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INCREASING OF SOUND INSULATION OF WINDOWS IN EXISTING BUILDINGS

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INTRODUCTION

The achievement of convenient acoustic comfort in flats located near main roads with heavy traffic is possible only by increasing the transmission losses of facades. The best way of using the money for this purpose is to insulate windows in such locations where the smallest amount of money helps most people.

Passive acoustic defence can be carried out in three steps namely: study by field measurement (estimation), planning and construction work.

ESTIMATION

After the estimation of traffic noise exposure and the costs of improvements is necessary to determine those road sections where the transmission loss of facades should be increased.

Estimating the needed transmission loss difference it is accepted that the insulation of facade wall is better than that of windows structures. This difference should be more than 10 dB. This way the costs of improvement can be concentrated of facade construction.

Insulation difference (ΔR_W) can be determined [1]

$$\Delta R'_W = L_{Aeq,out} - 3 - L_{Aeq,in} - R'_W$$

where $L_{eq,out}$ = noise exposure level 2 metres in front of facade, dBA

$L_{eq,in}$ = noise level in the living room, dBA

R'_W = waited sound insulation of windows in field

Correction factor of 3 dBA comes from the frequency characteristics of traffic noise and from the reflection effect of facade. [2]

R'_w is influenced by local acoustic structure environment. It can be determined from the equation

$$R'_W = R_{w,lab} - 10*lg\ S/A + K_\Theta + \Delta R$$

where $R_{w,lab}$ = waited sound insulation of windows structure measured in laboratory, dB

S = surface of windows structure, m^2

A = equivalent absorption area of the room, m^2

K_Θ = correction factor originated from the angle of incidence of sound intensity

ΔR = sound insulation reduction caused by field construction influence

During the estimation the noise exposure level on facade is determined by measurement while the other factors are characterised by interval based on the results of previous measurements. Laboratory sound insulations are given for some main types of windows used most frequently in Hungary.

The question to repair or change the windows structures should be answered at the first step. Changing the windows is faster than repair them and the result is safer, but in Hungary due to architectural principles and regulations mostly the reparation is used.

PLANNING

The most important part of the whole work is planning. At this step the sound intensity on the facade should be exactly determined for all buildings. This is the step when the architectural characteristics (type, size, glazing of window and state of facade) should be known in order to decide about the methods of reparation.

Reparation could be achieved by

- adjustment of wooden and metallic structures,
- seal of frame,
- seal of casements and walls,
- glazing improvement (changing of thickness and more layers)

During the acoustic estimation the needed level of waited transmission loss ($R'_{W,ew}$) should be determined and also reachable level of the average transmission loss should be known.

Knowing the noise exposure level on the facade it is possible to calculate the minimum level of waited transmission loss.

$$R'_{W,ew} = L_{Aeq,out} - L_{Aeq,in} + 10*lg\ (S_F/0,3V) + 5$$

where S_F = surface of facade to be protected, m^2

V = volume of room to be protected, m^3

Waited sound transmission loss reachable by the selected constructions can be calculated from the eq.

$$R'_{w,aw} = -10 \cdot \lg (1/S_F \cdot \Sigma S_i \cdot 10^{-0,1 \cdot R_{wi}}) + K_\Theta$$

where $R'_{w,aw}$ = waited sound transmission loss reachable by the selected constructions,

R_{wi} = laboratory transmission loss of i-th element of facade, dB

S_i = surface of i-th element of facade, m^2

K_Θ = correction factor from the average angle of sound incidence

Its value can be determined by field conditions and evaluations on local sound field and building arrangement.

Knowing the reachable sound insulation it can be decided whether the sound transmission loss is satisfactory or not. The reachable level of sound insulation is influenced not only by the windows, but by other structural elements of the facade. The waited sound transmission loss in Hungary is strongly influenced by the ventilation tubes of gas heaters, box of roller shade. The sound insulation capability of dense facade elements very often is smaller than it is needed.

If the mentioned obstacles or possible architectural prescriptions make impossible the achievement of requirements the problem should be solved in acoustic ways (for example changing the destination of the rooms to the street or decreasing the flats value).

In table N° 1 all the parameters are presented. The needed sound insulation is calculated for the individual buildings but in the case of multilateral sound exposure the calculation must be carried out from all sides. In one building windows of the same structure and highest sound insulation characteristics are used. [3]

During the passive acoustic defence the third step is the construction work itself. This time an agreement should be signed by owner of the house etc. After finishing the works additional measurements are to be carried out.

ACHIEVEMENTS

During the last two years using the described technology more then 5000 m^2 of windows have been improved by 36 - 41 dB. Less than 5 % of sound insulations are the cases when the waited transmission losses have not been achieved because of gas heaters or other structures.

REFERENCES

[1] MSZ 04.601-4,5:1989 Building acoustics. Air-borne noise insulation testing and requirements of facade constructions

[2] W.-D. Kötz: Zur Berechnung des „massgeblichen Aussenlärmpegels" nach DIN 4109. Ein klärendes Wort zum „3 dB-Zuschlag".Zeit für Lärmbekämpfung 43 (1996) 41-44.

[3] J. P. Nagy, M. Bite, I. Dombi: Study for passive acoustic defence of buildings near a new bridge in Budapest. (1995)

Sound Insulation Requirements of Front Window Structures

Building	Window		Sound exposure on facade		Parameters of protected room		$R_{W,lab}$ [dB]	ΔR_e [dB]	Needed sound insulation R_W [dB]
	Type	Effective area S [m^2]	$L_{Aeq,out}$ night [dB]	Θ [degree]	Volume V [m^3]	A [m^2]			
8-9. Hamzsabégi street	1	2.1	56.3	9.8	22	6.6	36	-2.8	33.1
	2	3.6			50	15.0	37		34.1
	3	2.6			55	16.5	39		36.1
	4	1.1			21	6.3	39		36.1
	5	3.6	55.0	23.7	51	15.3	36	-2.2	33.8
	6	2.1	56.3	39.3	35	10.5	38	-0.8	37.2
	7	2.6	55.0	23.7	69	20.7	39	-2.2	36.8
	8	1.3	56.3	53.0	18	5.4	37	+1.8	38.8
12/a Szerémi	9	4.0	55.0	54.4	56	16.8	36	+1.7	37.7
31/a Baranyai			56.0	63.0			37	+4.0	41.0
83/a Budafoki			56.3	73.8			38	+8.1	46.1
12/a Szerémi	10	3.6	55.0	54.4	50	15.0	36	+1.7	37.7
31/a Baranyai			56.0	63.4			37	+4.0	41.0
83/a Budafoki			56.3	73.8			37	+8.1	45.1
12/a Szerémi	11	3.4	57.6	21.7	44	13.2	38.6	-2.4	36.2
31/a Baranyai			57.0	20.9			38	-2.4	35.6
83/a Budafoki			61.3	73.8			42	+8.1	50.1
83/a Budafoki	12	1.0	62.1	43.7	17	5.1	44	-0.2	43.8
12/a Szerémi	13	3.0	56.1	53.7	50	16.0	38	+2.3	40.3
31/a Baranyai			56.4	53.7			38	+2.3	40.3