ATS11-05415

Improvement of Tunnel Waterproofing Performance by Execution of Watertight Temporary Support (WTS)

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ABSTRACT

According to investigations conducted on the existing underground tunnels, one of the most primary problems observed in these infrastructures is water leakage due to the penetration of water through damaged waterproofing system and final lining. While the water infiltrate through the soil, there is a high probability that corrosive materials such as acids and sulfates may dissolve in the water. As a result, waterproofing membrane starts corrosion after contact with corrosive water and tunnel will experience irreparable structural damages such as steel reinforcement corrosion and concrete cracks. Hence, the major problem in all existing underground tunnels is the direct contact between high volumes of aggressive water with the main waterproofing membrane without any defense opportunity. Execution of a watertight temporary support (WTS) right after each partial excavation can be a proper solution to this problem. The objective of this paper is to demonstrate the positive roll of WTS in improvement of tunnel waterproofing performance. In this study the standard test method ASTM C 642 has been carried out to estimate the porosity and pore volume in concrete specimens. Furthermore, a cement based polymer was added to test mortar mixture to reduce the porosity and permeability of hardened specimens. According to the final results, percentage of volume of permeable pore space or porosity (ϕ) less than 11% was achieved for mortar specimens which were contained 7.5% to 20% acrylic polymer modifier (APM) while the porosity of reference specimen was 14.42%. Additionally, the best result was obtained for the test mortar specimen which was contained 12.5% APM, with 9.78 % porosity.

KEYWORDS

Corrosion; Permeability; Porosity; Shotcrete; Temporary support; Tunnel waterproofing membrane.

1. INTRODUCTION

Underground infrastructures including macro and micro tunnels such as subway tunnels, mining tunnels, water, gas & oil supply tunnels, sewer and culverts are always expensive to build, repair and maintain but are essential for the wealth creation and development of the nations. Therefore, they must be built with a long term design life which is related to structural and waterproofing stability of tunnel.

The soil which is covered the underground tunnels contain a variety of corrosive materials [10], [12]. Thus, when groundwater penetrates towards the tunnel it can absorb all these aggressive materials from the soil. Hence, direct contact between this aggressive water with the main waterproofing membrane causes major damages to waterproofing system of the tunnel (Figure 1). Then, after seepage through the main waterproofing membrane, this corrosive water by penetrating into fabric of the tunnel final lining can cause steel reinforcement corrosion and concrete cracks (Figure 2). As a result, the water leakages start to damage the final concrete structure just a few years after construction of the tunnel.

As we can see in Figures 1 and 2, the common problem in all existing underground tunnels is the lack of a primary water reducing system.