

## Resource efficient reinforcement concept for precast tunnel segments

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### Abstract

The global increase in world population and the growing demand of mobility leads to new huge infrastructure projects all over the world. Due to the circumstance, that every infrastructure project is unique and dependent on local conditions the optimization of single structural elements is not that common in the field of reinforced concrete structures. When it comes to building tunnel structures using a tunnel boring machine (TBM), a lot of almost identical tunnel segments called tubbings are needed. Already a reduction of a few centimeters of the tunnel segment thickness, leads to a significant saving of concrete when it comes to tunnel structures with a length of a few kilometers. The thickness of the tunnel segments mostly depends on the design of the radial joints of the individual tunnel segments. That is why the Institute of Structural Engineering of the TU Wien developed a new reinforcement concept for tunnel segments which increases the load bearing capacity of the radial joints significantly. With a patent application submitted, tunnel segments with the new reinforcement concept were manufactured, tested and it was shown that the TU Wien proposal significantly improves the load bearing capacity of tunnel segments.

Due to a presented design approach for determining the load bearing capacity of the segments and a first simplified quantification of the resource saving potential it can be said that the newly developed joint design is a great possibility for constructing tunnels with thinner tunnel segments.

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

### 1 Introduction

An essential characteristic when building infrastructure constructions is the high degree of individuality of the structures and the low degree of material utilization. For infrastructure buildings with a lifespan of 100 years and more (e.g. 200 years for the Brenner Base Tunnel [1]), reinforced concrete with its technical properties is still an irreplaceable building material. One approach to save resources, in addition to optimize the manufacturing process, is the optimal utilization of the building materials according to their properties. Ideally, this means finding a balance by using building materials according to their physical properties, their environmental impact and still considering the structural requirements.

A tunnel built with precast tunnel segments is made up of segment rings along the longitudinal axis of the tunnel. To avoid concrete spalling between the segments in the longitudinal joint due to the relative rotation of the tunnel segments, a reduced cross-section in the contact area is necessary (Figure 1a). The dimension of the contact area of the tunnel segments is often the decisive factor for designing the thickness of the tunnel segments.

#### 1.1 Motivation

When it comes to build a tunnel, the thickness of the tunnel segments has an enormous impact on the material consumption of the infrastructure project. In the most cases the decisive part for designing the tunnel segment rings is the