IN-LB	Inch-Pound Units
SI	International System of Units

Guide for Precast Concrete Tunnel Segments

Reported by ACI Committee 533

ACI 533.5R-20

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First Printing
April 2020
ISBN: 978-1-64195-097-8

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The worldwide trend in construction is toward mechanization and automation. This trend has led to continued rapid progress of mechanized tunneling. Advantages over conventional tunnel construction methods include, but are not limited to, occupational health and safety, faster advance rates, and reducing construction labor requirements. Mechanized tunneling in soft ground using tunnel boring machines is often associated with installing precast concrete segmental lining. However, very little industry-wide guidance has been provided by practice and code organizations. This document provides guidelines for precast concrete tunnel segments, including the most recent developments and practical experience, in addition to information on all aspects of design and construction. These guidelines are based on the knowledge and the experience gained on numerous precast tunnel projects in the United States, and available national and international guidelines often used as industry references.

Keywords: design; durability; fiber; gasket; joint; lining; precast; segment; tolerance; tunnel.

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ACI 533.5R-20 was adopted and published April 2020.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Precast concrete segments are installed to support the excavation behind the tunnel boring machine (TBM) in soft ground, weak rock, and fractured hard rock applications. As shown in Fig. 1.1, the TBM advances by reacting against the completed rings of precast concrete segments that typically provide both the initial and final ground support as part of a one-pass lining system. These segments are designed to resist the permanent loads from the ground and groundwater as well as the temporary loads from production, transportation, and construction. Currently, very little guidance is provided for tunnel designers and contractors by local or international authorities, and there is an acute need for a document to clearly highlight the practical design principles, advances in construction, and the research needs in this area. Tunnel segments are generally reinforced to resist the tensile and compressive stresses at the ultimate limit states (ULS) and the serviceability limit state (SLS). Special attention is paid in this document to common methods in ULS and SLS designs of these elements. In addition, detailed design considerations are presented, such as concrete strength and reinforcement. Gasket design as sealing elements against groundwater inflow, connection devices, and fastening systems are introduced, followed by segment tolerances, measurement, and dimensional control systems.

1.2—Scope

This document provides analysis, design, and construction guidelines exclusively for one-pass precast segmental lining that is installed almost instantaneously with excavation inside TBM shields only a few yards behind the TBM cutterhead. Linings that are installed long after passing of an open-mode TBM, cast-in-place concrete linings, and segments of other materials such as steel and cast-iron segments do not fall within the scope of this guideline. Two-pass lining systems, which are no longer popular in modern tunnels, are not specifically discussed but can still benefit from the guidelines. More information about the two-pass linings can be found in ITA WG2 guidelines. This guideline provides methods of design and construction for TBM tunneling in soft ground as well as weak and fractured hard rock tunneling. The guidelines and recommendations in this document can be applied to tunnels of different types, such as road, railway, and subway tunnels; headrace, water supply, and waste water tunnels; and service, gas pipeline, and