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Punching/Shear Strength of a Full-scale Tested Bridge Deck Slab

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Abstract

For reinforced concrete (RC) slabs without shear reinforcement, shear and punching can be the governing failure mode at ultimate limit state if subjected to large concentrated loads. Punching of RC slabs without shear reinforcement has been a challenging problem in assessment based on current standards. To examine a previously developed enhanced analysis approach, this study was conducted by applying continuum FE analyses to a 55-year old RC bridge deck slab subjected to concentrated loads near the main girder in a field failure test. The influence of parameters such as boundary conditions, location of concentrated loads and shear force distribution were investigated.

Keywords: Shear and punching of RC slabs, Bridges, FE analysis, full-scale bridge test

1 Introduction

For reinforced concrete slabs without shear reinforcement, shear and punching can be the governing failure mode at ultimate limit state when subjected to large concentrated loads. Currently, building codes of practice provide several approaches to check the two-way punching strength of flat concrete slabs.

According to previous studies, non-linear FE analysis was able to predict shear and punching capacity with high accuracy, for example, Polak et al. [1] and Shu et al. [2]. Recommendations on how to make modelling choices when using 3D continuum elements was also presented in Shu et al. [3][2]. Results showed that not only the shear and punching capacity could be predicted, but also that influence of parameters such as specimen size and amount of flexural reinforcement was reflected in the non-linear FE analysis.

Furthermore, the shear force distribution in RC slabs and its relation to the critical shear crack has been investigated using continuum element FE analysis in Shu et al. [4]. However, all the studies mentioned above were carried out based on laboratory experiments. The application of these methods to structures in reality is also needed to show their applicability and advantage. In the past, only a limited number of the bridges deck slabs have been tested to failure. In addition, the developed enhanced analysis method has not been applied on such field tests.

The aim of this study was to examine the developed modelling methods developed by Shu el al.[2][3] and investigate the response of a real structure in engineering practice. A full-scale field test has been carried out to a 55-year existing RC bridge [5], with a failure test of the deck slab under concentrated load near the girder, leading to a shear type failure of the slab; Figure 1.

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