Technische Universität Braunschweig

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Influence of Curvature on the Fatigue Behaviour of Post-Tensioned Steel

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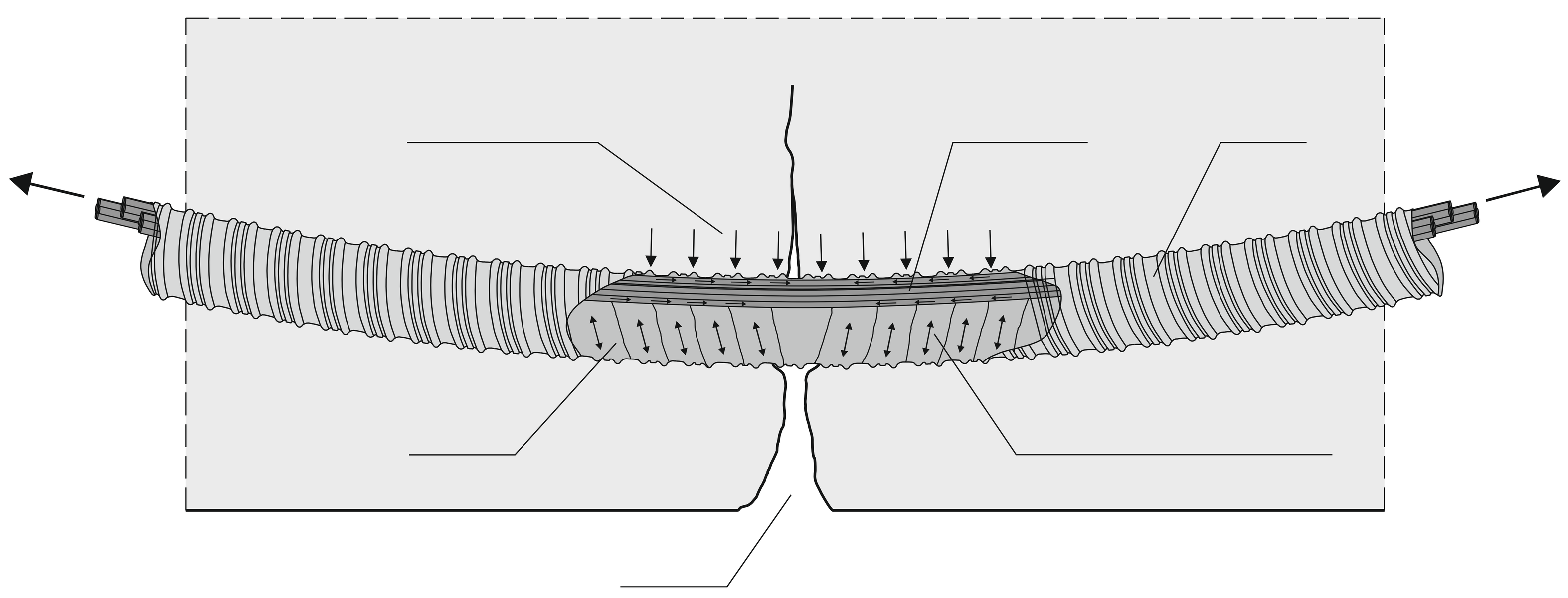
Fatigue Life of Concrete Bridges

The majority of bridges in Germany is constructed as post-tensioned concrete structures. Due to increasing traffic loads and proceeded service lives of existing bridges the fatigue life of bridges gains more and more importance. In post-tensioned concrete constructions the fatigue life is predominated by the fatigue strength of prestressing steel which can be significantly lower than the ultimate capacity.

Typical Post-Tensioned Concrete Bridge with Traffic Loads (Picture: http://www.eurotransport.de)

Local Stress Conditions of Tendons

The fatigue behaviour of curved tendons is affected by many influences and mechanisms resulting from the specific stress conditions in post-tensioned concrete girders. Basically, fatigue failure of the prestressing steel will occur predominantly in regions of high curvature caused by high lateral contact loads and friction between steel and duct (fretting corrosion). Thus, the fatigue life of curved post-tensioned steel can be significantly reduced compared with prestressing steel tested “in-air”.

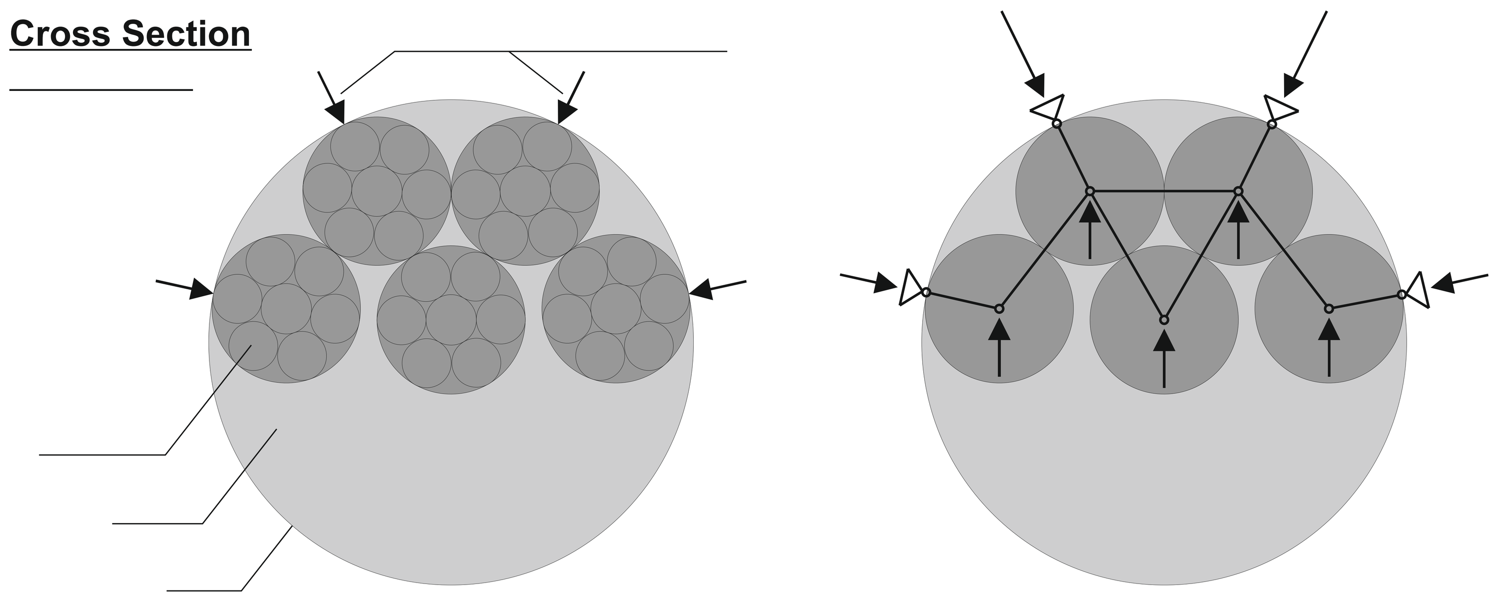


Specific Stress Conditions at Post-Tensioned Concrete Girdes with Curved Tendons

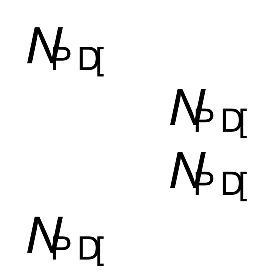
Effects of Lateral Pressure on Concrete (left), on the Duct (middle left) and on the Prestressing Steel (middle right) as well as resulting Wire Fractures (right)

Influence of Curvature

In order to quantify the influence of curvature on the fatigue behaviour of post-tensioned tendons, test results from literature as well as own test results were evaluated with regard to the maximum local contact loads between steel and duct determining the cable factor k_{max}. It could be stated that the cable factor and thus the lateral pressure is correlated with the fatigue life of the prestressing steel: With an increased lateral pressure the fatigue strength can be reduced significantly. Further theoretical studies are currently being carried out to propose a modified verification approach reflecting the fatigue strength of prestressing steel in consideration of various curvatures of tendons.



Local Contact Loads between Steel and Duct due to Lateral Pressure (left) and resulting Cable Factor k_{max} (right)



Determined Cable Factors k_{max} of different Test Results in context of the WÖHLER-Line according to EC2+NA

References

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