

# Strengthening of a City Center Tunnel with Concrete Screw Anchors under Special Boundary Conditions

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## 1 Abstract

The Altstadttring-Tunnel is one of the essential east-west traffic routes in the city center of Munich and was constructed in the late 1960s. Segment 34 of the tunnel was built directly underneath the existing Prince-Carl-Palais, a historic building from 1804. Therefore 15 pre-stressed concrete girders with an effective depth of 3.5 m and a maximum span of up to 30 m were built which now form the tunnel roof slab. These girders were pre-stressed with steel nowadays well known for stress corrosion cracking. A recalculation of the slab showed that no ductile failure can be guaranteed in case of a progressive rupture of the tendons. Therefore, a concept for strengthening the slab was developed using concrete screw anchors as post installed bending and shear reinforcement. The concrete screw anchors are normally installed as anchoring elements in cracked and non-cracked concrete and are available with diameters up to 22 mm. Developing this concept further, it is straight forward to use these anchoring elements as post-installed reinforcement in existing concrete structures. This new strengthening system was developed at the University of Innsbruck in the last few years and can fulfill the special requirements of this project, such as installation of the strengthening system from underneath the tunnel slab during ongoing use of the structure. High strength steel with diameters of up to 63.5 mm will be used as post-installed bending reinforcement covered with a new shotcrete layer on the underside of the tunnel slab. In total 59.3 tons of new flexural reinforcement and 7199 concrete screws for strengthening the shear capacity of the girders will be used to ensure a ductile failure of the tunnel slab. The on-site work started in March 2019 and is expected to take two years to complete.

**Keywords:** strengthening of concrete structures, post-installed bending reinforcement, post-installed shear reinforcement, concrete screw anchors

## 2 Introduction

Most of the existing infrastructure in Central Europe was erected in the late 1960s up to the early 1980s, thus now being between 30 and 50 years old. This is valid not only for the age of concrete bridges, as

shown in [1], but also for other infrastructure structures such as tunnels.

Since the erection of these structures the basis for the structural design has changed significantly. In particular the design against shear failure in the European standards has become more restrictive in