Finding Fouled Ballast inside Railway Foundation Using Featured GPR Signals

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ABSTRACT

Currently about 85% of the railway structure is constructed traditionally in Taiwan, which means the foundation of railways is composed by in-situ soil materials and covered by ballast, sleepers and tracks. The rail is continued by fishplates and then bolted. While train passes, the deflection would be generated by repeated loads from the trains. The force transfers through ballast to the saturated foundation, may create vacuum to draw phenomenon, called pump effect or mud pumping. As the phenomenon occurring, the material would be carried out and then cavities under the ballast grows larger. It may induce serious train derailment capsized. Neiwan branch line was constructed in 1951 in the traditional formation and is famous for its scenery in Hsinchu county. The section from milestone marked K16+600 (Chutong station) to K27+900 (Neiwan station), about 12km long, was selected to be studied herein. According to official records, the ballasts in this section were replaced and sub-ballasts were re-compacted in 2012 to 2013. About 30 pumping cases were observed in May, 2015. Furthermore, about 34 new pumping cases were observed in Feb, 2016. That means the pumping phenomenon is frequently occurred. The pumped materials were collected to be analyzed. The result shows that distinctive from the studied cased reported in foreign documents, excepting mud, other kinds materials were observed in the studied area. Only 50% of them were ML(mud), others were CL(clay) or SM(sand). Different material would form differently in outlook shapes. The piping paths of different materials presents unique mechanism as well. The purpose of this study is to find the paths of pumping materials by in-situ GPR inspection and appropriate interpretation, and then evaluate the mechanism of soil pumping. The result shows that the traditional method for interpretation of GPR signals is not suitable. Featured GPR signals is therefore proposed in this study for enhancing interpretation.