



# Geomechanical evaluations of Karaj tuffs for rock tunneling in Tehran–Shomal Freeway, Iran

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## Abstract

This paper attempts to present a general approach to geomechanical evaluations of Karaj tuffs required for design and support of Tehran–Shomal Freeway tunnels. The freeway is to cross the Alborz Mountain Range through twin road tunnels varying from 300 to 6300 m in length with as much as 500 m of cover. Eocene Karaj tuffs crop out in more than 50% of the freeway route. Along this sector of the freeway, the Taloun and Alborz tunnels, each with 12 m width, are to be excavated. Geomechanical evaluations of the tuff masses were carried out using material properties, site investigations, and rock mass classification (RMC). The results of the evaluations show that the tuffs are structurally sensitive to fractures due to tectonic setting of the region. The degree of fracturing that controls the tuff mass characteristics was used to classify the rock masses into three main groups. The rock mass strengths were also determined using the integration of Rock Mass Rating (RMR) and Hoek–Brown failure criterion. Both empirical and numerical analyses indicate that the faulted tuff mass is not stable enough in tunnel openings and thus should be supported. Although the crystalline tuff mass analyses showed no indications of the plastic zone developments in tunnel surroundings, application of support system is recommended due to the jointed nature of the rock mass. Similarly, the required support system for the stability of each rock mass group in openings was also analyzed.

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## 1. Introduction

Tuff rocks under investigation in this study belong to the Eocene Karaj Formation. This formation crops out in south central Alborz Range, where twin road tunnels of about 30 km length are to be excavated along the Tehran–Shomal Freeway. This Freeway, with about 120 km in length, is considered as the

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largest civil project under construction in Iran. This project, which is to run through the highest portions of the Alborz Mountain Range, connects capital city of Tehran to coastal regions of the Caspian Sea in the north (Fig. 1). Maximum altitude of the freeway is designed to be 2500 m. However, the highest elevation of the freeway route is about 3300 m. Therefore, the freeway has to drive into twin road tunnels, varying from 300 to 6300 m in length, with as much as 500 m of cover. The Taloun tunnels with 5 km in length, 40% of Alborz tunnels with 6.3 km in length, the Baghdareh tunnels with 2.2 km in length,

and more than 15 other small tunnels, each less than 2 km in length, are to be constructed in the Eocene Karaj tuffs.

Generally, tunnel stability could be assessed by either empirical or numerical approaches. Both approaches for tunnel design require data on geomechanics and the rock mass properties. The primary objective of geomechanics and the rock mass classification systems is to quantify the intrinsic properties of rock masses using laboratory tests on rock materials, site investigations of the rock mass structures and characteristics, and the rock mass ratings.

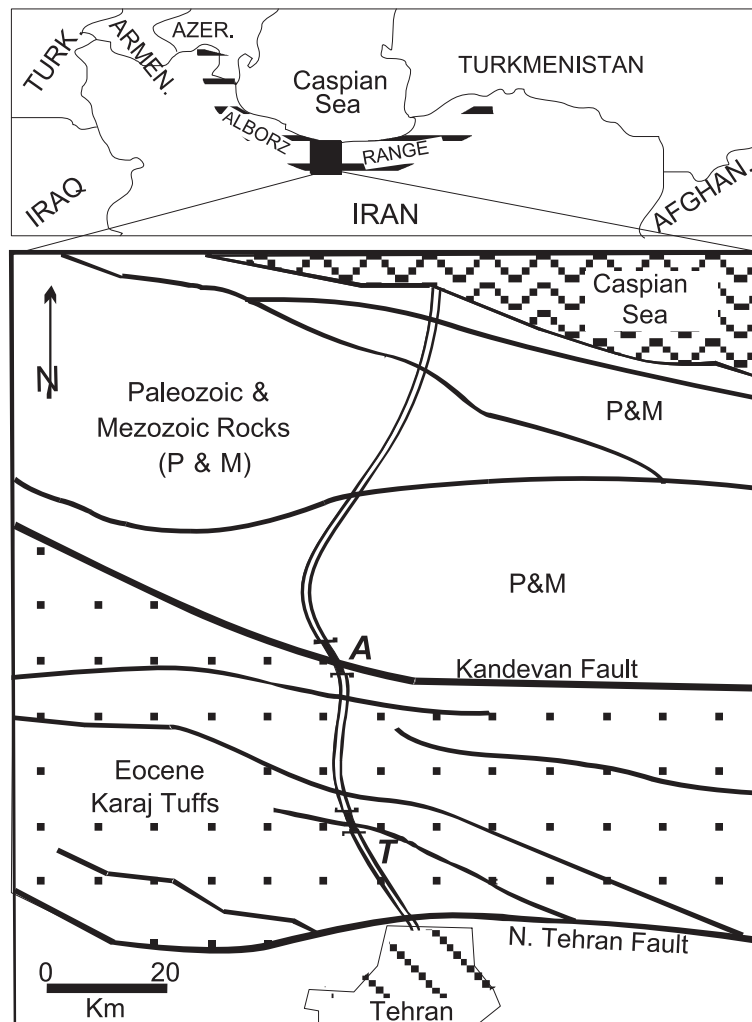


Fig. 1. Sketch maps showing the location of Tehran–Shomal Freeway and distribution of the Eocene Karaj tuffs (stippled area). Location of the Taloun and Alborz tunnels in the freeway is shown by abbreviated letters of T and A, respectively. Note to the orientation of the faults (heavy lines) which are sub parallel to the central Alborz Range.

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