# Butt-jointed reinforcement bars in the longitudinal joints of tunnel segments: Experimental investigation

**Clemens Proksch-Weilguni, Marion Decker, Johann Kollegger**

*Institute of Structural Engineering, TU Wien, Vienna, Austria*

**Contact:** clemens.proksch-weilguni@tuwien.ac.at

## Abstract

A tunnel lining built with a TBM (tunnel boring machine) consists of a large number of segments interacting via joints, that are commonly decisive for the design of the segment. In order to overcome this limitation, the Institute of Structural Engineering at TU Wien developed a novel reinforcement concept to enhance the longitudinal joint in terms of the ultimate load.

This paper presents the results of an experimental campaign on large scale test specimens investigating the load-bearing behavior of load transfer zones under compression with butt-jointed longitudinal reinforcement bars. The focus is on the effects of using a minimum transverse reinforcement on the load-bearing capacity of the segments. Based on the satisfactory results, it can be stated that the TU Wien reinforcement concept has a great potential for improving the performance of highly stressed tunnel segments.

**Keywords:** segmental tunnel lining, precast tunnel segments, joint reinforcement, resource-efficient structure

## 1 Introduction and motivation

Building the load-bearing tunnel structure with a segmental lining has gained growing relevance within recent decades and is now an internationally established and frequently used construction method. The load-bearing capacity of the longitudinal joint is typically the decisive factor when designing tunnel segment rings. This is due to the reduced cross-section of the segment in the longitudinal joint, accounting for installation and durability requirements.

In order to improve the performance of the longitudinal joint, the Institute of Structural Engineering at TU Wien developed a novel reinforcement concept. The concept is based on the installation of butt-jointed reinforcement bars in the load transfer zone, which leads to an improvement of the load-bearing capacity. With this approach, the longitudinal joint is no longer the weakest link in the segment ring. The new reinforcement concept is covered by a patent application [1, 2]. National patent phases have begun in Europe, the United States, Canada, and China.

The proof of concept of the innovative reinforcement concept has already been done in 2019 [3, 4]. In this paper, first results of a new extensive experimental campaign, which includes the investigation of different reinforcement concepts, are presented and compared with the results of the 2019 tests. In the new test series, the transverse reinforcement is reduced to a minimum according to the current European standards [5, 6]. The evaluation of the performance of the TU Wien reinforcement concept combined with a minimum of transverse reinforcement was the main motivation for the presented experimental investigations.

## 2 TU Wien design approach

According to the new concept, additional reinforcement bars, as indicated in Figure 1, are positioned precisely adjacent to the contact surface $A_{c0}$ of the longitudinal joints. Therefore, the compressive force operating in the tunnel segment ring can be transferred in the contact area through



https://doi.org/10.2749/newdelhi.2023.0778