The Abrasion and Brittleness Coefficients of Tabriz's Metro Aggregates

Amirhasan Rezaei Farei[1*], Masoud Mostafaei[2], Kazem Razavi[3]
1. Azarbaijan Shahid Madani University, Tabriz, Iran
2. Geotechnical Engineering Master Degree, Tabriz, Iran
3. Tabriz University, Tabriz, Iran

Extended Abstract

(Paper pages 617-644)

Introduction

Urban development and rapid extension of cities have been accompanied by a considerable growth in mechanized tunneling. The abrasivity of rock and even soil is a factor with considerable influence on the wear of tools. Soil abrasion and the resulting tool wear has a major impact on machine operation, utilization, and tunneling costs and time. One of the problematic aspects of working in abrasive grounds is the frequent need for the replacement of cutting tools, especially in pressurized face tunnel boring machines (TBMs). The effect of worn and damaged TBM cutter heads has been documented for numerous tunnel projects around the world. However, the lack of a standard or universally accepted test for soil abrasivity in geotechnical investigations has made the prediction of tool wear a difficult task.

Material and methods

A reliable prognosis of the abrasiveness of soils on a project would be of great benefit for designers, clients, and contractors. Many abrasion tests exist for rocks, and some have been proposed for soils; however, there is no universally accepted or international standard test for soil abrasivity testing. One of the most important and available tests in this field is LCPC abrasivity test which was developed by the Laboratoire Central des Ponts et Chaussées in the 1980's. The LCPC Abrasivity Coefficient (ABR or LAC)

can be used as a measure for both the abrasivity of the soil material and the influence of the grain size. The abrasivity testing of rock is controlled by well-known parameters, whereas in soils many factors are influencing the abrasivity such as in-situ soil conditions, sedimentary petrology and technical properties.

Tabriz metro line 2 Project about 22 km in length that will connect eastern part of the Tabriz city to its western part, considered as a case study. The project comprises a single tunnel which has been constructed using two earth pressure balance EPB-TBM with a cutting-wheel diameter of 9.49 m. In this study, based on geological and geotechnical properties, the tunnel route was divided into four parts and the abrasion and brittleness coefficients of alluviums determined by LCPC test. Besides that, the influences of some factors such as moisture content, mineralogy, grain size and shape, type and amount of foam have been studied.

Results and discussion

Based on more than 130 LCPC test results, in general, the Tabriz Metro's line-2 route alluviums have the abrasion in the range of low to very high and the brittleness in the range of high to very high. In order to measure the effect of moisture content on abrasion and brittleness coefficient, the LCPC test was done on some samples related to the tunnel route in dried and moistened modes (5%, 0%, 15%, 20%, 25%, and 30%). Three types of sandstone, andesite, and conglomerate of the route were used to test the effect of moisture and petrology on abrasion. In a moisture range of 0 to 5%, in all types of materials, abrasion was increased. In a moisture range of 5 to 10%, abrasion was decreased in all three types, and this shows that a moisture level of 10% is a normal moisture content to create minimum abrasion. The behavior of sandstone and conglomerate is similar at higher moisture contents, and an increase in moisture content to 30% can increase abrasion of materials in both types. In conglomerate, abrasion at higher moisture levels is significantly more than in other modes. In andesite, an increase in moisture content to 20% can increase abrasion,

although the abrasion is decreased with a moisture content of over 20%. In most samples, increase in moisture content led to decrease in brittleness of materials. In general, the highest abrasion level was related to conglomerate and the lowest level was related to sandstone. Moreover, andesite was at a lower level than conglomerate and a higher level than sandstone in terms of abrasion. Also, the results show that increased grain size led to increased abrasion, and the changes in andesite were greater than in sandstone.

In order to test the effectiveness of foam on abrasion, the foam used in workshops (A 168) made by Komeil Company Kashan was used for four types of petrography: conglomerate, andesite, sandstone, and silica. This test was conducted in the range of dried to 100 ml foam. In all types, decreased abrasion is observed from 0 to 20 ml and increased abrasion is observed from 20 to 100 ml.

Conclusion

The following conclusions are drawn from this research.

- With regard to the effect of grain size, increased size of grains could lead to more abrasion and less brittleness
- In terms of the effect of mineralogy, the conglomerate had the most effect on abrasion. In terms of brittleness, andesite was the most brittle.
- When the foam is moisturized in the sample, minimum abrasion is observed and above this level, the abrasion is increased.

Keywords: LCPC test, soil abrasion, Tabriz metro aggregates, foam.

*Corresponding Author: Rezaei.ah@azaruniv.ac.ir