Track irregularity and mechanical characteristics analysis of CRTS I ballastless track under subgrade frost heaving

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Abstract

Harbin-Dalian high-speed railway is located in the northeast of China, part of which belongs to seasonal frozen area. In seasonal frozen area, the seasonal frost heaving and thaw settlement of subgrade will lead to local uneven subgrade frost heaving deformation, which will cause overarching deformation of track structure, even cause structural damage and track irregularity, and affect train safety directly. On the basis of full site investigation, taking CRTS I ballastless track in frost heaving area of Harbin-Dalian high-speed railway as research object, the spatial finite element model considering the interlayer contact characteristics was established using ANSYS finite element software. The transfer properties of track irregularity, interlayer separation characteristics and mechanical characteristics under frost heaving condition were analyzed. It provides an important reference for the design of ballastless track in cold and seasonal frozen area.

Keywords: high speed railway; CRTS I; ballastless track; subgrade frost heaving; track irregularity.

1 Introduction

For seasonal frozen area, frost heaving and thawing settlement are the key factors that lead to the poor line quality and affect the operation quality of high-speed railway [1-3]. According to the frost heaving investigation data of "the sixth issue of freezing damage monitoring log" provided by Shenyang Railway Administration, 76% of the 281670 measuring points of Harbin-Dalian high-speed railway subgrade have frost heaving phenomenon, of which the frost heaving vertical deformation of 5~10mm accounts for 21.9%, the frost heaving vertical deformation of 10~15mm accounts for 3.7%, and the frost heaving vertical deformation of 0.49% measuring points exceeds 15mm [4]. Under the cyclic dynamic load of high-speed train, the longitudinal irregularity of subgrade in frost heaving area transfers to the upper ballastless track structure quickly, resulting in the separation of track slab and mortar layer, baseplate and surface layer of subgrade, and even the complete loss of bond strength, which affects the track regularity and loading capacity directly. In addition, in cold environment, the durability of concrete baseplate and mortar layer under repeated freezing-thawing cycles is greatly reduced [5-6], and the material performance reduction leads to uneven stress of track structure and cracks and fatigue damage. It is of great significance to study the deformation and mechanical properties of track structure under the condition of frost heaving.

Domestic and foreign scholars have carried out extensive and in-depth research on the frost heave of high-speed railway ballastless track subgrade in severe cold regions. Zhao Guotang [7] and Li Juan [8] proposed reasonable management standard of frost heaving of ballastless track

https://doi.org/10.2749/seoul.2020.123
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