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Failure Mechanism of Tunneling in Clay; Solution by GFRP reinforcement

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Abstract

There has been an increasing demand for new tunnels in respond to rapid growth in cities. Earth pressure balanced or slurry shield tunneling method is commonly used to construct tunnels in soft ground to improve stability and safety. The use of this kind of reinforcement in tunnel segments allows several advantages mainly related to durability aspects or when provisional lining is forecast. This paper is going to consider the mechanism of failure for tunneling in clay and to find the solution by one of the most respectable kind of reinforcement. The use of GFRP rebars as structural reinforcement in precast tunnel segments, allows several advantages in terms of structural durability or in cases of temporary lining that will have to be demolished later. The application of glass fiber reinforced polymer (GFRP) reinforcement in concrete structures, has encountering an increasing interest worldwide, for several applications in civil engineering.

Key words: failure mechanism, tunnel segments, GFRP rebars, analytical simulation

1. Introduction

There has been an increasing demand for new tunnels in respond to rapid growth and needs in urban areas. It is well recognized that tunnel face stability is vital for the safety of tunnel construction in soft ground. The shield tunneling method is commonly used in soft ground to improve stability and safety. Since water and earth pressures at the tunnel face have to be balanced by a supporting medium, either pressurized fluid for slurry shield or spoil of excavated soils for earth pressure balance shield are commonly adopted. No matter what type of shield is used, the design and control of applied pressure at an excavated tunnel face require the pressure to be large enough to maintain face stability (i.e., preventing active failure) but not too large to avoid blow-out at the face (i.e., passive failure). The failure may endanger human life and cause catastrophic damage to the structures within the influence zone. Besides tunnel face stability, soil deformation shall be minimized to ensure a tunnel construction does not inducing distress in adjacent structures and services. The stability of tunnel face has been studied extensively in clay (Broms & Bennermark, 1967, Mair, 1979, Davis et al, 1980). Mair (1979) provided extensive experimental evidences of the collapse of tunnel face in clay. The extensive experiment evidences can be used to validate the existing analytical solutions based on limit analysis (Leca & Dormeniux, 1990, Soubra, 2002, Davies et al, 1980). Although many experimental evidences are available for active failure of tunnel