CERIS Civil Engineering Research and Innovation for Sustainability

Modelling railway slab track towards enhanced dynamic performance and reduced track deterioration

Summary

Within the framework of the European requisites for 2030/2050 railways, the future research on ballastless tracks should develop ecological and cost-efficient slab tracks for very high-speed and mixed traffic with enhanced performance, low track deterioration and reduced risk vulnerability. The main scope of this research is to predict the structural behaviour of ballastless systems through the development of a powerful finite element tool. The ongoing research can be divided in three important milestones: (i) Conception and development of railway train/ track models; (ii) Further developments focusing on the estimation of slab track long-term performance; and (iii) Optimized slab track guidelines.

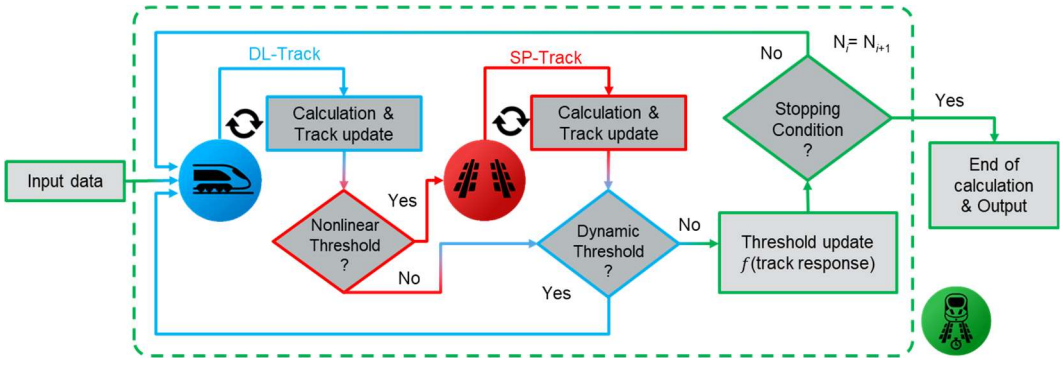
The first work milestone, outlines the modelling process of the railway system and the development of two short-term numerical models: a reduced linear dynamic model (DL-Track) and a detailed non-linear model (SP-Track). These two models perform static and dynamic simulations due to the effects of train loading and temperature. Taking in consideration the assumed goals,

in the second work milestone a hybrid model will be built, with a dual approach for both short- and long-term estimations that uses the interaction between DL-Track and SP-Track models (Hybrid model = DL-Track + SP-Track). The long-term effect in the slab track will be achieved through simulation of millions of cycles, emulating several years of track lifetime, and in each cycle, several parameters are updated. The final work milestone and major contribution of this study is obtained with the application of the developed hybrid model. With this powerful tool, a parametric analysis could be performed, moreover recommendations and design guidelines will be outlined: suggestions on slab track configuration and some track component properties; suggestions upon reinforcement bars inside the concrete slab track to improve cracking control; identification of some design limiting factors, etc.

Furthermore, different solutions of slab track will be evaluated, and possible recommendations will be drawn about new concept ideas to achieve reduced deterioration and low track maintenance.

Keywords

Slab track, railways, finite element modelling, experimental tests, train-track interaction, dynamic behaviour, long-term behaviour, track maintenance and renewal, life cycle cost.



Long-term calculation process of the full hybrid model.

PhD student
Samuel Ribeiro Matias

PhD program
Transportation Systems (IST, University of Lisbon)

Supervisor
Patrícia Ferreira (CERIS, IST, University of Lisbon)

Co-supervisor
-

Period
2015-2021

Funding
FCT scholarship (PD/BD/113751/2015)