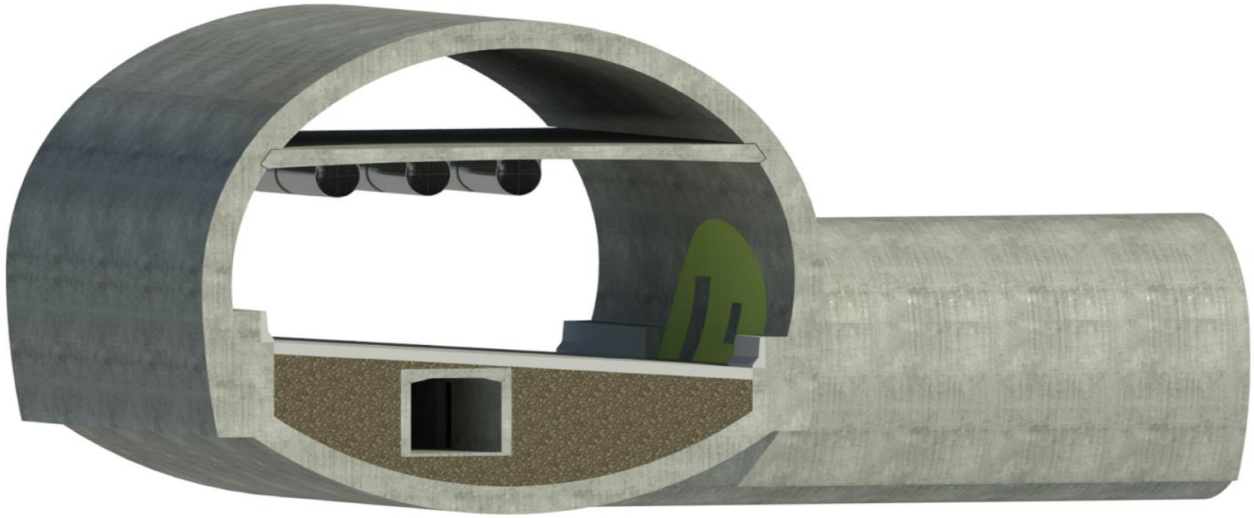
Tunnel Villa Carcina, A4 Highway Connection



Highway junction between the A4 motorway and the Valtrompia Valley, Brescia, Italy

The construction of the tunnel Villa Carcina is the centrepiece of the connection between Brescia and Lumezzane. The bidirectional tunnel also provides underground connection ramps with the City of Sarezzo

Scope

- The 3'652 m long tunnel will connect the northern part of the city of Brescia with Lumezzane
- 2 underground link tunnels, 1'011 m and 552 m long are foreseen to link the city of Brescia with Sarezzo
- A ventilation building will be built at the north portal to fulfil the ventilation requirements
- The lining is double shell with drained condition
- The project is an expertise of technical variant, starting form an original design dated 2006

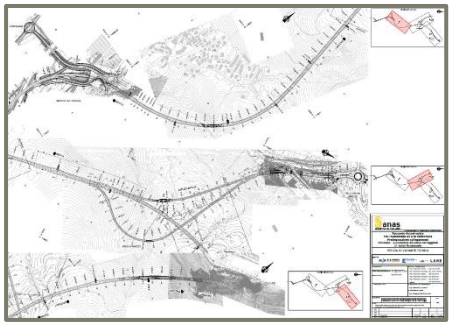
Challenges

- In the original design, 2 monodirectional tunnel were foreseen, therefore a complete redesign of safety was required;
- Underpassing of road and building, min. overburden ca. 5 m, at the south portal;
- Portal area of Sarezzo located in a dismissed cave;
- Large tunnel section (ca. 200 m^2) up to a max. of 600 m^2 at the connection between main and link tunnels
- Almost 15 years passed since the approval of the original design and Contractor awarded

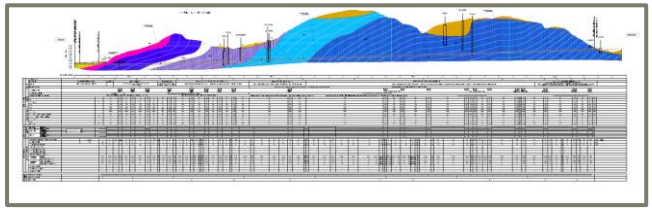
Amberg Services

- Final design of all the underground structures
- Design of the plant engineering part for the whole project
- Risk analysis

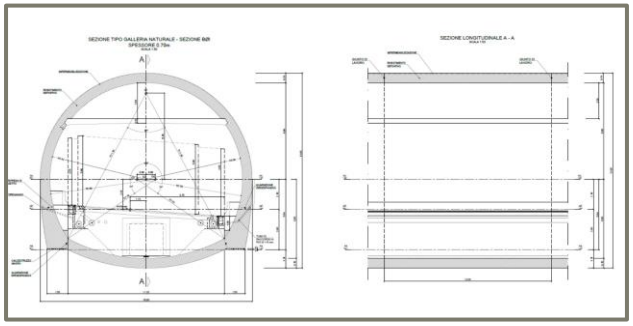
AMBERG ENGINEERING



- Plan view of the Villa Carcina tunnel



- Longitudinal profile of the Villa Carcina tunnel



- Inner lining of the standard tunnel section

AMBERG FACTS

Contracted value JV
- EUR 2'177'725.74

Contracted value Amberg
- EUR 1'028'154.54

Project Phases & Duration
- Technical variant of the original design dated 2006 → 2018 -2020

Project details
- 3'652 m mined tunnel, cross section width 16.25 m, height 14.70 m, excavated cross-section 196 m^2
- Link tunnel to and from Sarezzo, 1'011 and 552 m
- Cut-and-cover tunnel Codolazza (l = 133 m)
- Cut-and-cover tunnel Lumezzane (l = 20 m)
- Cut-and-cover tunnel Sarezzo (l = 20 m)
- Ventilation building at Lumezzane portal
- 12 laybys, every max. 300 m, for the evacuation of the people in direction the evacuation corridor below the road
- 5 pedestrian cross-connections form the link tunnels to the main tunnel (escape corridor below the road)
- SOS- and hydrant every 75 m
- Extinguishing water supply with connection to existing system
- Intermediate slab for the removal of exhaust air
- Escape corridor positioned below the road
- Separation system for mountain, meteor and dirty water
- Installation site in Codolazza, Sarezzo and Lumezzane

CLIENT FACTS

Overall costs
- Total EUR 195 Mio. (base: December 2017)

Project overview
- The new connection between Brescia and Lumezzane will allow to reduce the traffic congestion of the provincial road which connect the Valtrompia valley to the city of Brescia. The project was defined as strategic more than 20 years ago, but went through several vicissitudes related to the financial approval of the project.
- DTV > 28'000 vehicles
- The tunnel tube is excavated from the east portal (Codolazza) with a max. gradient of 3 %
- A low point is identified ca. 250 m after the beginning of the natural tunnel and therefore a pumping station is there foreseen to bring to the outside the water and traffic water
- Construction time preparing work: 2019 – 2020
- Construction time main work: 2021 – 2024

Geology
- Limestones of different types and quality. Possibility of local and regional fault zones.
- Two of the three entry cuts are in soft-ground layers, which consist on both clay, lime, sand and gravel deposits
- The water table is predicted to be for most of the tunnel at max. 15 m above the tunnel crown
- The existence of a suspended water reservoir has been detected in first part of the tunnel and an undrained section has been designed for the crossing of this area
- Around the mining tunnel, the coverage varies between 5 m and 320 m.

Contact person
Engineer Giancarlo Luongo, RUP – Responsible
ANAS SpA, Headquarters Milano, Italy
Tel.: +39 02 82685340
eMail: g.luongo@stradeanas.it

AMBERG ENGINEERING

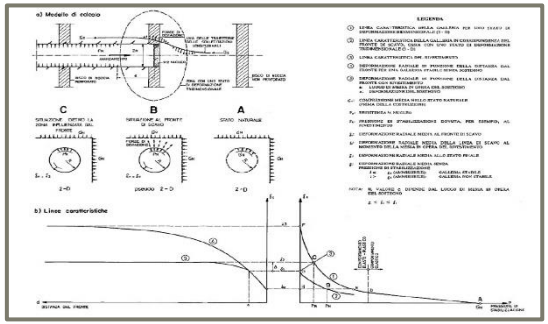
CHALLENGES

Buildings at the Codolazza portal area

Valtrompia Project Overview

- The project has been stopped for several years due to internal issues related to the Italian internal situation and therefore the normative have been changed with direct reflection on the design
- The main decision consisted in the elimination of one of the two tunnel, with the direct effect that the remaining tunnel is now bidirectional
- For the reason above, an intermediate slab for ventilation purposes and an evacuation/safety corridor have been included into the standard section with the consequent increase in term of square meters.
- The different use of the tunnel also required a revision of the length of the acceleration and declaration lines

ENGINEERING APPROACH

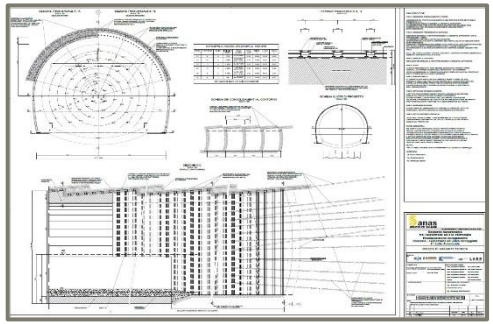


Characteristic lines method

ADECO Design method

- The tunnel is designed according to the ADECO Method, as required by the ANAS guidelines
- All the 3 phases of the Method – Cognitive, Diagnosis, Therapy – are carried for the significant and critical section of the tunnel
- Variation in terms of overburden, rock quality and geometrical section of the tunnel are considered for the definition of the temporary and final rock support
- The existing design from 2006 and the presence of the Contractor already on site narrows the margin of intervention for major changes in the design itself
- Shotcrete and steel arches have been chosen as the main temporary support method, they can be combined with pipe umbrella at the crown or face support in section of the tunnel where worse rock conditions are expected.
- The intermediate slab and the escape route are designed and calculated separately as independent part of the tunnel, since they are required to maintain their own functionality in case of accident.

TECHNICAL SOLUTIONS



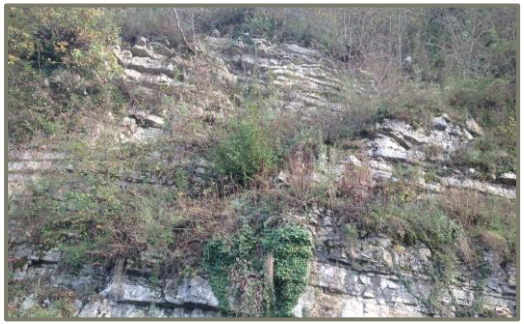
Rock support for tunnel excavation

Underpass of building at Codolazza portal

- The natural tunnel at the Codolazza portal starts with the underpass of both road and civilian building
- The overburden is reduced to ca. 5,5 m at his lowest point. The material to be excavated consist in both clay and sandy/gravel layer
- Ground improvement measures are put in place, from the surface, with installation of both self-drilling steel anchors and fibre glass bolts
- The anchors are injected with both chemical or expanding cement grout in order to stabilize a 3 m layer of soil below the building
- The excavation of the tunnel follows with the installation of pipe umbrella in the crown and face support with VTR bolts
- Buildings and tunnel are constantly monitored in term of convergence, subsidence and vibration.

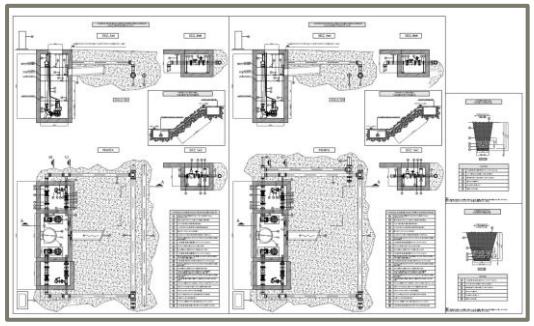
AMBERG ENGINEERING

CHALLENGES



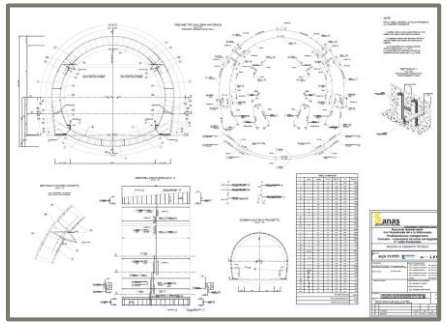
- Rock formation at the Lumezzane (north) portal

- Portal area of Sarezzo

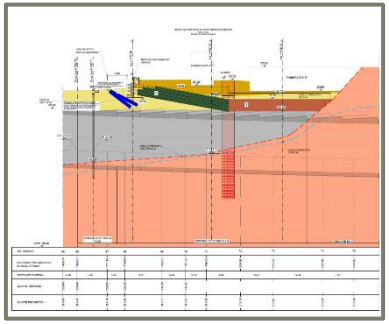


- Pumping water system at the tunnel lowest point

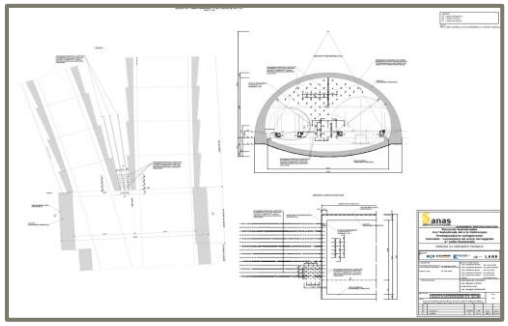
ENGINEERING APPROACH



- Reinforcement drawing of the tunnel

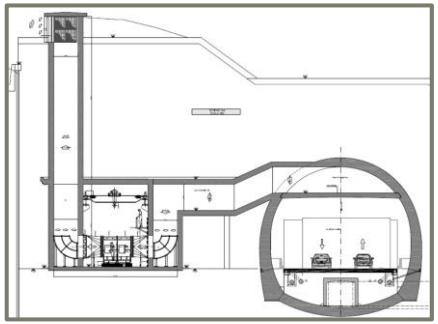


- Cut of the tunnel

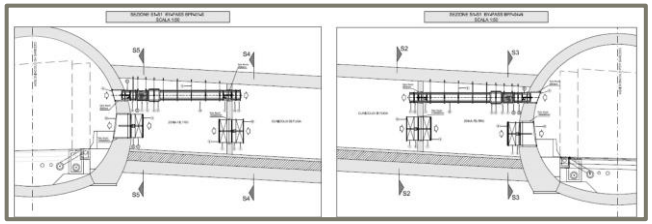


- Underground connection main tunnel – link tunnel

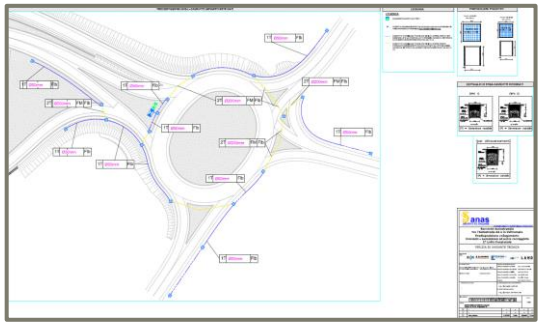
TECHNICAL SOLUTIONS



- Ventilation building at the north portal



- pressure system of the escape routes



- Roundabout works

AMBERG ENGINEERING

AMBERG KEY PEOPLE INVOLVED

Salvatore Mercurio
Senior Project Manager
Technical Lead – Project Manager

smercurio@amberg.ch

Dr. Marco Bettelini
Director Ventilation and Safety
Dep. Project Manager

mbettelini@amberg.ch

Frank Wiegand
Director Division International
Member of the JV Steering Committee

fwiegand@amberg.ch

AMBERG ENGINEERING