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A RELATION BETWEEN TRANSMISSION LOSS AND AIR INFILTRATION CHARACTERISTICS IN WINDOWS

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Summary.

Within a research plan financed by CNR (Research National Council) for the aim of saving energy consumption in building heating, a procedure for field measurement of air infiltration characteristics by means of acoustical methods has been identified. The paper presents the measurement results which were worked out in order to find a single figure quantity for each parameter. The conclusion is that the determination of the air infiltration class of windows on the basis of the transmission loss data is possible, in the approximation limits of the method.

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In 1977 the Italian National Research Council (CNR) instituted a research plan for the saving of energy. One of the proposed items deals,with the saving of energy in building heating with particular reference to the optimization of windows, which as it is known, often represent one of the main sources of dispersion. The behaviour of a window with respect to energy wasting is well described by means of its air infiltration characteristic, in terms of air flow per second referred to the total window surface ($m^3h^{-1}m^{-2}$). This quantity can be determined by a standard laboratory procedure; on the contrary no normalized method exists for field measurements on windows already set up in finished buildings.

The I.E.N.G.F. undertook the task of working out a method for field measurements of air infiltration characteristics by means of transmission loss measurements, the strong correlation between the two quantities being considered.

At the Acoustics Laboratory an apparatus for the measurement of sound transmission loss according to ISO 140 is available (fig. 1). An installation for the measurement on the same sample of air infiltration characteristics has been set up (fig. 2). 4 different windows were tested:

a) steel frame, single glazing 6 mm thick;
b) aluminium frame, single glazing 5 mm thick;

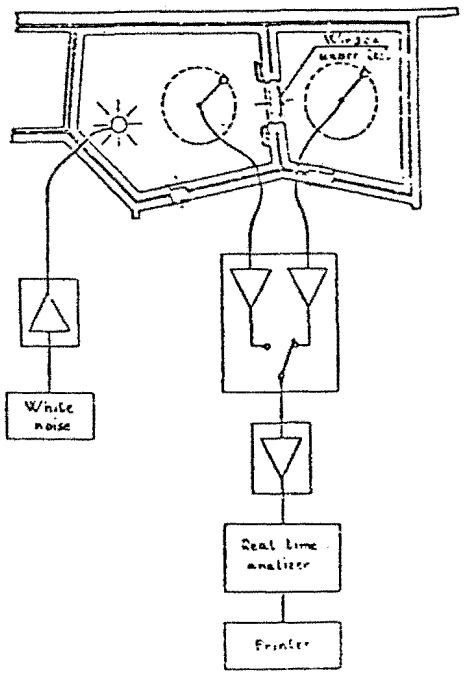

fig. 1

c) plastic frame, double glazing 4+12+4 mm thick;
d) double frame: outside steel frame, single glazing 2 mm thick, inside wood frame, single glazing 3 mm thick.

Both sound transmission loss as a function of frequency (in the range 100÷3150 Hz) and the air infiltration characteristic were measured on each sample. Fig. 3 reports, as an example, the sound transmission loss vs. frequency values (window c)) in five sealing conditions. One can observe that sound transmission loss gradually decreases with increasing air infiltration, mainly at frequencies in the medium of the measurement range. As observed by some authors ([1], [2]) such a behaviour depends from the frame shape or, more precisely, from the shape of the slits through which the air flows.

In the complex 26 sound transmission loss and air infiltration characteristics were determined for the 4 windows tested. In order to find a correlation between the two quantities, it is necessary to express them both by a single representative parameter. As far as air infiltration characteristic is concerned, its variations as a function of pressure are rather regular and therefore the value of the air flow at 100 Pa ($Q_{S\ 100}$), as computed from linear regression analysis, is considered as a good synthetical parameter. On the con-

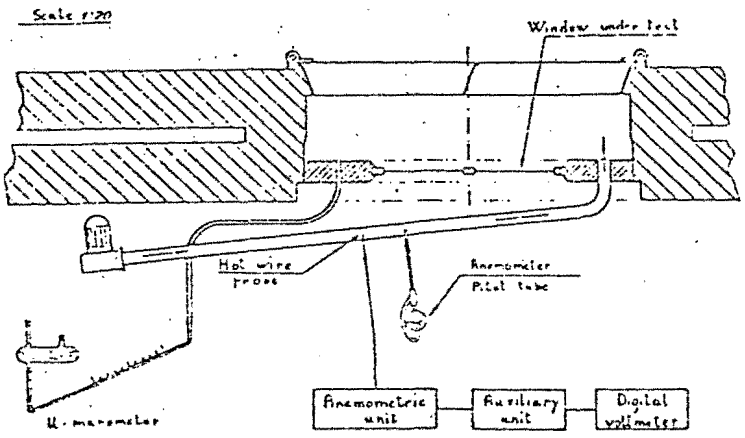

fig. 2

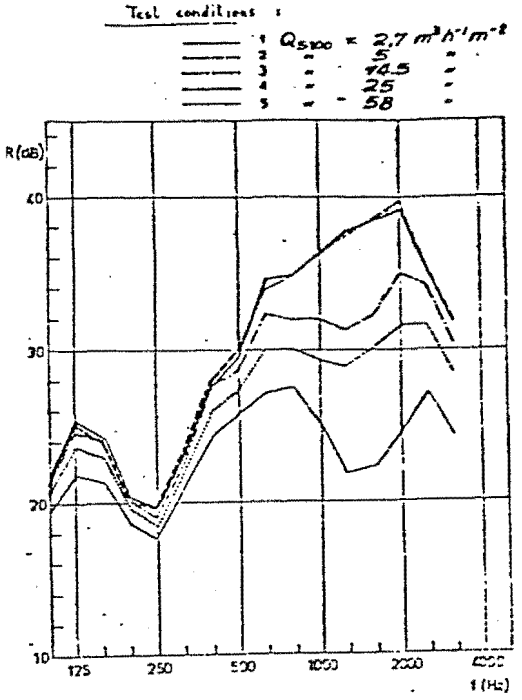

fig. 3

trary, the variations of the sound transmission loss as a function of frequency are irregular; therefore the synthetical index must be based on a weigthing over the whole frequency range. Two methods have been investigated, consisting respectively in the computation of the index R_W (according to ISO R717) and of the attenuation R_A in dB(A) obtained from the difference between a typical traffic noise spectrum and the curve of sound transmission loss under test.

The following parameters were calculated: R_A and R_W for each test condition; the difference ΔR_A and ΔR_W (between condition 1 -perfect sealing- and the other conditions) for each window.

The index R_W looks as the more representative: fig. 4 reports its differences ΔR_W as a function of the logarithm of the air flow $Q_{S\,100}$. One can observe that in the case of single frame windows the variations are well approximated by a straight line, the standard error of estimate being within 0.75 dB. The same figure reports the limits suggested by document UEATC [3] for the classification of windows with respect to their air infiltration characteristics.

The intersection between the axis of abscissas and the line of best fit, point of zero transmission loss, falls inside the classification zone of best performance.

The measurement precision is predicted by means of statistical calculations which take into account the repeatibility and reproducibility data reported in the Acoustics Standards.

In the approximation limits of the method, the following conclusion can be drawn: the air infiltration class of a window can be deduced on the basis of field measurements of sound transmission loss, the acoustical performance in perfect sealing conditions being known.

The correlation between sound transmission loss and air

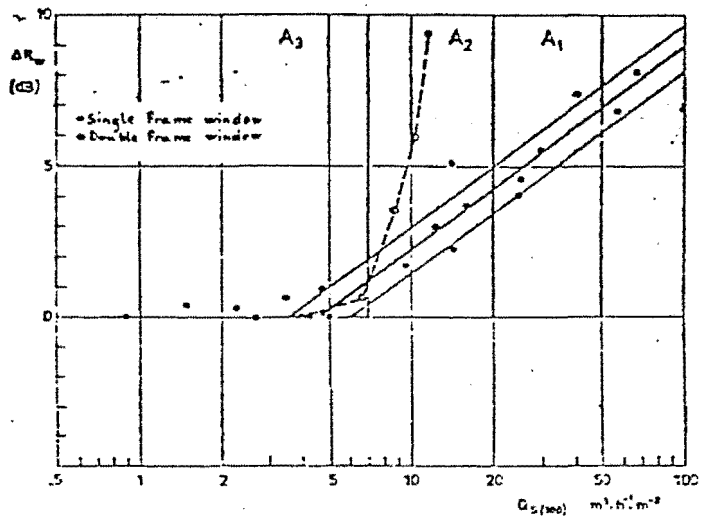

fig. 4

infiltration class can be fixed, according to the results worked out, as:

- class A3: $\Delta R_w \leq 2$ dB
- class A2: $2 < \Delta R_w \leq 5$ dB
- class A1: $5 < \Delta R_w \leq 7$ dB
- unclassified: $8 \leq \Delta R_w$ dB.

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[3] UEATC (Union Européenne pour l'agrément technique dans la construction): Directives comunes pour l'agrément des fenetres, Cahier CSTB n. 1227(Gen.- Feb. 1974) livraison 14[illegible].