Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art – Peila, Viggiani & Celestino (Eds)

Milan to Genoa high speed/capacity railway: The Italian section of the Rhine-Alpine corridor

P. Lunardi
Lunardi Geo-Engineering, Milan, Italy

G. Cassani & A. Bellocchio
Rocksoil S.p.A., Milan, Italy

N. Meistro
COCIV, Genoa, Italy

ABSTRACT: The new high speed/capacity Milan to Genoa rail line will improve railway connections between the Liguria port system with the main railway lines of Northern Italy and the rest of Europe. The project is part of the Rhine-Alpine Corridor, which is one of the corridors of the Trans-European Transport Network (TEN-T core network) connecting Europe's most populated and important industrial regions. The Rhine-Alpine Corridor constitutes one of the busiest freight routes of Europe, connecting the North Sea ports of Rotterdam and Antwerp to the Mediterranean basin in Genoa, via Switzerland and some of the major economic centres in the Rhein-Ruhr, the Rhein-Main-Neckar, regions and the urban agglomeration in Milan, Northern Italy. The new high speed/capacity rail line will be 53 km long, of which 39 km in tunnels. The new line will be connected to the existing line through four interconnections, 14 km long. The construction started in April 2012 and the completion of the six sections is scheduled for April 2021. The adopted excavation methods are conventional (ADECO RS) and mechanized. The paper will describe this complex project from a design point of view for both excavation methods, conventional and mechanized.

1 INTRODUCTION

The high speed railway Milan-Genoa is one of the 30 European Priority Projects adopted by the European Union on April 29, 2004 (Project n. 24 "Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen") as a new European project, the so-called "Bridge between Two Seas", a rail-link Genoa-Rotterdam. The line will improve the connection between the port of Genoa and the Po Valley inland and further with Northern Europe stimulating a significant increase in transport capacity, in particular in freight transportation, aiming to meet the growing traffic demand. The line runs along the Genoa-Milan route reaching Tortona, and proceeds along the Genova-Alessandria-Turin route up to Novi Ligure, crossing the provinces of Genoa and Alexandria. The new line will be connected to the South at Voltri and Bivio Fegino through interconnections with the railway facilities at Genoa hub and with dock basins of Voltri and Porto Storico, while connection to the North will be ensured by the existing railway lines Genoa-Torino and Tortona- Piacenza-Milan. The total length of the line will be approximately 53 km; the project requires the construction of 36 km of tunnels running through the Apennine mountains between Piedmont and Liguria. The overall scope of underground works, including dual tube single-track running tunnels, adit and interconnection tunnels, exceeds 90 km (Figure 1).

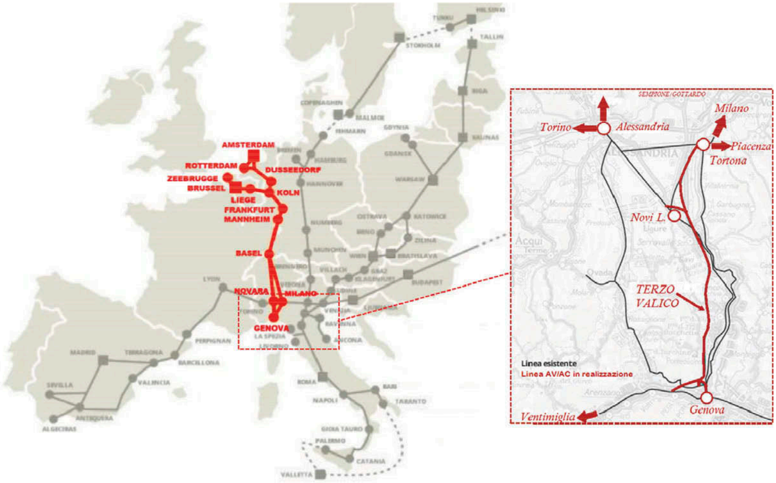

Figure 1. Terzo Valico dei Giovi: general project layout.

The underground portion includes the approximately 700 m long Campasso Tunnel and the two interconnecting tunnels at Voltri, each with a length of approximately 2 km. Four intermediate access adits (Polcevera, Cravasco, Castagnola and Vallemme) are anticipated for the Valico Tunnel, both for structural and safety purposes. From the Serravalle Tunnel exit, the main line is predominantly above ground or in an artificial tunnel, until it joins the existing line in Tortona (en route to Milan), while a diverging branch line with a turnout speed limit of 160 km/h establishes the underground connection to and from Turin on the existing Genoa–Turin line. In terms of construction, the tunnels listed in Table 1 are the most significant underground works of the Terzo Valico. Tunnels excavations are designed and executed with conventional (61,7 km) and mechanized excavation (30,7 km) method with an overburden varying from 5,0 m to 600,0 m and cross sections area between 75 and 365 m^2. In compliance with the latest safety standards, the underground line consists of two single-track, side-by-side tunnels with cross-passages every 500 m which allow each tunnel to serve as a safe area for the other (Figure 2).

The General Contractor in charge of designing and building the Terzo Valico is the COCIV Consortium formed by the following major Italian construction companies: Salini Impregilo (64%), Società Italiana Condotte d'Acqua (31%) and CIV (5%).

Table 1. Terzo Valico Tunnels.

Tunnels	**Lunghezza**	**Section Type**	**Excavation method**
Campasso	710 m	*single tube - dual track*	Conventional
Valico	27.032 m	*dual tube - single track*	Conventional & Mechanized
Serravalle	7.094 m	*dual tube - single track*	Mechanized
Volti Interconnection	3.023 m	*single tube - single track*	Conventional
Cravasco Adit Tunnel	1.260 m	*single tube - single track*	Conventional
Polcevera Adit Tunnel	1.763 m	*single tube - single track*	Mechanized
Castagnola Adit Tunnel	2.470 m	*single tube - single track*	Conventional
Val Lemme Adit Tunnel	1.590 m	*single tube - single track*	Conventional
Val Lemme Safety Area	750 m	*dual tube - single track*	Conventional
Novi Ligure Interconnection	2.860 m	*dual tube - single track*	Conventional
New route NV-01	1.010 m	*dual carriageway road*	Conventional
New route NV-02	306 m	*dual carriageway road*	Conventional
By-Pass	4.810 m	*pedestrian & vehicle way*	Conventional

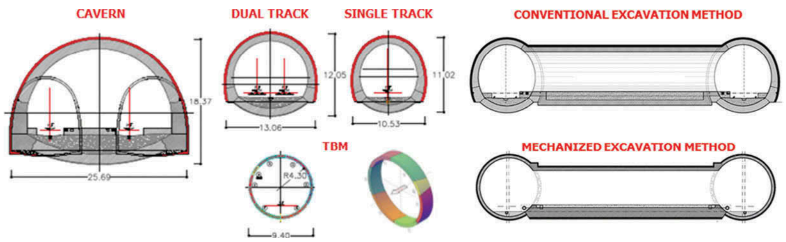

Figure 2. Terzo Valico dei Giovi: Cross-section of railway tunnels.

2 THE PROJECT

2.1 *Characteristic of the new railway line*

Design standards provide for a maximum speed of 250 km/h on the main line, 100–160 km/h for interconnections, a maximum gradient of 12.5 ‰, a DC power supply of 3 kV but with infrastructure that provides for 2 x 25 kV AC, and a Type 2 ERTMS signalling system.

A safety stop equipped for the evacuation of train passengers in the event of an accident or a significant failure is planned for inside the Valico Tunnel at the Vallemme adit tunnel.

The system involves the juxtaposition of the two railway tunnels with two other pedestrian tunnels for the evacuation of passengers; the tunnels are 750 m long and are linked together via a “transect” that passes over both tracks, reaching the Vallemme adit, which serves both as the emergency exit and as the emergency vehicle access point (Figure 3).

This overpass, along with a 15 + 15 by-pass, connects the two platforms with the two evacuation tunnels and affords the passengers of a damaged train safe passage to the opposite plat-form to board another train or, in extreme cases, route them to the safety exit at the Vallemme adit. The construction of a vehicular tunnel system that connects the adit tunnel with the odd track evacuation tunnel is also planned.

The railway line is crossed by means of a level passage. There are plans for a second safety area at Libarna, in the above-ground section of the line between the Valico and Serravalle Tun-nels; it will be equipped with a priority shelter track and will have the dual function of communications area and safety area.

2.2 *The geological overview*

The tunnel section of the “Terzo Valico” extended from Genoa to Tortona among two main geological units (Figure 4):

– from Genoa to geological contact zone with Tertiary Piedmontese Basin (TPB) (chainage 19+500), the layout in entirely within the Sestri – Voltaggio Zone (ZVS); particularly this zone is characterized by the “Argille a Palombini” Formation (aP), a sequence of argilloschists, claystones and limestone lenses; between chainage 8+500 and 12+500, rockmass is highly tectonized and squeezing because of tectonic Alpine evolution;

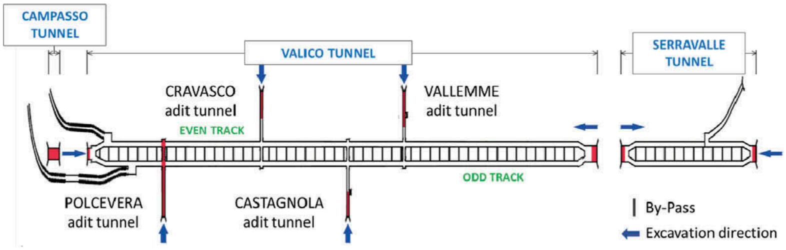

Figure 3. Terzo Valico dei Giovi: Running Tunnel layout.

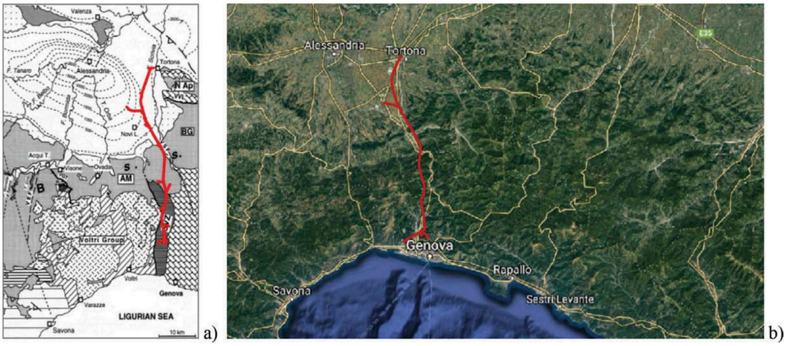

Figure 4. Terzo Valico dei Giovi: a) geo-structural setting; b) Satellite view.

– from change 19+500, tunnel stretch crosses Tertiary Piedmontese Basin Units (TPB), a sedimentary sequence constituted by conglomerates, sandstones, marls, claystones.

The ZSV represents an important tectonic area, and with the “Gruppo di Voltri” forms a complex geological context (“nodo collisionale ligure” di Laubscher at. al. 1992), interpreted as the West to East transition from Alpine rock sequences to Appennine rock sequences.

The ZSV is constituted by three different tectonic units, two of them ophiolitic (Cravasco-Voltaggio and Figogna) and the last one, Gazzo-Isoverde unit. During various stages alpine evolution, these three units experienced different temperature and pressure conditions (metamorphism) that determined the natural growth (by the original protoliths) of chrysotile, actinolite and tremolite.

The TPB represents the overlying tertiary sedimentary cover sequence of the ZVS. The Terzo Valico tunnel section crosses this important and very complicated geological, structural and lithological context, because of its involvement in the Alpine Evolution Phases. The tunnel stretch passes through the contact zone between The ZVS and TPB units, too. The most important lithologies along the alignment (Figure 5), from south (Genoa) to north (Milan) are listed below:

– claystone schists with limestone lenses (Palombini)-aP; this unit represents the predominant lithological unit (most than 60%);
– lenses of basalts in the claystones schists unit,
– sedimentary unit constituted by conglomerates, sandstones, marls and clays; this unit is the predominant lithological unit in the lowland area.

2.3 *The Sestri Voltaggio Zone (ZVS)*

The survey phase allow to identify “geomechanical groups” based on the following main factors:

– lithological criteria (petrographical and mineralogical composition, the degree of alteration, possible presence of water);
– structural criteria (characteristics of joints, RDQ index, foliation intensity, tectonisation intensity, such as the presence of folded structures including also microscale folding);
– lithomechanical criteria (with reference to the first assessment of physical properties, strength and deformability).

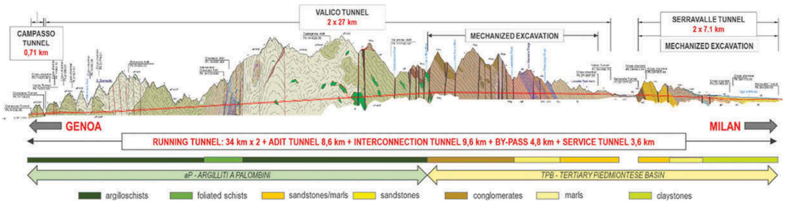

Figure 5. Terzo Valico dei Giovi: geological profile.

The evidences gathered during the excavation of exploratory tunnels, performed at the initial stage of the project, were complemented by interpretation of in situ investigations and the results of laboratory tests carried out for final design and detailed design stage. Classification of sampled material in terms of lithological composition, foliation pattern and recurring calcite veins has confirmed, also at the sample scale. The geomechanical parameters are summarized in Table 2.

2.4 *The Tertiary Piedmontese Basin Units (TPB)*

The Tertiary Piedmont Basin crops out in the southern part of the Piemonte region, northwestern Italy. Formed on a backvergent segment of the Alpine wedge after the meso-Alpine collisional events, the TPB and its highly deformed Alpine substratum became involved in the growth of the Apennines orogenic wedge from the Oligocene.

The section crossed by Terzo Valico is mainly constituted by conglomerates, sandstones, marls and clays. The geomechanical parameters are summarized in Table 3.

Table 2. Claystone schists.

Formation	γ [kN/m^3]	υ [-]	E_{op} [GPa]	σ_c [Mpa]	m_i [-]	GSI [-]
GR1	27	0,25 - 0,3	3 ÷ 7,8	30 ÷ 40	15 ÷ 20	45 ÷ 55
GR2a	27	0,25 - 0,3	1,5 ÷ 2,0	10 ÷ 12	20 ÷ 25	40 ÷ 45
GR2b	27	0,25 - 0,3	1,0 ÷ 1,5		15 ÷ 20	35 ÷ 40
GR3a	26	0,3	1,0 ÷ 1,2	5 ÷ 7	19	30 ÷ 35
GR3b	26	0,3			19	25 ÷ 30

Table 3. Tertiary Piedmont Basin geomechanical parameters.

	Formation	γ [kN/m^3]	υ [-]	UCS [MPa]	σ_t [Mpa]	m_i [-]	GSI [-]	E_{RM} [MPa]
Conglomerates of Molare	**Molare** *high cementation*						50÷55 (52)	3500÷5000 (4250)
	Molare *medium cementation*	26,00	0,25÷0,30	5÷30 (14)	1,60	18÷24 (21)	40÷50 (47)	1750÷3500 (2600)
	Fault Zone						35÷40 (37)	700÷1500 (1100)
	FMa	25,80	0,25÷0,30	10÷32 (22)	3,00	13÷21 (17)	35÷50 (45)	850÷2500 (1650)
Marls of Rigoroso	mR	25,50	0,25÷0,30	25÷45 (35)	2,50	5÷9 (7)	40÷55 (48)	1000÷3200 (1750)
	Fault Zone (mR)	25,50	0,25÷0,30	12.5÷25 (18)	2,50	5÷9 (7)	35÷40 (37)	300÷1000 (650)
	fR	25,60	0,25÷0,30	20÷40 (30)	2,70	10,75	35÷55 (43)	550÷2100 (1050)
	Fault Zone (fR)	25,60	0,25÷0,30	12÷20 (16)	2,70	10,75	30÷40 (35)	200÷1100 (580)
Costa Montada	uMa	23,50	0,30	7÷25 (14,50)	1,50	5÷9 (7)	45÷55 (50)	310÷2000 (1020)
	uMb	25,80	0,30	10÷32 (22)	3,00	13÷21 (17)	35÷50 (45)	850÷2500 (1650)
	uMc	24,50	0,30	7,5÷28 (17,50)	2,00	10,75	35÷50 (40)	300÷1200 (630)
Costa Areasa	fCa				≈ uMb			
	fC (FC1)	23,5	0,3	7÷25 (14,50)	1,5	5÷9 (7)	45÷55 (50)	310÷2000 (1020)

3 TUNNELS DESIGN

Conventional method will be used for the excavation of the Castagnola, Cravasco, Vallemme adit tunnels and for 20 km from South Entrance of Valico Tunnels while for its remaining length the excavation will be approach from the North Entrance using mechanized method. Serravalle Tunnels and Polcevera adit tunnel will be excavated by mechanized method.

3.1 *Conventional Excavation Method*

The survey phase allow to divide the rock mass into "geomechanical groups". Each group is characterized by a specific set of strength and deformability parameters that determine its stress-strain response to the excavation. In view of these assumptions, it became necessary at the design stage to determine a full set of section types, verified through all possible scenarios (depending on the overburden and on the variability of geomechanical parameters valid for statistically defined intervals). The main section types adopted, grouped according to the type of behaviour category, A, B and C. The 'variabilities' to be applied were designed for each section type for statistically probable conditions where, however, the precise location could not be predicted on the basis of the available data. It is essential to identify the variabilities for each tunnel section type that are admissible in relation to the actual response of the ground to excavation, which will in any case always be within the range of deformation predicted by the ADECO-RS approach. This is because it allows a high level of definition to be achieved in the design and also at the same time the flexibility needed to be able to adopt quality assurance systems during construction to advantage.

A design and contract instrument, called Guideline (Figure 6.a), has been defined for all tunnel sections (Figure 6.b), in order to manage the application of these section types. For each section type (Figure 6.c), a specific range of application was defined together with a variety of stabilization interventions assigned to it. In this way each section type, without changing the final structural characteristics of the tunnel, can fit to actual geomechanical conditions, the rock mass hydrogeological properties, tunnel face extrusion pattern and cavity deformation type.

The Guidelines, managing section type application, allowed to define the criteria that the designer can rely upon during the construction works in order to:

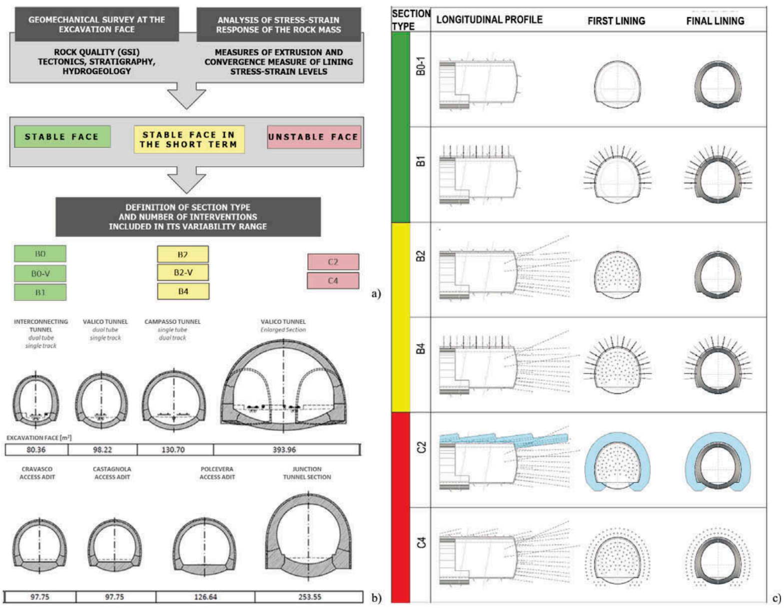

Figure 6. Terzo Valico dei Giovi: a) flow chart for guideline application; b) tunnel sections; c) section type.

– confirm the most applicable section type, selecting it from among those already assigned to a particular tunnel stretch;
– define the section type most suitable for the actual geomechanical context, according to the designed variability;
– identify a different section type from those assigned to each particular stretch or anyway envisaged in the design for the same formation, in case actual conditions encountered during the excavation differ from those predicted.

During the design phase the following set of components were defined:

– section types each with specific interventions to control the ground deformation in the various geomechanical contexts specified at the survey phase;
– uniform sections of underground alignment, in terms of deformation response of rock mass to the excavation, together with a set of section types assigned to them; each section type is characterized by a percentage of its application defined by a special parametric analysis;
– alert and alarm threshold values set for rock mass and lining deformation parameters to be monitored during construction works by means of the instruments specified in the monitoring plan;
– three levels of variability established for the designed interventions (minimum, medium and maximum) defined for each section type, and introduction of Guidelines as a management tool operating with a complete set of different excavation sections.

3.2 *Mechanized Excavation Method*

The Serravalle Tunnel will be completed entirely with mechanized excavation, using two 9,73 m diameter EPB TBMs. The excavation of the Valico Tunnel will be carried out using both technologies: conventional excavation from the southern entrances and from the four access adits, and mechanized excavation, using two 9,77 m diameter EPB TBMs, from the northern entrances. Also the Polcevera tunnel, an adit one, was excavated by mechanized method. Table 4 summarize the characteristics of the used TBMs.

The Serravalle tunnel is a 7 km long tunnel, of which 6.3 km have a section with separate tubes, excavated by mechanized method. From the southern portal, the tunnel is in a context of transition between relief and plain (up to approximately pk 32+300). The overburden in this section vary from a minimum of 27 m (pk 30+500 approx.), up to a maximum of 130 m (pk 30+200 approx.).

Over pk 32+850, the tunnel pass through a lowland context, where the overburden gradually decrease reaching minimum value equal to 5–6 m, close to the northern portal. In the section between pk 32+850 and 33+500 the route is part of an urbanized area, included in particular a commercial area of the municipality of Serravalle. In this sector, the tunnels cross a geological context characterized by the presence of a palaeo-riverbed and a tectonized area.

The TBM - EPB has been selected for the excavation of Serravalle Tunnel considering the local condition. These machines are flexibly designed in terms of support and excavation methods. The tunnelling mode can be adapted to changing ground, requiring relatively short conversion times

Table 4. Terzo Valico Tunnel Boring Machines.

TBM CHARACTERISTICS	*Serravalle Tunnel*	*Valico Tunnel*	*Polcevera Tunnel*
Type		EPB Shield	
Excavation Diameter	9,730 [m]	9,770 [m]	9,790 [m]
Shield lenght	10,225 [m]	11,000 [m]	9,800 [m]
Power	4.000 [kW]	4.000 [kW]	4.680 [kW]
Bulkhead pressure	5,0 [bar]	5,0 [bar]	4,0 [bar]
Segmental Lining Outside ∅	9,40 [m]	9,40 [m]	9,45 [m]
Segmental Lining Inner ∅	8,60 [m]	8,60 [m]	8,65 [m]

This means that even tunnels with extremely varying geological and hydrogeological conditions can be constructed safely using the TBM-EPB. The following mode can be selected:

– Closed Mode with ground conditioning: excavation to be used if the tunnel face is not self-supporting (unstable) and/or when a groundwater pressure is to be balanced. The closed mode is typically known as EPB mode.
– Semi Closed Mode with compressed air: can be applied if the tunnel face is stable but if at the same time significant more water is flowing into the excavation chamber. Then, the water inflow could be prevented by application of compressed air.
– Open Mode: excavation can be applied if the tunnel face is stable and if just locally some disturbance or fissures are encountered. A groundwater pressure cannot be handled in this operation mode.

Figure 7 shows the correlation between the excavation mode and geological formation while the Table 5 summarizes the advantages and disadvantages of single excavation mode.

The north entrance of Valico Tunnel, from km 27+327,50 to km 19+700, will be characterized by dual tube single track excavated by mechanized method (from Radimeno Shaft). This section of Valico tunnels are inside the Tertiary Piedmont Basin and cross the following geological context:

– Costa Areasa Formation: flyschoid formation consisting of poorly cemented silty marl, cemented marl carbonates, poorly cemented sands and fine sandstones.
– Costa Montada Formation: arenaceous marls and medium to coarse sandstones.
– Marls of the Rigoroso Formation and the Costa Areasa Formation. Silty, clayey marl with intercalations of fine sandstone (Rigoroso Marls). Cemented marls and sandstones (Rigoroso Flysch).
– Conglomerates of the Molare Formation, consisting of polygenic conglomerates in benches and strata in an arenaceous matrix. The Molare Formation contains groundwater flow systems, making groundwater locally significant. In fact, the uppermost part of the Molare Formation is more highly cemented and contains an aquifer system which is widely used as a source of potable water. With regard to lithostratigraphic properties, excavation challenges are linked to the strong granulometric heterogeneity of the conglomerates,

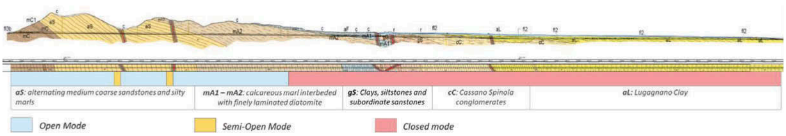

Figure 7. Serravalle Tunnel: excavation mode related to the geological profile.

Table 5. Advantages & Disadvantages of different excavation modes.

EXCAVATION MODE	ADVANTAGE	DISADVANTAGE
CLOSED MODE *Excavation by soil conditioning (foam and water)*	•Low wear of the TBM's mechanical parts •Production Increase •Good control of TBM	•The excavated material is too fluid and not shovelable •The excavation material must sediment in a settling tank
OPEN / SEMI-OPEN MODE *Excavation without soil conditioning (only water when necessary)*	•The excavated material is easy to handle •The excavated material can directly delivered to cleaning up site	•Reduction of Tunnel Production •TMB difficult driving •Very high wearing of cutterhead and screw

specifically to the occurrence of large stone blocks embedded in a poorly cemented fine matrix with poor cohesion.

Figure 8 shows the correlation between the excavation mode and geological formation.

The assessment of works impacts on aquifers is an aspect with important repercussions during tunnels design. A detailed hydrogeological studies for designing the underground works related to Terzo Valico has been carried out and presented in a previous paper (Lunardi, 2016) regarding the assessment and mitigation of the tunneling impacts on the existing aquifers.

Referring to the hydrogeological conditions the authors considering important to recall the following consideration applied to the Valico Tunnel. The tunnel excavation causes the generation of a plastic zone, with the resulting detension around the cavity, which could increase, even significantly, the degree of hydraulic interconnection inside the bored ground mass. The permeability increases in the immediate vicinity of the cavity for a distance at least equal to the radius of the plasticization band and the water distributed around the tunnel could transfers the corresponding hydraulic head to the tunnel lining. In particular, considering the waterproofing condition of the tunnel, it is possible to evaluate the evolution of hydraulic head around the cavity (Figure 9) which develops as follow:

– during the excavation phase, the initial natural hydraulic head determines a continuous flow from the saturated mass inside the tunnel (drain behavior of the tunnel and zero value hydraulic head);
– once the excavation is completed and the lining installed, the load starts to increases (timing depends on the overall permeability of the system);
– from short to long term, the hydraulic head on the tunnel is rebalanced and it will be definitively restored to a level equal to, or possibly lower than, the initial natural level, depending on the extent of irreversible disturbances induced to the entire system by the excavation;
– when the hydrogeological condition is completely rebalanced, the hydraulic head will not only act on the lining at the intersection with the individual aquifer discontinuities, but probably along a larger section of the tunnel, due to the creation of a permeable zone along the plastic band surrounding the entire tunnel, which extends parallel to the tunnel axis.

The rebalanced hydrogeological condition determines the drainage intervention.

The hydraulic head used as a reference value during the drainage intervention design was the one corresponding to the undisturbed condition. The permeability condition of Valico tunnel are summarized in Figure 10 and by the following category:

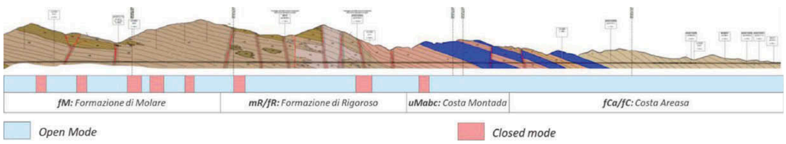

Figure 8. Valico Tunnel: section tunnelled by EPB excavation mode related to the geological profile.

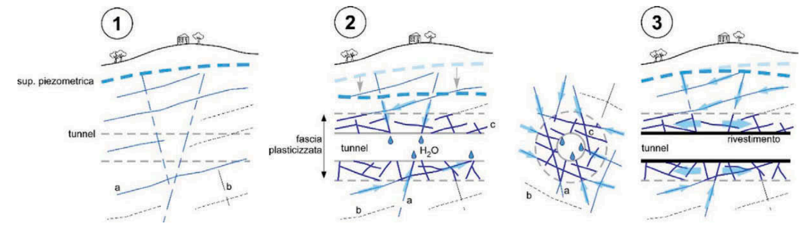

Figure 9. Hydraulic head and water table evolution consequent to tunnel excavation: 1. Undisturbed condition; 2. Excavation phase & generation of a plastic zone; 3.Long term condition.

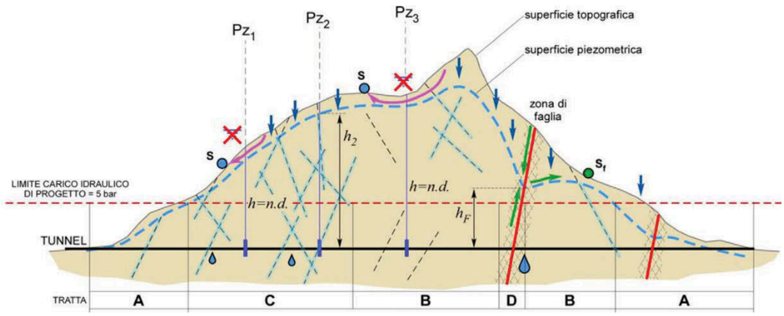

Figure 10. Hydraulic head and water table.

A. hydraulic head < 0
B. hydraulic head > 50 m and rock mass permeability coefficient from 0 to extremely low value (typical condition for TPB's Marls);
C. hydraulic head > 50 m and rock mass permeability coefficient from low to medium value (typical condition for claystone and molare formation);
D. hydraulic head > 50 m and rock mass high permeability coefficient value.

The condition listed above required the definition of different type of intervention (summarise in Figure 11) related to the control of hydraulic head and water table level.

Nowadays Polcevera adit tunnel is completely excavated, it has been tunneled trough Argille a Palombini – aP. Figure 12 shows the geological profile of Polcevera adit tunnel. The ground mass consists of Claystone schists with limestone lenses («palombini»).

From a geological point of view, the aP is categorized as a lithostratigrafic complex composed of micaceous carbonate schists of dark grey colour, containing a very strong pervasive foliation and an abundance of intrafolial quartz and albite-bearing veins. The spacing of schistosity planes ranges from a few millimetres to several centimetres and locally the rock mass is strongly foliated. The aP contains diffused layers of very compact microcrystalline limestone, called "Palombini", characterized by massive texture ranging in thickness from centimetre to decimetre scale and interbedded with phyllite. The calcareous intercalations are heterogeneously and discontinuously distributed and, therefore, their location is not predictable. Schists may also contain lenticular basaltic bodies, often very fractured, which can occur associated with banded jaspers.

The experience gained during Polcevera Adit tunnel excavation, has been useful for the evaluation of the critical issues which affect the mechanized excavation through "Argille a

			Intervention Type		
	Hydraulic head	Permeability	Drain Type	Drainage Section Step	Drains per Section
A	< 50 m	-	*NO INTERVENTION REQUIRED*		
B	> 50 m	0 ÷ low	Slotted Drain Ø 77 mm + geotextile	36 m *every 20 rings*	n° 2 minimum quantity
C	> 50 m	low ÷ medium		27 m *every 20 rings*	
D	> 50 m	medium ÷ high		1,8 m *every rings*	

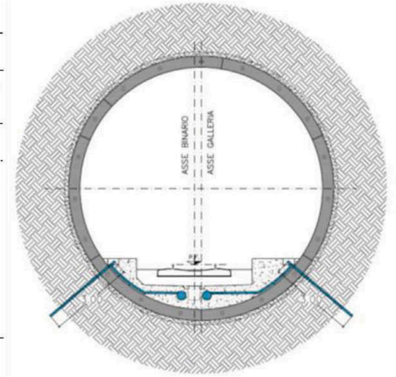

Figure 11. Intervention for the control of hydraulic head and water table level.

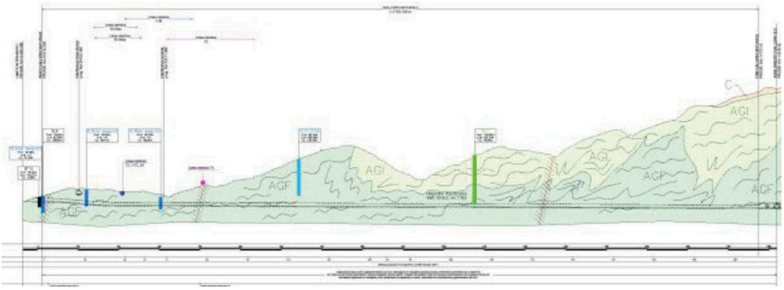

Figure 12. Polcevera adit tunnel geological profile.

Palombini" (i.e. monitoring parameter, such as: geological condition variation, tunnel convergence, TBM components wearing) and job site organization (i.e. conditioner material selection, excavated material treatment).

4 CONCLUSION

The Terzo Valico is a new high speed/ high capacity railway line that allows to strengthen the connections of the Ligurian harbour system with the main railway lines of Northern Italy and Europe. The project is part of the Rhine-Alps Corridor, one of the corridors of the strategic trans-European transport network (TEN-T core network) that connects the most densely populated and industrial regions of Europe.

The new railway line concerns a total of 53 km, 37 of which in tunnels, and involves 12 municipalities in the provinces of Genoa and Alessandria and the regions of Liguria and Piedmont. The Terzo Valico will be connected to the South, through the interconnection of Voltri and Bivio Fegino, with the railway network of the Genoa hub, for which important works of functional adaptation and enhancement are underway, as well as the port of Voltri and the historic port. To the north, from the Novi Ligure side, the route will connect with the existing Genoa-Turin lines (for traffic flows in the direction of Turin and Novara/Simplon) and to the Tortona-Piacenza line (for traffic flows in the direction of Milan-San Gottardo).

In line with the strategy of favouring eco-sustainable transport modes, the project will transfer significant amounts of freight traffic from road to rail, with advantages for the environment, safety and the economy, respecting the European prescription.

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