

SOUND INSULATION PILOT PROJECT ON BUILDINGS IN THE PROXIMITY OF AN AIRPORT AREA

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ABSTRACT

Thirteen buildings located in close proximity of Malpensa 2000 Airport were selected in order to improve their acoustic insulation against aircraft traffic noise. After two years of works, the expected results have been obtained: windows and roofs with better acoustical performances (up to 48 dB of sound insulation) and sound insulated air inlet systems were used. Acoustic laboratory tests and field measurements of the involved building elements have been carried out before and after the modification. Regarding the gained experience, two books dealing with a set of technical solutions and design guidelines have been distributed both to planners and residents.

INTRODUCTION

The sound level contours in the environment around Malpensa changed very much when the existing airport was increased and turned into a hub called Malpensa 2000, and also a great number of flights were moved there from the Linate Forlanini Airport.

In order to reduce the impact on the inhabitants living around the airport, the Lombardy Region drew up a specific Agreement Plan. The main aim of the agreement was to realise a series of actions developing some improving effects on residential buildings' conditions, ranging from acoustic improvements up to displacements of inhabitants for the cases where the disturbance was too high to reduce.

The Lombardy Region co-ordinated all the interventions, involving different bodies, each with a different role. The Municipalities located in the Lombardy Region around the airport were entrusted with the selection of the buildings on which it was possible to make significant interventions. Together with Aler of Varese (Lombardy Residential Building Firm) the Municipalities co-operated in some stages of the works. The Lombardy Region granted the whole technical intervention through a specific contract entered with ICITE-CNR, renamed ITC (Construction Technologies Institute) on February 2002, an institute of the National Council of Research. It was meant to be a significant intervention with a demonstrative result for similar cases, a sort of example of good practice. It had the following main tasks:

- evaluating the different degree of acoustic disturbance of each building;
- suggesting the technical solutions for the improvements to be applied both to existing and new buildings;
- studying the best solutions in relation to different kinds of each specific situation (i.e. structure typology, materials and elements already existing, locations, noise degree);
- carrying out a demonstrative intervention, aiming at the maximum performances obtained by using current technologies and a reasonable budget;
- drafting a technical guidelines handbook, the first in Europe having these specific characteristics, dealing with the sound insulation improvement techniques and the experience gained, able to give some help in similar interventions and conceived for architects, engineers and specialists working in the building sector;
- providing a booklet conceived for the inhabitants living near the airport.

The works being completed, it is possible to state that the above aims were well achieved and also that it is reasonable to present the experience gained as a correct demonstration of good practice for similar cases, like a sort of pilot experience.

It is also interesting to underline those aspects which are innovative and that during the activities were decisive with reference to the final quality:

- drawing up a technical tender based on more recent laws in the sound field and at the same time prepared very strictly for the firms involved in the works, in order to put some limits to guarantee a high level of quality of the implementation;
- providing technical assistance during all the activities based on specific acoustic knowledge;
- highest control of all products' performances;
- providing specific assistance to the people in charge of the supervision of works as a sort of warranty of quality on the installation of the elements and during the whole process.



Figure 1: The field of acoustic ITC interventions: the area located near the Malpensa 2000 hub.

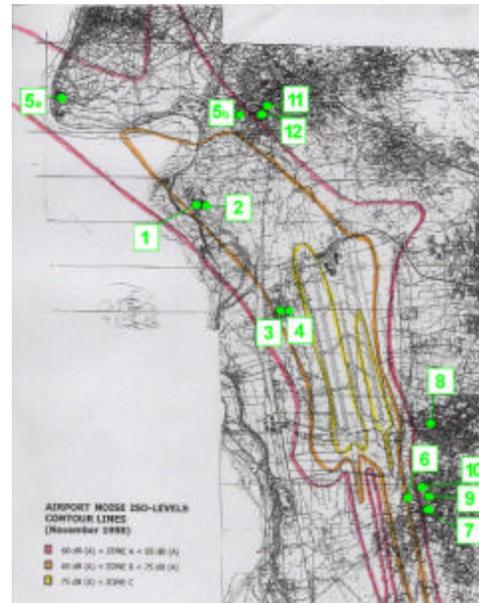


Figure 2: The airport noise isolevel contour lines during the experimentation and the buildings involved.

THE STAGES OF THE INTERVENTION

The buildings selected for the interventions were all public buildings (nurseries, primary and secondary schools), located in zones characterised by airport noise levels of 60 and 65 dB(A), as visible in the Figure 2. Buildings were chosen on the one hand according to their specific characteristics and on the

other hand by considering their territorial location, because of the possibility of having buildings with different conditions of noise disturbance.

Considering all aspects on the whole, the experimentation presents two interesting characteristics:

- it provides useful suggestions in order to follow a correct methodology;
- it suggests the best solutions from the acoustic point of view, strictly related to the different disturbance degree and to the different existing conditions of the buildings.

The experimentation was planned following three main stages: the pre-modification examination (analysis and measurements), the realisation of interventions and the post-modification examination considering the entire experimentation.

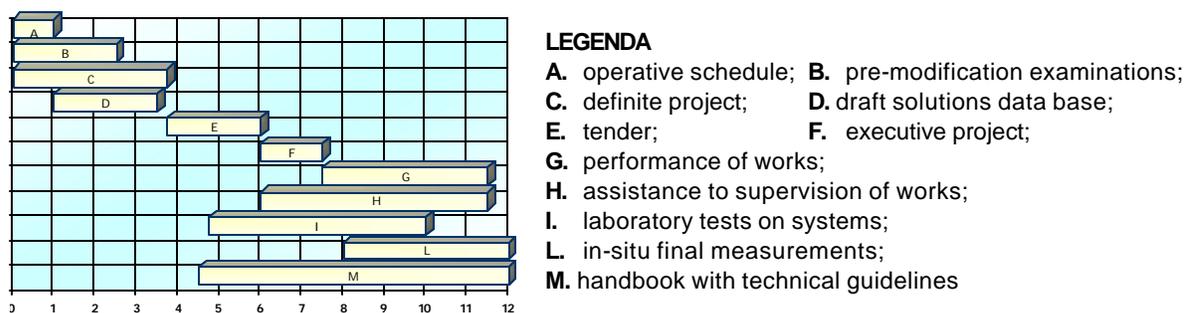


Figure 3: The different stages of the experimentation.

Pre-Modification Examination

The first stage of the experimentation started with a pre-modification examination of the acoustic performances on the buildings involved. ITC made a detailed analysis on: the characteristics of the buildings and the control of the acoustic performances before the interventions.

Regarding the first point, the analysis concerned the specific characteristics of each building, both on the basis of technical drawings, photographs and in-situ investigations.

For each building the analysis was made on the specific characteristics, regarding the way of construction (i.e. materials, structures, sizes), regarding the indoor distribution (i.e. kind of rooms or their positions) and regarding technology (i.e. windows opening and closing or glasses), also including the maintenance of the entire building and of single elements.



Figure 4: Pre-modification examination – analysis of the conditions of each building involved.



Figure 5: Pre-modification examination – in situ control of the acoustic performances.

Regarding the second point, researchers made a detailed in-situ control of the acoustic performances of each building in the initial conditions. This examination was made by considering the following significant parameters:

- the sound insulation of the facade;

- the apparent sound reduction index of the elements involved in the sound transmission, in particular windows, glasses, opaque external walls, internal partitions and roofs;
- the reverberation time in some selected cases.

The methods for the measurements and the parameters used for this case are those envisaged by the most recently approved international technical laws (EN ISO) and also by national (Italian) ones, regarding acoustic pollution (particularly DPCM 1997, December 5th). For what concerns the measurements of the sound insulation of the facade, the source for the noise was a generating source with standardised range. In addition, in some cases we also used the noise coming from the traffic of the planes taking-off or landing in the airport itself.

The Realisation of the Interventions

The second stage mainly consisted in the planning and realisation of the interventions regarding in particular acoustic performances. For each building the researches of ITC drew up the project, based on the previous measurements and on the theoretical forecasts acquired of the first stage.

The interventions were designed for each building by considering needs and characteristics, which are different for each of them (i.e. degree of disturbance, proximity to the airport, maintenance).

In order to define the interventions, the building was considered as an organism, a body in which each technical action does not only affect the single structure, but it is also interrelated with the others.

From the acoustic point of view the main weak points accountable for the possible noise transmission from the outside to the inside were identified, and the interventions were planned by giving a strong relevance to these points. The main technical measures principally concerned the building's envelope, that is the most important part considering the airport noise, and in particular:

- all the opening parts (i.e. interventions on windows, doors, types of opening and closing, window-sills, materials, joints, introduction of air inlet devices);
- roofs (i.e. materials, maintenance, degree of insulation, interventions to improve the elements' performances or to replace the existing ones);
- facades (divided according to the structural characteristics, the materials and the different percentage of windowed parts calculated on the wall's surface).

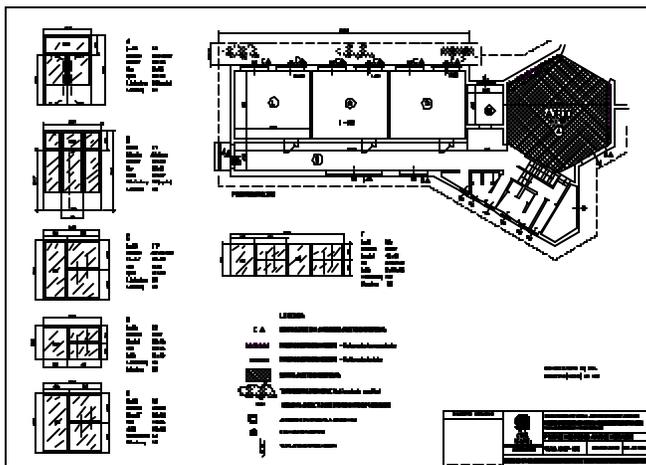


Figure 6: Realisation of the interventions – example: one of the technical ITC lay-outs.

Figure 6 represents one of the lay-outs which were drawn up in the project and it shows an example of the kind of interventions realised. In general the interventions can be grouped into two main blocks:

- interventions of reconstruction or total replacement of elements or parts not able to ensure a sufficient acoustic performance (particularly windows and roofs);

- supplementary interventions (i.e. application of additional layers and introduction of air inlet devices able to provide the right air exchange in indoor rooms and also characterised by a high insulation performance).

The project was mainly planned to guarantee the elements' performances, pointed out in the technical drawings and also carefully specified in the technical tender for the firms involved in the works. All the technical needs and performances to be provided were specified in the tender on the basis of current laws (i.e. safety and fire behaviour). In order to keep high performance levels during the works, a particular attention was drawn to installation in the construction yard, that is always a critical aspect in view of the final acoustic result.

Post-Modification Examinations

In Laboratory

At the same time of the previous stage, materials, components and systems used for the pilot project were evaluated in ITC acoustic laboratory, in order to check the correspondence to the performances declared by the firms. This check allowed to control the quality of the single elements both in themselves as materials and as a whole (i.e. the glass without the frame and the entire window), on the basis of the values measured in laboratory.



Figure 7: The post-examination stage – some of the laboratory tests.

In Situ

A series of final measurements and evaluations following completion of the works on the buildings was carried out to evaluate the correspondence with the laboratory tests and to check the interventions, mainly to verify the right installation made by the firms.

In Figure 8 it is possible to compare the acoustic insulation values before and after the interventions, measured in some of the rooms of the considered buildings. It is interesting to underline that the minimum improvement gained is 8 dB, while the best one is up to 21 dB. In most cases the limit value defined in the tender is well reached (from 40 dB up to 47 dB).

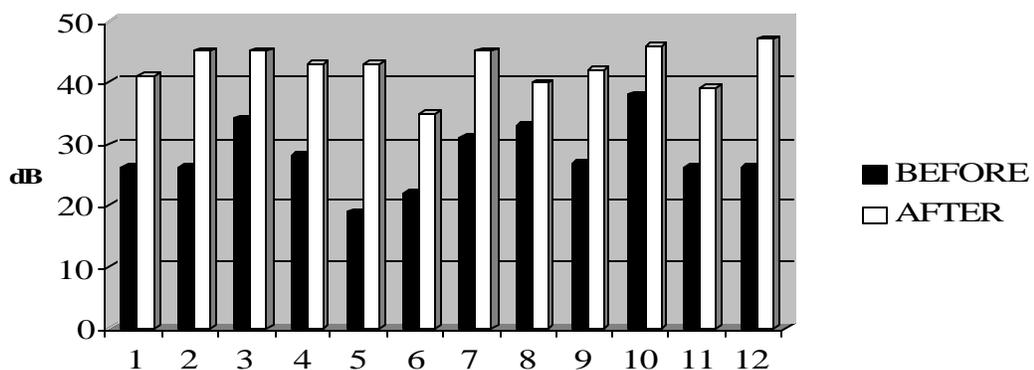


Figure 8: The post-examination stage – acoustic insulation values in some rooms, measured before and after the interventions.

DISSEMINATION OF RESULTS

At the end of the works, a guidelines handbook was drafted and then published with the title “Guidelines for the acoustic insulation of buildings located in airport areas”. The book is conceived for administrators, architects, engineers and specialists working in the building sector. It aims at providing a specific help with theoretical acoustic bases, references to current laws, directions about methodology, technological solutions and teachings coming from the experiences made.

The handbook is unique in its kind in Europe. It presents an inventory of technical solutions regarding possible interventions on existing buildings and also a working methodology including some useful suggestions for acoustic improvements.

The guidelines handbook helps taking into account the different options when choosing the best solutions for the single and particular building on which the intervention has to be made, regarding its specific structural characteristics.

It is presented as a tool with a general validity, not only linked to the specific situation of Malpensa, and that is why it may have an evolving peculiarity in the future, assuming that there is the will to keep it up-to-date by including new materials and new technologies that will be introduced in the construction products market. At the moment the feasibility of its translation from Italian to English is being assessed.

Finally, an illustrative booklet is now also being drafted, conceived for the inhabitants living close to the airports. The booklet aims at providing an actual help to the people experiencing the same kind of troubles, disturbed by airport noise, referring then to the guidelines handbook for technical deepening. The booklet, “Leave the noise outside your home!”, aims at suggesting to inhabitants living close to airports that it is first of all possible to put into practice good acoustic improvements and then how to do it, pointing at some useful basic indications about the most important aspects regarding acoustics, such as laws and technologies.

In conclusion, these two books are part of a larger project regarding dissemination of results carried out at different levels, also with a view to creating a technical documentation centre on the net.



Figure 9: The dissemination of results – the technical guidelines handbook.



Figure 10: The dissemination of results – the booklet conceived for inhabitants.