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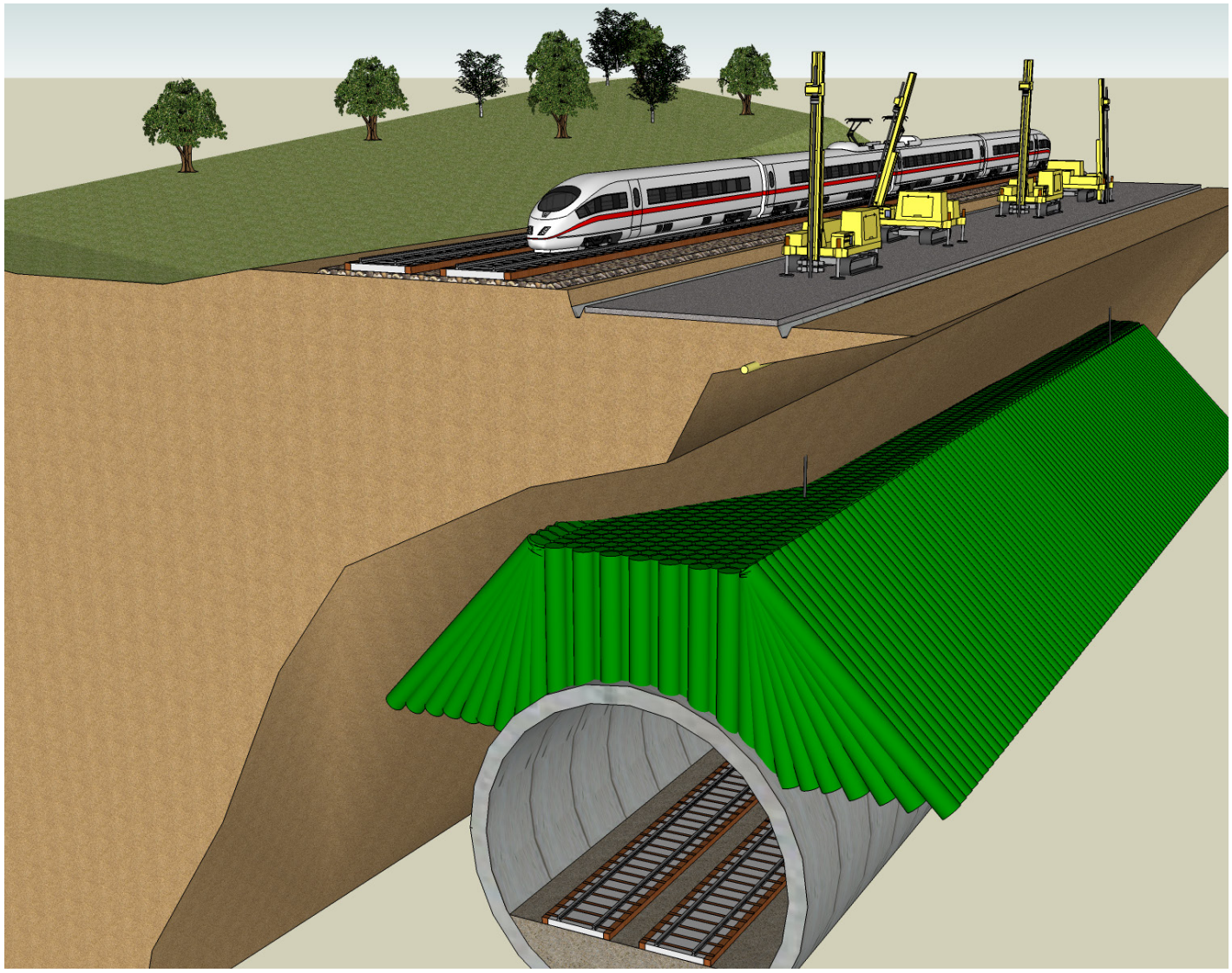
ROCK - SOIL TECHNOLOGY AND EQUIPMENTS

PACCHIOSI DRILL

CONSOLIDATIONS



TRINIDAD MONTCADA (SPAIN)

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PROJECT:

Jet grouting treatments using **PS1** technology - Formation of solid consolidated ground in the areas of departure and arrival of the TBM-EPB during the construction of the tunnel on the high-speed railway line MADRID-ZARAGOZA-BARCELONA-FRENCH BORDER section NUDO DE LA TRINIDAD-MONTCADA.

EXECUTION PERIOD:

November 2008 – March 2010

CLIENT:

UTE AVE TRINIDAD

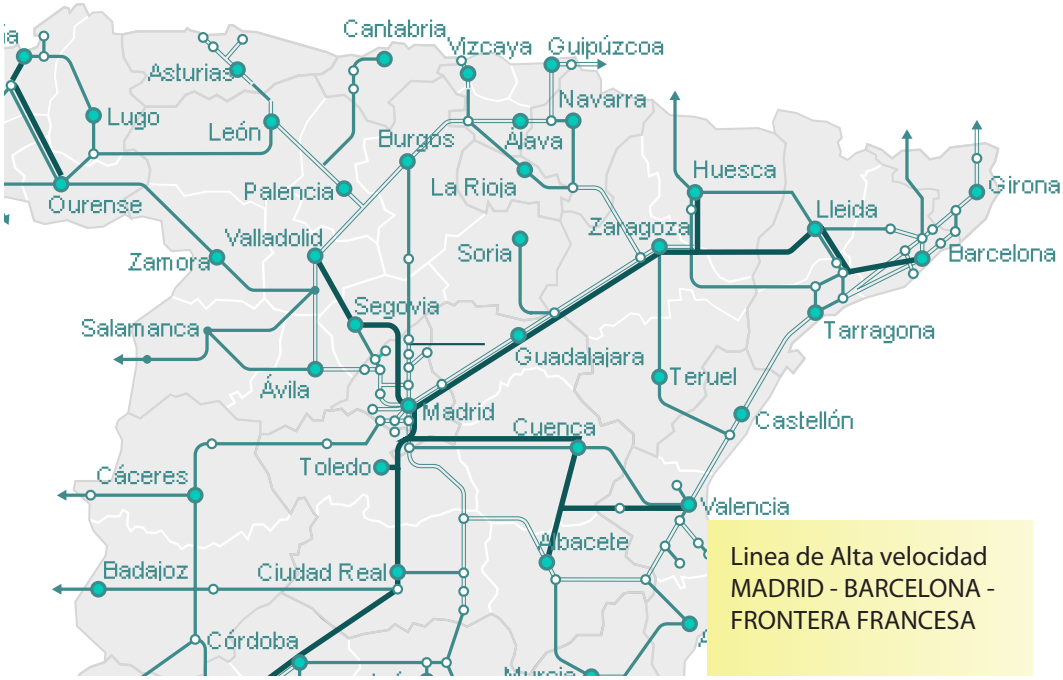

Fig. 1. Plan of Spanish High-Speed Railway

Introduction

The project involved the construction of the railway tunnel for the high speed railway line in the Nudo de la Trinidad - Montcada stretch, located in the northern outskirts of Barcelona; this was part of the project managed by ADIF (Adminisstrador de Infraestructuras Ferroviarias) co-financed by the EU Cohesion Fund for the construction of an interconnecting railway network between Spain and France.

Geology.

The zone in question is affected by lithological contact of material of the quaternary period (alluvial deposits consisting of sands, gravels with sandy matrix and clay with gravel) with Paleozoic era material (slate with different degrees of deterioration and the presence of porphyry granite and quartzite).

The route of the tunnel, particularly in the section adjacent to Rio Besos, intercepts the contact between the above layers - the area involved in the consolidation.

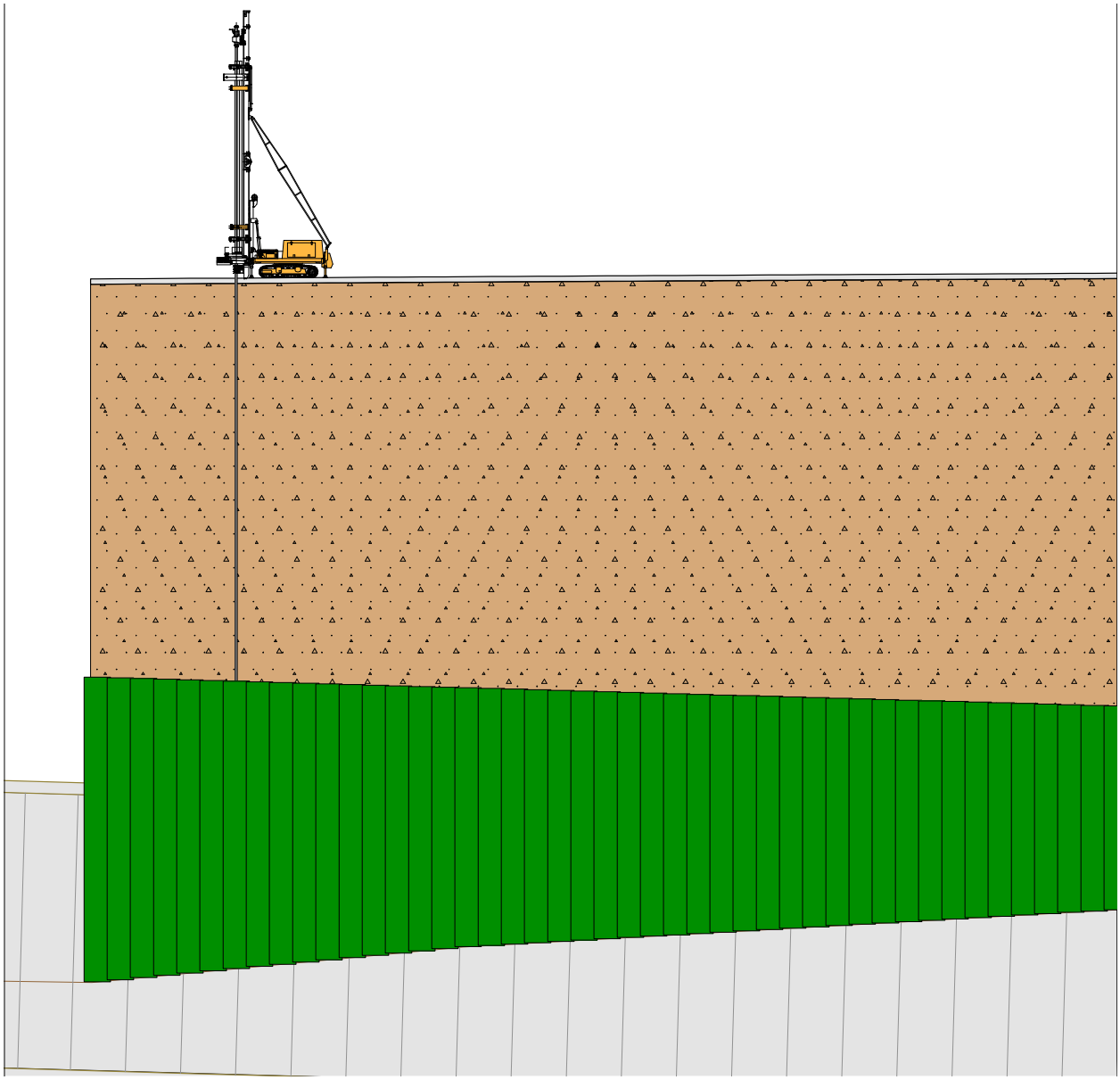

Fig. 2. General longitudinal section showing columns' layout and depth at "Jaula" location

DESCRIPTION OF INTERVENTIONS.

Tunnel departure - arrival area.

The intervention, divided into different areas, included the creation of solid, homogeneous and consolidated ground; the purpose of the intervention was to enable safe passage of the TBM-EPB in areas of reduced coverage and adjacent to buildings, railway lines and pipelines.

TUNNEL DEPARTURE AREA

Campo de futbÓl

This was the first intervention; the solid ground area was created using 2,265 **jet grouting** columns with a secant of ø 1.00 meters using **PS1** technology; it was placed at a depth of between 10 and 16 metres below ground level in a 100x14 metres parallelepiped shape.
The consolidation ensured the passage of the TBM-EPB in an area where there are many school buildings in close proximity (fig.2)

Fig. 3. General view of site with adjacent buildings

Jaula

The area called "Jaula" is the first point of approach of the TBM-EPB (fig. 4); it was developed to allow the start of the tunnel inside a box (Jaula, in fact) formed by side walls and jet grouting consolidation at the surface. It is particularly important to be able to "visually" verify the treatment (fig.4 - 5 and 6); 439 **jet grouting** columns were created of ø 1.00 m using **PS1** technology.

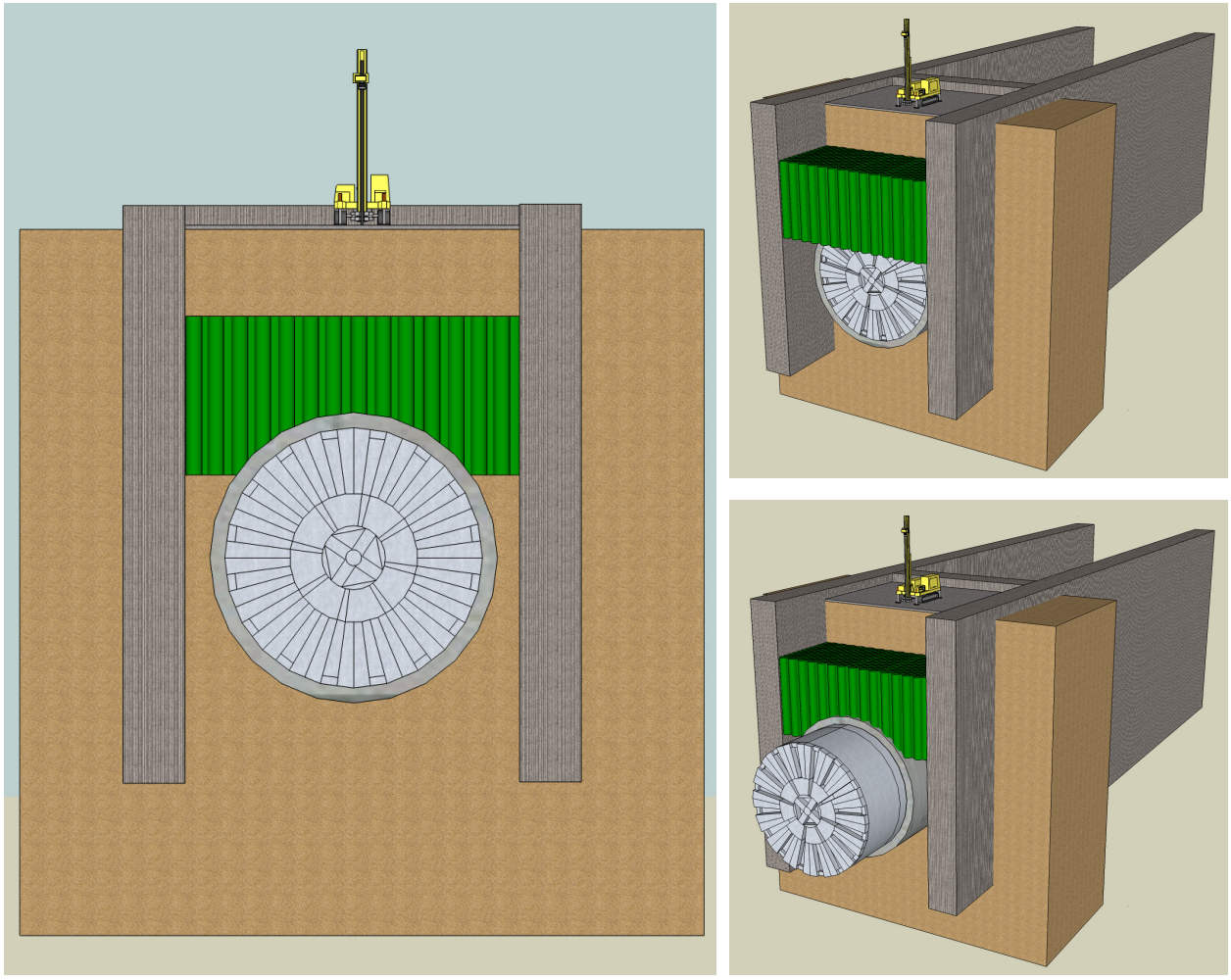

Fig. 4. 3D sketches of intervention

Fig. 5. Particular of TBM at start

Fig. 6. View of good Jet Grouting soil treatment as present in front of TBM cutting head

Caseta gas (fig. 9)

The route of the tunnel is aligned with a surface structure called "caseta de gas" at a low depth path; within the "caseta de gases" pass two lines that include high-pressure gas control valves equipped with flexible joints; during the consolidation phase, sloping columns were drilled in addition to a careful non-invasive sequence as the tolerances of gas pipeline joint movements were only a few tenths of a millimeter; further consolidation had to ensure the same tolerances in the event of surface movements during the passage of the TBM-EPB; 439 **jet grouting** columns of ø 1.00 m were constructed using **PS1** technology.

Fig. 7. PACCHIOSI P1500ES drill rig at work for sub-vertical treatments

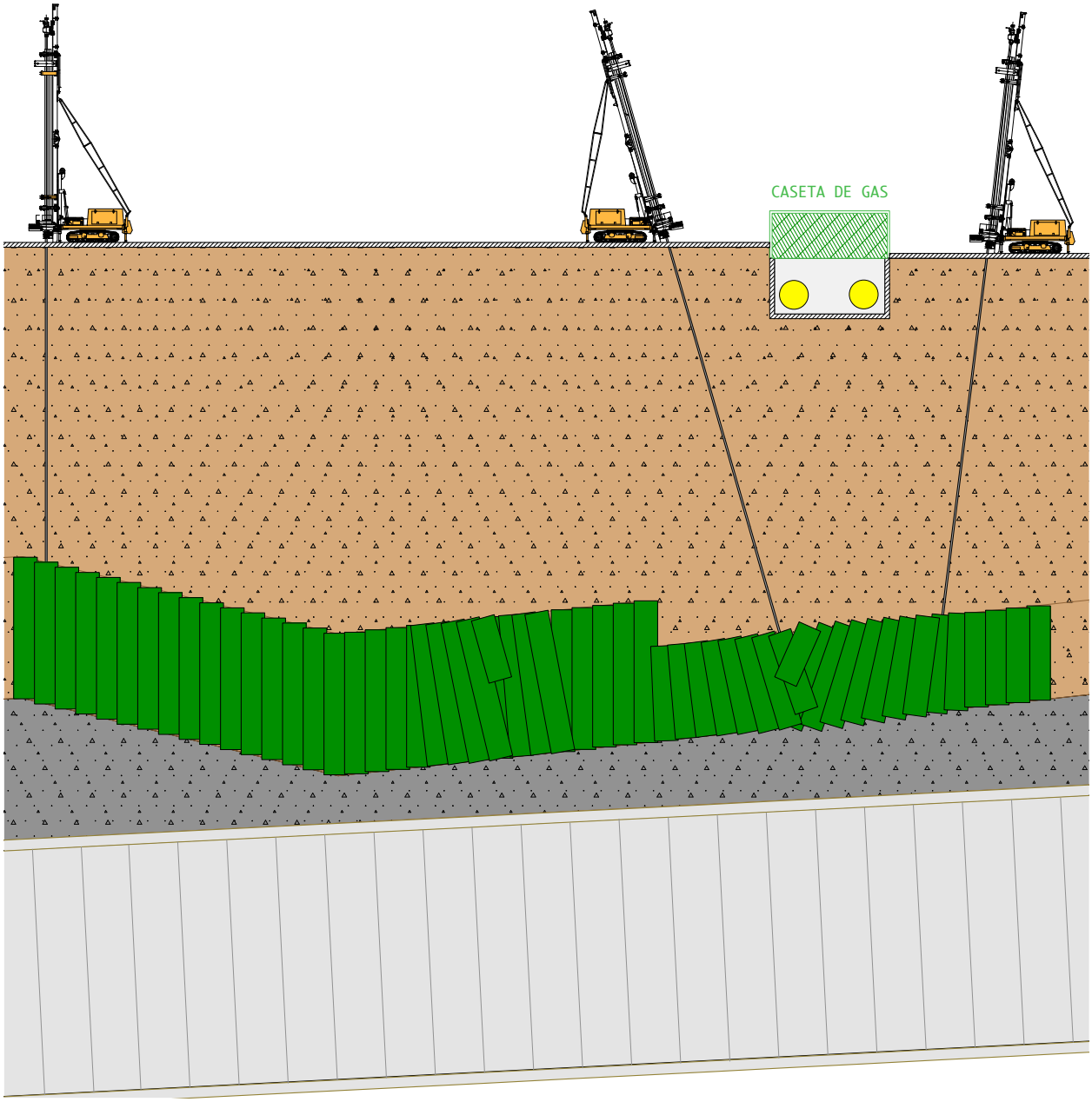

Fig. 8. General longitudinal section showing columns' layout and depth at "Caseta de Gas" location

TUNNEL ARRIVAL AREA.

Riu Besos

IIn this area, the tunnel route passes through an area with surface structures such as a twin-track railway line; the tunnel axis is located directly below this line; this therefore required the realization of solid, consolidated ground using sloping bore holes; there is also a high-pressure gas line which, as well as the railway line, greatly limited the work area and above all the drilling points.

The consolidation involved constructing 6,074 columns using **PS1** technology. These contributed to the formation of a structure of variable thickness between 4.50 metres

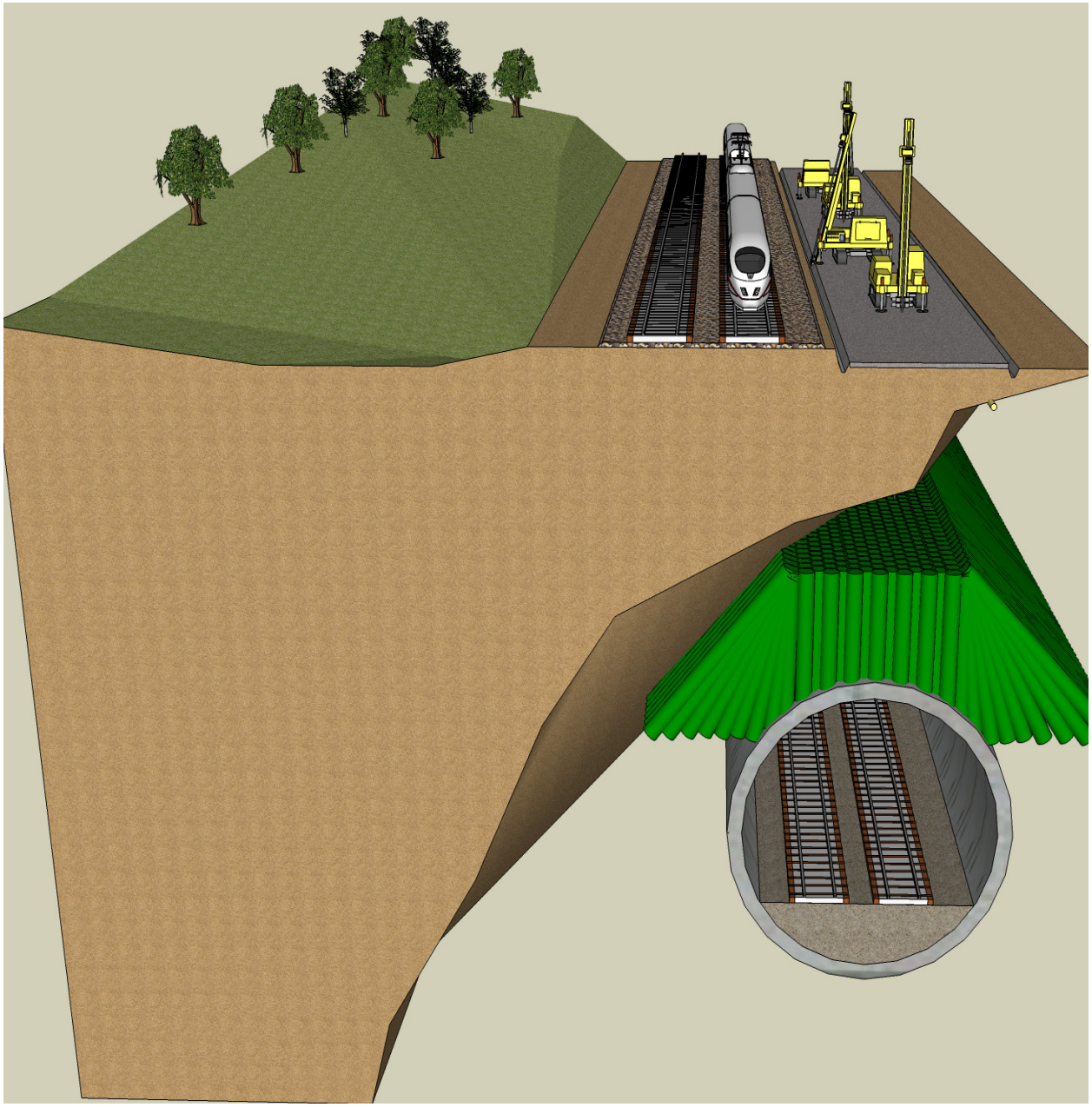

Fig. 9. 3D sketch showing inclined columns' layout and depth at "Riu Besos" location

and 12 metres with a base of 14 meters, thus creating an insulating layer between the land involved in the tunnel excavation and the overlying layer.

TECHNICAL INFORMATION

Recordings were made with graphics (**Pacchiosi PRS3**) of the parameters used both for injection and for drilling.

The technology used was **PS1 PACCHIOSI**.

Quality controls were performed during works such as core sampling of the jet grouting treatment, the mechanical characteristics of which were laboratory tested.

Resistance and uni-axial strength after 28 days reached the set values within the range required by the project; the values achieved were between 5.1 and 5.5 MPa.

Fig. 10.PACCHIOSI P1800ECS2 drill rigs on work platform

Fig. 11. Photographs of cored samples

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