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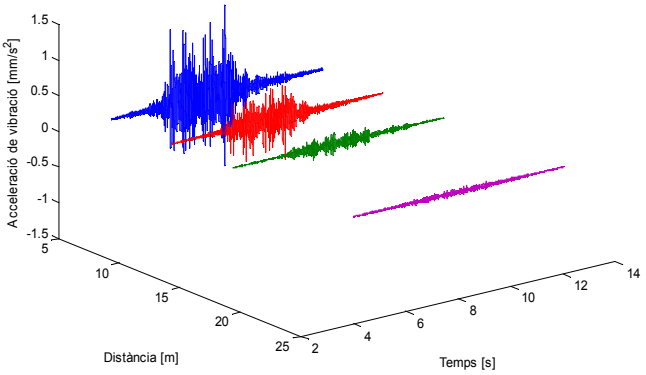
Ingeniería Vibroacústica

Transportation

Case studies

Bages Train-tram
Barcelona
2009



Scope

Ground borne vibrations are predicted using a semi-empirical model. Two experimental measurement campaigns were executed: on one hand, characterization of the vibration emission due to similar rolling stock that will be used in the project, and on the other hand, dynamic soil properties characterization.

Dynamic soil characterization were conducted using the *drop weight* technique, where the soil is excited by a heavy mass dropped from a certain height and the vibration levels are measured at different distances from the source.

The project results were the vibration levels at track sideway due to future railway infrastructure operation.

Situation and description

Due to the existence of freight train lines from Manresa to Suria and Sallent, it is considered to create a railway system with rolling stock capable to connect two cities at intercity speed and capable to be used as a tram for city lines.

This new railway infrastructure had to be executed at grade with 27 km of total length, with 4 km of urban lines (tram) and 23 km pf intercity lines (train).

Objective

Vibration impact assessment project due to future railway infrastructure operation.

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L9 Barcelona Underground

2010

Situation and description

New Barcelona Underground L9 line crosses the whole city, from Barcelona Airport to Badalona and Sta. Coloma, with a total length of 47.8 km and 52 new stations.

L9 is a unique deep line with sections at more than 60 m depth, executed with 12 m diameter EPB boring machine and with two tracks superimpose. The upper track has been laid on an intermediate concrete slab never before executed all over the world.

Objective

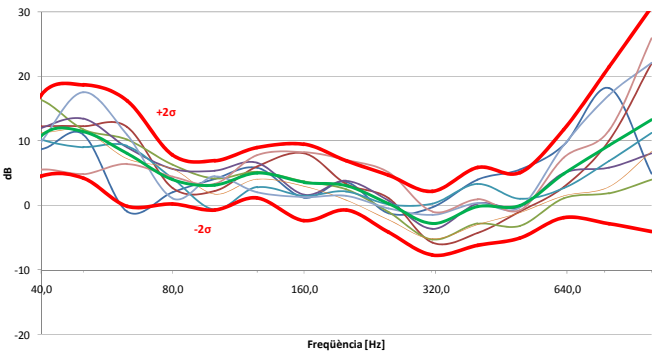
Dynamic characterization of the intermediate concrete slab during rolling stock pass-by.

Scope

Dynamic test on 8 intermediate concrete slab modules (20 m length each module), using rolling stock as vibration excitation.

24 simultaneously high sensitivity seismic accelerometers were used to carry out the test. Vibration levels were recorded at the concrete slab and tunnel walls.

Results showed that the intermediate concrete slab have an homogeneous dynamic behavior along the track length.



Acknowledgments

To ETSEIB Vibrations Laboratory and ETSEIAT Laboratory of Acoustics (LEAM) from Technical University of Catalonia.

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FGC line extension in Sabadell

2012-2013

Scope

The project was divided into two phases:
- Phase 1: vibration level into buildings were predicted using a semi-empirical model, which was validated with experimental vibration measurements.
- Phase 2: detailed FEM-BEM models were developed to study locations where phase 1 showed that vibration levels into buildings were near standards limits.

The project results were the vibration levels into buildings due to the future regular railway operation. Different elastic track solutions were studied in order to optimize track behaviour.

Acknowledgments

To ETSEIAT Laboratory of Acoustics (LEAM) from Technical University of Catalonia.

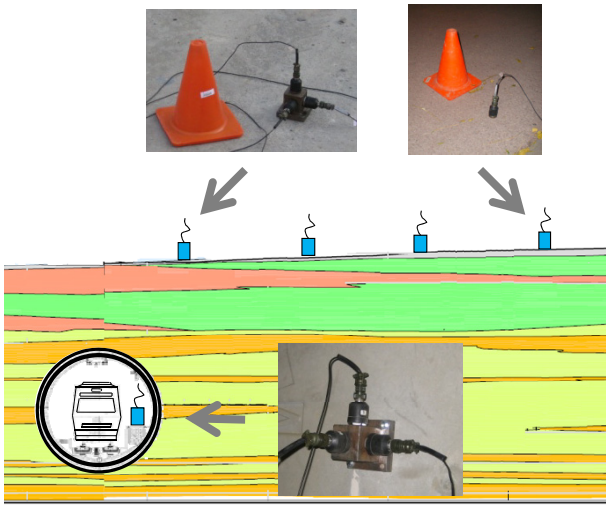
Situation and description

Catalonian Railways (FGC) line S2 which now is finishing its itinerary at Sabadell-Rambla Station is being extended from South to North bound of the city to connect different suburbs.

S2 line extension is being executed with a double-tube 6 m inner diameter EPB boring machine. The extension total length is about 5.7 km with 4 new stations as well as a new depot.

Objective

Vibration impact assessment project to predict vibration level into buildings due to future railway infrastructure operation.



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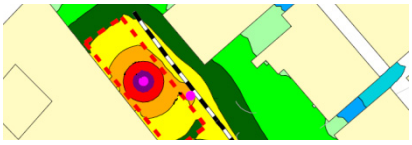
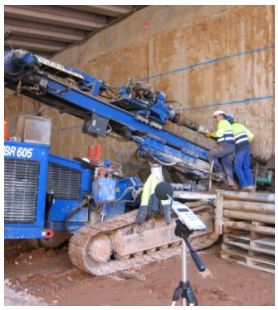


Public works' noise impact

2010



Scope

Noise impact assessment is carried out using a well-known acoustics prediction software. To model the site, the surrounding topography was carefully introduced, taken into account building heights, digging depth, etc...

In order to feed the prediction model with real data, noise emission measurements of similar machines that was planned to be used in the project, were recorded.

After the calculation of noise levels at building façades, abatement solutions in order to minimize it were design since noise levels exceeds standard limits.

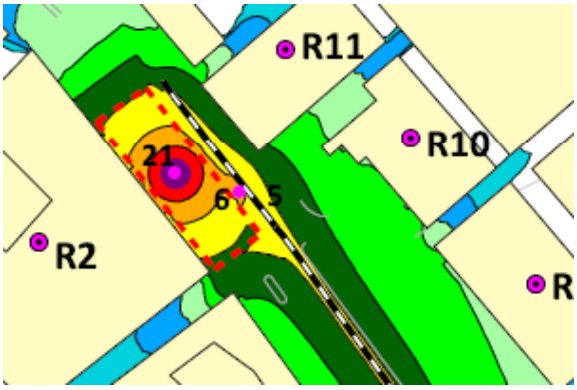
Situation and description

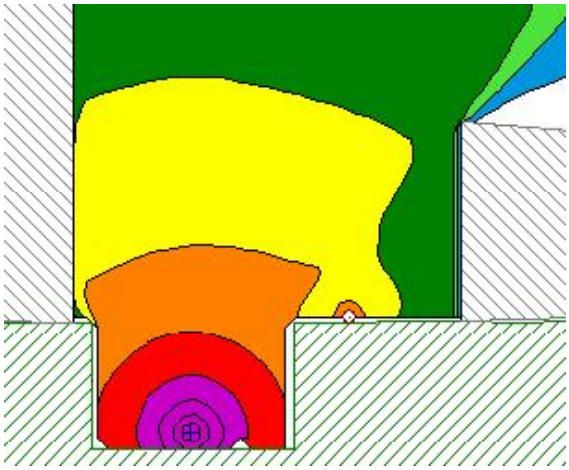
Catalonian Railways (FGC) have an investment plan to improve their stations. In this framework, it is studied to restyle one of the most important urban station in Barcelona.

The restyling considers the excavation at open air during day time as well as during night time. Therefore, noise levels caused by these works are susceptible to annoy neighbourhood.

Objective

Noise impact assessment project due to public works to be carried out in an important urban station in Barcelona.





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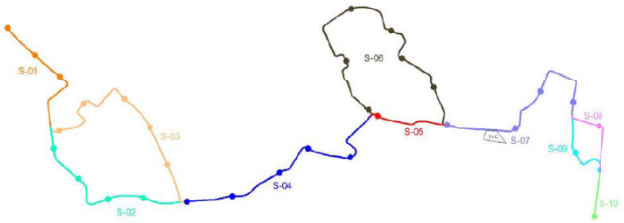
Bellaterra-Montcada Tram

2010



Situation and description

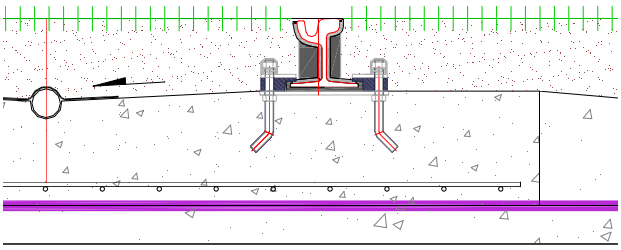
A new tram line is proposed to join Bellaterra University area with Montcada i Reixac, crossing Cerdanyola and Ripollet.

This new line is expected to be a double track railway system with embedded rails and with a total length between 12 km and 15.5 km (depending on the final layout).

The infrastructure mainly runs in urban areas which are really narrow and densely populated.

Objective

Vibration impact assessment project due to future operation of a new intercity tram line.



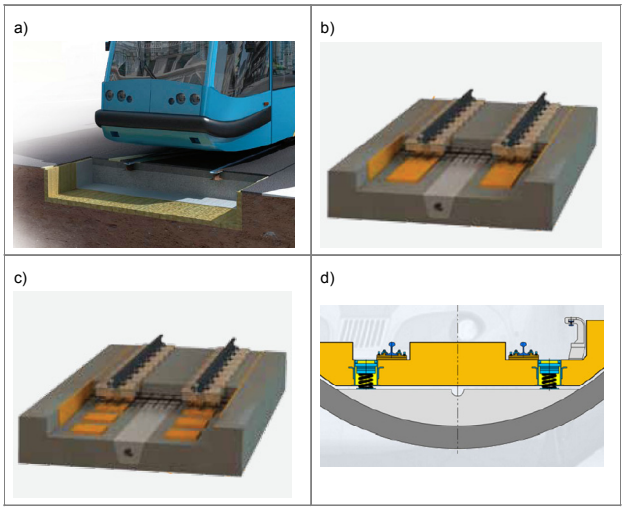
Scope

Vibration analysis was carried out using a self-developed semi-analytical model.

Input data used in the project was the vibration emission levels of the tram which is being operated in Barcelona. This is because the planned tram had similar characteristics as well as the same superstructure design.

The prediction model considers ground borne vibration propagation through soil and its transmission to nearby buildings, where vibration levels were assessed according to national standards. Therefore, geology and building structure are key data.

The project results are the foreseen vibration levels into buildings during future tram operation and the abatement solutions (if needed) to be implemented in order to meet the vibration limits according to standards.



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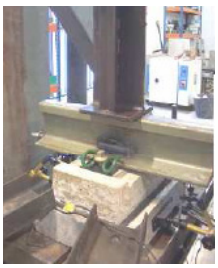
RECYTRACK

2011-2015



Description

RECYTRACK is the acronym of "*Elastomeric eco-friendly material based on end-of-life tyres blended with organic bind resin for railway applications*", a R&D European project granted by European Commission LIFE+ 2010 programme.

The total budget of the project is about 1.5 M€, it is 45.97 % granted by the European Commission and is expected to finish by March 2015 (42 months).

The project consortium is composed by the following Spanish companies:

Coordinator beneficiary:

acciona Infraestructuras

Associated beneficiaries:

adif LADICIM LABORATORIO DE LA DIVISIÓN DE CIENCIA E INGENIERÍA DE LOS MATERIALES AV ingenieros

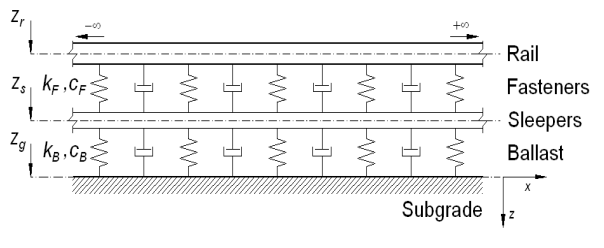
Scope

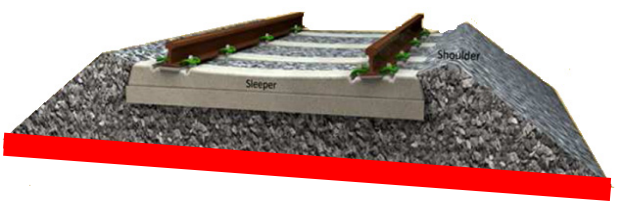
The main project tasks are briefly describe:

1. Definition of legal, technical and economic requirements of the value chain.
2. Elastomeric solutions vibratory design using an analytical superstructure/soil model.
3. Prototypes and elastomeric solutions mechanic characterization at laboratory.
4. Manufacturing of the products and implementation in real sites.
5. Vibration behaviour monitoring in real sites.

Objective

Elastomeric Under Ballast Mat and Isolated Block System based on end-of-life tires blended with organic bind resin for railway applications.





Acknowledgments

To the European Commission for granting the project through LIFE+ 2010 programme.

PROYECTO RECYTRACK
LIFE 10 ENV/ES/000514

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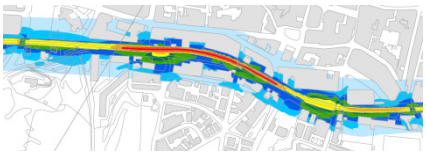
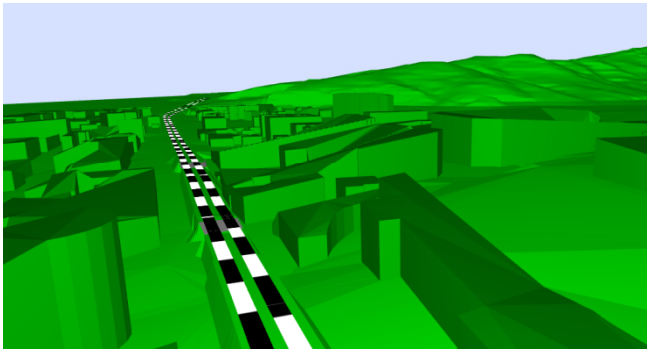


Noise Action Plans

2014-2015



Scope

First of all, an experimental noise measurement campaign is carried out in order to determine the current outdoors noise levels at specific points during railway operation. Noise levels for different types of rolling stock are measured.

A virtual noise model is developed using the predictive noise software CadnaA.

Simulation results allows to calculate outdoors noise levels, the areas where noise levels are higher than those permitted and, therefore, the noise reduction objectives to be achieved using noise abatement solutions.

Design of the noise abatement solutions (mainly noise barriers) in order to reduce noise levels under those permitted.

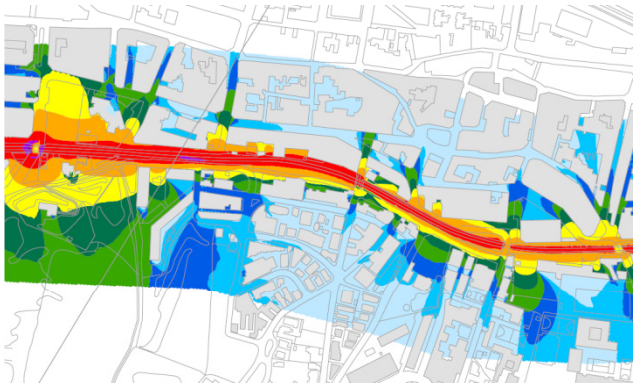
Situation and description

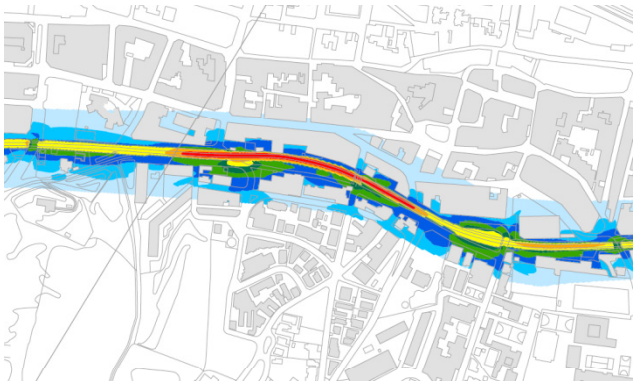
In Europe, the responsible of transportation infrastructures has to elaborate noise strategic maps in order to assess the population exposition to noise levels generated due to infrastructure's operation.

The results of the noise strategic maps are the current noise situation and the population affected to those levels. As a consequence, noise action plans has to be defined and applied to get the appropriate acoustic quality in each area.

Objective

Detailed outdoors noise levels at nearby buildings and noise abatement solutions' design to minimize the railway infrastructure noise impact.





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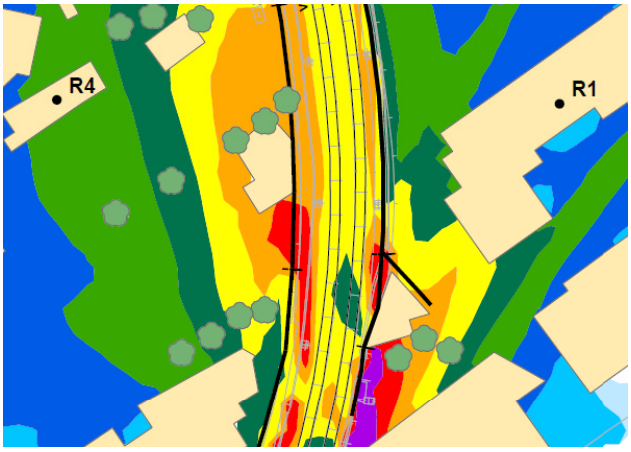
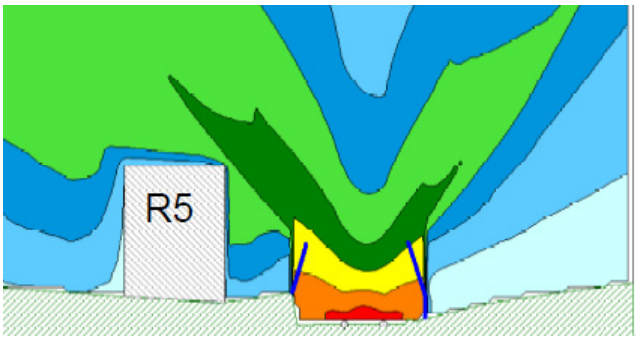
Noise Barriers Design

2014





Scope

In a first stage, as it's done in all noise abatement solutions' design projects, in situ experimental noise measurements are carried out during the operation of the railway infrastructure.

A virtual model of the railway infrastructure surroundings is developed using the predictive noise software CadnaA, properly validated with experimental noise measurements.

Simulation results allow to calculate the noise abatement solutions' efficiency in terms of dBA reduction.

Adequate noise barriers are designed and defined down to the last detail in order to construct them. After its construction, noise levels are measured to check the noise reduction efficiency.

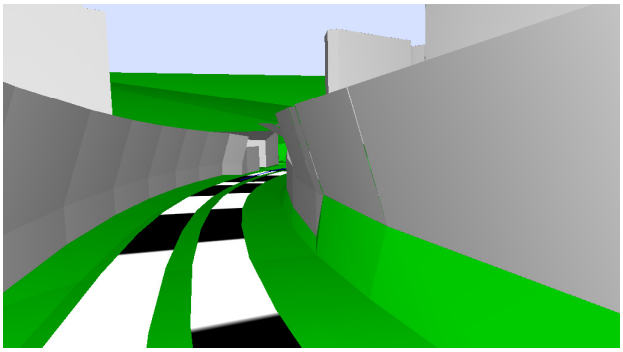
Situation and description

A railway infrastructure is running through a high-density populated area, close to residential buildings. The consequence is that annoying outdoor noise levels are induced at building façades.

As a consequence, Railway Administrator have to enhance outdoor noise conditions using noise abatement solutions that minimizes those noise levels at building façades.

Objective

Acoustic model of the area and noise abatement solutions' detailed design in order to improve outdoor noise landscape near railway infrastructure.



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Barcelona Hotel Vibration Isolation

2016

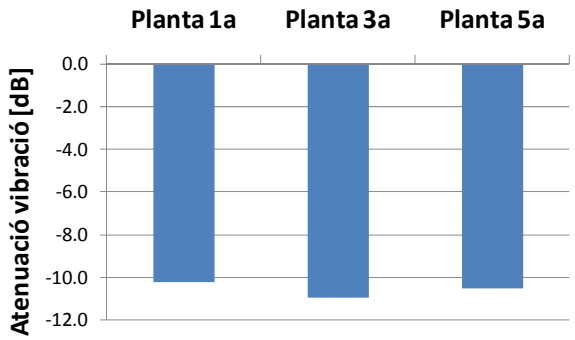
Scope

Vibration measurements into existing building before its refurbishment were carried out. Vibration levels and spectra were calculated.

From vibration spectra, dynamic properties of vibration isolators to achieve a proper vibration reduction are defined. A passive isolation system based on high flexibility steel springs is used.

These steel springs are located at top of pillars, some of them at ground floor and others at basement level. Therefore, the building is isolated above this level.

Vibration measurements after the building refurbishment were carried out to check the isolators efficiency in terms of vibration reduction. It was check that reduction objectives were reached.



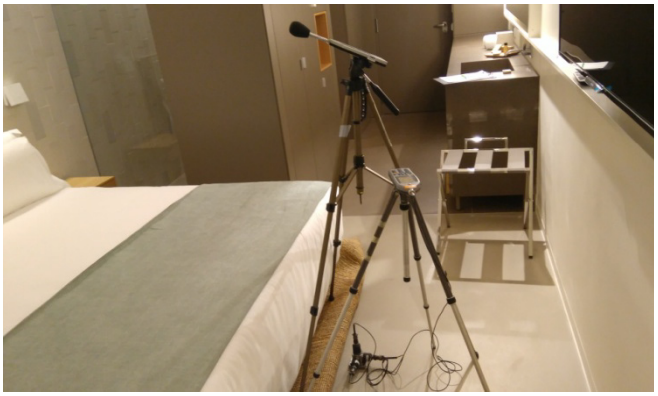
Situation and description

Ohla Eixample Hotel is a 5 star hotel located in the heart of Barcelona, where an underground railway is running near the building foundations.

Before the construction of the Hotel, vibrations due to railway were clearly perceptible; hence the hotel direction decided to isolated the building against vibrations and offer fully comfort to its guests.

Objective

Measurement of vibration levels at the existing building before the construction of the hotel and vibration isolators' design to get low vibration levels induced into the hotel to be constructed.



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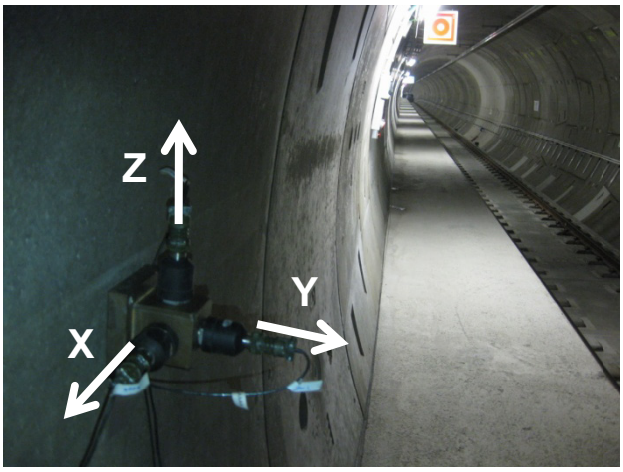
Tunnel Vibration Measurements

2010- 2016



Situation and description

Since its establishment, AV Ingenieros have been intensely working in the control and prediction of noise and vibration generated by railway infrastructures.

AV Ingenieros have large experience in the measurement, control and modelling of noise and vibrations due to railways, into tunnels as well as into buildings

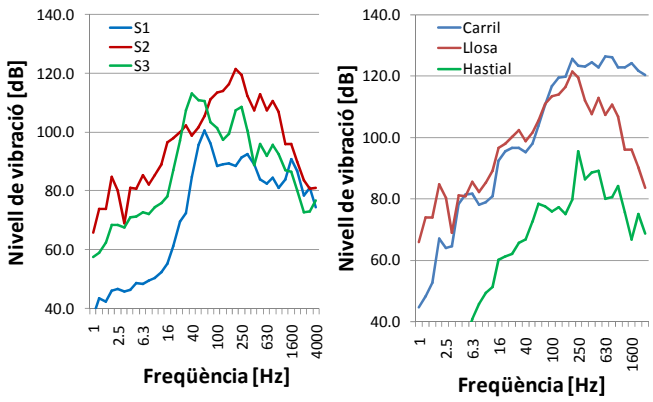
AV Ingenieros have been working for all Barcelona Underground network, also in its new double-deck L9.

Scope

Railway tunnels are set up with low and high sensitivity accelerometers, depending on the position of the accelerometer.

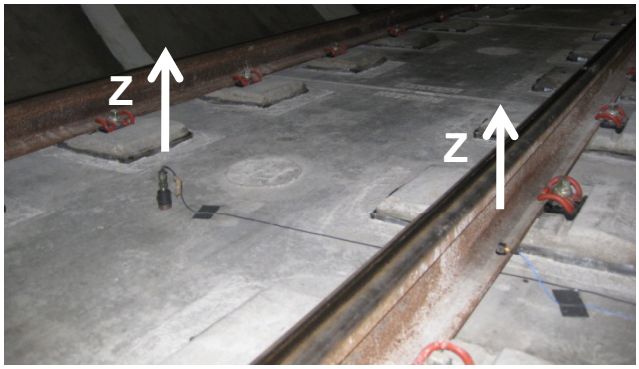
Usual positions to place accelerometers are the rail, where a low sensitivity vertical accelerometer is attached between two sleepers, the concrete slab, where a high sensitivity vertical accelerometer is considered, and the tunnel wall, where 3 orthogonally high sensitivity accelerometers are placed to measure the vibration vector.

Time-dependant signals from all sensors are simultaneously acquired and later post-processed to obtain vibration spectra.



Objective

Vibration measurements into railway tunnels to determine the efficiency against vibrations of different types of superstructures, applied vibration abatement solutions, the effect of wheel and rail roughness on vibration generation as well as getting input data for predictive vibration models.



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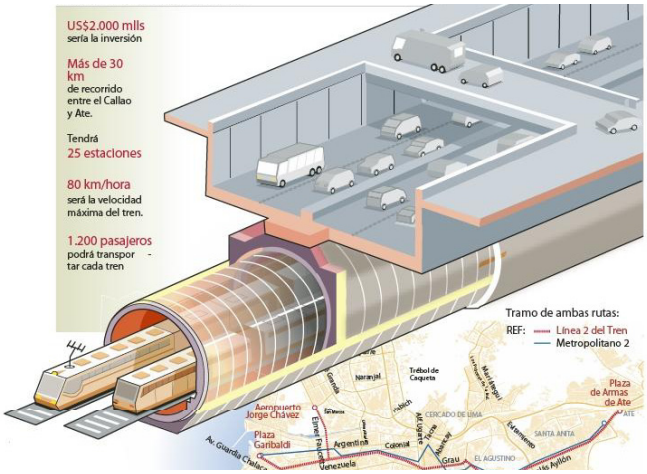
L2 Metro Lima (Peru)

2015-2016



Situation and description

The city of Lima (Peru) has one operational underground line and is constructing its second line, named L2, which will connect the suburbs Municipalidad Ate and Callao Harbour.

L2 line is being executed using conventional methods as well as a 9.26 m inner diameter EPB boring machine. The total length is about 33 km with 25 new stations as well as two new depots.

Scope

At a first stage, vibration levels into buildings considering a predefined superstructure composition were predicted using a semi-empirical model.

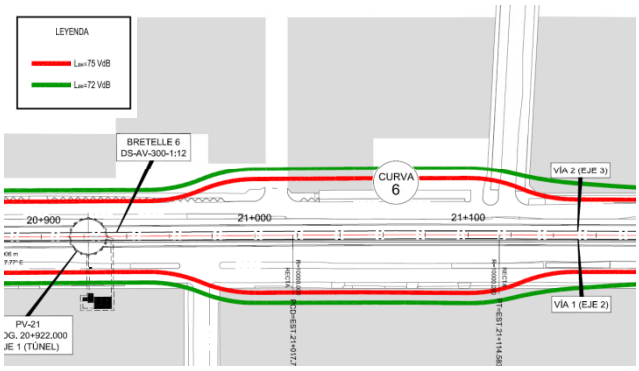
The prediction model considers the rolling stock characteristics, track composition, ground geological conditions and building dynamic behaviour.

Areas where vibrations levels were higher than those permitted were identified. Vibration excesses were quantified.

Finally, the under-slab mat to be installed in order to decrease the vibration levels were defined down to the last detail.

Objective

Vibration impact assessment project to predict vibration level into buildings due to future railway operation and under-slab mat design to reduce vibrations where needed.



Inversión aprox.	Duración del recorrido	Estaciones	Pasajeros (aprox.)	Tiempo de ejecución	Beneficiados
US$ **1.800 mlls**	45 minutos	25	600.000 diarios	2 años solo estudios	4.000.000 de personas

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