Nonlinear finite element analysis of tests of reinforced concrete slabs

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Abstract

In the Netherlands, many existing reinforced concrete slab bridges were built more than 50 years ago. Upon assessment with the new codes, a large number of this type of bridge rate insufficiently. Since many of these existing bridges present complex material properties and boundary conditions, proof load testing is considered an effective method to assess their capacity. However, to be able to safely apply proof load testing on slab bridges, verification in the laboratory is necessary. Therefore, experiments on reinforced concrete slabs of 5 m × 2,5 m × 0,3 m under a concentrated load with varying shear span to depth ratios are carried out in the laboratory of Delft University of Technology. Additionally, nonlinear finite element analysis is used to simulate the experiments following the guidelines of nonlinear finite element analysis published by the Dutch ministry of infrastructure and water management. The results from the finite element and experimental analyses are compared in terms of peak load, failure mode, and crack pattern. A good agreement between the experimental and numerical investigations is observed.

Keywords: reinforced concrete slab; non-linear finite element analysis, phased analysis, crack pattern.

1 Introduction

In the Netherlands, many existing bridges, in particular reinforced concrete slab bridges, were built in the 1960s and 1970s. These bridges were not designed for the actual traffic loads and could present material deterioration. Furthermore, the design codes have changed in the last decades, assigning larger live loads, a closer distance between the axis, and reducing the calculated shear capacity. Therefore, upon assessment with the new codes, a large number of these bridges rate insufficiently for shear.

Many of the existing bridges present complex material properties and boundary conditions. Therefore, they cannot be accurately assessed with analytical methods. In such cases, proof load testing is considered an effective method. The principle of proof load testing is to apply a factored live load to directly demonstrate the capacity of the structure. When the structural response of the bridge does not exceed the predefined limits or stop criteria, the test proves the bridge's capacity.

Recently, in the Netherlands, proof load testing has become an interesting option. Therefore, the shear and flexural behaviour of reinforced concrete slabs without shear reinforcement are being

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