

GROUND IMPROVEMENT AT ROME METRO-LINE B1 **PONTE DELLE VALLI, ROME, ITALY**

GROUND IMPROVEMENT AT BRIDGE ABUTMENT

Product: Groutmaster SR10S; ETAM 38/27 3v Valved pipes;
EPM 27300 Flex-2C Pol Packer

Project Framework

Line 'B1' is the branch of the Metro 'B' from Piazza Bologna to the G.R.A. (Great Ring Road) The metro lay out will be developed according to the forecast General Plan of the Rome Municipality.

The catchment area of the Line 'B1' is the North-east of Rome, includes the municipalities II, III and IV with a population of half a million people living in "Bologna-Nomentano", "Trieste-Africano", "Montesacro" and "Oltre Aniene". With a geographic area similar to the City of Bologna, vehicular traffic relies upon just three bridges: "Ponte delle Valli", "Ponte Tazio" and "Ponte Nomentano". The new metro line, within an integrated public transport network, enables residents of the northeast quarter to travel directly to the center of the city and the EUR district.

Rome Metro implemented the "Bologna to Conca d'Oro" section and from "Conca d'Oro to Jonio". A future extension is planned from Jonio in the direction of the Bufalotta district to arrive near the G.R.A.

The 3.6km long metro line section constructed in this phase is entirely underground and includes three new stations:

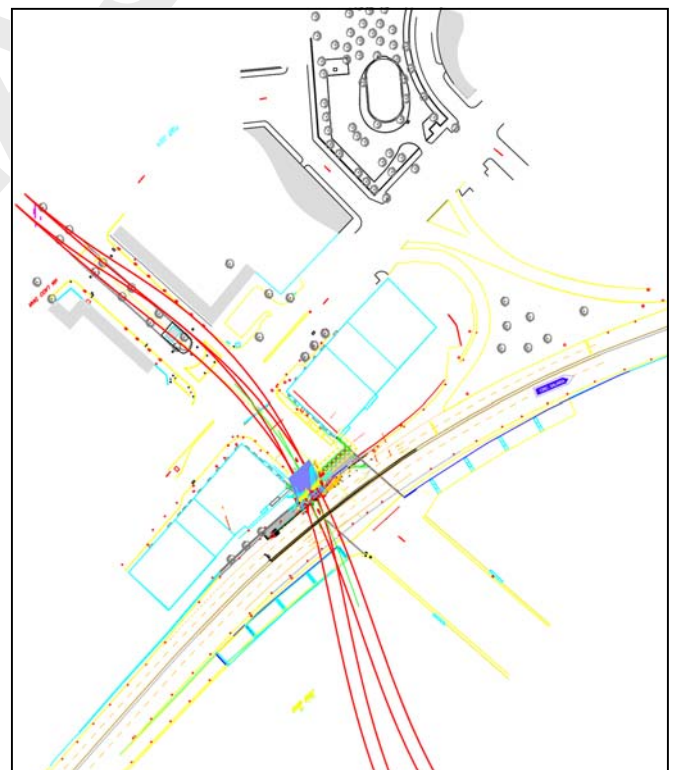
- Annibaliano (at Annibaliano Plaza)
- Libia/Gondar (along Libia Avenue near the Piazza Palombara Sabina)
- Conca d'Oro (beyond Aniene, near the Piazza Conca d'Oro).

Problem

The "Ponte delle Valli" bridge, built in 1963, link the aforementioned districts to the city centre. A road bridge with pedestrian lane, it crosses the eastern Ring Road (Tangenziale Est) and the rail line into the Tiburtina station. The alignments of the Metro Line B1 tunnel line passing under this bridge was predicted to cut the foundation piles.

Solution

Ground consolidation work was therefore required beneath the foundations of the Ponte delle Valli. Initial designs included only a cementitious grout. However, following the first grout trials, low soil permeability prevented effective grout penetration and a change in technology was required. Low pressure grouting with a chemical mix was subsequently successfully used; the effectiveness of this grouting was demonstrated when the head of the TBM reached the consolidated soil, the excavation pressure considerably increased.



Project plan

Date: 2008

Client:

COMUNE DI ROMA

Main contractor:

SALINI (General); RIMATI (Specialist);

Designer / Specialist

TECNIMONT (General); STONE (Specialist)

Products used:

Groutmaster SR10S: 157.5t ~ 315 m³ injected mixture

Date of construction:

2008

Injection equipment

The chemical mixture providing the waterproofing and consolidation function was injected using special equipment:

- **EMP 27300 Flex-2C Pol:** Twin mechanical packer for grouting with two leather and plastic sealing caps and flexible central pipe which provides better adaptability to deformations of the ETAM series pipe, fitted with valves, during the grouting phases. It is a special packer with both cap diameters available (For details see the appropriate Technical Data Sheet).
- **E-T.A.M 38/27 3V:** Valved rigid PVC grouting pipe, with three valves each meter produced with quick coupling sleeve (For details see the appropriate Technical Data Sheet).



Packer - EMP 27300 Flex-2C Pol

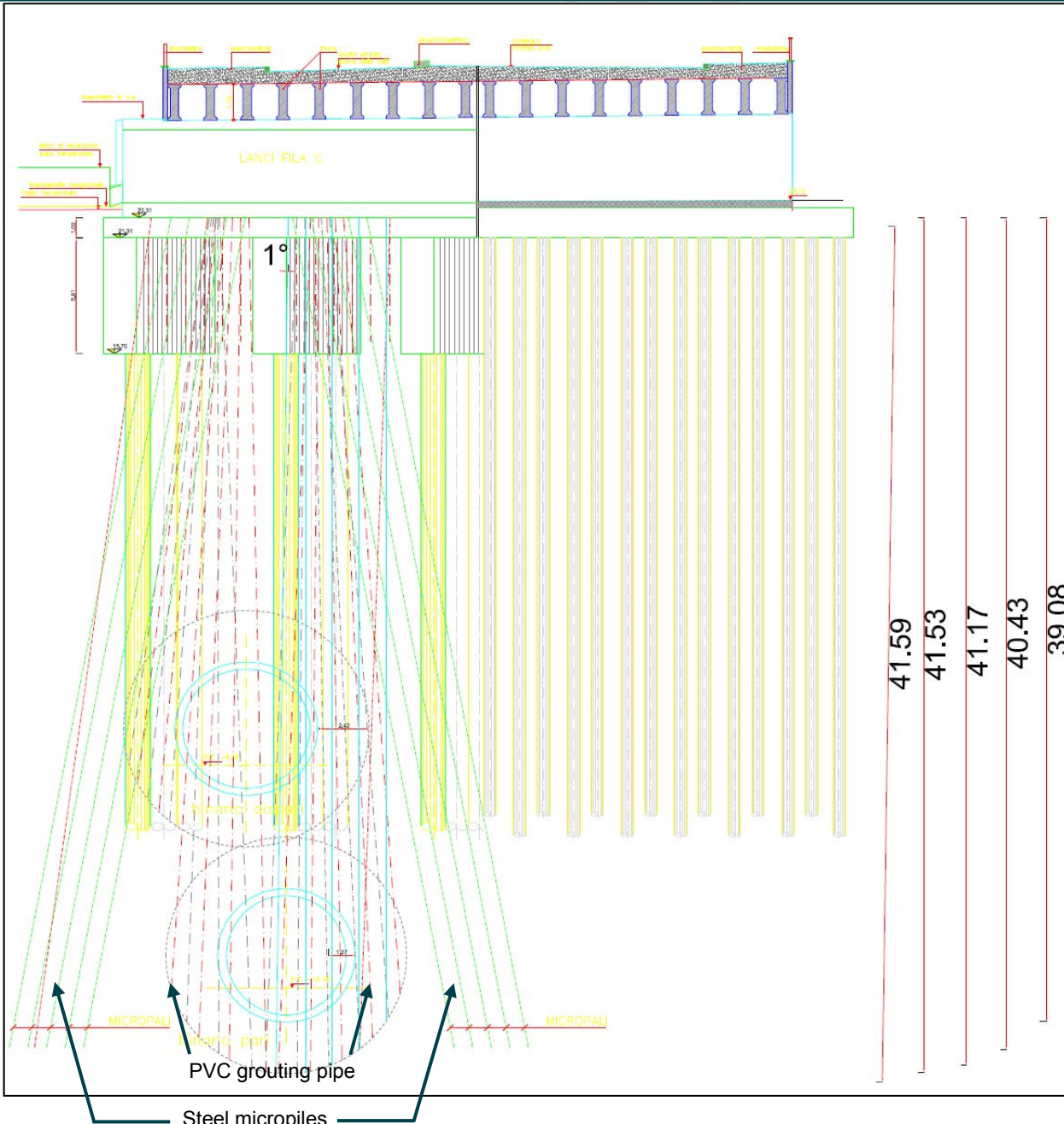


Valved pipe-ETAM 38/27 3v

GFT

Final Design

Date: 2009



Chemical mixture injection operations:

1. Setting out drill holes
2. Drilling
 - The drilling method was selected based on the soil characteristics, site conditions and design requirements (hole length and/or angle).
3. Injection equipment
 - After drilling, the PVC grouting pipe, with 2 valves per meter, was inserted
 - The cavity between the pipe and the drill-hole walls was grouted, at low pressure, down the pipe.
 - After the cavity was filled, the pipe was washed through, to enable the insertion of the packers for the high pressure injections at each valve.
4. Selective grouting
 - After 12 and/or 24 hour from the cavity filling, selective grouting was carried out for each valve with a packer. Continuous checks were made of the grouting pressure and grout volume.

To reach the required ground improvement, three stages of grouting were performed:

- 1st stage: Cement grouting at 20-30 bar or 60 litres/valve.
 - 2nd stage: After 12 or 24 hours, cement mixture grouting at 15 bar or 60 litres/valve.
 - 3rd stage: Chemical mixture grouting with a maximum pressure of 15 bar or 60 litres/valve.
- After each grouting stage, the PVC pipe was washed through.

Throughout the grouting process continuous monitoring of key indicators was carried out:

- Verification of all grout volumes and pressures registered for each valve
- building settlements monitoring with specialist equipment.

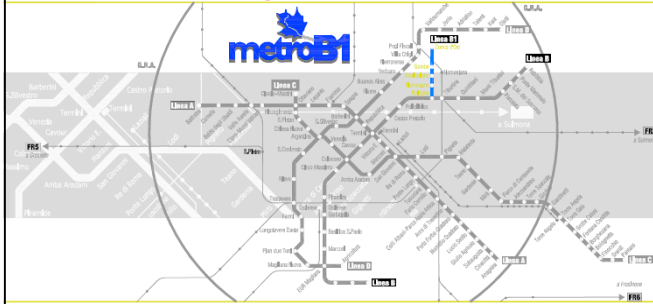


ROMA

METROPOLITANA DI ROMA - LINEA B1

Diramazione della Linea B
Piazza Bologna - Piazza Conca d'Oro

ing. Piero Lattanzi - RESPONSABILE DEL PROCEDIMENTO
ing. Andrea Sciotti - DIRETTORE DEI LAVORI



Appalto Integrato
ELABORATI DI CANTIERIZZAZIONE

OPERE DI PRESIDIO
TRATTA LIBIA - CONCA D'ORO
OPERE DI PRESIDIO
SPALLA PONTE DELLE VALLI
Consolidamento mediante Iniezioni

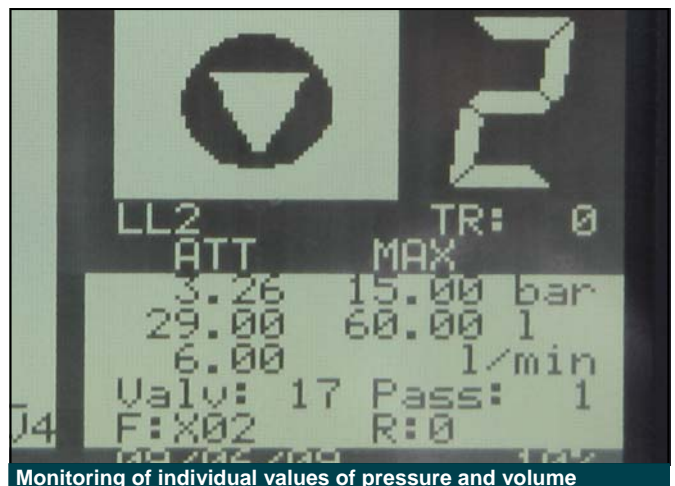
APPALTATORE: A.T.I. SALINI COSTRUTTORI S.p.A (Capogruppo e Mandataria) con TECNIMONT S.p.A
I.C.O.P. S.p.A - T.P.M. S.r.l. (Imprese Mandanti Cooptate)

DIRETTORE TECNICO: ing. Giovanni Saggio (Albo Ingegneri Prov. TR n. A536)
DIRETTORE DELLA PROGETTAZIONE: ing. Andrea Francosini (Albo Ingegneri Prov. RM n. A23680)

PROGETTISTA: ing. Francesco Magnorini (Albo Ingegneri Prov. TO n. 8231)
CONSULENZA SPECIALISTICA: STONE s.p.a.

PROGETTO	LM.	EMS.	ARG.	TRATTA	CAPITOLO	OPERA	TIPO	PROGR.	REV.	SCALA
L B 1	K	D	M	G L 3 0	F A 3 0	P D V	D A	0 0 7	F	VARIE
REV.	DESCRIZIONE	REDAATTO	DATA	VERIFICATO	DATA	APPROVATO	DATA			
G40	AGGIORNAMENTO LANCE FILE A-B	GC	07/05/2009	CRZ	07/05/2009	MGF	08/05/2009			
E20	REVISIONE LANCE PER INTERFERENZA SOLETTA	COM	09/12/2008	MAF	04/12/2008	IGB	04/12/2008			
F20	REVISIONE PER AGGIORNAMENTO AREA CANTIERE	GC	21/01/2009	CRV	22/01/2009	MAF	23/01/2009			
F21	AGGIORNAMENTO INCLINAZIONE POS. 20-2H	GC	26/01/2009	CRZ	27/01/2009	MGF	28/01/2009			

Project details **Date: 2009**



Grouting mixtures

SHEATH MIXTURE

- Cement 325 $c/w = 0.5$
- Stabilizer additive (Bentonite) $b/w = 0.04$
- Specific weight 1.31 t/m^3

CEMENT MIXTURE

- Pozzolanic cement 425 $c/w = 1$
- Stabilizer additive (Bentonite) $b/w = 0.03$
- Fluidifier additive (ratio on cement weight) =1%
- Compressive strength (mono-axial @ 28day) $\geq 3.0 \text{ MPa}$
- Specific weight $1.5 \div 1.55 \text{ t/m}^3$
- Marsh viscosity $35 \div 45 \text{ sec.}$
- Apparent viscosity $10 \div 20 \text{ cP}$

CHEMICAL MIXTURE

- Type: GRTM SR10 $p/w 0.57 \div 0.64$
- Density (20°C) $1.30 \div 1.37 \text{ kg/l}$
- Starting viscosity $5 \div 12 \text{ cP}$

TBM route "Bologna - Conca d'Oro"

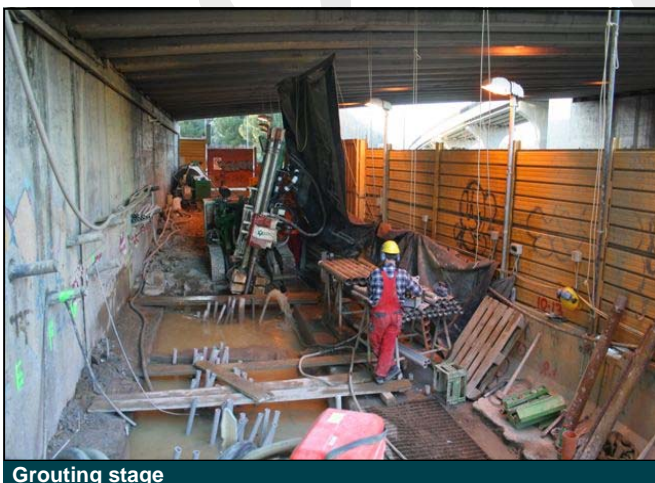
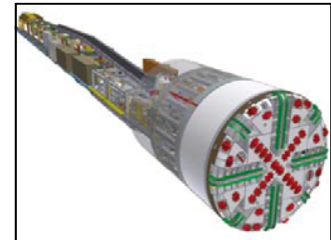
CHARACTERISTIC DATA

EPM - Earth Pressure Balanced Shield

Length:	10.9 m
Total weight:	400 t
Excavation diameter:	6.69 m
Installed power:	2500 kW

PERFORMANCES

Head torque:	7,000 kN
Thrust:	50,000 kN
Head pressure:	5.5 bar
Excavation speed:	till 100 mm/min
Average excavation speed:	10 m/day
Screw conveyor capacity:	385 m ³ /h
Excavation area:	36.21 m ²
Length single feed:	1.40 m
Excavation volume single feed:	50.7 m ³
Excavated volume per single feed:	100t



Grouting stage



EPBS S387 Tunnelling Machine

ELAS Geotecnica S.r.l.

Centro Commerciale San Felice – Lotto 3/21 – 20090 Segrate (MI)

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