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Improving existing façade insulation against railway noise

J. A.E. Paris-Newton, D. Chapman, C. Luciani and R. G. Mackenzie

Building Performance Centre, 42 Colinton Road, Edinburgh, EH10 7DT Edinburgh, UK
j.paris@napier.ac.uk

The Environment Round Table of the French government ("Grenelle de l'environnement") has focused efforts on the development of alternatives to road transport. A conclusion from these studies has been that railway usage is expected to increase in the future. Departmental noise transport committees were set up in 2001 in order to make an inventory of noise sensitive receivers and to look at technical solutions that could be implemented.

A pilot project is currently being undertaken which studies the insulation offered by existing dwelling façades on approximately a thousand properties subject to railway noise. In order to quantify the sound insulation performance, measurements of façade insulation have been carried out and compared to the day and night-time performance targets detailed by the policy document "Circulaire du 25 Mai 2004". Where necessary, the façade sound insulation and ventilation performances have been improved to meet the requirement of the aforementioned regulations.

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1 Introduction

The public debate "Rhone Valley and the Environment Round Table" ("Grenelle de l'environnement") has focused on the development of alternatives to French road transport, including rail. Throughout France, and in particular in the Rhônes-Alpes Region, the use of freight trains for goods transportation is likely to increase over the next few years. It is almost certain that this will impact the soundscape of areas located in the vicinity of affected railway lines.

In 2001 Departmental monitoring of noise generated by land transport infrastructure began. This work includes the identification of noise sensitive receivers, and deciding upon noise protection measures proposed by infrastructure managers.

A contract signed between Réseau Ferré de France and the French government in November 2008 holds the national commitment to process 2500 Noise Sensitive Receivers (NSRs) over the period 2008-2012. Implementation of the national policy against noise pollution has thus accelerated significantly since 2009. A law passed on 3rd August 2009 implementing suggestions put forward by the Environment Round Table has provided increased resources to mitigate against noise produced by rail infrastructure [2].

The government has made available to the Agency for Environment and Energy (ADEME) a national funding allocation for the treatment of NSRs. "Circulaire du 25 Mai 2004 [1]"addressing the funding of these measures to assess and treat NSRs (railway noise) was supplemented by an agreement signed on the 1st December 2009 between ADEME and Réseau Ferré de France (RFF). This agreement provides funding for insulating the façades of noise-sensitive buildings, supported 80% by ADEME and 20% by RFF, for the period 2009-2011 [3].

This paper presents a case study that highlights the steps carried out in order to provide NSRs located within three towns in the Rhone Valley region with an upgrade to the sound insulation performance of their façades. The main challenge of the project was to effectively mitigate against railway noise for a wide range of NSR types. These included different sizes of buildings, different construction techniques and different building periods, each of which requires catered noise mitigation measures. A particular consideration has been that the work demands direct contact between our consultancy team and the residents involved, as well as with professional building companies, and so care has been required in terms of the level of technical advice provided to residents.

2 Applicable national legislation

The regulations in place in France which define NSRs call for three conditions to be fulfilled. Firstly, the type of receptors must be residential, educational, or institutional. Secondly, the building permits must be dated prior to 6th October 1978. And finally, the noise levels outside of the buildings must be in excess of at least one of the threshold values outlined in Table 1.

Table 1. Maximum railway noise levels at the building façade, in dB (A)

Acoustic parameter	Railway noise level
L_{Aeq}(6h-22h) (1)	73 (2)
L_{Aeq}(22h-6h) (1)	68 (2)
L_{den}	73
L_{night}	65

(1) Parameters defined in article 1 of the guidance document from 5th May 1995; these are considered to be at 2 m from the façade with the windows closed; they can be measured in accordance with French Standard NF S 31-088 (Railway Noise).

(2) The guidance document from 8th November 1999 concerning the limitation of railway traffic noise defined a further criterion:IF = LAeq – 3 dB(A) ; with IF(6h-22h) = 70 dB(A) for daytime, and IF(22h-6h) = 65 dB(A) for night-time.

The sound insulation performance targets for the building façades are calculated based on the rules set out in the regulatory document "Circulaire du 12 juin 2001" [4] as follows:

- $D_{nT,A,tr} \geq$ I(6h-22h) – 40 dB, which corresponds to an internal daytime noise limit of 40 dB(A),
- $D_{nT,A,tr} \geq$ I(22h-6h) – 35 dB, which corresponds to an internal night-time noise limit of 35 dB(A),

3 Initial assessment of railway noise at all NSRs

In 2009 a third party carried out railway noise impact assessments in the cities of Bourg-Sain-Andéol, La Voulte-sur-Rhône and Serrières in order to produce noise maps of the Givors - Nîmes railway line. This railway line, operational since 1880, is currently used exclusively for freight transport, but in the future is likely to carry some passenger trains. The noise maps thus modeled the predicted noise levels at the facades of all buildings near the railway line in 2030, in order for mitigation measures to protect against potential increased noise levels in the future.

Following these initial noise assessments, databases of NSRs were drawn up and a project was put in place to upgrade the sound insulation of all exposed NSR façades. 300 NSRs were highlighted in Bourg Saint Andéol, 323 in La Voulte sur Rhône and 363 in Serrières. The remainder of this report provides a case study regarding the assessment of exposed NSR facades in the town of Serrières.

4 Case study: Assessment and mitigation of railway noise in the town of Serrières

4.1 Project outline

The Serrières project began with a public meeting held to outline the technical objectives of the noise impact assessment and mitigation measures to residents located within NSRs. This was of particular importance given the nature of the project and its requirement to deal directly with residents.

It was a key to the success of this project to establish the involvement of the community and landlords that may not be aware of the significant of the railway noise.

For each NSR an initial audit has been undertaken to assess both acoustical sensitivity and thermal performance. The acoustical survey examined sources of acoustic weakness such as windows, doors and trickle vents. It also took into account the type and design of the roof and walls. The acoustic recommendations were formulated based on the findings of the audit and the insulation requirements of the façade.

The assessment of thermal performance carried out as part of this initial audit took into account the overall energy consumption of the NSR, and together with details such as the type of heating system and existing insulation, allowed an additional set of recommendations to be given to NSR residents to improve thermal efficiency. Although no explicit steps were taken to implement these measures, it was within the scope of the project to provide this information in order to help residents reducing their carbon footprint and energy spending. It should further be noted that in many cases the implementation of measures to enhance the acoustical performance of NSRs would likely have a positive impact upon the thermal efficiency (e.g. upgrading of single glazing to double glazing).

These initial audits have shown than 44% of residential buildings were still fitted with single glazing. Of the remaining double-glazed properties, 11% had upgraded from single glazing without changing the existing window frames.

In Serrières, 80 % of the NSRs' properties required, so far, acoustic façades treatments.

To carry out the audits each NSR property was visited and a report produced outlining the acoustical improvements required in order to satisfy the relevant legislation [1]. The reports also included suggestions for measures to improve thermal performance. The audit reports were then used by the relevant NSR property owner to obtain quotes from building contractors (e.g. window fitters) and to obtain planning permission from the local authority.

4.2 Method used for acoustical assessment of each NSR

The principle acoustical assessment tool was the noise map that included a model of the potential railway traffic in 2030. This allowed an estimate to be made of the predicted external noise levels due to likely increased railway traffic in the future. The key objective of this project was to use this data to suggest and implement noise mitigation measures on the NSR facades.

The steps involved in the assessment of NSRs' acoustical performance (before implementation of noise mitigation measures) are outlined in detail in Figure 1.

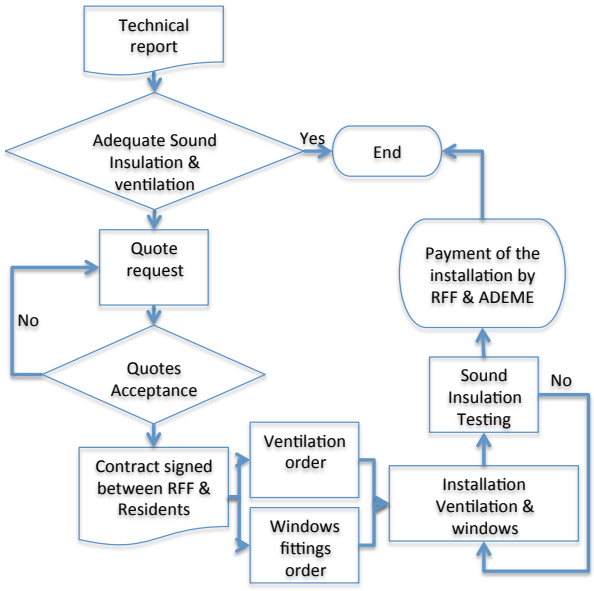

Figure 1. Flowchart illustrating the steps required to assess noise exposure, propose noise mitigation measures, implement them and verify their performance.

A further summary is presented below.

- All external windows and doors' dimensions are measured.
- All external the windows and doors are acoustically assessed.

- If the window is single-glazed the level of insulation is known to be insufficient and the window is replaced without need for an acoustical measurement to be carried out.
- If the window is double-glazed and the frame is in good condition, a measurement of the façade sound insulation level is undertaken and compared to its given performance target.
- The ventilation is assessed for the entire property.
- If the windows are acoustically adequate but the ventilation is not in accordance with the French regulations, a new ventilation system is installed.
- If the ventilation system is in accordance with the French regulations and the windows are replaced, care is given to make sure that the works does not degrade the ventilation system.

4.3 Implementation of noise mitigation measures

The main noise mitigation measure offered by the project involves the replacement of existing windows within NSR properties with high performance glazing. The design of custom windows is required, as they need to incorporate sufficient sound insulation technology. Some cases required windows with a sound insulation performance greater than 42 dB R_w+C_{tr}.

Figure 2. Example of mitigation solution, on the left single-glazed window without trickle vent, on the right double-glazed window with an acoustic trickle vent.

In French legislation any change to a building façade requires planning permission. As many of the NSR properties in Serrières are located in historical parts of the town, most of the windows are required to be timber frame by the building control officer in charge. Such windows have to be replaced with aesthetically identical products as much as practically possible. Wooden frames are more expensive than PVC frames, but have the added benefit of being environmentally more sustainable when adequately sourced.

Further complications have included the fact that many local window fitters are not used to installing acoustic windows. The recommendation for acoustic through-wall vents in residential properties has also brought up issues with local contractors, most of whom were previously unfamiliar with the technique and the products available on the market.

4.4 Assessment and funding of implemented noise mitigation measures

Pre-completion acoustic testing is undertaken for each NSR property following completion of the building works to verify their conformity to the regulatory targets. A test certificate is then prepared and has to be signed by all the parties involved, namely the contractor (generally a window fitter), the property owner and the consultant undertaking the acoustic test.

Acoustical testing is performed in accordance with French standard NF EN ISO 10052.

Figure 3. Example of façade sound insulation measurement in accordance with NF EN ISO 10052.

Testing undertaking on the completed installations; the results were typically within 3 dB of the design predictions.

Providing the funding cap is not exceeded, the contractor is paid directly by RFF after work completion so down payments are not required from property owners. Funding caps are calculated for a given NSR property according to the number of rooms impacted by railway noise above the regulatory threshold.

5 Conclusion

The primary outcome of this project has been the design and implementation of façade noise mitigation measures on a large number noise sensitive receiver (NSR) properties distributed across the towns of Bourg-Saint-Andéol, La Voulte-sur-Rhône and Serrières. These towns are located in the Rhone Valley region of France, and the NSRs are likely to be exposed to increased levels of noise due to the predicted increase in railway traffic over the coming years.

Noise pollution has been reduced for affected residents, but has also improved the aesthetics to the towns concerned. Improving the sound insulation performance of the façades has further provided increased thermal

efficiency for many NSR properties, hence decreasing the carbon footprint of each upgraded building. For most NSR properties the existing ventilation system was inadequate given the improved air tightness gained from the refurbishing works and therefore required the installation of acoustic trickle or through-wall vents despite the associated inherent thermal loss. This suggests that the upgrading procedure is unlikely to have any negative impacts on residents' health or NSRs' building fabrics caused by decreased fresh air renewal, which can occur in renovation project involving increased building air tightness.

A key challenge of the project was that many local window fitters selected to carry out the façade upgrades were inexperienced in the installation of acoustic windows or acoustic ventilators. This was further exacerbated by the fact that many ventilation products are still not efficient enough for residential properties in sunny and warm climates, such as the Rhônes-Alpes Region. In such climes many people prefer to leave windows open during the summer months to ensure adequate ventilation, and find that closing windows due to noise disturbance significantly degrades the efficiency of the ventilation system in the property.

Acknowledgments

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References

[1] Circulaire du 25 Mai 2004 relative au bruit infrastructures transport terrestres, Legifrance (2004)

[2] CERTU "Isolation acoustique des façades – guide technique et administratif pour le traitement des Points Noirs Bruit" (2003)

[3] Circulaire du 12 juin 2001 relative à l'observatoire du bruit des transports terrestres - Résorption des points noirs du bruit des transports terrestres, Legifrance (2001)

[4] Arrêté du 3 mai 2002 pris pour l'application du décret n° 2002-867 du 3 mai 2002 relatif aux subventions accordées par l'Etat concernant les opérations d'isolation acoustique des points noirs du bruit des réseaux routier et ferroviaire nationaux, Legifrance (mai 2002)

[5] NF EN ISO 10052 – Mesurages in situ de l'isolement aux bruits aériens et de la transmission des bruits de choc ainsi que du bruit des équipements, AFNOR (2005)