



Review on Methods for Non-Destructive Ballast and Formation Condition Assessment

Regular inspection and maintenance of railway track is always a major task for the rail industry. Ballast attrition, ballast and sub-ballast fouling and subgrade softening are the main reasons for track deterioration. Ballast attrition will exacerbate breakdown leading to significant fouling. Ballast and sub-ballast fouling will lead to poor drainage in the fouling material and then increase the moisture content of the subgrade posing undrained failure risks. Increase in moisture content and softening of the subgrade will also increase the potential of clay slurry being pumped up into ballast and sub-ballast layers under cyclic loading (c.f. liquefaction). One or a combination of these reasons can cause reduction in drainage capability, strength and stiffness of the track and eventually increase track differential settlements. Therefore, investigation of railway track should include assessment of ballast, sub-ballast and the formation. If information about any of these layers is omitted, then the true cause of poor formation sites cannot be ascertained satisfactorily, and consequently appropriate ground improvement schemes may not be implemented. The main tasks of railway track investigation can be summarized as follows:

1. Assessment of ballast condition, including thickness of clean ballast, fouling sources and fouling material, moisture content and extent of fouling, and modulus and resilience of the ballast.
2. Assessment of sub-ballast (if applicable) condition, including sub-ballast thickness, moisture content and fouling condition.
3. Assessment of formation condition, including measurement of the bearing capacity and stiffness of the formation.
4. Measurement of the overall stiffness of combined track components, that is, the rail, sleeper, ballast, sub-ballast and formation.

There are numerous methods that can evaluate the track condition. It is important to adopt a technique or a combination of several techniques to accurately and efficiently monitor the condition of thousands of kilometres of railway lines periodically. In the report “Review on Methods for Non-Destructive Ballast and Formation Conditions Assessment, 24 May 2009”, possible methods for assessing railway track condition are reviewed in detail. Advantages and disadvantages of these methods are discussed and compared. Ground Penetrating Radar (GPR), which is currently a popular and promising method, is introduced. Its applications and capabilities are reviewed and discussed. At the end, preliminary GPR test results obtained at University of Wollongong are presented and discussed.