Bond of Pretensioned Strands under High Cycle Fatigue

Mazen Ayoubi
Research Engineer
mayoubi@imb.rwth-aachen.de

Sebastian Bülte
Research Engineer
sbuelte@imb.rwth-aachen.de

Norbert Will
Chief Engineer
nwill@imb.rwth-aachen.de

Josef Hegger
Professor
heg@imb.rwth-aachen.de

Institute of Structural Concrete
RWTH Aachen Universtiy
Aachen, Germany

Summary

Within the current research project, over 60 pull-out-tests under cyclic loading have been performed to analyze the local bond behaviour of strands, followed by T-beam tests to determine the influence of cyclic loading on the anchorage length of strands.

In addition, numerical simulations were conducted to investigate the bond action of pretensioned strands, which also included investigations on creep development under cyclic loading.

The results of the theoretical and experimental investigations presented in this article aim to extend the existing state of knowledge on this topic and to derive design rules.

Keywords: bond anchorage, strands, precast concrete, cyclic loading, transfer length, high cycle fatigue.

1. Introduction

The behaviour of the bond between pretensioned strands and concrete under high cyclic loading is an important topic regarding slender and long-spanning structures, which are characteristic of modern architecture. For example, in bridges and industry buildings, precast and pretensioned concrete elements are very common.

The bond between pretensioned strands and concrete is characterized by the so-called “Hoyer effect”, which is the lateral pressure that occurs between pretensioned steel and its surrounding concrete when prestensioning forces are released. This effect influences the stress transfer from pretensioned steel to concrete, predominantly in the anchorage zone.

Along with our investigations [1],[2], subsequent research work on the bond anchorage of strands (e.g. [3],[4]) has proposed that the bond capacity of strands is composed of three main parts:

- a base value;

- a stress-dependent part;

- a slip-dependent part.

The base value of the bond is explained by adhesion and friction. The stress-dependent part results from additional friction caused by lateral pressure between the steel and concrete (Hoyer-effect) [5]. Due to their irregular geometry, the strands do not fit exactly in the given duct when slip between steel and concrete occurs. Therefore, slip increases the bond stress (slip-dependent part). As the lateral pressure and slip decrease along the transfer length (l_t), the bond stress is not constant within l_t (Fig. 1). Further explanations on the transfer of prestress forces can be found in [2].

https://doi.org/10.2749/222137809796078342
Distributed by structurae