



Early-age cracking behavior of advanced reinforced concrete pavement under environmental loading

Muhammad Kashif, Ahsan Naseem, Nouman Iqbal, Pieter De Winne, Hans De Backer

Department of Civil Engineering, Ghent University, Technologiepark 60, B-9052 Zwijnaarde, Belgium

Contact: muhammad.kashif@ugent.be

Abstract

The technological innovation of continuously reinforced concrete pavement (CRCP) that contains a significantly reduced amount of reinforcement and the same fundamental behaviour as CRCP is called advanced reinforced concrete pavement (ARCP). This new concept of a rigid pavement structure is developed to eliminate unnecessary continuous longitudinal steel bars of CRCP by using partial length steel bars at predetermined crack locations. In Belgium, partial surface saw-cuts are used as the most effective crack induction method to eliminate the randomness in early-age crack patterns by inducing cracks at the predetermined locations of CRCP. The reinforcement layout of ARCP is designed based on the distribution of steel stress in continuous longitudinal steel bar in CRCP and the effectiveness of partial surface saw-cuts as a crack induction method. The 3D finite element (FE) model is developed to evaluate the behaviour of ARCP with partial surface saw-cuts. The early-age crack characteristics in terms of crack initiation and crack propagation obtained from the FE simulation are validated with the field observations of cracking characteristics of the CRCP sections in Belgium. The finding indicates that ARCP exhibits the same cracking characteristics as CRCP even with a significantly reduced amount of continuous reinforcement.

Keywords: Early-age cracking; partial surface saw-cut; continuously reinforced concrete pavement; advanced reinforced concrete pavement; finite element simulation.

1 Introduction

Early-age cracking inevitably occurs in concrete pavements because of the temperature differences and stress development during the hardening process of concrete [1]. For this reason, transverse joints in jointed plain concrete pavement (JPCP) are intended to relieve the stresses in the concrete slab caused by environmental loading. Severe distress in JPCP includes the spalling and faulting over these joints, which increase the maintenance and rehabilitation cost and associated user inconvenience due to traffic control. The

continuous joints repairing throughout the life span of JPCP originates the concept of continuously reinforced concrete pavement (CRCP)[2-6]. The original intention of CRCP is to eliminate the transverse joints and enhance the pavement service life with minimal maintenance [7-9].

CRCP contains the steel bars continuously in the longitudinal direction and no gaps for the transverse joints. Hence, the cracking is allowed to occur as a result of the volumetric changes in the concrete pavement slab under environmental loads such as changes in temperature and moisture. The continuously placed longitudinal