced with Jet Grouting.

The works in reinforced concrete consisted of:

- a perimetral crowning beam (Fig. 5);

Fig. 4. View of the reinforcement of the columns composing the perimetral diaphragm of the well and perimetral beam.

Fig. 5. View of the intersecting Jet Grouting columns and crowning beam.

- a bottom slab 500mm thick (Fig. 6);
- • a load-sharing wall for the pipe-pusher station to use during insertion of the elements (Fig. 7).

Excavation of the shaft proceeded to a depth of about -7m below ground level.

The laser station necessary for alignment of the tunnel was also installed in the shaft (Fig. 8).

Fig. 6. View of the bottom cap on the track on which the tunnel elements will move.

Fig. 7. Reinforcement of the load-sharing wall for pipe-pusher.

Fig. 8. Laser station (marked with the arrow)

Fig. 9. Protection of shaft after completion.

After the minitunnel went into use, the drilling shaft was used as an accumulation and decanting reservoir for the water drained (Fig. 9).

Fig.10. Insertion of an element of the minitunnel.

Fig. 11. Elements of the minitun-nel.

Construction of the minitunnel for drainage.

Construction of the minitunnel was performed using the "pipe pusher" technique, starting from the vertical shaft using a shielded cutter pushed forward by hydraulic jacks (Fig. 10). The minitunnel consists of pipe sections about 2m long with an inner diameter of about l.80m (Fig. 11).

Fig. 12. Pipe pusher with intermediate station. The arrow shows the element preceding the intermediate pushing station (in yellow).

After each advance, the pushing station is withdrawn and a new element is positioned.

The problem of excessive pushing of the final sections of the pipe is overcome by installing intermediate pushing stations

To eliminate the friction between one element and the next in the pushing stage, wooden "bearings" were fitted between the sections, and to facilitate the glide over them,

Fig. 13. Picture of two section of the tunnel on which a wooden bearing was applied (shown by the arrow).

valves were installed so that a bentonite mixture could be pumped for lubrication. After positioning the elements, the valves were removed and draining filters were installed in their place.

The minitunnel is equipped with a sedimentation station, followed by a pumping station for the drainage.

Alignment of the effective axis of the tunnel with its theoretical axis, without interfering with the roadbed, was achieved with constant use of a laser device during the excavation and pushing stages (Fig. 8) which cast a luminous trace corresponding to the theoretical axis on a support fastened to the excavator. This made it possible to control the

Fig. 14. Excavation.

real position at all times, with respect to the theoretical. On termination of the works, as a final check, measurement was made of the effective position of the minitunnel compared with the theoretical position, and the maximum difference was 0.002m either way.

Filling of the "Sangritana" tunnel.

This operation consisted first of construction of two "buffers" at the ends of the section to be filled. To do this, holes where drilled (15 on 5 parallel rows) through which a cement conglomerate was pumped. After completing the buffers, it was possible to fill the tunnel using a method similar to the previous one, with a mixture of water-cement-bentonite in a ratio that would ensure its uniformity until it set. Setting was appropriately delayed to permit complete filling of all gaps.

Construction of the "A-frame" (Fig. 15).

The slope on which the northern opening of the "Castello" tunnel was to be placed showed a tendency to instability. To ensure safe working conditions, an "A-frame" was installed, consisting of 25 micropiles in two rows, one vertical row of 13 micropiles and another row tilted at a 20° angle consisting of 12 elements. The heads of the micropiles were inserted in a reinforced concrete beam to a depth of 0.85m. The beam had a total height of l m.

Fig. 15. Detail of the reinforced beam at the top of the A-frame.

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Drill Pac S.r.l. – Società soggetta a direzione e coordinamento di Ghella S.p.A
Sede Legale: Via Pietro Borsieri, 2/a - 00195 Roma (RM)
Tel. +39 06 45603.1 – Fax +39 06 45603040 – e-mail: info@drillpac.com
Sede Operativa: Frazione Borgonovo, 22 – 43018 Sissa Trecasali (PR)
Tel. +39 0521 379003 – Fax +39 0521 879922 - **Sito web:** www.drillpac.com