Responses and vulnerability of composite railway track slab to train derailments

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Abstract

Modern replacement of deteriorated timber transom sleepers by steel-concrete composite slabs can significantly improve asset management strategy for railway bridges over their life cycle. Track engineers can take advantage of steel-concrete composite technology over traditional concrete slabs. The design of such steel-composite track slabs has shown 10-20% reduction in the component depth and thus the weight. These benefits enable the composite slabs to fit brown-field maintenance project where merely aging transoms can be renewed and the new composite slabs can be installed over existing girders and support systems. In practice, railway bridge structure is designed to embrace redundancy assuring public safety. The risk and consequences of train derailment over the bridge has prompted railway authority to investigate the vulnerability of railway bridge system. Therefore, the design and modelling of this composite slab has been verified by previous work of the authors. This paper presents the dynamic responses and vulnerability of the composite track slabs to train derailments. A nonlinear finite element model of integrated train-track-bridge has been developed and validated using field data. The impact analysis has then been carried out using ABAQUS Explicit to evaluate the dynamic responses of the composite railway track slabs, benchmarked with quasi-static code-based design method. This study enhances the insight into the dynamic behaviour of vulnerable track slabs so that track engineers can predict the damage arisen from a train derailment.

Keywords: Railway bridge, steel, concrete composite, transom, railway bridge sleeper, track slab, train derailment, failure analysis, dynamic finite elements

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