

# PREDICTION OF THE GROUND CONDITIONS AHEAD THE TBM FACE IN THE TUNNELS OF GUADARRAMA (SPAIN), USING ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT)

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The tunnels of Guadarrama are a new twin tunnels crossing the Central Range between Madrid and Segovia, for the new High Speed Railway Line to the NW of Spain.

Its length are 28,3 km with a maximum overburden of 900 m.

The foreseen geology mainly consists in crystalline rocks, gneiss and granites, with a main graven in the Lozoya valley where poor quality sedimentary rocks from the Cretaceous are expected. Nevertheless also several faults have been detected in the crystalline massif with mylonites and water.

The tunnels are under construction using four double-shield TBMs, two of them manufactured by Wirth and the other two by Herrenknecht; all of them with an excavation diameter of 9,5 m.

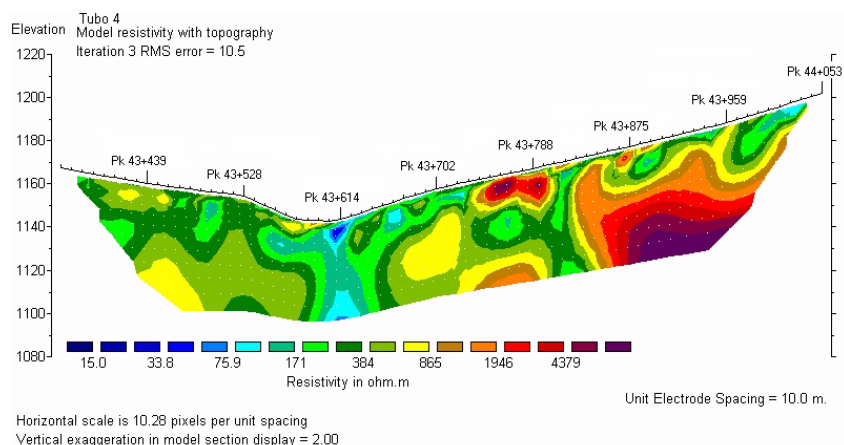
In order to predict in detail the ground conditions ahead the TBM face a revision of the geological features has been done.

This revision has consisted in a detailed geological mapping with a precise photogeology study and systematic electrical resistivity tomography (ERT) profiles in the axis of both tunnels. In the main faults inclined boreholes are drilled in order to perform dilatometer and permeability in situ tests.

In the attached Figure it is shown one of these profiles where it can be appreciated the excellent resolution obtained for the definition of one main fault, in the P.K. 43+614, with values of resistivity of 15 ohm·m, while a dyke of quartz gives a value of resistivity of 150 ohm·m in the P.K. 43+800.

For the definition of the characteristics of the faults also an analysis of the chargeability of every anomalie has been considered.

The tests done with a flexible dilatometer probe and Lugeon permeability tests have been demonstrated to be valuable tools in order to decide how to proceed with the TBM, and the kind of grout to be considered.



With all these data it is decided in advance if the TBM is going to work in a single or double way or if it is necessary to make a ground improvement ahead the face.

Some kind of expertise system is being done considering the data coming from TBM after it has crossed the expected faults, so this allows to feed back all the process.

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