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SOUND INSULATION BUILDING IN URBAN AREAS NEAR AIRPORTS

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ABSTRACT
Residential or offices areas built nearby airports cannot be treated with the same noise reduction procedures which are applied for highway or railways other then common terrestrial noises. This is mainly due to the specific noise spectrum of the source, in the range between 100 and 3150 Hz, the relative position and moreover its speed and direction. To define efficient noise reduction measurements thus it is necessary to use an adequate methodology of each building facade component taking into consideration the actual acoustic forcing power spectrum. In this work the spectral values are shown related both to the actual facades configuration and after the implementation of noise reduction measurements.

1 - INTRODUCTION
This work consists of two main parts: in the first part the average acoustic spectrum of Malpensa Airport for aeroplanes take-off phase has been derived through experimental measurements carried out in the surrounding of a building school located nearby the airport; in the second part sound transmission loss through the facade of the school building and also through single facade elements, like window and wall with different thickness, have been evaluated according to the average acoustic spectrum derived in the first part.

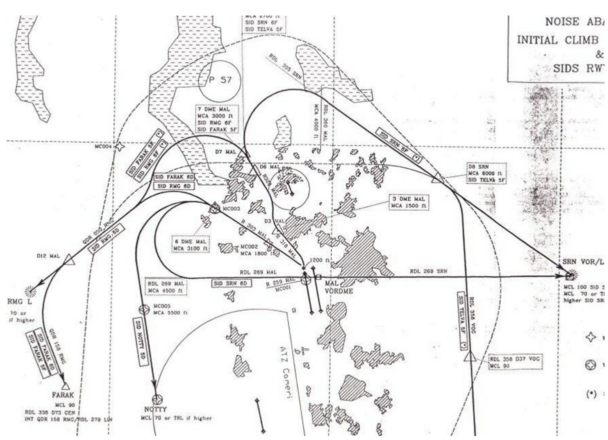

Figure 1: Main exit route from Malpensa airport and localization of the measurement station.

2 - MEASUREMENT ACTIVITY
The measurement activity has been carried out in the surrounding of a building school, located in Somma Lombardo town and situated inside the B respect zone (a zone in which the dB(A) level must not exceed 75 and where with a previous acoustic insulation it is possible to settle agriculture commercial and industrial activities). This site have been selected because it is one of the most significant according to

the runaways alignments and their utilization frequency for taking-off. The measurements station has been located on a balcony close to the building roof.

2.1 - "Macchi" school building

The school building is located in front of the runway RW24 and RW17 (SID); this site is just on the exit way of each take-off from the airport and is in higher position respect of the urban area. This building is two floors higher and it is a part of a larger school buildings complex built in several different times with different technologies. "Macchi" school building has been built around 1930 with bearing walls structure and has a sloped roof made with holed brickwork – concrete slab. The classrooms windows are 3 mm glass thick with wooden made frame.

2.2 - Phonometric measurements

The $Leq_{1.5}$ spectral noise measurements we have taken are related to 11 takeoffs in the morning from 9.00 to 10.30. The instrumental apparatus utilized for these measurements is the real time analyzer Larson Davis 2900. It was set up to sample the noise produced by each fly with a period of a tenth of second in the range between 20 and 20.000 Hz. For each takeoff the related aeroplane type has been identified by visual recognize, to be able to correlate the different noise production with airlines companies, which may take off with different procedures depending from relative destination, load etc.. In this way it has been possible to obtain 11 spectra related at as many specific flights in the range between 100 and 3150 Hz; from these spectra the average spectrum has been calculated, after called "average spectrum of aeronautic forcing power".

To analyze the possible acoustic performance differences of a typical building facade when the same building is affected by traffic noise, a total power equivalent traffic spectrum has been also derived from experimental measurements. This spectrum, called in the following "generic", has the same total power level then the average aeronautic, i.e. 69 dB.

Both spectra are shown in fig. 2, and it is important to note that the average aeronautic spectrum is characterized by higher pressure level at lower frequencies, while the "generic" one has higher pressure level at higher frequencies. That will give differences in the sound loss through the same wall, when the two different spectra are applied.

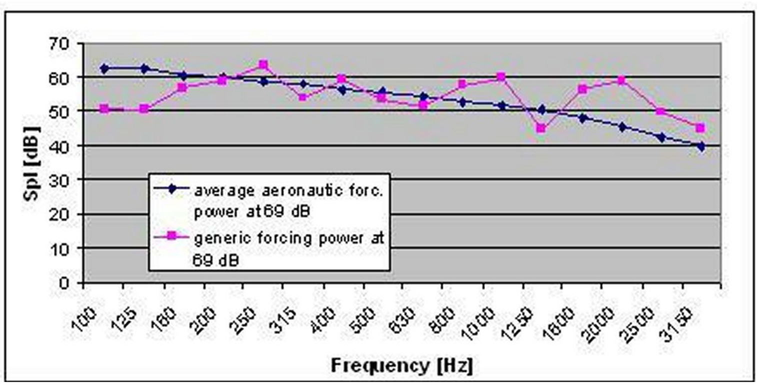

Figure 2: Average spectrum of aeronautic forcing power for Malpensa Airport compared to generic noise spectrum at the same power level of 69 dB.

3 - FACADE ACOUSTIC INSULATION

The facade acoustic insulation is referred to a typical classroom facade section, i.e. the external wall and its windows. The roof has not been taken into count, because it is so massive that it is not certainly the weakest element. Furthermore it is very difficult to upgrade this type of roof in the specific building contest.

The school facade is a composite "wall", compound of two different types of walls, massive bricks wall and light brick wall, and of windows, rolling shutter box. Surfaces of each different building component are shown below.

Building components	S [m²]	Totals S [m²]
massive bricks wall	12,54	
light brick wall	9,90	
rolling shutter box	2,64	25,08
windows	15,84	40,92

Table 1.

The sound loss R_C has been calculated according with:

$$R_C = R_a - 10\log_{10}\left[1 + (S_B/S_A) * 10^{\Delta R/10}\right] / \left[1 + (S_B/S_A)\right] \quad (1)$$

where:

- R_a = building element with the highest sound loss (A);
- S_A= surface of building element A [m^2];
- S_B= surface of building element B [m^2];
- R_B= building element with the lowest sound loss (B)
- $\Delta R_B = R_a - R_B$

3.1 - Actual situation

As above explained, the classroom external "wall" is compound of:

- massive brick wall 50 cm. thick;
- light brick wall under the windows, 12.5 cm thick;
- windows with 3 mm glass thick and with wooden made frame.

The sound loss analysis for each component in the frequency range from 100 to 3150 Hz shows that the component which has the lowest sound loss is the window.

3.2 - Improved situation

To improve the facade acoustic performance alternative configurations of the external wall have been tested, all employing a gypsum board on the wall under window and different types of windows with high acoustic property.

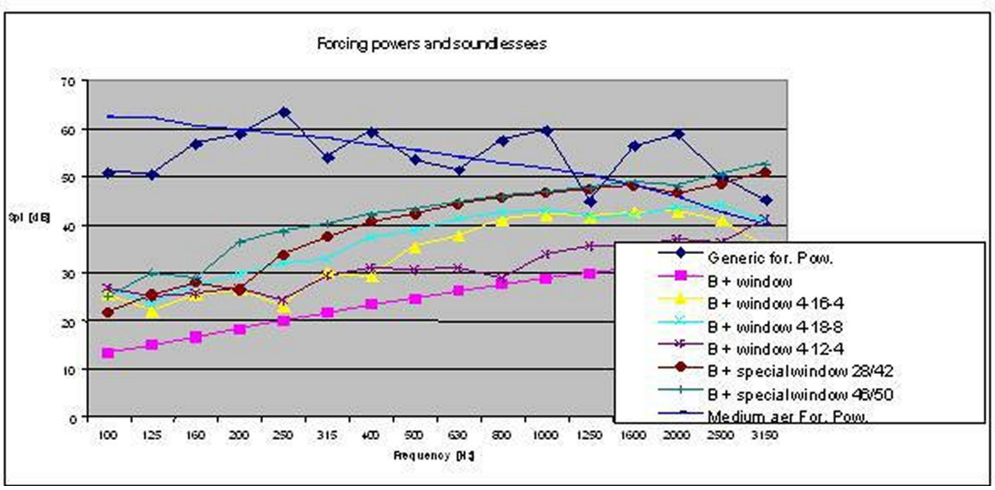

Figure 3: Sound loss spectrum of each facade configurations related to different forcing powers.

4 - OBSERVATION

For each configuration of the classroom facade wall, the R_W ISO normalized index and the sound losses, for both the aeronautic average spectrum and the generic noise spectrum of forcing power, have been calculated. The generic noise spectrum has been shifted in a way to ensure the same global sound level of the average aeronautic one.

CONFIGURATION	R_W [dB]	Sound loss. from aeron. f.power [dB]	Sound loss from generic f. power [dB]
B+ actual window	28,9	17	21
B+ window with 4-16- 4 mm glass	37,8	27	27
B+ window with 4-18- 8 mm glass	41,1	25	26
B+ window with 4-12- 4 mm glass	34,0	27	32
B+ special window 1 *	44,5	26	32
B+ special window 2 **	46,6	30	36

Table 2: Comparison among R_W normalized index and the sound level reduction for the two different forcing powers (B = facade with gypsum board applied on the wall under the windows, * = with argon, total thickness 22 mm, ** = with argon, total thickness 41 mm).

5 - CONCLUSIONS

There is evidence that the main characteristic of medium spectrum of aeronautic forcing power is to have high sound level at low frequencies. This fact is has a high impact on the sound abatement characteristics of some building components.
Moreover is possible to state that some type of high quality windows do not give a real contribution to enhance sound losses of the facade wall if these are involved from aeronautic noise.

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