High Performance Concrete Railway Sleepers

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Abstract: As an essential part of ballasted track, prestressed concrete sleepers play major role in track performance and safety. In spite of a huge amount of untapped strength, many concrete sleepers experience premature cracking. The cracks lead to stiffness reduction and also make the sleeper susceptible to diffusion of water and harmful ions which, in turn, causes to un-planed replacement of sleepers. In this research, some kind of high performance concretes such as Fiber Reinforced Concrete and Reactive Powder Concrete will be analyzed using LS-DYNA FEM, to investigate their behaviour under impact loads. The research is planned to provide better understanding of sleeper components interactions and identify the most suitable type of high performance concrete to increase ductility, durability and sustainability of concrete sleepers.

Introduction

Ballasted tracks have kept their dominant in railway around the world because of their advantages. Prestressed concrete sleepers, which distribute service loads from the rails to the substructure, are the major part of ballasted railway tracks. In spite of a huge amount of untapped strength, many concrete sleepers experience premature decays, especially, cracks that occur due to high magnitude wheel-rail impact loads. It is demonstrated that cracks strongly affect the lifetime of concrete sleepers and may result in increased corrosion or fatigue failure of reinforcement.

The interactions between sleeper and other components of the track have clearly been investigated. Further, many new types of concrete with favorite behaviour have been introduced. But, the investigation of these concretes as sleeper material has rarely studied, particularly, the behaviour under impact loads. The suitability of new concrete for utilizing in sleeper will be investigated in this research.

Methodology

The capability of finite element modelling in simulating the concrete behaviour, cracking and failure has been demonstrated. In this research the finite element analyzing package, LS-DYNA will be utilized to study the cracking behaviour of the candidate high performance concretes subjected to impact loads to identify the suitable type as sleeper material. The model is calibrated and validated based on experimental test results which are available in the literature. Then the properties are changed for different types of concrete to analyze the behaviour. The fastening system connectors, strands and their interface with concrete matrix are elaborately modeled as well as the simulated track condition, including rail and ballast, is modeled.

Expected Outcomes

The main objectives of this research are:

- better understanding of influence of fastening system connectors on concrete crack initiation.
- identify the most suitable kinds of High Performance Concrete to make more ductile, durable and sustainable sleeper.