An improved multibody simulation model for switches and crossings. Numerical and experimental results”

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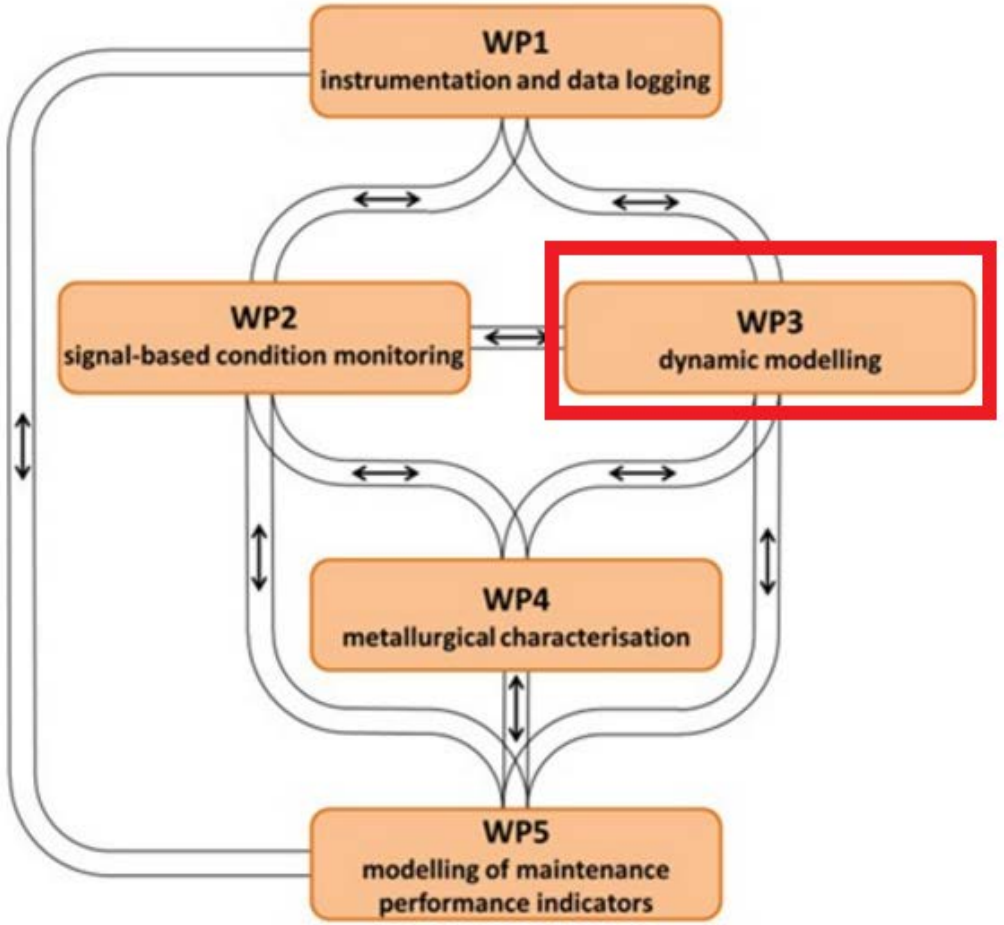
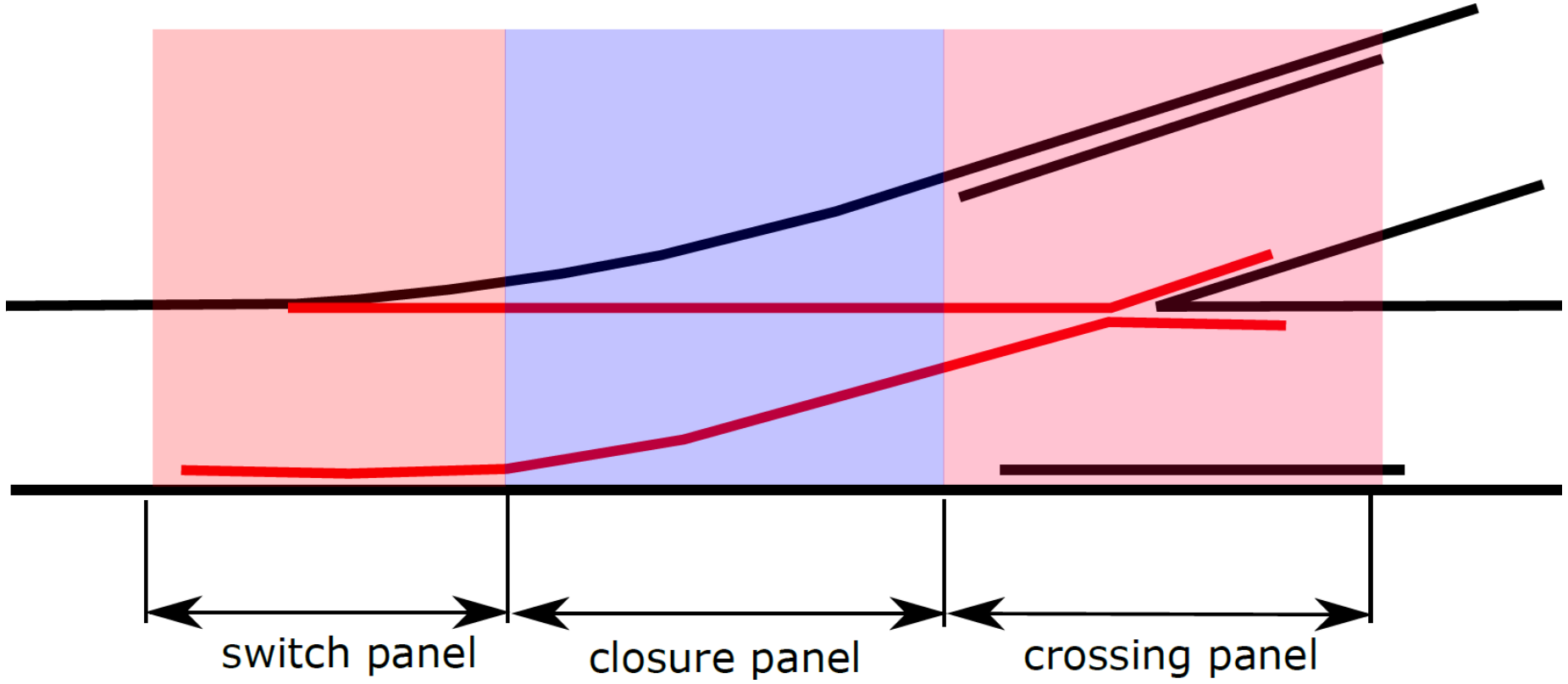
outline

1. Introduction
2. State-of-the-art
3. Numerical models
4. Case of study: numerical & experimental results
5. Track degradation analysis
6. Conclusions and future work

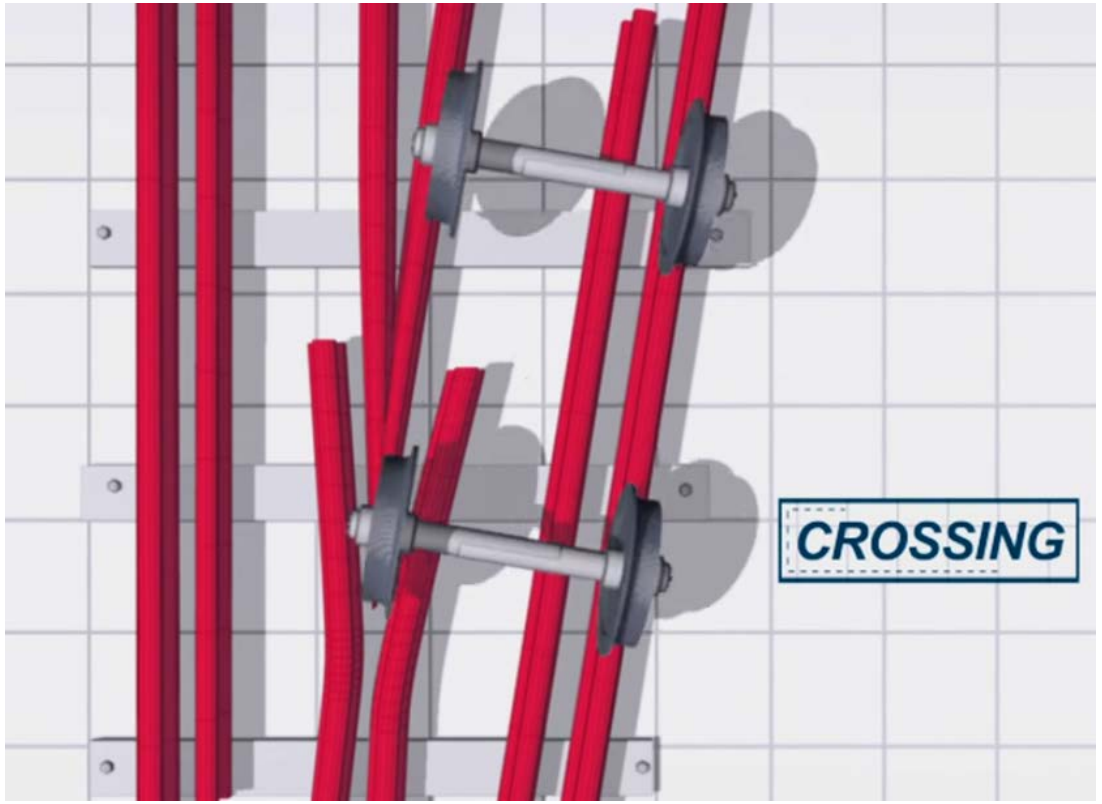
introduction



Motivation of this work



More detailed description



Source: Network Rail

Importance of switches and crossings

- They are a critical part of the railway infrastructure
- S&Cs are very complex and as result, very difficult to maintain
- In Denmark and other countries, roughly 1/3 of maintenance budget for track is used for S&C (replacement of components, weldings, grinding, tamping…).

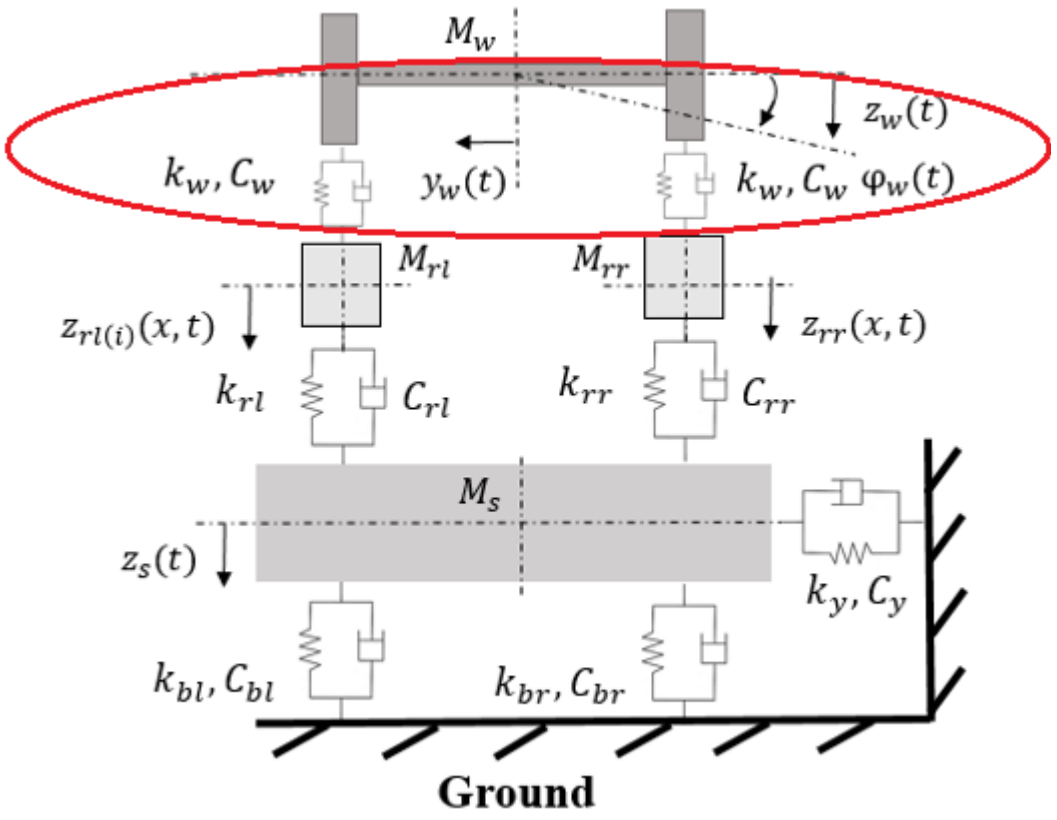
Scope of the work

- Improve the state-of-the-art

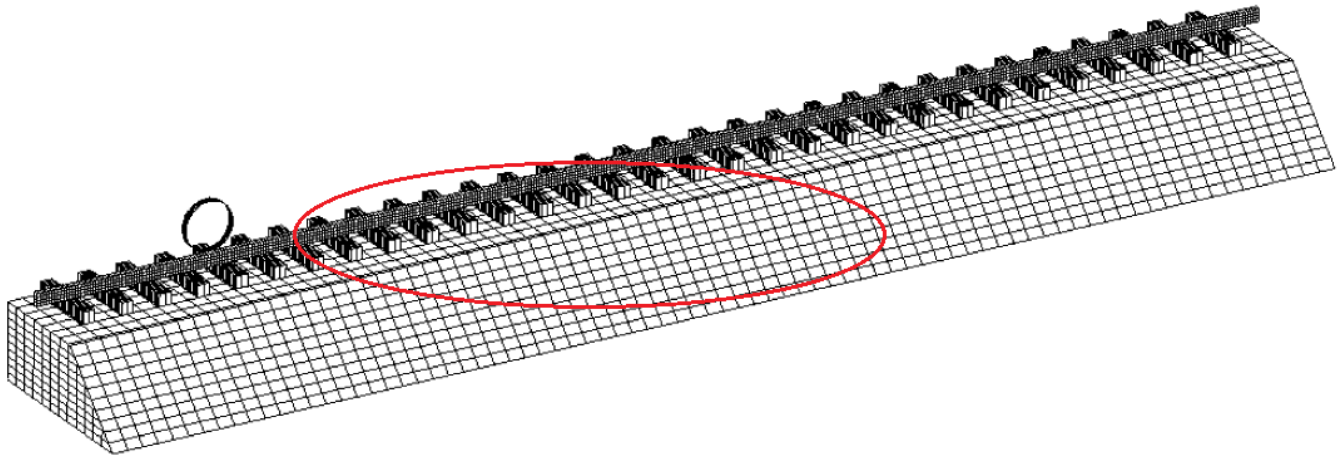
- Why?

- Current software to simulate train/track interaction at S&Cs: MBS (Multibody Simulation Software) and FEM (Finite Element Method)

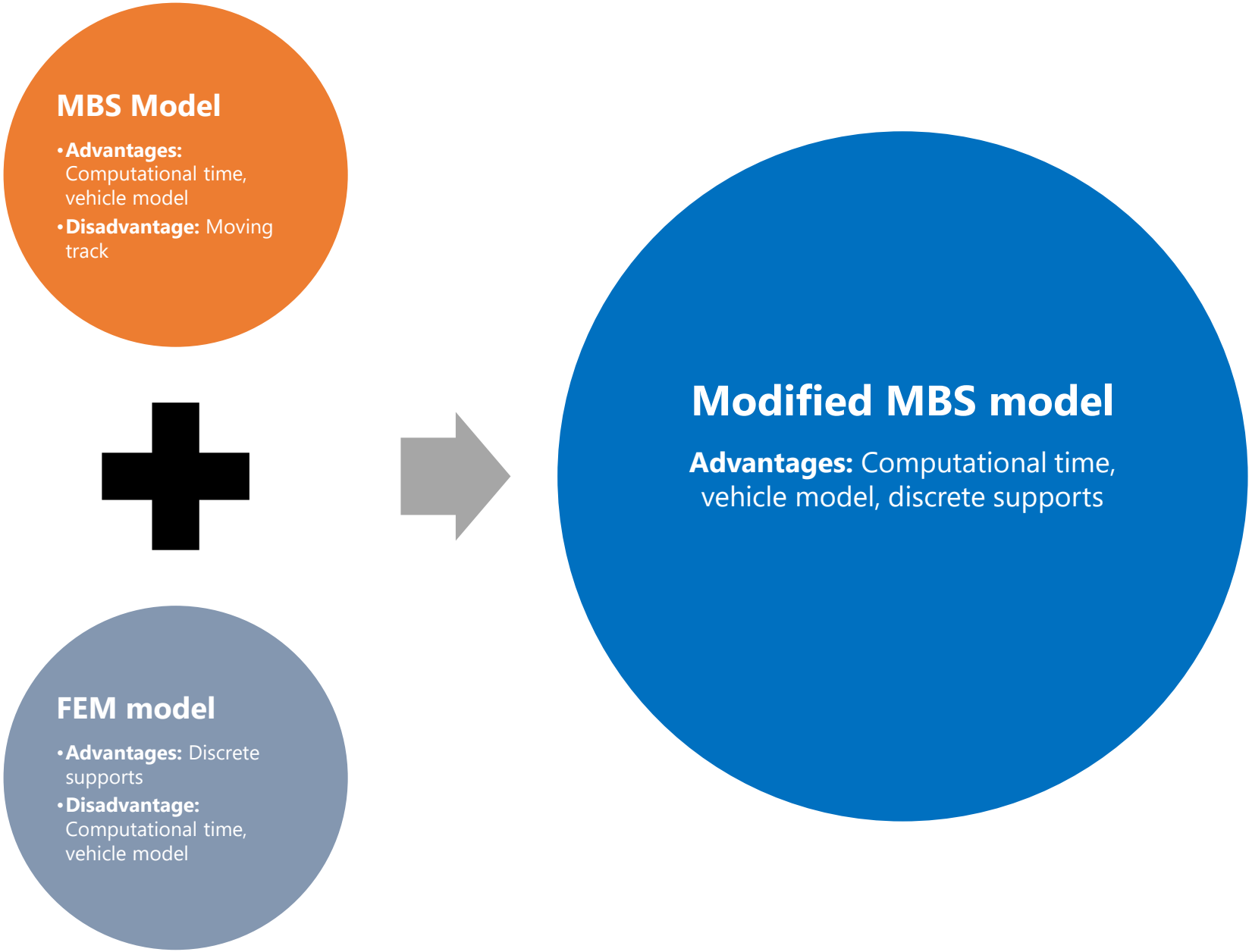
MBS-GENSYS

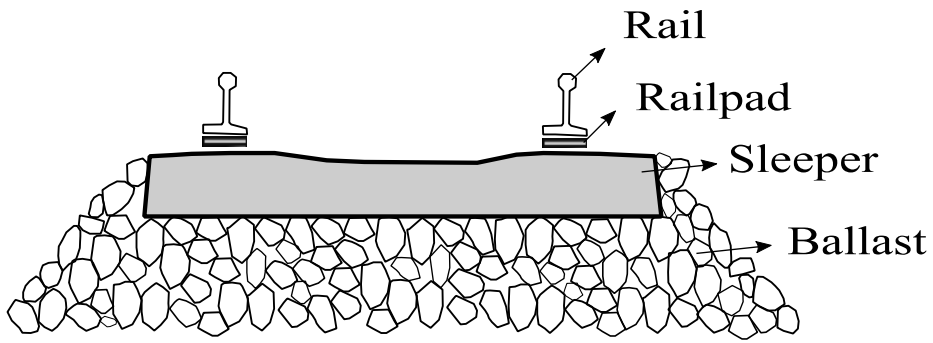


FEM-ANSYS

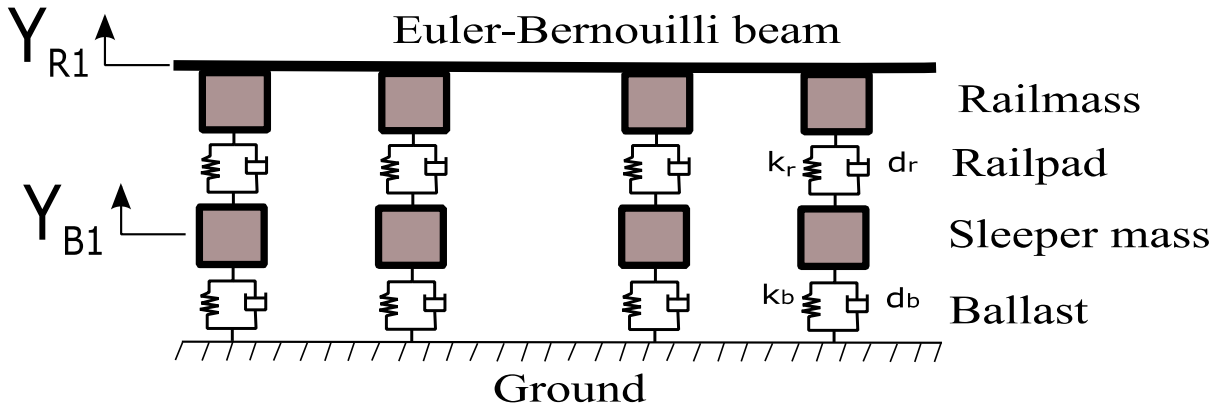


Source: Tore Dahlberg

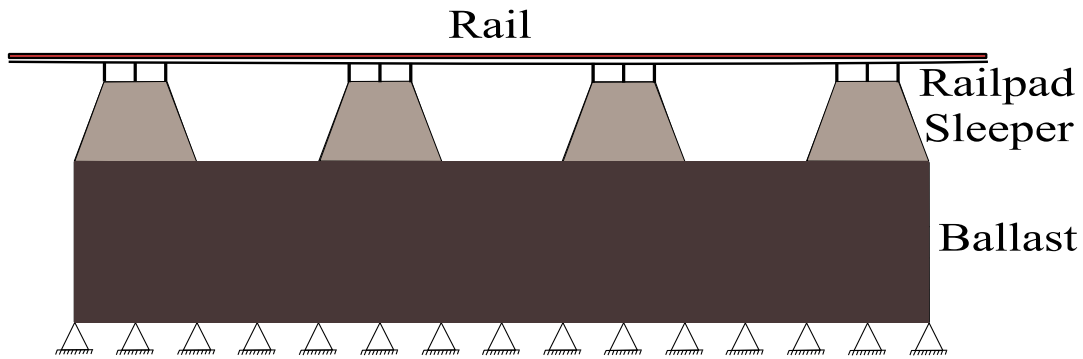

MBS Model
•Advantages: Computational time, vehicle model
•Disadvantage: Moving track
FEM model
•Advantages: Discrete supports
•Disadvantage: Computational time, vehicle model
Modified MBS model
Advantages: Computational time, vehicle model, discrete supports



(a)



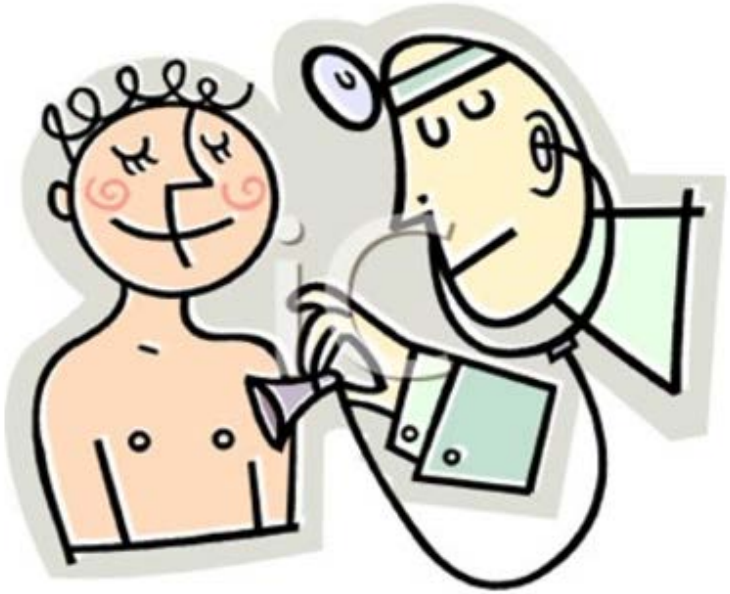
(b)



(c)

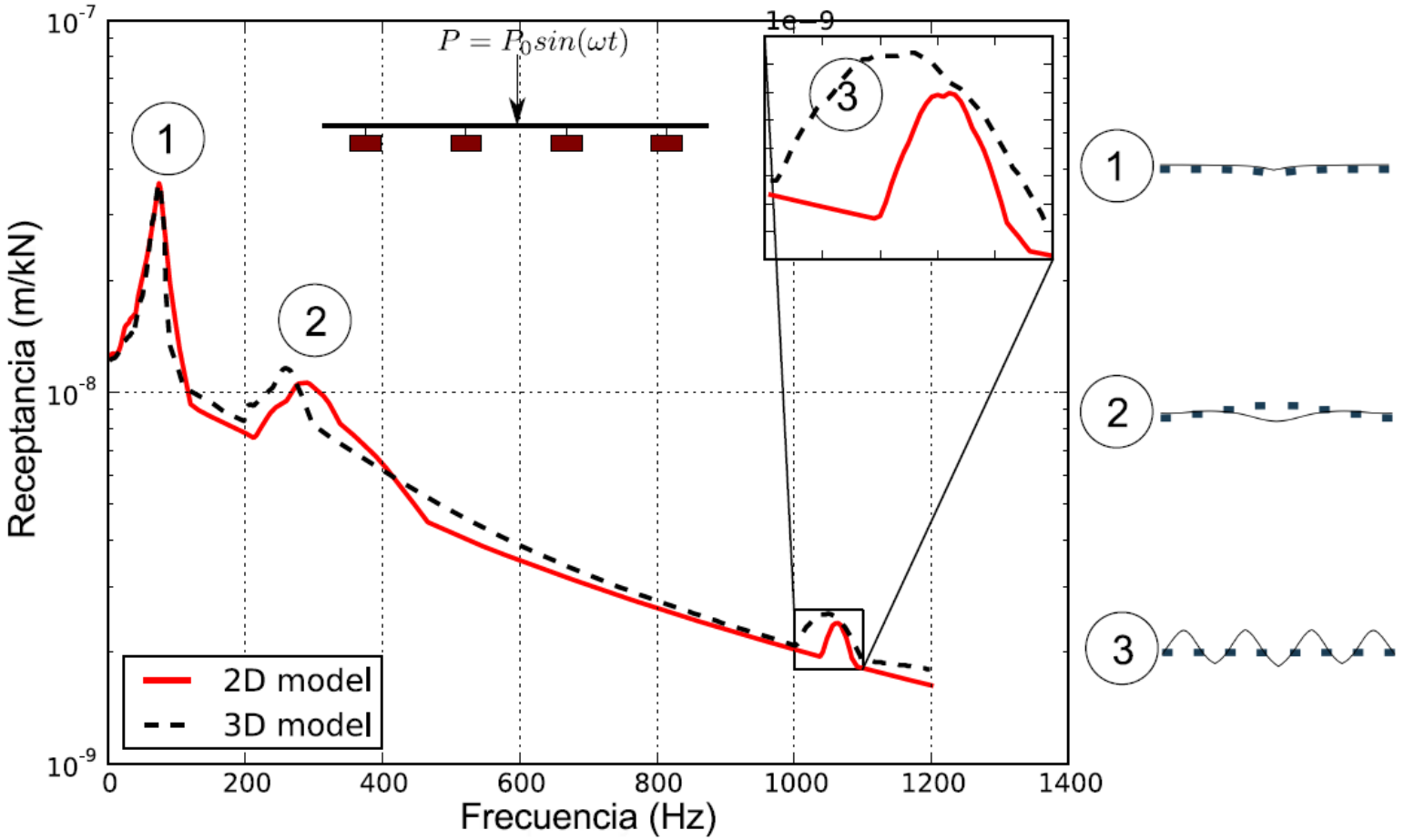
Source: adapted from Tore Dahlberg

Validation of the model: receptance test



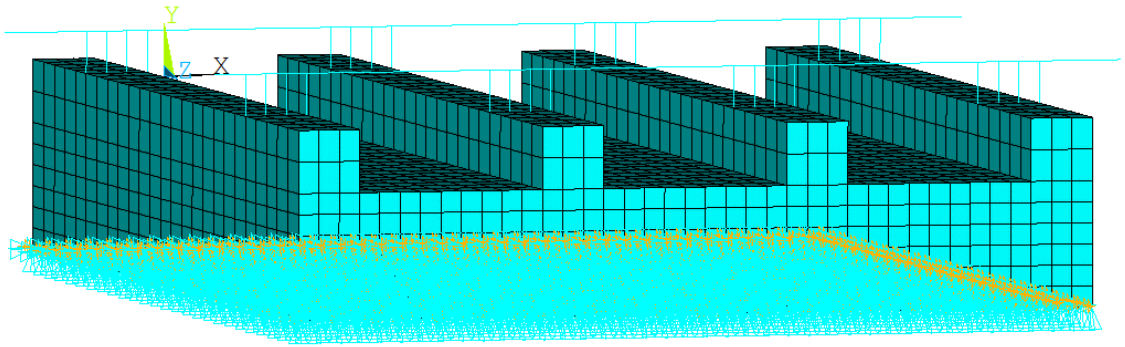
Source: http://slideplayer.com/slide/4647595/

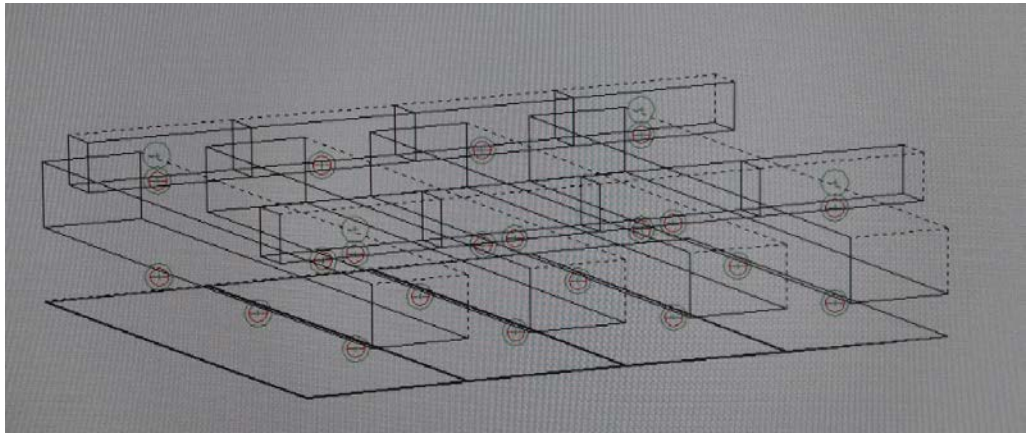
RECEPTANCE function



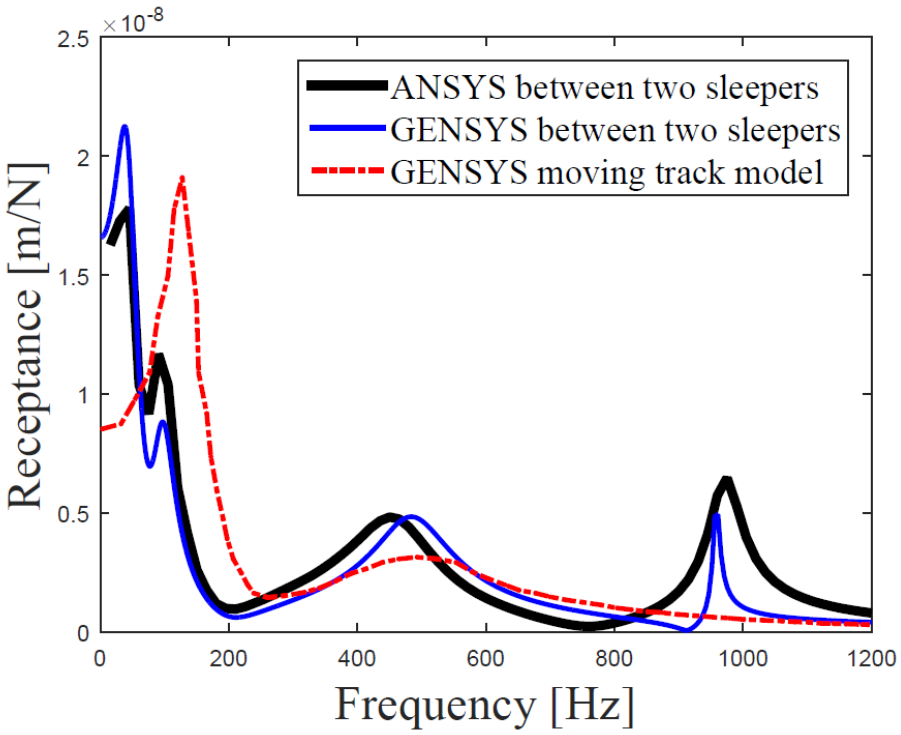
Source: Nguyen Gia Khanh doctoral thesis

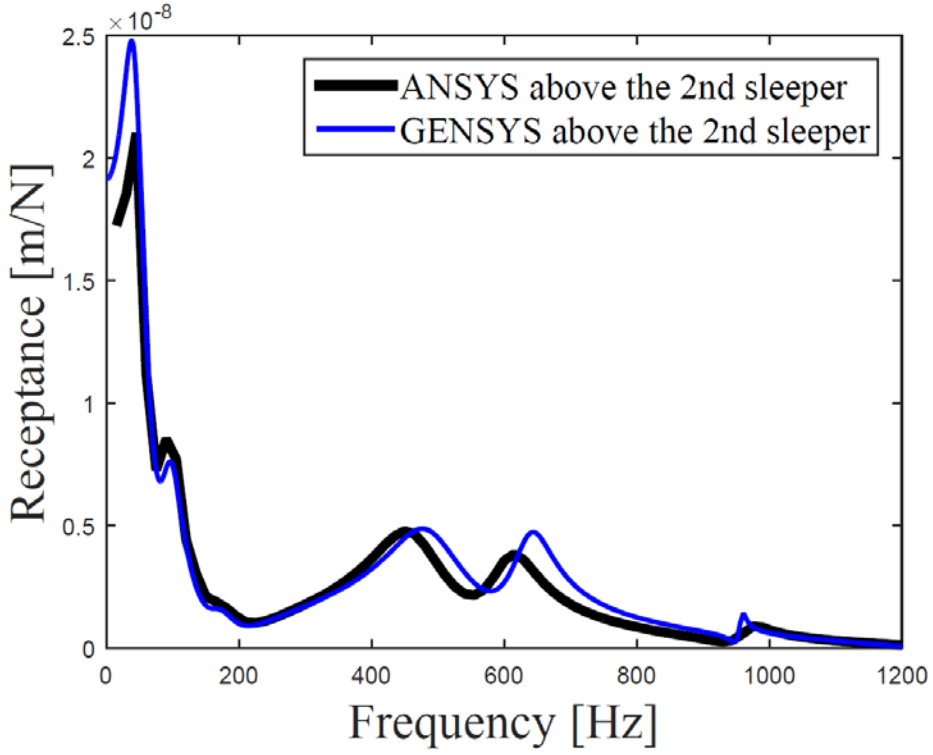
Track model validation



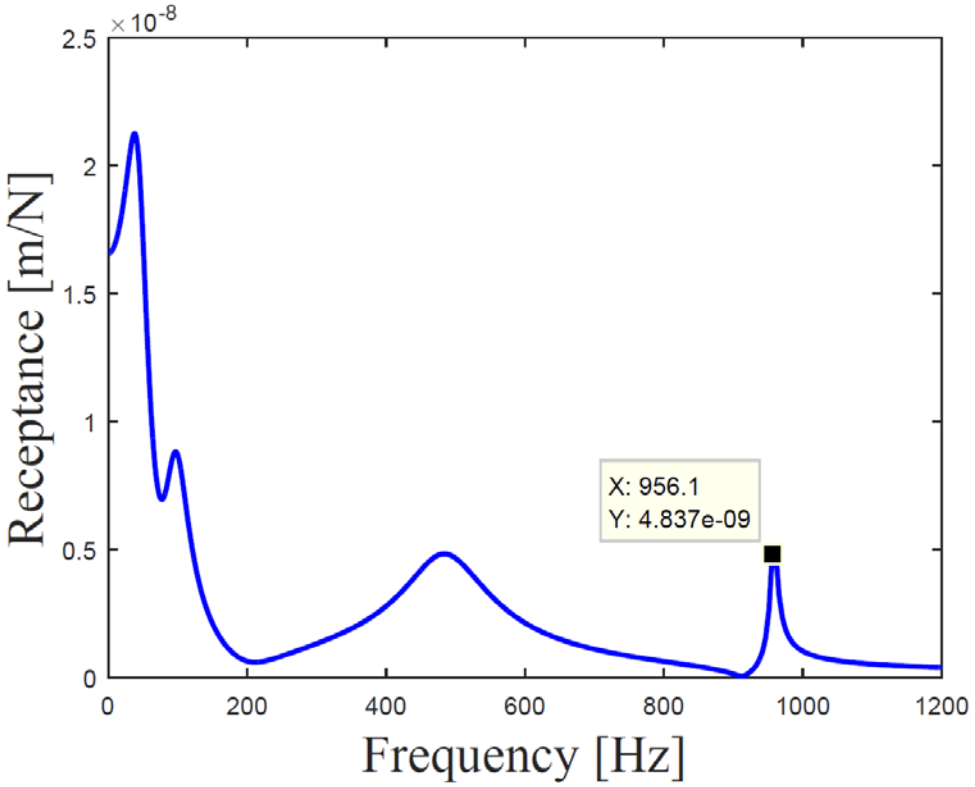


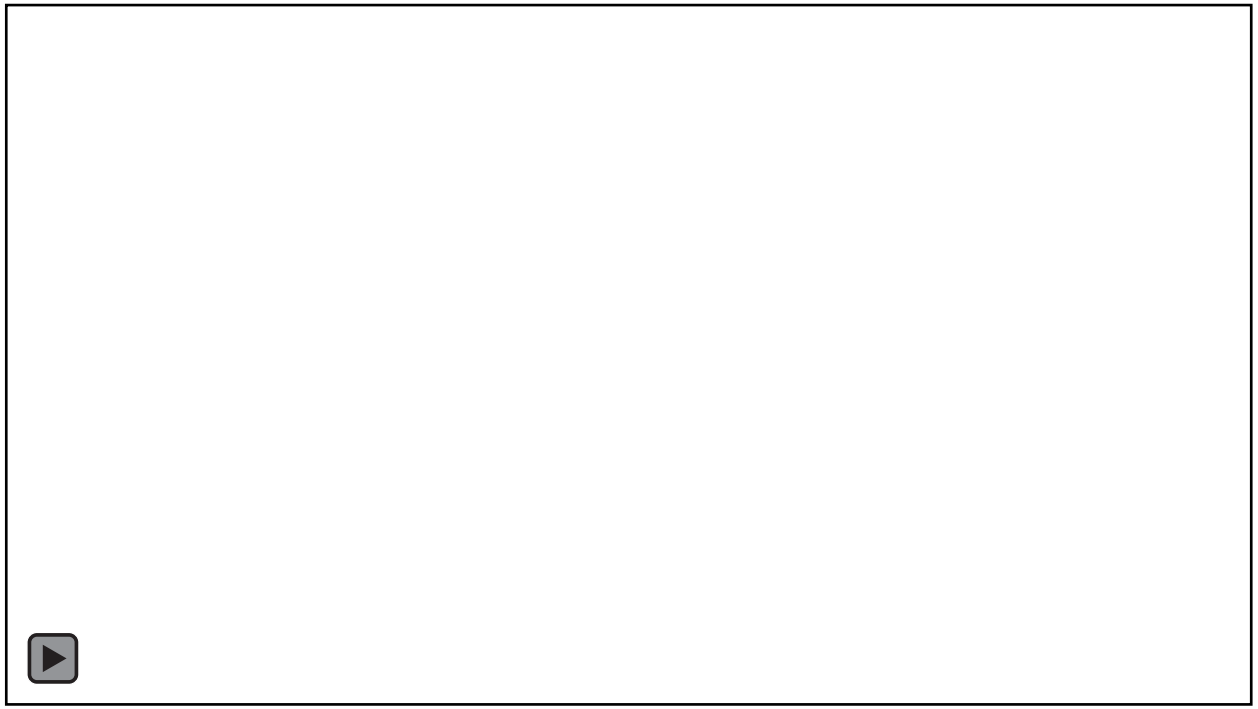
FEM and MBS comparison



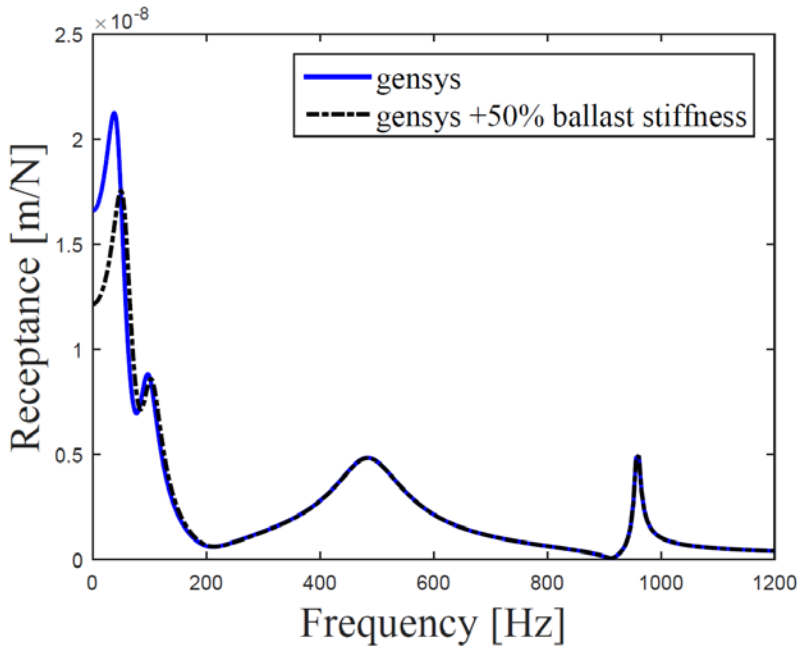


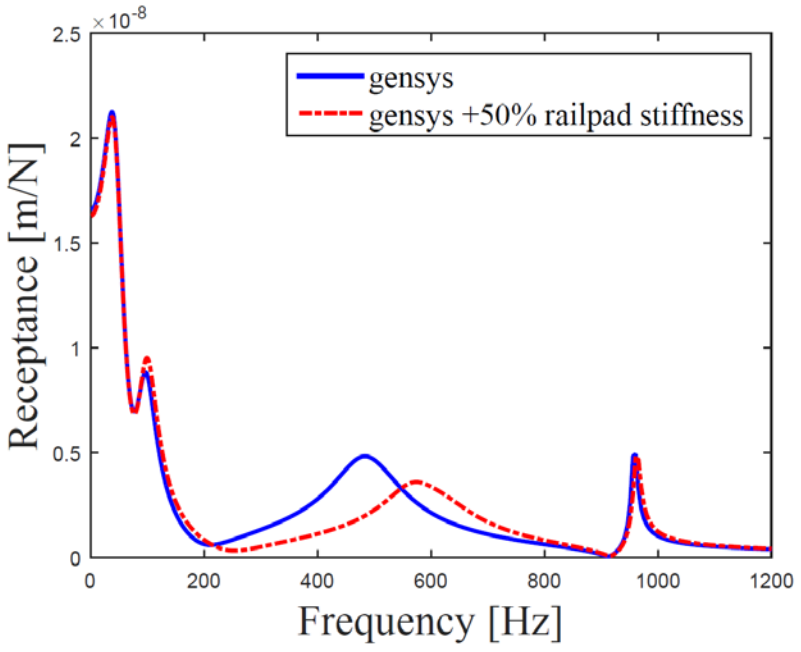
Receptance GENSYS: pinned-pinned frequency

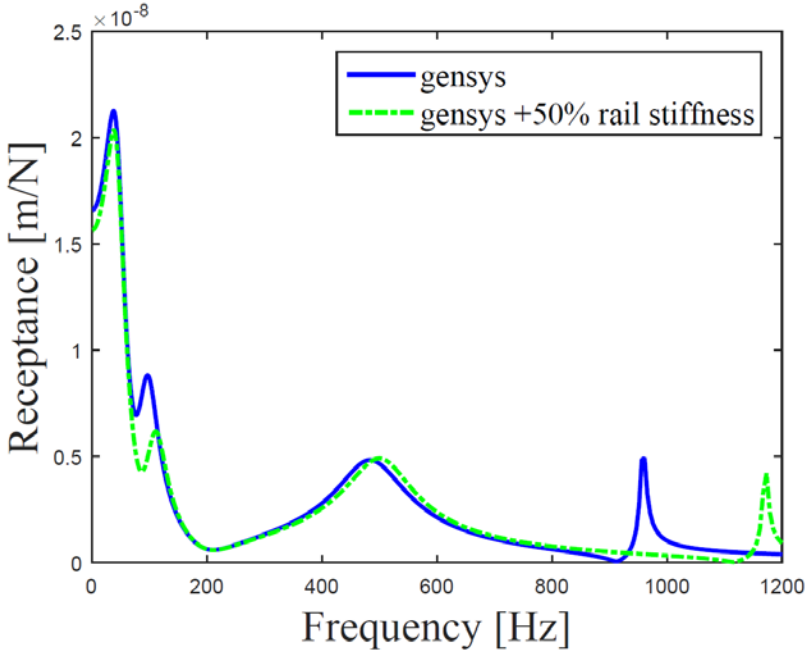




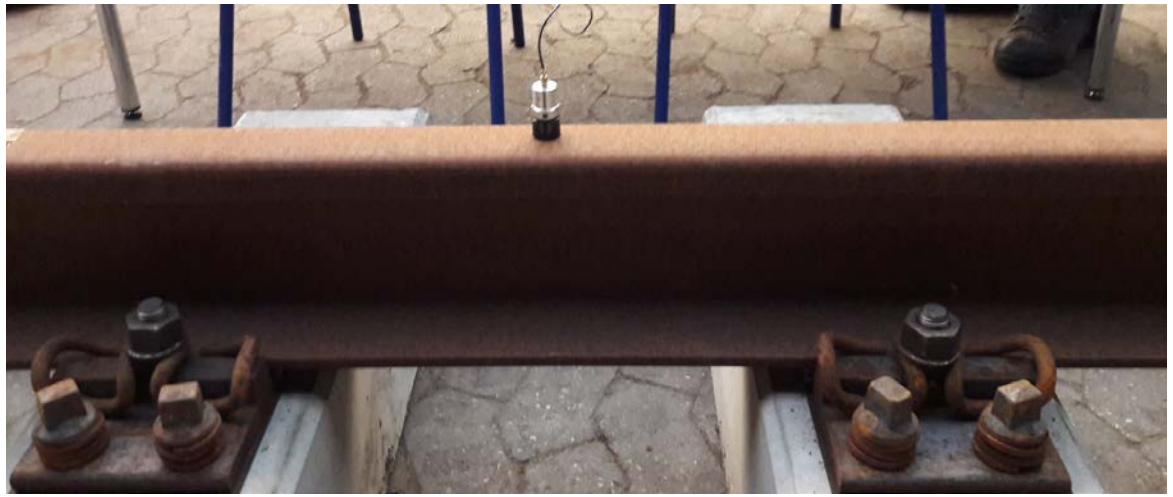
Influence of the different elements



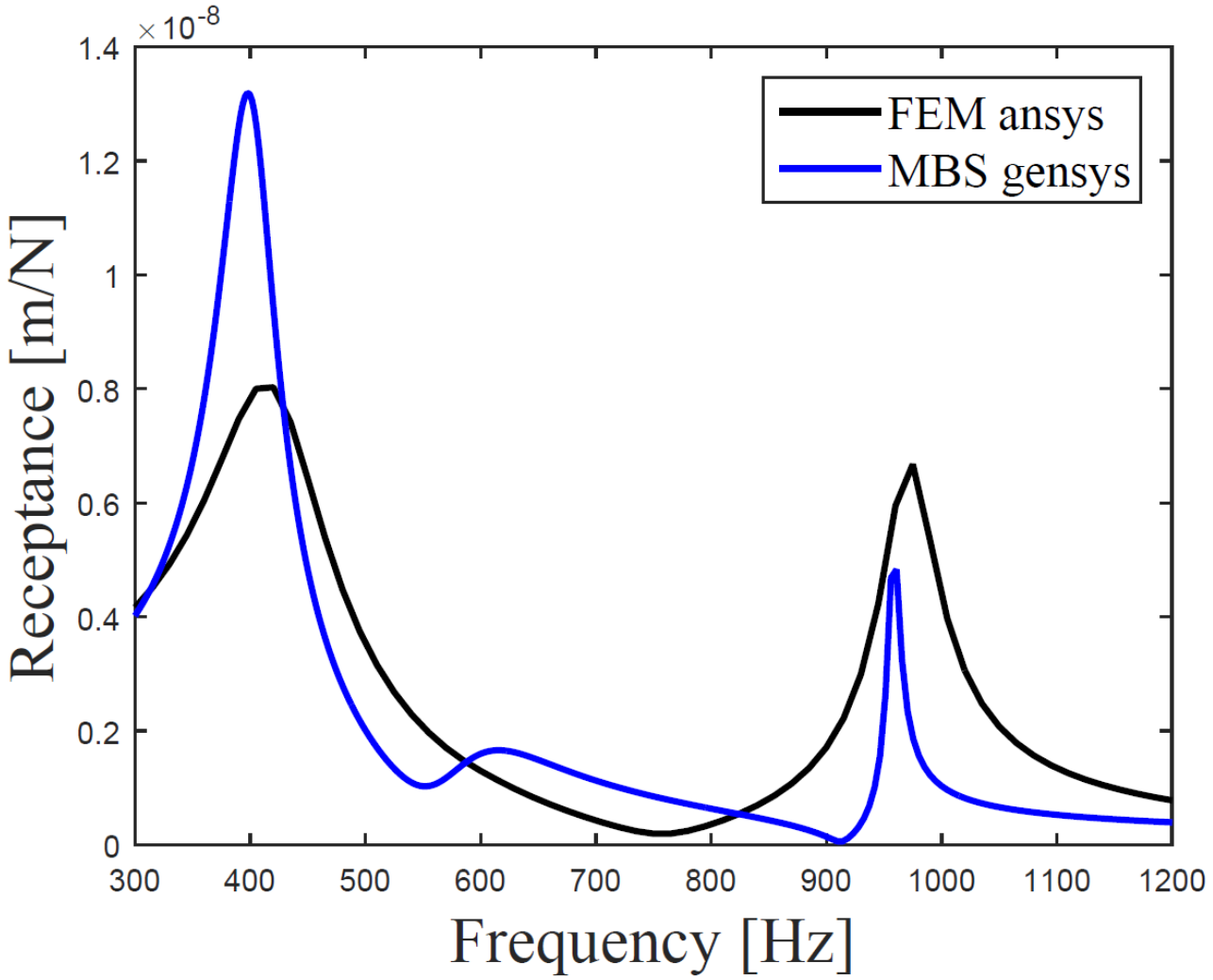




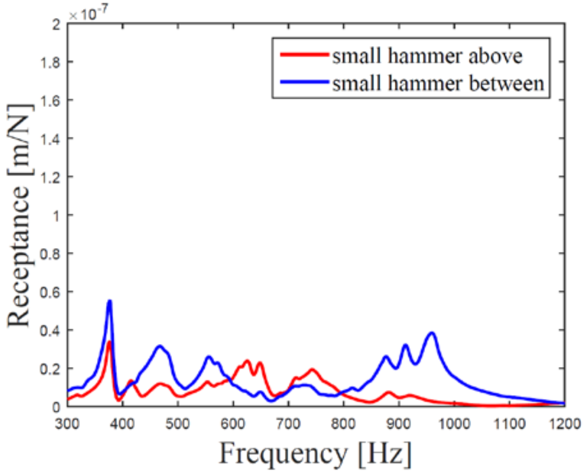
Track models validation: receptance test

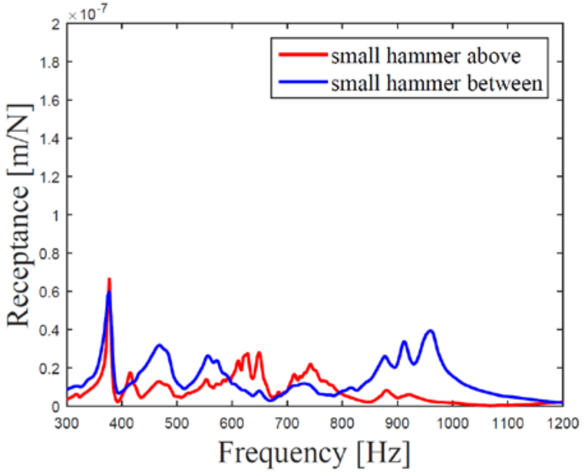


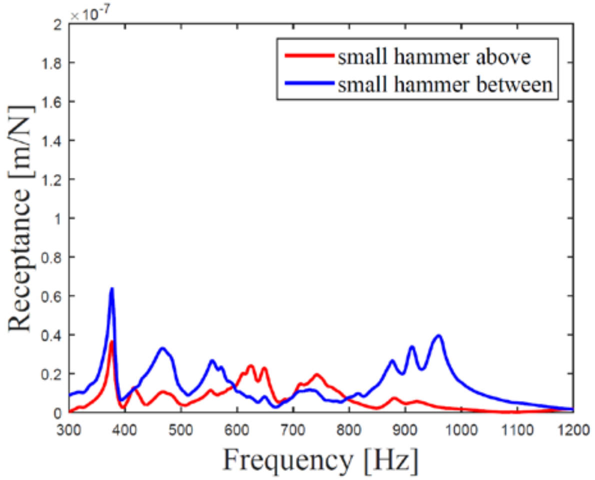
Previous step to experimental results…

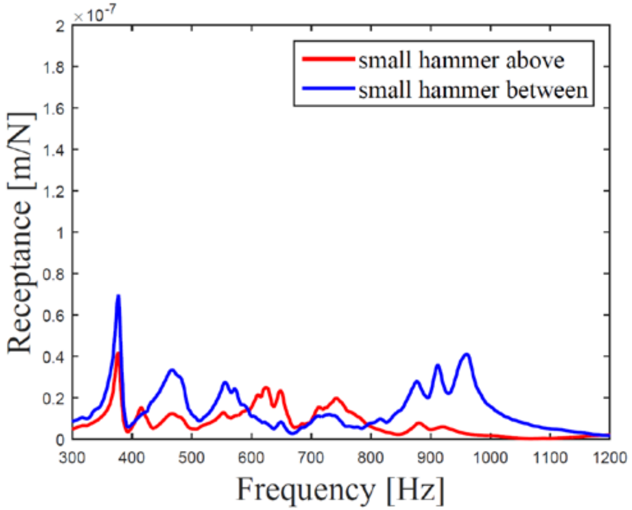


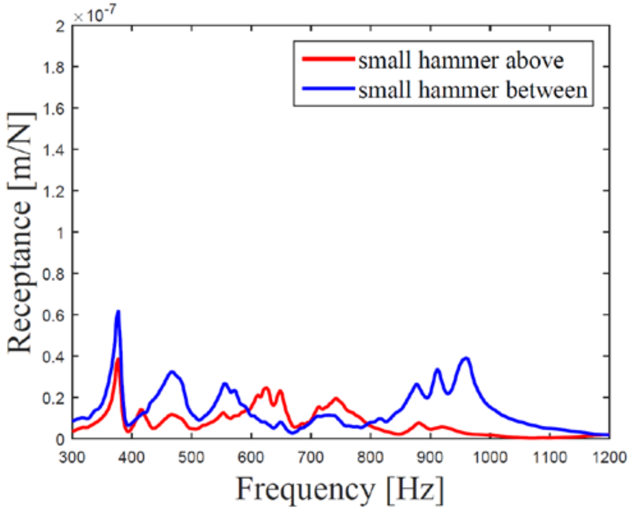
Experimental results: Receptance test







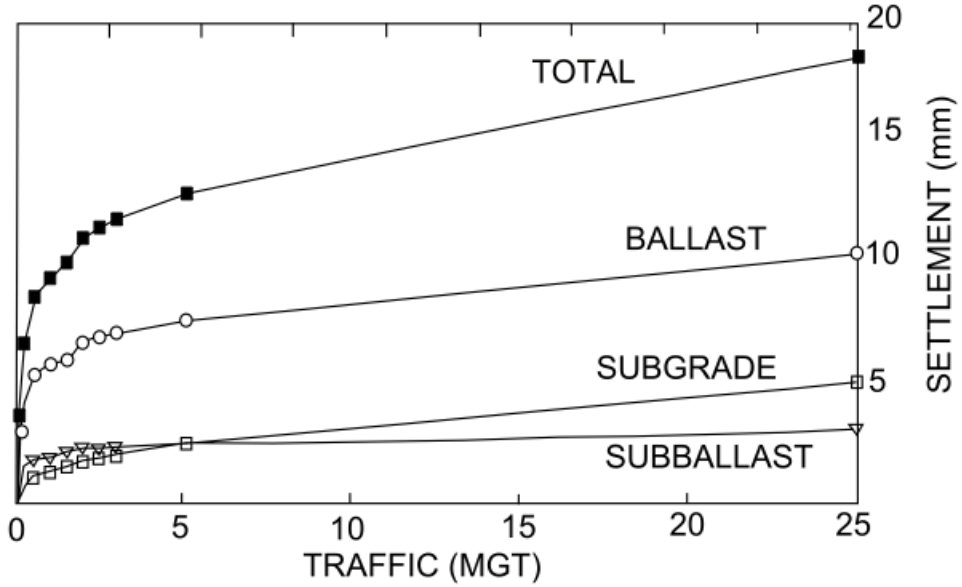


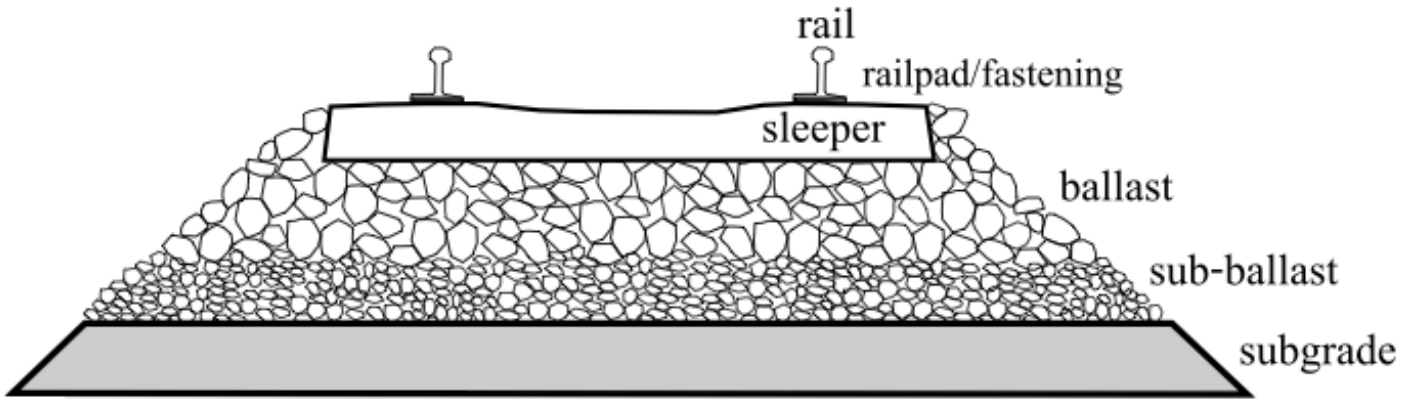


Track degradation analysis

Track settlements: EMPIRICAL LAWS

- According to Selig and Waters the contribution of the ballast layer settlement may represent up to **70%** of the overall settlement of the track



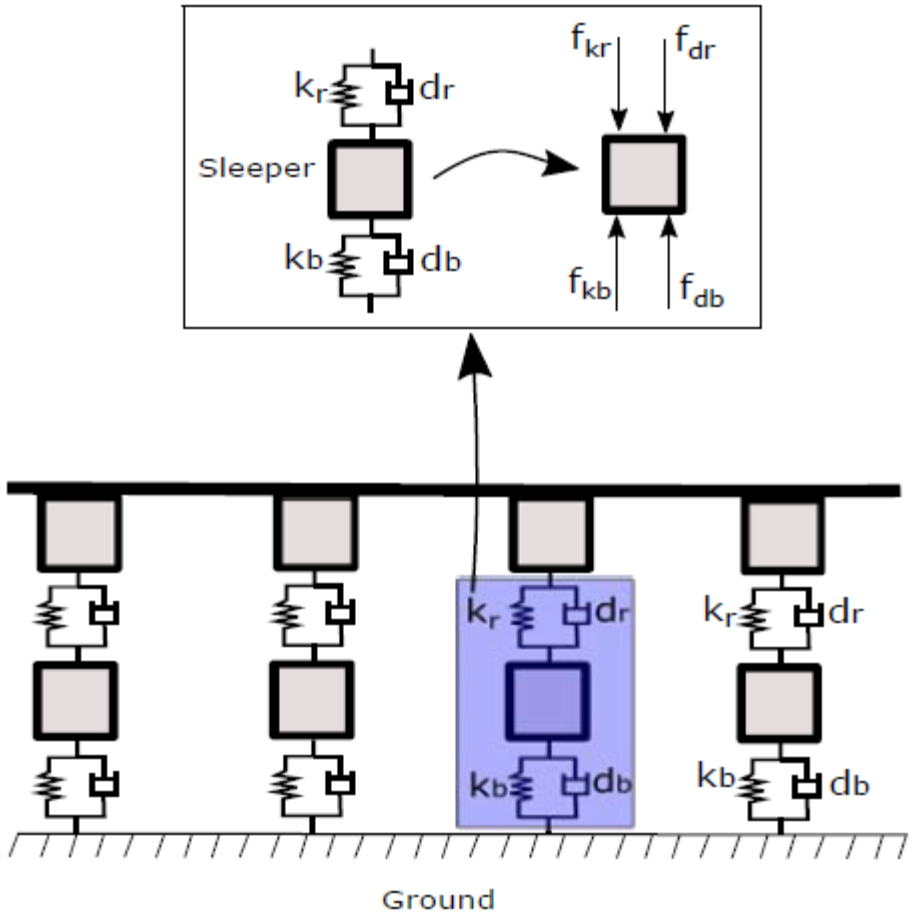


Source: Selig and Waters, Tore Dahlberg

Track settlements: EMPIRICAL LAWS

Nguyen et al. (2015) , in their numerical works, pointed out that the permamenent deformation of the track is strongly influenced by the **train load** and the **number of train passes**

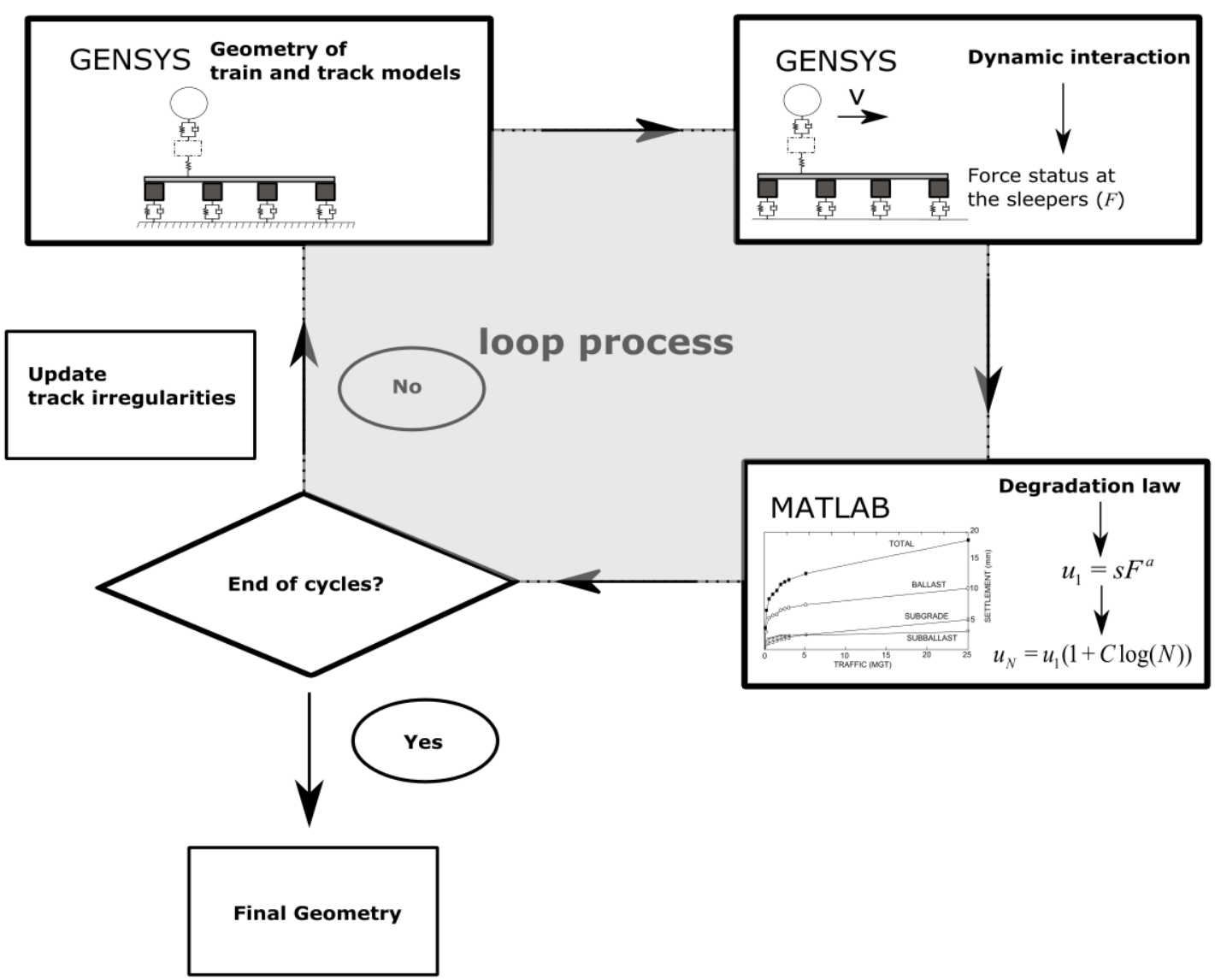
Track settlement MBS (Hunt, 1996)



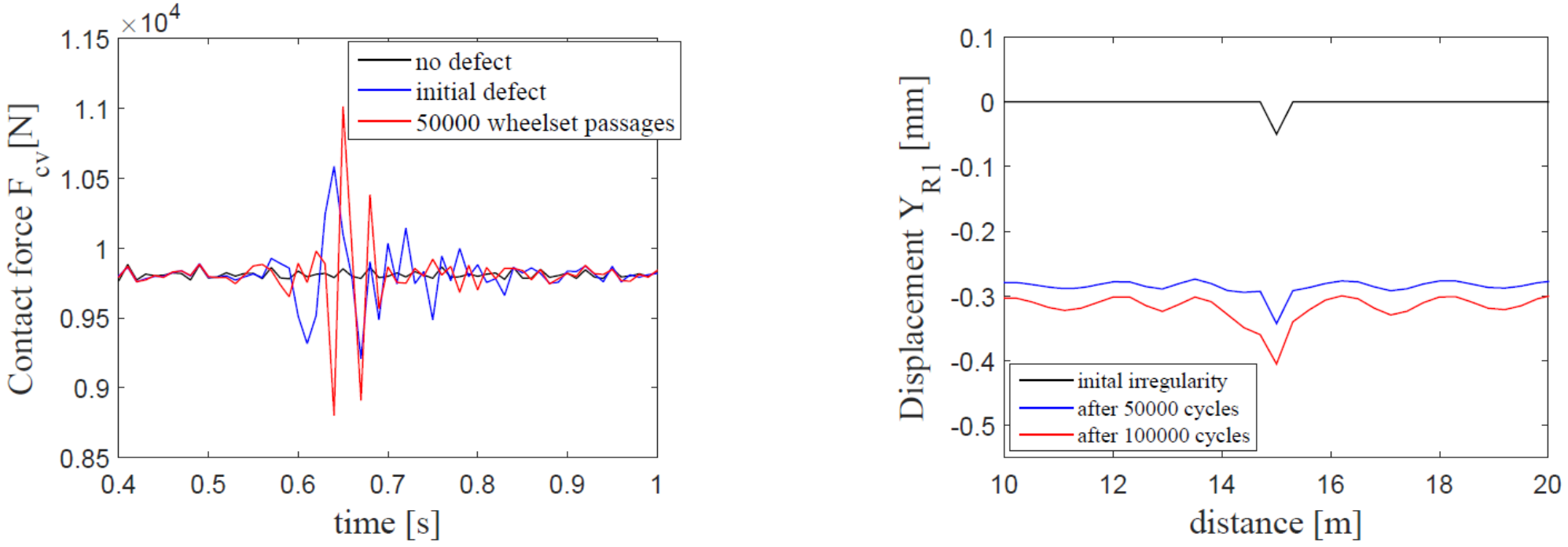
$$u_N = u_1(1 + C\log(N))$$

$$u_1 = sF^a$$

Degradation loop



Degradation analysis



(a) (b)

Figure 8– Degradation analysis results.
(a) vertical wheel/rail contact forces; (b) track irregularities.

Conclusions and future aspects

- Capabilities of the MBS model to obtain forces, accelerations… (time history of different variables) at the sleepers or other elements of the track

- Computational time makes the model suitable for optimization or probabilistic analysis (a lot of calculations are required)

- This methodology needs to be implemented into a real S&C numerical model, calibrated with experimental data

THANK YOU FOR YOUR ATTENTION!