Numerical evaluation of horizontal cracking potential in continuously reinforced concrete pavement under varying saw-cut depths

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Abstract

The objective of this study is to evaluate the horizontal cracking potential in terms of vertical tensile stress development near longitudinal steel bar in the continuously reinforced concrete pavement (CRCP). For this purpose, a three-dimensional (3D) finite element (FE) model of the CRCP segment with partial surface saw-cuts has been developed using the FE tool Diana 10.3. The early-age behaviour of CRCP subjected to external varying temperature field condition has been evaluated by using the staggered structural-flow analysis. The characteristics of the early-age crack pattern in terms of crack initiation and crack propagation obtained from the FE model are compared with the field observations of cracking developments on the CRCP sections in Belgium. The FE results indicate that the vertical tensile stress in concrete near the longitudinal steel bar develops at the transverse crack interface. It translates that the horizontal crack perpendicular to the vertical concrete stress can initiate from the transverse crack depending on the magnitude of stress against developing concrete tensile strength. It has also been observed that the deeper the saw-cut, the larger the magnitude of vertical tensile stress and the higher incident of horizontal cracking. Moreover, the developed 3D FE model can be further used to optimize the early-age behaviour of CRCP in advance of costly field trials.

Keywords: Horizontal cracking; vertical tensile stress; continuously reinforced concrete pavement; finite element simulation.

1 Introduction

Punch-outs are the most severe structural distress of continuously reinforced concrete pavement (CRCP). They are formed at the outer edge of the concrete slab by a combination of two transverse cracks and one connecting short longitudinal crack [1, 2]. Although, there is no direct correlation between transverse crack spacing and punch-out formation, however, the narrowly spaced cracks triggers the punch-out development as shown in Figures 1 and 2. Field observations indicated that the lower the average mean crack spacing, higher the probability of concrete spalling and punch-out formation [3-7].

Full-depth repair of CRCP reveals the partial depth punch-out formation which is associated with horizontal cracking at the steel depth [8].

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