39th IABSE Symposium – *Engineering the Future*
September 21-23 2017, Vancouver, Canada

Experimental and Numerical Investigations on the Shear Capacity of Existing Prestressed Concrete Bridges

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Abstract

Systematic re-analyses of prestressed concrete bridges in Germany show, that only some 5% can fulfil all requirements given by current design standards whereas more than 60% of the bridges exhibit relevant or severe deficits. Hereby, the majority of the deficiencies are related to insufficient shear capacity. In order to more realistically assess the actual shear capacity, several research projects have been launched comprising numerical and theoretical investigations as well as extensive experimental testing. The present paper will firstly illustrate typical deficiencies of existing concrete bridges and will then discuss current research activities on the shear capacity. In doing so, experiments using an innovative laboratory setup will be described allowing a realistic testing of concrete beams at a reduced length utilizing the substructure technique. Finally, full-scale experiments on a prestressed 7-span continuous road bridge will be presented and discussed.

Keywords: Existing concrete bridges; assessment of bearing capacity; re-analysis; shear capacity; numerical modelling; experimental testing; full-scale experiments.

1 Introduction

Current re-analyses results for existing prestressed concrete (PC) bridges in Germany show, that only some 5% can fulfil all requirements given by current design standards whereas more than 60% of the bridges exhibit relevant or severe deficits. Besides the age, the general structural condition and continuously increasing traffic loads these deficiencies may also be attributed to modified codes and regulations. With more than 56,5% of the deficient bridges this particularly applies to insufficient shear capacity (V_{Rd}) which is in direct relation with the bridge age and corresponding standards, respectively. Accordingly, the majority of the concrete bridges built before 1966 exhibit dramatic deficiencies in shear mainly because of a systematic minimum shear reinforcement missing in the former DIN 4227:1953.

In order to more realistically assess the shear capacity, several major research projects have been launched recently including extensive laboratory testing as well as in-depth numerical and theoretical analyses. In addition, also in-situ load-bearing tests are performed on existing PC bridges prior to demolishment. The present paper will firstly illustrate typical deficiencies of existing concrete bridges and will then present current research activeties related to the shear capacity. Hereby, experiments using an innovative laboratory setup will be described which allows a realistic testing of concrete beams at a reduced length utilizing the substructure technique. Besides the general shear capacity also the efficiency of different types of shear reinforcement (including outdated stirrups no longer admitted) and scale effects are investigated. In addition to conventional measurement techniques also innovative fiber-optic systems are

https://doi.org/10.2749/vancouver.2017.2126
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