Airborn sound isolation homework

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Room Acoustics - Music and Acoustic Engineering -Politecnico di Milano

1 Calculate the sound reduction index of each component

1.1 Facades

The material that has been chosen to design facades of the room under study is lightweight concrete, 300 mm thick. The Sound Reduction Index (dB) are shown in Tab. 1. Since

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
37	37	42	51	58	58	58

Table 1: Octave-band values for the SRI of the facade walls.

the values are given in octave bands, we need to interpolate them linearly to obtain a curve in 1/3-octave bands so that they are consistent with the reference curve. Linear interpolation is calculated using:

$$R_f = R_{f1} + \frac{f - f_1}{f_2 - f_1}(R_{f2} - R_{f2}). \qquad f_1 < f < f_2 \tag{1}$$

where $R_{fi} = R(f_i)$ indexes are referred to frequencies in 1/3-octave bands. The result can be found in F̈acade Wall" sheet. Moreover, its areic mass is $m' = 390\ Kg/m^2$. From the table, as well as from the Excel computations, the weighted sound reduction index is $R_w = 54$ and correction coefficients C and C_{tr} are -2 and -6, respectively.

1.2 Windows

The sound reduction indexes of the windows are taken from [1]. Here the authors report their measures of R in 1/3-octave bands from 100 Hz to 5000 Hz for different kinds of insulated glass units (IGUs) with double glass, all mounted in the same frame. These measurements are done in compliance with LST EN ISO 10140 series standards and the results were evaluated according to LST EN ISO 717-1 standard. For this homework

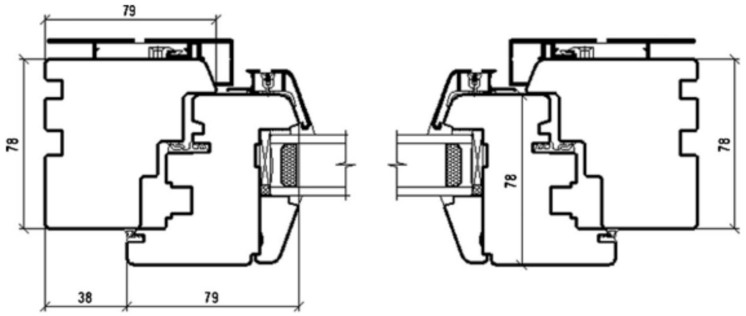


Figure 1: Horizontal cross section of tested window

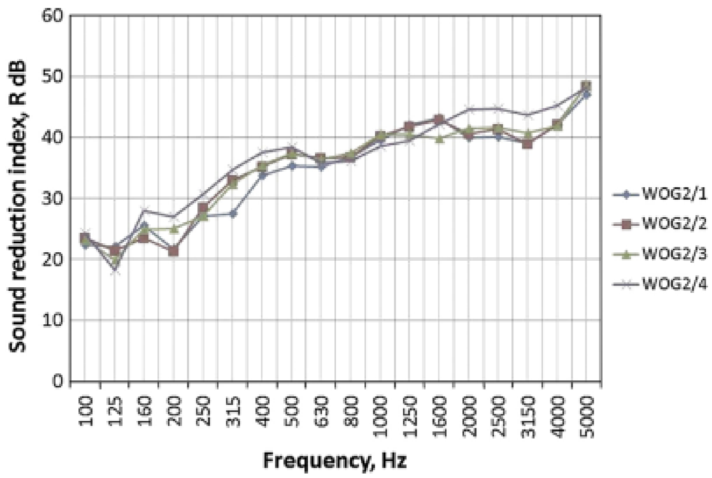


Figure 2: Sound reduction index in 1/3-octave bands for different IGUs [1]. The curve we used in this homework is the one labeled WOG2/1.

we chose the IGU that is referred to as WOG2/1 in the paper: it consists of two layers of ordinary glass[1] (4 mm and 6 mm of thickness respectively) with a 18 mm air gap filled with argon gas in between. Since the paper doesn't provide any information about material density, we used a common value of soda lime glass density, $\rho = 2530\ Kg/m^3$. The corresponding areic mass is $m' = 25.3\ Kg/m^3$. The sound reduction index curve for WOG2/1 can be seen in Fig. 2. Based on these values we have computed R_w, C, and C_{tr}. Our value of $R_w = 37\,\text{dB}$ and the one given by the authors coincide, while the coefficients C and C_{tr} are -2 and -6 in our computation but -1 and -5 according to the cited study.

[1]Ordinary" here stands for "not laminated", since other IGUs studied in the cited paper had one or both panes made out of laminated glass.

1.3 Floor and ceiling

Here too, we chose a material from the lecture slides: in particular, we chose the Ca-Si blocks (240 mm) as construction which has a remarkable areic mass (420 Kg/m^2). The sound reduction index values in octave bands are presented in Tab. 2.

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
38	38	46	54	62	68	68

Table 2: Octave-band values for the SRI of the floor and ceiling.

The weighted value given by table is 56 while it is 57 in the Excel, as well as correction coefficients are $-1, -6$ in the table while $-2, -7$ in the sheets.

1.4 Internal walls

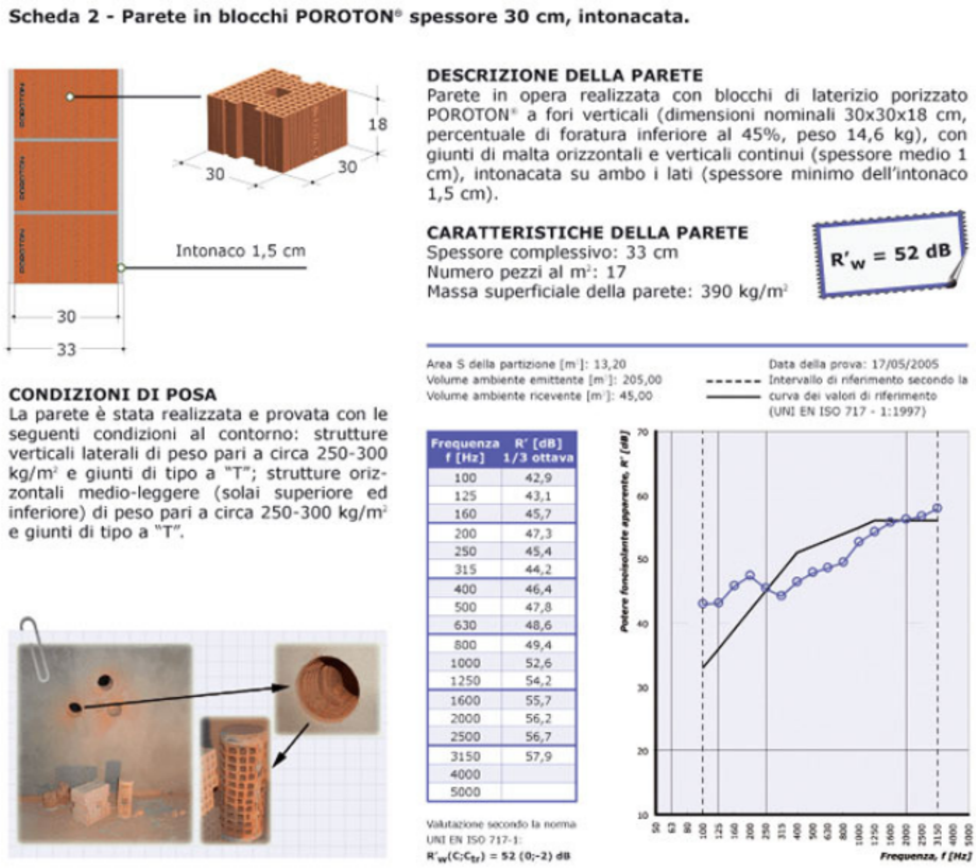
From the catalogue of an italian company called FOROSON we found results of measurement realized on their bricks. We have considered walls made of FOROSON bricks with plaster, of total thickness equal to 33 cm. The acoustic insulation properties were studied by the company according to UNI EN ISO 140-4 and R'_w was computed following the UNI EN ISO 717-1. Since we used the same standards in our computations, our results for R'_w, C and C_{tr} are the same as those of the catalogue (see figure 3).

1.5 Door

To ensure a fairly high sound reduction index, we chose to use a composite door with two wooden panels containing an inner rockwool layer; moreover, we chose to use live white oak for its high density [2] ($\rho = 800\,\mathrm{kg\,m^{-3}}$). The panels are 1 cm thick and the rockwool layer is 4 cm thick. Rockwool has a density of $70\,\mathrm{kg\,m^{-3}}$, which gives us an areic mass of $18.8\,\mathrm{kg\,m^{-2}}$. The resulting SRI of the door is 39 dB.

2 Verify the passive acoustic requirements of buildings

In the Excel, section "data", are resumed sound absorption of each component between room A and room B given by direct and flanking contributions. In section "joints" are computed vibration reduction index for each junction. The main result is the total weighted sound reduction index between room that is $50,29$ dB, above the legal threshold of 50 dB (D.P.C.M 5-12-1997) as well as the facade sound reduction index, which is 53.3 dB.



Scheda 2 - Parete in blocchi POROTON® spessore 30 cm, intonacata.

DESCRIZIONE DELLA PARETE
Parete in opera realizzata con blocchi di laterizio porizzato POROTON® a fori verticali (dimensioni nominali 30x30x18 cm, percentuale di foratura inferiore al 45%, peso 14,6 kg), con giunti di malta orizzontali e verticali continui (spessore medio 1 cm), intonacata su ambo i lati (spessore minimo dell'intonaco 1,5 cm).

CARATTERISTICHE DELLA PARETE
Spessore complessivo: 33 cm
Numero pezzi al m²: 17
Massa superficiale della parete: 390 kg/m²

R'w = 52 dB

CONDIZIONI DI POSA
La parete è stata realizzata e provata con le seguenti condizioni al contorno: strutture verticali laterali di peso pari a circa 250-300 kg/m² e giunti di tipo a "T"; strutture orizzontali medio-leggere (solai superiore ed inferiore) di peso pari a circa 250-300 kg/m² e giunti di tipo a "T".

Area S della partizione [m²]: 13,20
Volume ambiente emittente [m³]: 205,00
Volume ambiente ricevente [m³]: 45,00

Data della prova: 17/05/2005
Intervallo di riferimento secondo la curva dei valori di riferimento (UNI EN ISO 717 - 1:1997)

Frequenza f [Hz]	R' [dB] 1/3 ottava
100	42,9
125	43,1
160	45,7
200	47,3
250	45,4
315	44,2
400	46,4
500	47,8
630	48,6
800	49,4
1000	52,6
1250	54,2
1600	55,7
2000	56,2
2500	56,7
3150	57,9
4000	
5000	

Valutazione secondo la norma UNI EN ISO 717-1:
$R'_w(C;C_{tr}) = 52\ (0;-2)$ dB

Figure 3: Poroton results on plastered brick wall

References

[1] Kestutis Miskinis et al. "Comparison of sound insulation of windows with double glass units". In: *Applied Acoustics* 92 (2015), pp. 42–46. ISSN: 0003-682X. DOI: https://doi.org/10.1016/j.apacoust.2015.01.007. URL: http://www.sciencedirect.com/science/article/pii/S0003682X15000092.

[2] Forest Products Laboratory. *Wood Handbook - Wood as an Engineering Material*. Madison, Wisconsin: United States Department of Agriculture, 2010.