Development of Nonlinear Railway Track Model Applying Modified Plane Strain Technique

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Abstract: The contribution of ballast and subgrade layers behavior to railway track performance is given insufficient consideration in the current railway track models. In particular, stress- and traffic-dependent characteristics need to be incorporated into the analysis. In this research, a new theoretical model is developed to include nonlinear characteristics of the track substructure such as resilient modulus and nonrecoverable strain, incorporating for the first time stress- and traffic-dependent properties of track sublayers. The new model uses a modified finite element plane strain technique which allows simulation of a three-dimensional load spread with a two-stage two-dimensional model. This technique keeps calculation time and cost to a minimum. Comprehensive field tests were conducted to evaluate the accuracy and reliability of the model. Challenging the current assumptions in the analysis and design of railway track systems, the impact of the consideration of the nonlinear properties of the ballast and subgrade materials on the accuracyof the theoretical results is discussed. The proposed technique was found to be accurate and easily applicable to railway track analysis.

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