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# Analysis of periodic cracks in surface layer of pavement structures

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ABSTRACT

As a critical issue for the pavement's quality service life, surface cracking of the pavement structure is an ongoing research topic which attracts many researchers. This paper presents a numerical study of the periodic cracks in surface layer of pavement structures based on the FEM method. The formation mechanism of the periodic cracks is analyzed and the evolving process is simulated. A parametric study, including effects of the layer thickness, tensile strength of surface layer and layer elastic modulus on the crack spacing is carried out. The numerical results indicate that the horizontal stress between two adjacent cracks decreases gradually as the crack spacing decreases. The horizontal stress transits from tensile to compressive when the crack spacing decreases to a certain value. Such a stress state transition leads to the periodic array of the surface cracks. The evolving process of the periodic cracks indicates that new cracks infill in sequence between two earlier formed adjacent cracks and the crack spacing decreases in half simultaneously. No more new crack can infill when the crack spacing reaches to a certain value even with the increasing of external load. Numerical simulations also show that the crack spacing is strongly dependent on the surface layer thickness, tensile strength of the surface layer and elastic modulus of the surface layer.



## 1. Introduction

Surface cracking in pavements has long been regarded as a main cause of deterioration in roadways because surface water penetration can reduce the strength of the sub-base layers and result in broader cracks and potholes. Thus, surface cracking has a direct bearing on pavement's quality and service life, which attracts more and more attention in recent years [1–5]. There are many different types of pavement crack shapes, with occasionally complex morphologies. Nonetheless, crack patterns existing on pavements are generally classified into the following four categories: (1) longitudinal cracks, (2) transverse cracks, (3) block cracks and (4) alligator cracks.

Among these crack patterns, an interesting phenomenon can be found at some pavements that cracks are periodically distributed and spaced equally, as shown in Fig. 1. These periodic cracks can also be observed at surface of bridge pavement structures. Xu and Zhang have surveyed the cracks of steel orthotropic bridge deck pavement [6]. They found that the longitudinal crack is the main crack style, as indicated in Fig. 2. Chen et al. [6] reported the characteristics and propagations of the cracking of asphalt surfacing on long-spanned steel bridges. According to their long-term observation, longitudinal crack was also the main crack style and these short longitudinal cracks formed earlier would soon propagate parallel cracks if there were not properly sealed. These short longitudinal cracks occurred at/near the ribs or the girders, as shown in Fig. 3. Another type of longitudinal cracks of asphalt surfacing which occurs in between the trough of ribs is also mentioned, as shown in

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