

CASE STUDY



Fine-tuning acoustic isolation in buildings

ACCIONA Infrastructure is ranked among the leading construction companies in the world, and is recognised for implementing the most advanced and innovative techniques and technology. R&D is vital to keep the company at the cutting edge, and in relation to technological developments ACCIONA Infrastructure created a team to analyse noise and vibration. Where traditional acoustic isolation calculation methods show important deviations, ACCIONA Infrastructure's research is improving results by refining the methodology, and ultimately improving building designs.



The company

ACCIONA
Infrastructure engineers
Gloria Valverde and
Raquel Cortinat



ACCIONA Infrastructure covers all aspects of construction from engineering to project execution and maintenance. This includes the management of public works awards, especially in the area of transport (roads, motorways) and building construction, among which the most significant projects have been hospital services and education centres.

The company works along two main lines of business – civil works and construction. Additionally, its organisational structure has special support units for the construction side, among which the most important units are the metal structures workshops, the machinery service, infrastructure maintenance, the facilities unit and the engineering unit, as well as various specialised auxiliary companies.

ACCIONA Infrastructure is part of the ACCIONA group, which is one of Spain's principal business groups and a leader in the fields of infrastructure development and management, renewable energy, water and services.

Research

With more than 15 years of experience, the company is now a leader in R&D and innovation and uniquely among construction companies it owns a 3500 m² Technological Centre, 14 equipped laboratories and a 2500 m² workshop established in Alcobendas (Madrid).

Technological Centre

More than 150 professionals are based at ACCIONA's Technological Centre as part of a multi-disciplined, international team. Here engineers join biologists, physicists, chemists, architects, computer technicians, and more specialists besides, all working together to improve ACCIONA's technological and scientific capacities. Their ultimate goal is to satisfy customer needs and assure the competitiveness to provide international and local market growth.

The Acoustics Group

In 2006, ACCIONA Infrastructure created a small working team to address the noise and vibration analysis required in relation to developments by the Spanish Department of Technological Innovation.

This team consists of specialists in civil, mechanical and acoustic engineering, working on four main areas:

- Acoustic characterisation of new composite materials
- Structural dynamics in composite materials
- Vibroacoustic analysis of new systems for railway infrastructures
- Advanced acoustic consultancy for buildings

Advanced acoustic consultancy for buildings

An Omnipower Sound Source Type 4292 is teamed up with a Sound Level Meter Type 2250 for building acoustics investigations



In 2007, following the publication of the Spanish Technical Building Code (CTE), ACCIONA decided to carry out acoustic quality analysis on buildings. They wanted to develop their understanding of the sound isolation required, and thus improve future designs. For this they created the Acoustics Group.

To perform the assessments, ACCIONA Infrastructure acquired two types of tools – calculation and simulation (for acoustic assessment on building projects) and measurement (for on-site analysis).

In practise, the Acoustics Group collaborates with the relevant construction project manager to ensure they cover all the details of the work process at the different construction stages – the project phase, early and advanced stages, and after the work is completed. In this way, an exhaustive study of the acoustic behaviour of buildings can be performed throughout the process – from beginning to end.

New approach to acoustic isolation

Traditional acoustic isolation calculation methods show important deviations for various reasons – for example, the approaches taken to the characteristic parameters of building structures, and the influence of the joint compression on the vibration reduction index (K_{ij}), etc. These deviations usually cause an overdesign of the building structures, which ACCIONA Infrastructure is striving to avoid.

“The experience gained in successive years forced us into a more advanced approach,” says Raquel Cortinat, an engineer with ACCIONA Infrastructure’s Acoustics Group. “To reduce these deviations, as well as those arising from incorrect installation, our line of research starts by focusing on the calculation and measurement of building sound isolation.”

“The experience gained in successive years forced us into a more advanced approach”

Raquel Cortinat, Engineer

“The first step was to model new types of joints through Statistical Energy Analysis (SEA). We tried to obtain simple expressions that represent the Kij for new structural joints, which are not included in the current standards. At the same time, we have started to perform on-site measurement of Kij according to ISO 10848-1: 2006, in order to get information about the different types of joint behaviour.”

As in modal analysis, this actual test information is used to check and refine modal models.

Measurement equipment implementation

The engineers use LAN-XI Data Acquisition Hardware. Here, two input modules are shown with two battery modules, which give the system hours of power for field measurements.



For on-site buildings analysis, ACCIONA decided to start with a complete set of equipment to measure acoustic parameters. This included Brüel & Kjær’s Hand-held Analyzer Type 2250,

“PULSE software and LAN-XI Data Acquisition Hardware are the most appropriate tools for us to carry out this measurement in a simple way”

Gloria Valverde, Engineer

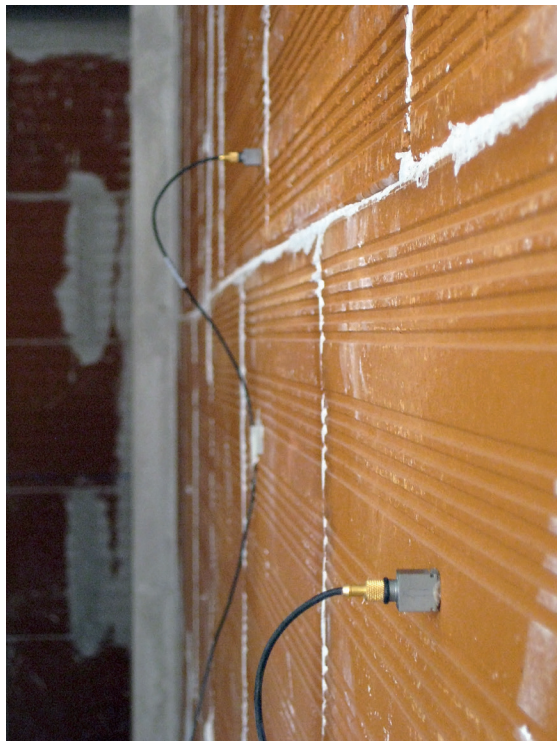
Omnipower Sound Source Type 4292 and Tapping Machine Type 3207.

“We chose this instrumentation due to two widely-known features – the equipment’s great performance and the quality of service,” explains Raquel Cortinat.

ACCIONA Infrastructure contacted Brüel & Kjær again when they needed to undergo a more complex line of research with more channels and parameters, and decided on a PULSE data acquisition and analysis system.

Gloria Valverde, another engineer with the Acoustics Group explains, “PULSE software and LAN-XI Data Acquisition Hardware are the most appropriate tools for us to carry out this measurement in a simple way. The recording audio option was very useful for us. In many on-site cases where the measurement conditions are not controllable, signals that are not perceived may be affecting the measurement. Recording all signals can help us discard what does not interest us. One of the advantages of PULSE is that data can be easily exported to ASCII format and processed by other mathematical calculation software such as PULSE Reflex.”

Brüel & Kjær accelerometers help ACCIONA Infrastructure’s engineers to develop new acoustic isolation methods that avoid over-designing buildings



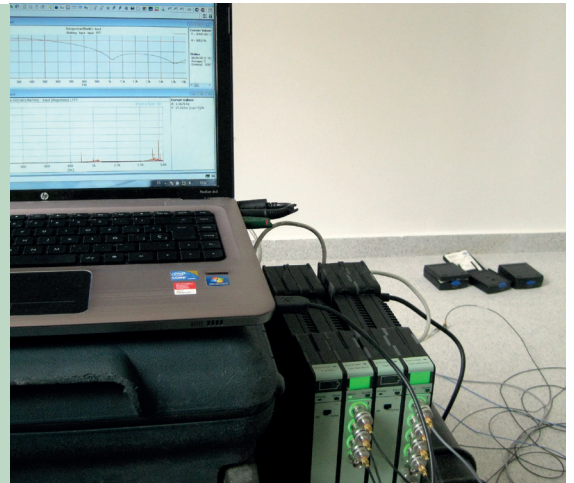
Why Brüel & Kjær?

The decision in this case was made for two main reasons. "Firstly, the instrumentation performance fulfilled our needs perfectly," explains Raquel Cortinat. "And secondly, the use of any current multi-channel analyzer requires a considerable learning period. So the fact that a company offers personalised and timely technical assistance facilitates and reduces this period. For this reason, taking into account our previous experience, the decision was to continue working with Brüel & Kjær.

Our satisfaction with the work done by Brüel & Kjær comes from the relief and confidence of working with qualified staff that solve all the problems that can arise, while using the equipment in a quick and efficient manner."

Brüel & Kjær equipment

- Sound Level Meter Type 2250
- Omnipower Sound Source Type 4292
- Tapping Machine Type 3207
- Multiple LAN-XI Data Acquisition Hardware modules
- PULSE FFT Analysis Type 7770
- PULSE Time Data Recording Type 7708
- **Post-processing** with PULSE Reflex and Matlab



Satisfied with the results, ACCIONA Infrastructure has acquired new Brüel & Kjær transducers, accelerometers and microphones to optimise its working processes.

Although the current line of research is only just starting, ACCIONA Infrastructure has more contact than ever with the Brüel Kjær support team, and the Acoustics Group has relied on Brüel & Kjær's solutions to carry out its consultancy work in construction.

Future

Looking to the future, the Acoustics Group wants to continue to increase its research fields and develop new methods, for which it will require assistance from Brüel & Kjær.

In other groups that are part of ACCIONA Infrastructure, research into new composite materials is being carried out where it will be necessary to characterise the sound absorption coefficient and acoustic impedance.

Within structural dynamics, in order to develop more complex structures and to extend the line of new railway infrastructure systems, ACCIONA Infrastructure will acquire new PULSE Reflex software packages to facilitate the technical analysis of results.

ACCIONA Infrastructure's advanced building research consultancy wants to make a complete study of buildings with SEA, and to validate these models they will acquire new structural excitation methods such as shakers and impact hammers to expand their measurement possibilities.