Shear strength evaluation of RC bridge deck slabs according to CSCT with multi – layered shell elements and PARC_CL Crack Model

Beatrice Belletti, Matteo Scolari

Department of Civil Engineering, University of Parma, Parma, Italy

Aurelio Muttoni, Raffaele Cantone

Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Contact : beatrice.belletti@unipr.it

Abstract

The shear resistance of RC slabs without shear reinforcement subjected to concentrated loads near linear support is usually calibrated on the base of tests on one – way slabs with rectangular cross section. However, the actual behavior of slabs subjected to concentrated loads is described properly by a two-way slab response. The aim of this paper consists in the evaluation of the shear resistance of bridge deck slabs using analytical formulations and Nonlinear Finite Element Analyses (NLFEA). The obtained numerical results are consequently compared with experimental observations from two test campaigns. The case studies were analysed by NLFE analyses carried out using the constitutive Crack Model PARC_CL (Physical Approach for Reinforced Concrete under Cycling Loading) implemented in the user subroutine UMAT.for in Abaqus Code. In order to predict properly global and local failure modes through a NLFE model, a multi – layered shell modelling has been used. As shell element modelling is not able to detect out – of – plane shear failures, the ultimate shear resistance of these slabs is evaluated by means of a post – processing method according to the Critical Shear Crack Theory (CSCT).

Keywords: Reinforced Concrete, Deck Slabs, Shear Strength, Nonlinear Finite Elements Analyses

1 Introduction

In the past, deck slabs of RC hollow box or T – beam bridges have been designed without shear reinforcement. In many cases, the structural safety cannot be verified by the new Codes for most of them, [1]. Hence, it is necessary to reassess the shear capacity of these bridges: the shear resistance design value $V_{Rd,c}$ of members without shear reinforcement is only based on empirical equations and not on a mechanical model that could take into account of different shear –bearing mechanisms. Linearly supported RC slabs without shear reinforcement subjected to concentrated loads can fail in shear, [2]. Shear can be assessed with two different approaches: by checking the punching shear resistance on a control perimeter around the loading area or by evaluating the beam shear resistance over a prescribed effective width b_w, [3] - [5], (Figure 1). The load carrying mechanisms for linearly supported RC slabs under concentrated loads is different for one –way or two – way slabs as the acting shear forces and bending moments at the shear critical region could potentially vary by increasing the level of load due to redistribution of

https://doi.org/10.2749/222137815818358385
Distributed by structurae