RAIL 2. Engineering from Railway Vibration

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About us...

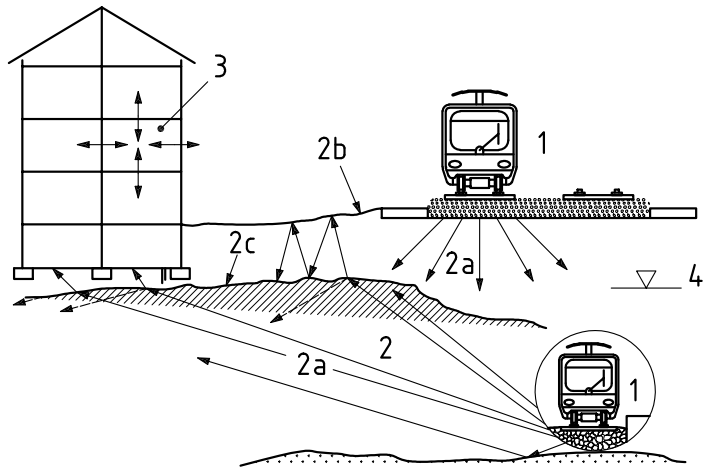
International collaboration...

- KU Leuven (Belgium)
- Federal Institute for Material Research and Testing (Germany)
- ITeCons–Universidade de Coimbra (Portugal)
- Heriot Watt University (United Kingdom)

Research projects...

- ExcelBEM – Horizon 2020
- BIA2013-43085-P
- BIA2010-14843
- PTDC/ECM/114505/2009
- PT-2006-024-19CCPM

Emission, transmission and immission mechanims



Key

1 source

2 propagation:
- 2 a body waves (compression, shear)
- 2 b surface waves (e.g. Rayleigh, Love)
- 2 c interface waves (e.g. Stoneley)

3 receiver (vibration, re-radiated noise)

4 water table

NOTE The components of the system comprising source, propagation and receiver are interdependent.

Figure 1 — Example of source, propagation and receiver system

ISO 14837-1:2005 Mechanical vibration. Ground-borne noise and vibration arising from rail systems. Part 1: General guidance.

Soil-structure interaction

Noise and vibration arising from railway

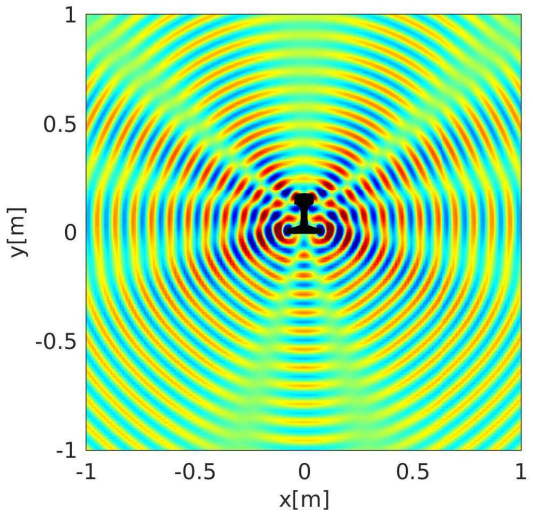
- Train-track-soil-structure interaction
- Ground-borne vibration
- Radiated noise

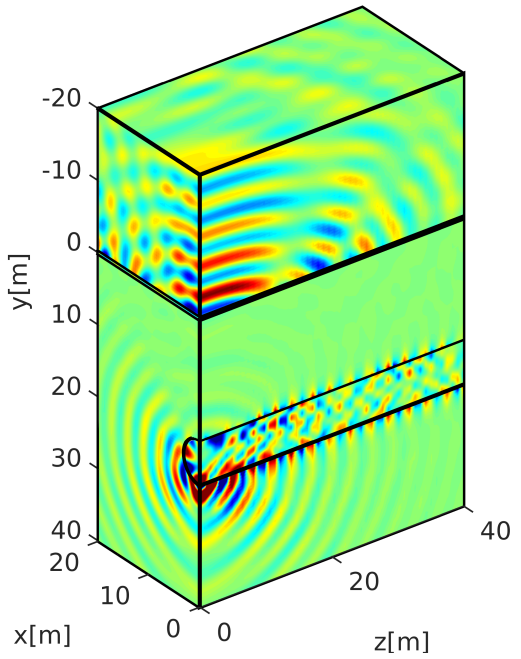
D. Connolly, P.Alves Costa, G. Kouroussis, P. Galvín, P.K. Woodward, O. Laghrouche. **Large scale international testing of railway ground vibrations across Europe**. Soil Dynamics and Earthquake Engineering, 71, 2015, 1–12.

Numerical methods

- Wave propagation in soils
- Sommerfeld radiation condition
- Semi-infinite medium
- Dynamic behaviour of structures
- Non-linear effects

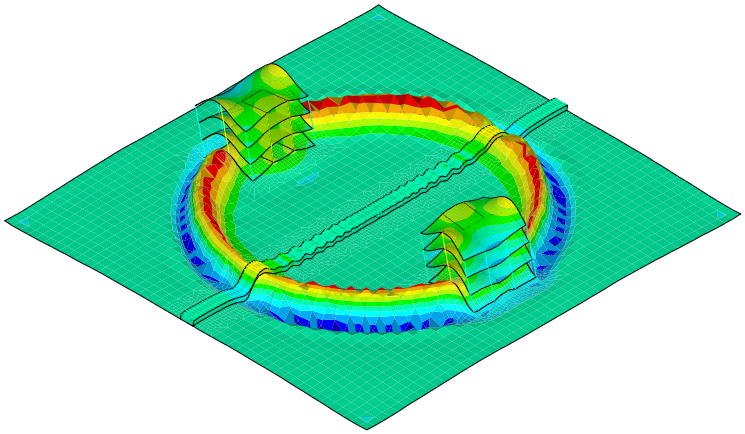
A. Romero, A. Tadeu, P. Galvín, J. António. **2.5D coupled BEM-FEM used to model fluid and solid scattering wave**. International Journal for Numerical Methods in Engineering, 101, 2015, 148–164.



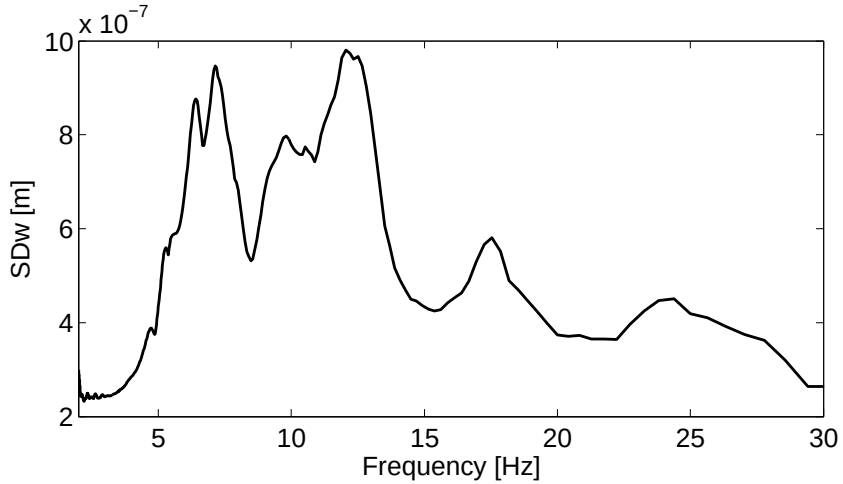


New challenges...

- Reliable model
- Uncoupled source-receiver model
- Scoping model
- Response spectrum analysis (RSA)
- Neural networks and deep learning
- Design recommendations



Case study– 12 story building
S103 train travelling at $v = 104$ km/h



	Detailed	Scoping
L_{aw} [dB, ref 10^{-6} m/s^2]	69.8	73.2
CPU time	3-10 h	$<$ 1 min

Ley 37/2003, de 17 de noviembre, del Ruido

Cloud computing

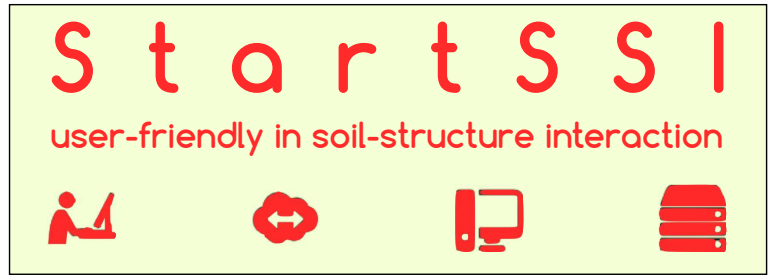
- Soil-structure interaction problems
- Know-how
- Hardware/Software
- Consultancy

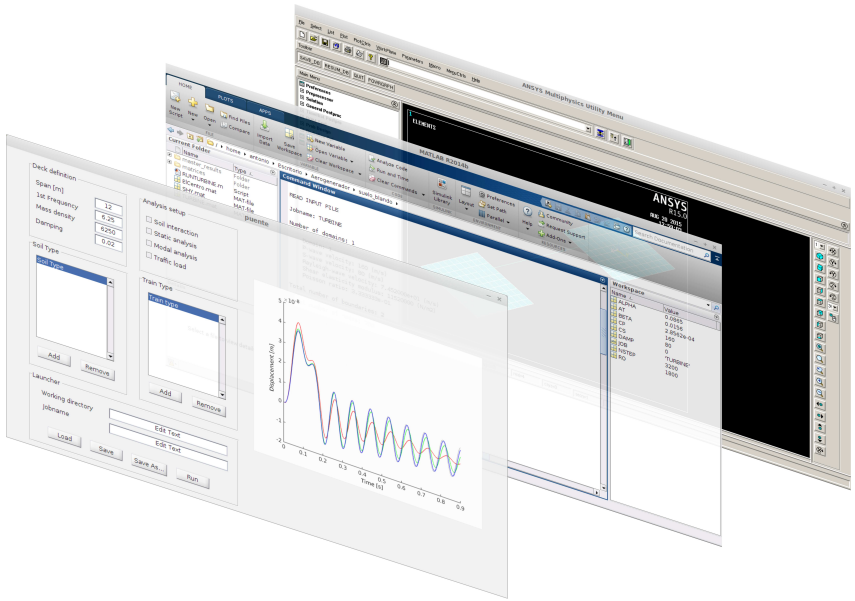
3 layers– client/server architecture

- User layer (PC, laptop, tablet, smartphone)
- Managment layer
- Computing layer (cluster)

Nash computer system

- Xeon Haswell-EP E5-2680
- 48 cores
- Memory 128 GB





Alojado en CICA

SSIFIBO v1.0
MATLAB TOOLBOX
SOIL STRUCTURE INTERACTION WITH FINITE AND BOUNDARY ELEMENTS

Features

- Complete set of subroutines for the BEM in time domain
- Gateway to import `ANSYS` structure model
- `SuperLU` library for solving linear system of equations
- Distributed computation using `MATLAB Parallel Computing toolbox`
- Generated C/C++ codes using the `MATLAB Coder`
- SSIFiBo facilitates its use in academic and engineering environments
- Package modularity makes possible simple and efficient implementation of new enhancements

Applications

- Vibrations induced by HST
- SSI on resonant railway bridges
- Induced vibration in buildings
- Wave propagation in soils
- Dynamic stiffness on pile foundations
- Seismic effect in tall structures

MATLAB ANSYS

P. Galvín, A. Romero. **A MATLAB toolbox for soil-structure interaction analysis with finite and boundary elements**, Soil Dynamics and Earthquake Engineering, 57, 2014, 10-14

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