Chapter 61
Geological and Geotechnical Investigations in Tunneling

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ABSTRACT

The one of important matter of the design of tunnel is that choosing of the building materials and to make away rock material from tunnel walls or surface. Another important point is that these factors are effective for the building of tunnel process. It is necessary to investigation detailed the matters such as choosing the route of tunnel, the method of excavation, design of tunnel, choosing of the building material, to preparing to application Project, revision of the Project, recycling of the rest materials etc. The one of important duty of engineer is that to realize the importance of security and economic conditions together. It isn't random the economic and timing work about this type of project, on the contrary it is definitely depending on good geotechnical and geological pre-research. The research which is along the route of tunnel supply economic and feasible work for the Project. The unit of in this book we will describe the methodology of tunnel building by using suit geotechnical and geological processes.

1. INTRODUCTION

The history of tunneling starts with Semiramis, the Queen of Babylon (2160s BC), who built tunnels connecting one building to another. In order to change the river bed of Euphrates, Babylonians built a pass tunnel of 4.6×3.6 m in size covered with bricks in today's Iraq.

Tunneling technique was quite advance during the ancient Egyptians. Romans lighted a fire to crumble rocks. Compact rocks were crumbled by cutting with saws and drills and by drilling. The first derivation-tunnel was opened in AC 79-89 in Titus rock environment. The two closed parts of tunnel are in 130 m in length (Figure 1) and tunnel has a total length of 1380 m with all open spaces. In general, in closed and open sites tunnel has a height of 7 m and width of 6 m. The cross-sectional area of Titus tunnel is around 42 m^2 and cross-section of open sites is locally more than 100 m.

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Following 1600s, gunpowder was used for tunneling. By the discovery of dynamite by Alfred Nobel in 1867, gunpowder was replaced by dynamite. St. Gotthard railway tunnel with length of 57 km is the longest tunnel in the world. The Seikan tunnel which was opened in Japan in 1980 has length of 54,100 m. The Gotthard on Alp Mountains in Switzerland operated since 1978 is the longest highway tunnel. The English Channel that was completed in 1993 has a total length of 50.5 km of which 37.9 km extends under the sea.

Mont Blanc tunnel with length of 11.700 m opened in 1965 and Frejus tunnel with length of 12.700 m opened in 1978 are other tunnels connecting Italy to France through the Alp Mountains (Vardar, 2013).

By means of technical and financial achievements for a successful tunnel project, careful and precise site investigations are needed. (Kvartsberg, 2013). Similarly, insufficient investigations contribute the excess budget and time delays (Harding, 2004; Riedmüller and Schubert, 2001). Based on geological models of the project area obtained during office studies, engineers can plan site investigations(Harding, 2004). It is inevitable that tunnels opened with inadequate geotechnical and geological investigations yield unsuccessful results or time delay. For example, the Ayaş tunnel with length of 10086 which is proposed to be a railway tunnel between Sincan and Ayaş for the Istanbul-Ankara railway is unfinished because of inadequate investigations. When the tunnel works were started preliminary geologic investigations were not completed and detailed geologic works were not implemented. Another unfinished tunnel is T26 tunnel at the İnönü-Vezirhan part of the Ankara-Istanbul fast train project that is excavated by TBM. Due to excess stress in the rock environment this tunnel is unfinished and cannot be excavated. The Eurasia Tunnel Project that connects the European and Asian parts of Istanbul (Figure 2) and Marmaray Project that is an immersed tunnel under the Bosporus were successfully completed. An immersed tunnel under the Bosporus with ~1.4 km in length, tunnels drilled on both sides with length of ~11 km and 5 stations constructed in the frame of Marmaray Project. In order to determine geologic characteristics along the Marmaray Route a total of 6570 m were drilled. For this purpose, sea floor geology 49 boreholes with length of 1750 m were drilled.

The Eurasia Tunnel in progress: The Eurasia Tunnel Project (Istanbul Strait Road Tube Crossing Project) connected the Asian and European sides via a highway tunnel going underneath the seabed. The Eurasia Tunnel will cover a total of 14.6 kilometers. 5.4 kilometers of the project will be a two-story tunnel constructing below the seabed utilizing special technology with approach tunnels, On the other hand, facilities including the expansion of existing highway and reinforcement studies are being carried

Figure 1. Different geometries of tunnels opened in Titus rock environment