

## Safety against Tunnel Fire for Post-Installed Reinforcement

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### Summary

As traffic space is becoming scarce in urbanized areas and flyovers are often not wanted for reasons of aesthetics and noise, urban tunnels become more and more important to accommodate the increasing traffic.

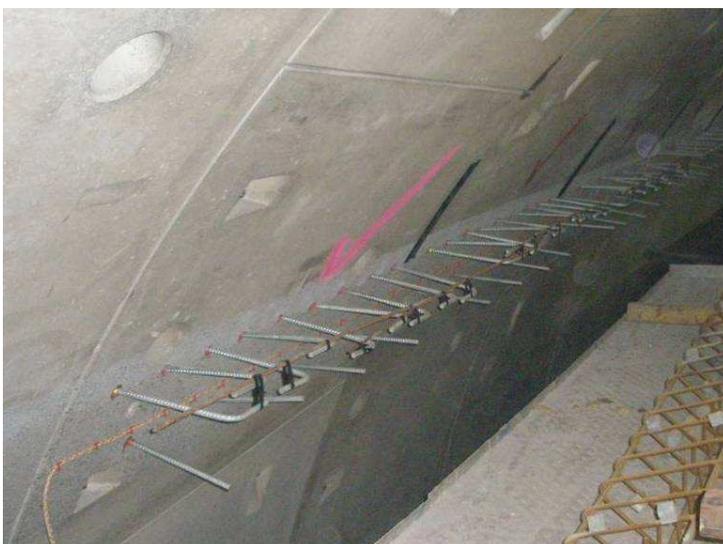
A common way to connect carriageways or ceiling slabs to circular tunnel linings is to apply post-installed reinforcement. If an appropriate adhesive is used, connecting reinforcement can be considered as cast-in-place reinforcement for design purposes as confirmed by corresponding European Technical Approvals.

However, under fire conditions, the bond of the adhesive is not comparable to that of cast-in-place reinforcement. In order to get reliable design data for post-installed reinforcement under fire, specific tests were performed. Combination of the experimentally derived critical temperatures for the rebar adhesives with the temperature evolution in the concrete results in fire design data for post-installed reinforcement.

Sometimes the concern for tunnel fires is so primordial, that general design data are not sufficient. This paper also shows the example of the Shanghai-Chongming tunnel in China, where specific fire tests were performed in order to confirm the safe behaviour under fire of the post-installed reinforcement.

**Keywords:** tunnel linings, connections, fire, post-installed reinforcement, test based design

### 1. Introduction: Post-installed Reinforcement



*Fig. 1: Post-installed reinforcement*

Continuity between new and existing parts of a concrete structure can be created by drilling holes into the hardened concrete and installing connecting reinforcement by means of an adhesive. Such complete and easy-to-apply injection systems for the bonding post-installed bars have been on the market for some years now [1]. The main advantage of such systems is that need not be installed already while the first part of the concrete structure is built. Thus the connection can be installed exactly at the location where it is finally required. This is especially useful in rehabilitation and extension projects, but also if the connections cannot be integrated in a prefabrication process such as tunnel linings (Fig. 1). If