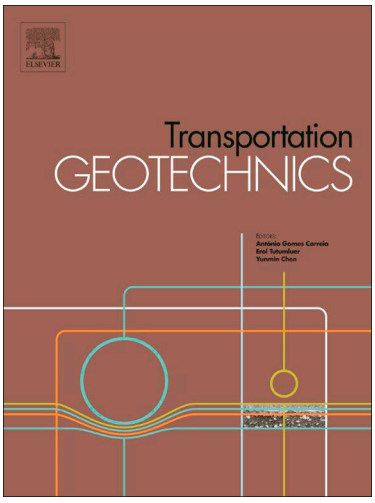

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Full scale laboratory testing of ballast and concrete slab tracks under phased cyclic loading

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Abstract

Full-scale laboratory-based testing is used to compare the long-term settlement performance of a precast concrete slab track section to a ballasted track (with concrete sleepers) resting on a compacted substructure. The railway track substructure is constructed from a 1.2 metre deep combined subgrade and frost protection layer, according to modern high-speed rail standards such as those specified in Germany. Phased cyclic loading is then used to simulate the primary loading mechanism of a train after 3.4 million load cycles representing many years' worth of train passages. Displacement transducers, earth pressure cells and accelerometers are employed to determine the permanent settlement, the cyclic displacement, transient stresses and vibrations of the track. The equipment, loading combinations, material properties and experimental displacement results are presented and compared. The results indicate that the ballasted track experienced 20 times more settlement when compared to the concrete slab track under the same loading conditions, even though the ballasted track was tested at a slightly higher compacted state due to the concrete slab track test being conducted first.

Keywords: Full-scale cyclic testing; Railway track settlement; Railway track stiffness; Long-term track behaviour; Ballast and concrete slab track

1 Introduction

It is well known that high-speed railway track design presents many challenges in comparison to conventional speed railways. Currently, both ballasted and concrete slab tracks are being used for high-speed railways worldwide and it is recognised that both forms have advantages and disadvantages. It is generally known that the initial cost of installation of ballasted track is cheaper in comparison with concrete slab track but on the other hand the maintenance costs of ballasted track are higher [1,2]. Nevertheless, ballasted track has been continuously developed since the beginning of the railways and it is still the most common track system used today. Due to the overall poor performance of ballast for increased train speeds, the use of concrete slab track has attracted a lot of attention and various slab track forms have been produced and tested in recent years.

Full-scale testing has been used to investigate the performance of various parts of the railway track structure. For example, full-scale model tests with simulated train moving train loads has been developed to explore the dynamic performance and long-term behaviour of concrete slab tracks [1,3]. In the case of ballasted track, a two-layer railway track model was developed and tested [4]. It was reported that the subgrade plays an important role in the global track stiffness and hence the deterioration of vertical track geometry [5]. It was noted that a low track stiffness value can result in a flexible track with poor load distribution and a high track stiffness value can cause greater dynamic