

Jet grouting

LA DUCHÈRE TUNNEL LYONS NORTHERN RING ROAD

FRANCE

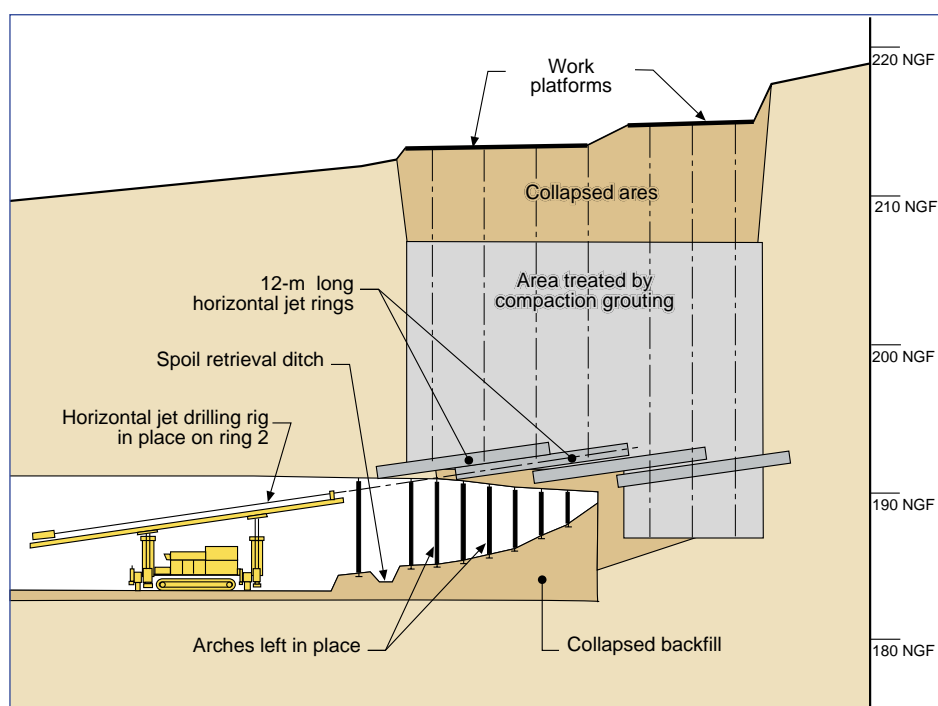


Consolidating a collapsed tunnel via compaction grouting from the surface and horizontal jet grouting while progressing

Under the La Duchère district, the Lyons "Boulevard Périphérique Nord", or Northern Ring Road, crosses the crystalline hills of the Monts du Lyonnais via two motorway tunnels, with 12-m openings. Excavation is performed in weathered gneiss using the standard method of extraction with explosives.

At the western end of the South pipe nearest the hillside, because of extremely weathered ground covered by 15 to 20 m of clayey-sandy colluvium, the screw and discharged concrete support structure was reinforced by arches every 1.5 m. However, at PM 201, the tunnel face crumbled and collapsed soil resurfaced, thus creating a 15 to 20 m-diameter and 4 to 5 m deep depression.

The tunnel was partially banked up and distorted arches propped up by backfill-supported HEB 220 sections. Then, after a survey was carried out from the surface and the neighbouring North tunnel under construction, ground treatment was performed including:



Longitudinal section showing treatment by compaction grouting and horizontal jet

CLIENT:	COURLY (COMMUNAUTÉ URBAINE DE LYON)
MAIN CONTRACTOR:	BOUYGUES DUMEZ-GTM GROUPING
WORKS EXECUTED BY:	BACHY
WORKS PERFORMED:	FROM JANUARY TO MARCH 1995

MAIN FIGURES:

Horizontal jet

- 4 conical rings including 22 or 23 columns each
- Pre-boring using down the hole hammer with recording of parameters

Solid injection

- 1,200 m of boring with recording of parameters
- 200 m³ of mortar used, therefore about 4% of ground area to be treated

- reconsolidating collapsed ground from the surface via the compaction grouting method, with a drill mesh of about 3 x 3 m.

- building an umbrella vault while moving forward from the tunnel, using 4 slightly divergent (about 11°) concentric rings of 12 m-long jet grouting columns, reinforced by 89 mm-diameter and 12.5 mm-thick pipes. In each conical ring, the columns are spaced out every 0.75 m (for an 80 cm-diameter in collapsed parts) and cones fit together in order to ensure permanent dual protection of superposed columns.

Horizontal jet works

Until about PM 200, where existing distorted arches have to be taken down, the back of the umbrella vault is supported by the last newly-installed arch and its front is supported by an old, previously-installed arch. From PM 200, where there are no more existing arches, the back of the umbrella vault is supported by the last newly-installed arch and its front is supported by the tunnel face.

Problems arose when producing the reinforced columns, because of extremely variable soil, from hard gneiss to a mass of decompressed fallen clayey rocks, and within the congestion of existing arches and props.

These problems were solved thanks to using a drill with a long horizontal pole enabling to bore without cutting rods and equipped with an arm handling same-length heavy framework pipes.

Thus, hard ground was able to be crossed by down the hole hammer, then performing jet treatment (single jet process) without taking down rods, by replacing deep drill by the jet monitor, and even reboring in fresh jet spoil, via framework pipes. As most drilling uplifts slightly, the pipe must be inserted with low-pressure slurry injection and final "key" injection, after sealing the pipe circumference, is required to make up for loss of slurry due to gravity during various column execution stages.

Compaction grouting works

Compaction grouting from the surface was performed first, via 2 drilling rigs working at one shift.

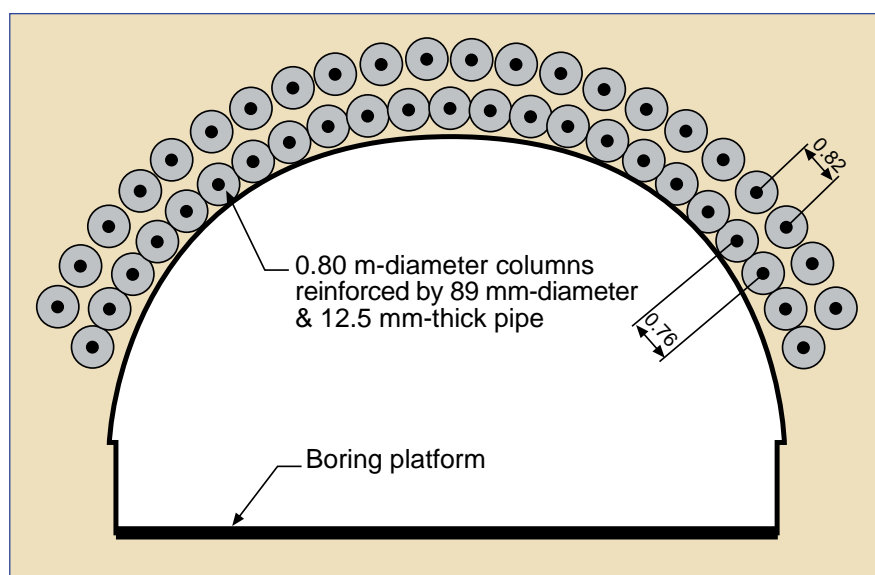
All boring was performed while recording boring parameters and mortar injection pressure was limited to 15 bars in the lower area (for the last 5 metres under the tunnel and in front of the tunnel face) and pushed to a maximum of 40 bars in the uppermost 10 meters of treatment.

Amounts of mortar injected, per boring operation, usually varied from 1 to 5 m³. However, some drilling used between 10 and 25 m³.

Pressure and amount injected were also systematically recorded.

Works results

Following such various treatment, the difficult removal of spoil and distorted arches, as well as their replacement by new arches, was performed withholding major problems and the tunnel was able to progress again after only a two-month stoppage.



Standard cross-section of jet treatment