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Technical note

Excavation and support design of the Dicle–Kralkizi water tunnel: an overview

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Abstract

Tunneling projects have their uniqueness in terms of engineering problems. The expertise gained from analyzing these projects establishes a sound basis for future application. This paper conveys experiences gained during the construction and support of the design of the Dicle–Kralkizi water tunnel, Turkey. Tunnel stability problems including overbreaks and surface subsidence are evaluated. An analysis of the breakdowns, factors controlling advance rate and the overall performance of tunnel are covered. The accumulated information presented here is believed to be useful and reliable for a successful tunnel excavation in similar formations.

Keywords: Water tunnel; Shallow tunnel; Tunnel excavation; Tunnel support; Tunnel stability and geology

1. Introduction

The Dicle–Kiralkizi project was developed for irrigation purposes serving the Mardin and Savur plain as part of South East Anatolia Project. The project was managed by General Directorate of State Hydraulic Works (DSI) and developed by GURIS Corporation. As seen in Fig. 1, the project passed under parts of the city (31 + 664.70–32 + 139.70). Underground tunnel construction became necessary due to the Elazig–Diyarbakir Highway and the railway. The rest of the project was realized as open channel. Sarp Engineering Corporation prepared the excavation and support design of the project.

2. The geology

In the first 65 m of the formation overlaying the tunnel upper miocene age grey–brown coloured selmo formation which is formed by claystone, mudstone, siltstone, sandstone and gravel. On the surface, the rest of the 410 m part plio quaternary age grey–black cloured massive basalt formation takes place. Since the thickness of the basalt over selmo formation is in between 1 and 9 m, the tunnel was driven inside the selmo formation (Parlak, 1997).

As seen in Fig. 5, the geotechnical studies included the drilling of 76.50 m in length three exploring boreholes. Recovered cores were used to establish the geotechnical properties of the different strata were encountered. The strength of encountered different strata is presented in Table 1.

Information gathered included the thickness and underground water table mapping. The drilling program indicated that the tunnel would be excavated below water table.

The geological and rock mass properties at the tunnel level are summarized as follows:

- *Borehole 1*: The geology was shown to be 2 m claystone formation overlay as a 9 m laminated gravel–sandstone. The claystone formation is a low-grade gravel, and the sandstone layer low grade cemented with a clay

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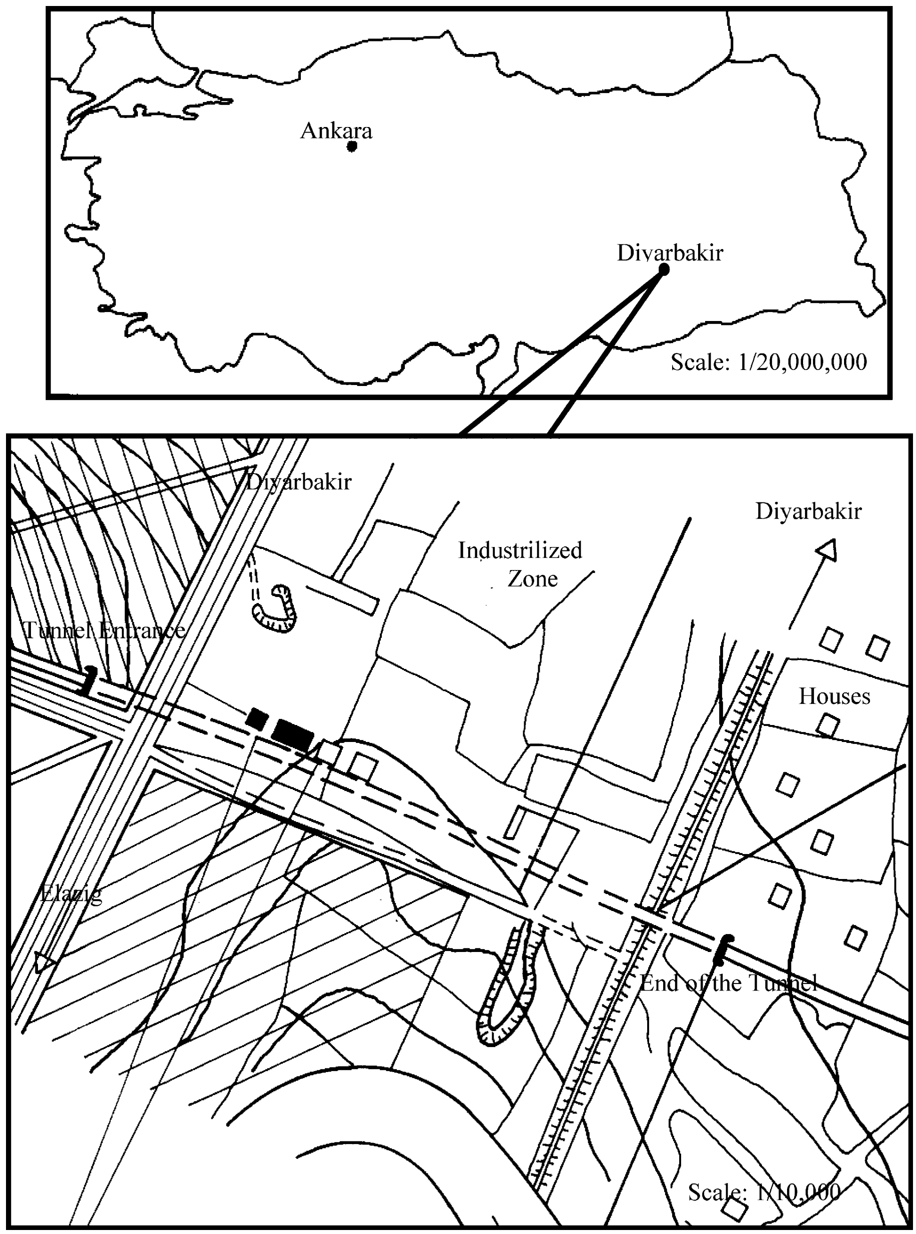

Fig. 1. The general layout of the tunnel axis.

layer. The rock quality designation (RQD) value was high (80%) in the upper part of the tunnel and very low (20%) in the lower 9 m.

- *Borehole 2*: the encountered formations included 10 m of gravel–claystone and 1 m of claystone formation. The RQD value was medium (30%) and the permeability was high.
- *Borehole 3*: The geology was shown to be 6 m of claystone, 3 m of gravel and 2 m of claystone. The RQD value of claystone was high (90%) and permeability was low. On the other hand, the RQD value of gravel was low and permeability was high.

3. Method of construction

The New Austrian Tunneling Method (NATM) has been used since the tunnel diameter is relatively large and the geological formations varied frequently along the route. The tunnel has been excavated in a two bench sequence; upper and lower. The excavation of the upper bench for the total length of the tunnel (475 m) was completed before the lower bench was commenced the upper bench was a half-circle, 56.52 m^2 in cross-section, and the lower bench was 68.4 m^2.