

## FEATURE OF TECHNICAL SERVICE

**Subject** Executive Project – Detailed executive design and variant construction design of - ANAS GE 34/08 S.S. 1 «Nuova Aurelia» - Access to the port hub in Savona interconnection between the A10 toll booths of Savona and Albisola and the ports of Savona and Vado: Variant at S.S. 1 Aurelia in the stretch between Savona Letimbro creek and Albissola Marina and Albisola Superiore

**Carried out by** ATI (SGAI - D'Appollonia - Eletec2000) **Carried out by** SGAI srl of E. Forlani & C.

**Client** Letimbro scarl **Client** Letimbro scarl

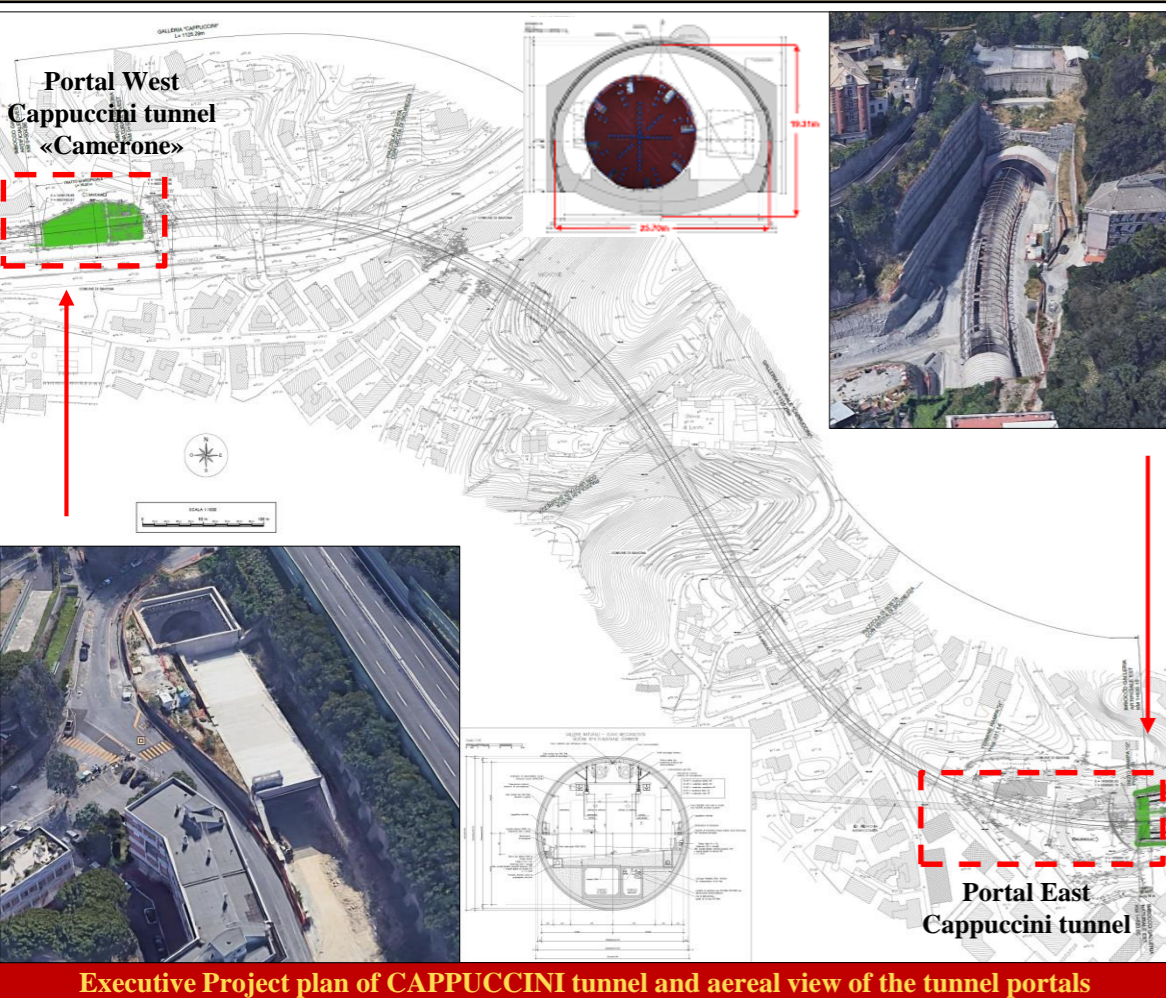
**Service length PE** 2010 - 2011 **Service length PE-PC** 2012 – 2019

**Value of works PE** € 130'164'012,19 **Value of works PE-PC** € 145'373'827,00

<b>Categories value PE performed totally by SGAI</b>	S.03	€ 553'405,37	<b>Categories value PC</b>	S.03	€ 553'405,37
	S.04	€ 3'661'579,06		S.04	€ 3'661'579,06
	S.05	€ 5'785'766,34		S.05	€ 5'785'766,34
		€ 850'217,45		S.06	€ 850'217,45
		€ 1'437'574,66		D.04	€ 1'437'574,66
		€ 80'749,00		V.03	€ 80'749,00

## NATURAL TUNNELS - Computational aspects - Simulation, results and checks

The analysis and the study of the stress-strain framework were carried out by simulating the structure with a numerical model of three-dimensional finite elements, solved with SAP 2000 calculation code (CSI Computer & Structures, Inc.: "SAP2000 Integrated Software for Structural Analysis and Design" Ver. 8.2. Berkeley, California (USA). 2002; The analysis and the simulation of the soil-structure interaction were conducted through 2D and 3D modeling using PLAXIS software.



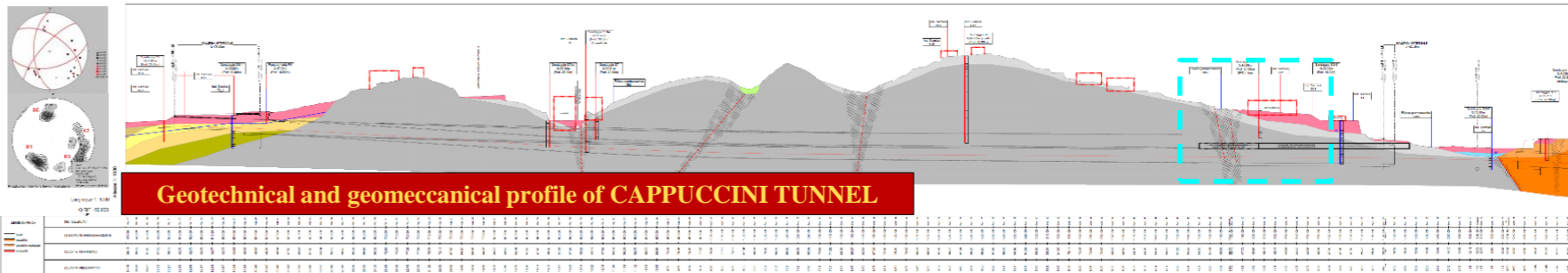
Executive Project plan of CAPPUCINI tunnel and aerial view of the tunnel portals

## NATURAL TUNNELS – Design issues and their resolution

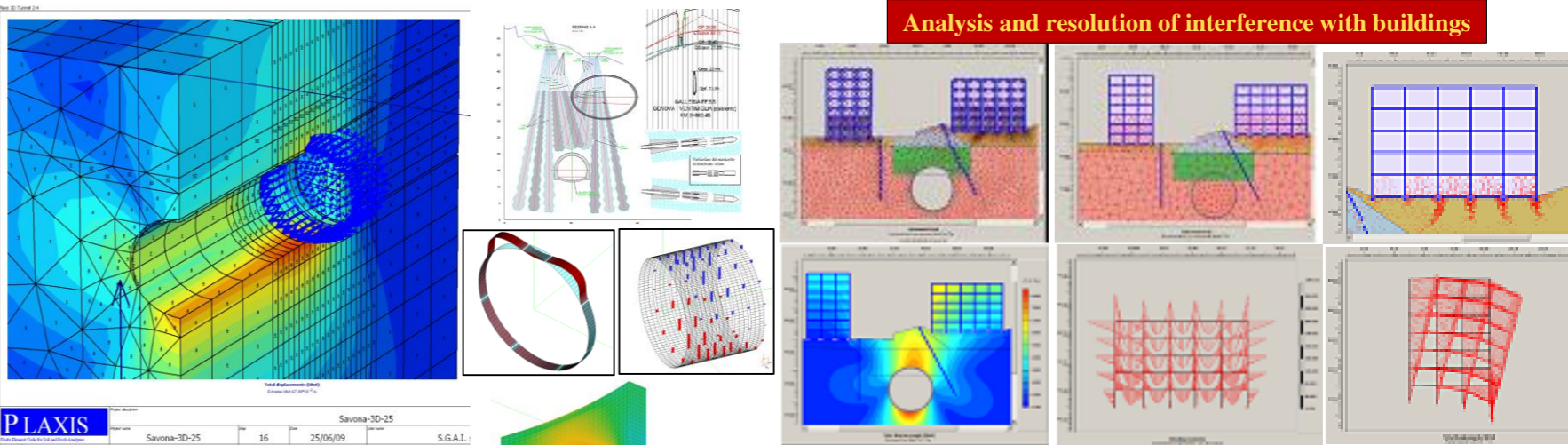
The infrastructure project foresees that over 75% of the road layout develops underground with 4 NATURAL GALLERIES: G. Cappuccini, G. San Paolo, G. Basci and G. Grana; the first three tunnels were carried out by means of an integral shield cutter (TBM) with a diameter of 13.50-13.70m while the last one, G. Grana, with traditional methods.

Due to the transit of the TBM between one tunnel and the next, it was necessary to provide a special "saddle" for sliding between the different entrances, also providing for the construction of the 20x18m high chamber 20m high supported by bulkheads of large diameter, for the dismantling of the shielded boring machine at the West entrance of the Cappuccini tunnel. The first 180m, from the East portal of the Cappuccini tunnel, are in traditional excavation to allow the entry of the H and G ramps of the Miramare interchange. Several critical issues involved studies, modeling, surveys and monitoring aimed at making design choices such as interference: with the Monte Pasasco railway tunnel, with the existing Albissola motorway tunnel and with several waterways (Rio Termine, Rio Basci) and numerous buildings adjacent to or above the excavation. The choices made have greatly reduced the risk of damage to buildings, especially the valuable ones (Villa Gentile and Villa Fresia) where a strong fracturing of the rock mass was found, which required additional investigations and consolidation.

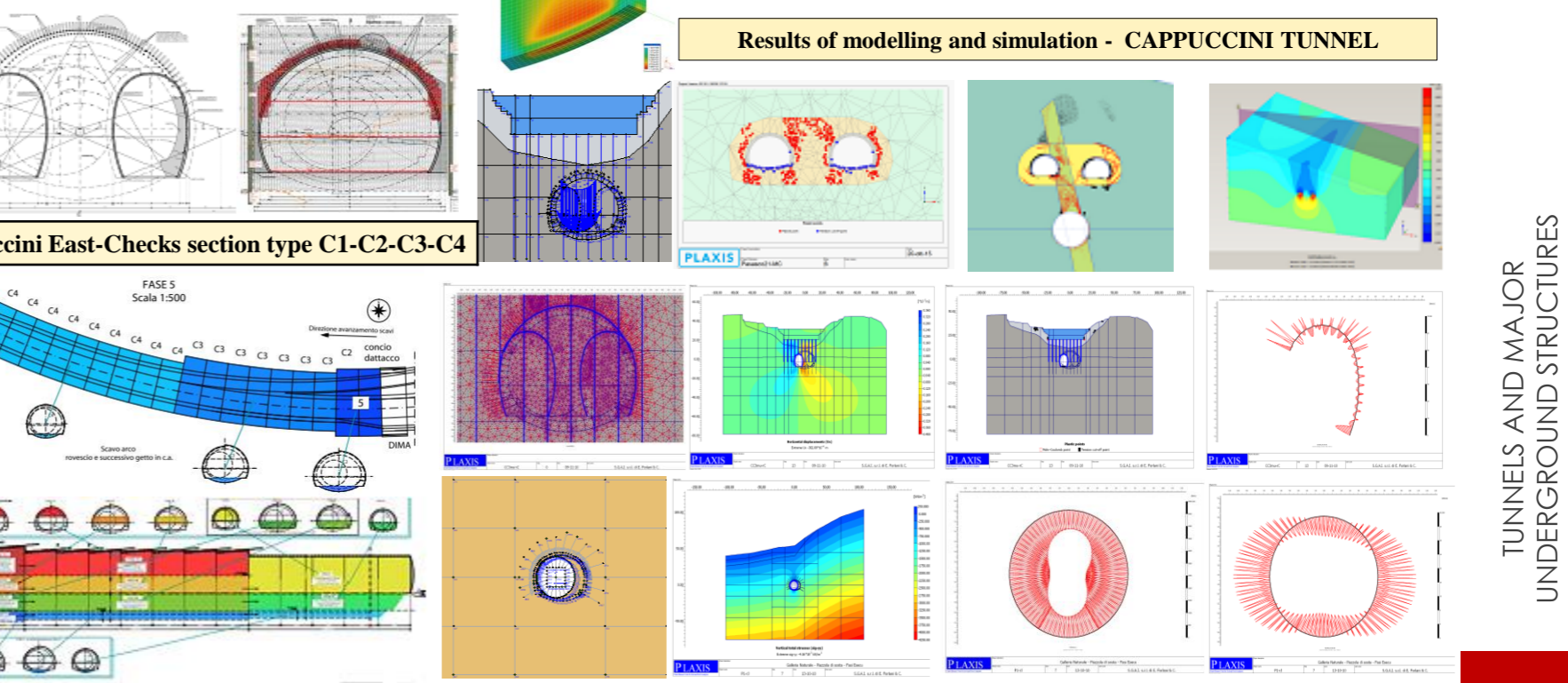
Particularly important are the tunnel entrances in the Miramare interchanges, that is one of the most delicate node due to the large volumes of open excavation, sustain works and necessary crossings, as well as the numerous interferences due to the presence of buildings, services, tunnels etc.



Geotechnical and geomechanical profile of CAPPUCINI TUNNEL

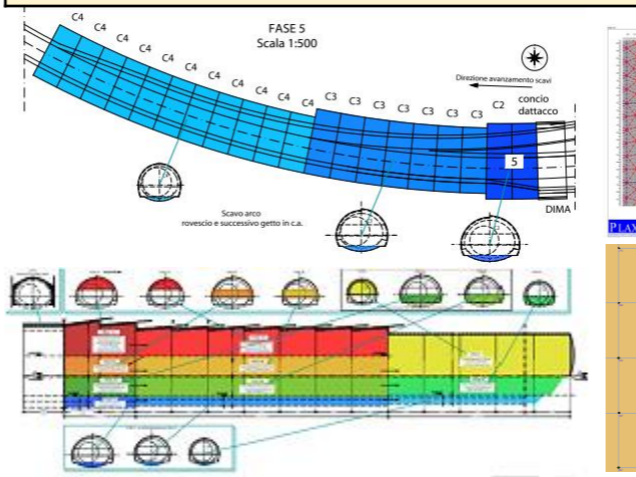


Analysis and resolution of interference with buildings



Results of modelling and simulation - CAPPUCINI TUNNEL

Cappuccini East-Checks section type C1-C2-C3-C4



TUNNELS AND MAJOR UNDERGROUND STRUCTURES