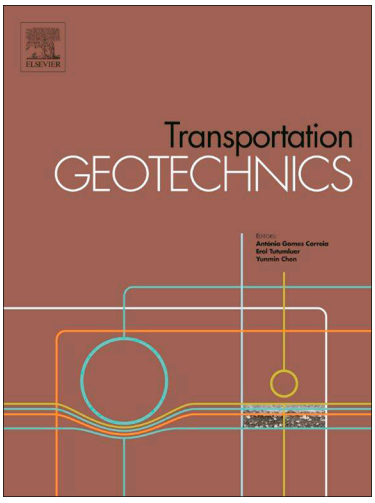

25 Years of Heavy Axle Load Railway Subgrade Research at the Facility for Accelerated Service Testing (FAST)

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25 Years of Heavy Axle Load Railway Subgrade Research at the Facility for Accelerated Service Testing (FAST)

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Abstract: This paper presents a summary of more than two decades of heavy axle load (HAL) railway subgrade research conducted at the Facility for Accelerated Service Testing (FAST). Railway subgrade, if inadequate and not reinforced/improved, can deform and fail progressively, causing significant track geometry degradation under HAL train operations. To understand how railway subgrade behaves under HAL and develop guidelines for design, maintenance and remediation, a number of tests were conducted in multiple phases at FAST to determine how a "soft" subgrade test section would affect track performance and to evaluate remediation methods that can be used to improve soft subgrade support for HAL train operations. Since its inception in the early 1990s, this subgrade testing program has produced a body of knowledge about railway subgrade behavior under 35.4-tonne axle loads. In addition to generating track degradation and maintenance demand data, the testing program provided valuable insight into the relationship between subgrade behavior and track performance. Results were obtained to understand how wheel loads were transferred to the subgrade, subgrade failure mechanisms, and how various soft subgrade remediation techniques performed.

Keywords: Heavy axle load (HAL); Facility for Accelerated Service Testing (FAST); subgrade; track geometry; remediation

Introduction

In many countries around the world, railways are placing increased demands on the track substructure (ballast, subballast, subgrade, and drainage) because of ongoing trends of increased axle loads and increased traffic. A significant part of railways' track maintenance budget is allocated to ballast tamping and surfacing operations to correct rough track geometry, which is often caused by problems and deformation in the track substructure under train operations. As axle load and traffic density increase, the condition of track substructure imposes an increasing influence on track performance. Poorly performing track substructure not only results in high rates of track geometry degradation, but also promotes higher rates of wear and deterioration of the rails, ties (sleepers), fasteners, and special trackwork (switch and crossing).

Track substructure problems are typically associated with poor drainage, degraded ballast, and subgrade deformation or failure. In many cases, ballast degradation with poor drainage is the main culprit of track problems under HAL train operations, but in some cases soft subgrade support can be a major cause of track geometry degradation (Li, Hyslip, Sussmann and Chrismer, 2016; Tutumluer et al, 2015; Grabe and Shaw, 2010; Indraratna and Salim, 2005; Selig and Waters, 1994).

Under the sponsorship of the Association of American Railroads (AAR) and the Federal Railroad Administration (FRA), Transportation Technology Center, Inc. (TTCI) has conducted a long-running track substructure research program with the following main objectives: (1) determine the effects of increased axle loads, traffic density, and train speeds on track substructure performance, (2) determine root causes of track substructure deterioration under HAL, (3) quantify the effects of track substructure problems on track component life cycles, and (4) develop methodologies and guidelines for track substructure diagnostics, remediation, and maintenance. This paper, however, is only focused on the effects of soft subgrade support on HAL train operations and those remediation methods that can be used effectively to improve soft subgrade support for HAL train operations.