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STUDY OF NOISE PRODUCED BY ELEVATORS INSIDE BUILDINGS

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ABSTRACT

This paper studies the way in which elevators movement produces work perturbing noises. The studies were made on two types of buildings: a modern building, with noiseless elevators and another one with old elevators. Also, the measurements took place during 9^{00}-17^{00}, highlighting the way in which the noise level increases over the period when the elevators are most used: at the beginning and at the end of the work shift and at lunch break. This noise can be soften by using absorbent materials along with the replacing of the old elevators with new and performing ones.

1. Introduction

The starting point of any acoustics project involving noise in buildings is the establishment of suitable noise criteria for the most important building spaces [11], [14]. In most commercial and residential buildings it is desirable to have a certain level of noise ambient which serves to mask other intrusive noises [9], [15], [16].

2. Theory

In the 1950's was discovered that a single dB(A) number does not properly reflect the noise ambience of an acoustic space. That reference must be made to the frequency content of the noise. For this reason were proposed the Noise Criterion (NC curves) (fig. 1) [1].

In Europe the Noise Rating (NR) curves are popular (fig. 2) [1], [5]. These were meant to be applied to both internal and external environments. The difference between the NR and NC curves is that the NR curves extend below 63Hz. Because trends in building design are for compact plant rooms and services and for lightweight steel framed buildings the odds are stacked against progress [7], [12], [18].

In the USA, ASHRAE propose using RC curves (room criteria) for noise control, during the buildings project phase (fig. 3). It is necessarily to have a more stringent design criterion at the very low and very high frequencies, compared with NC and NR. Therefore noise control design will become more expensive [2], [8], [13], [17].

Table 1 shows a comparison of common noise criteria (and has been compiled by reference to space type).

Table 1 Ambient noise (according to noise criteria)

	Room types	NR (dB)	NC (dB)	RC (dB)
Very quiet	Concert and opera halls, live theatres (>500 seats)	20	10-20	15-20
	Private homes, churches, lecture rooms (>50 people)	25	20-25	20-30
Quiet	Public rooms in hotels, etc., hospital, offices, school classrooms	35	30-40	30-40
Moderately noisy	Toilets and washrooms, drawing offices, reception areas, lobbies, department stores	40	35-45	35-40
Noisy	Kitchen in hotels, hospitals, etc., laundry rooms, computer rooms, supermarkets	45	40-50	40-45

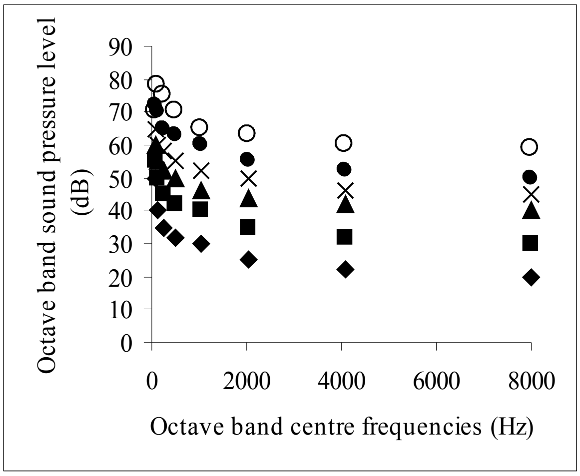

Fig. 1 NC curves (♦) – 20 Hz; (■) – 30 Hz; (▲) – 40 Hz; (x) – 50 Hz; (•) – 60 Hz; (o) – 70 Hz

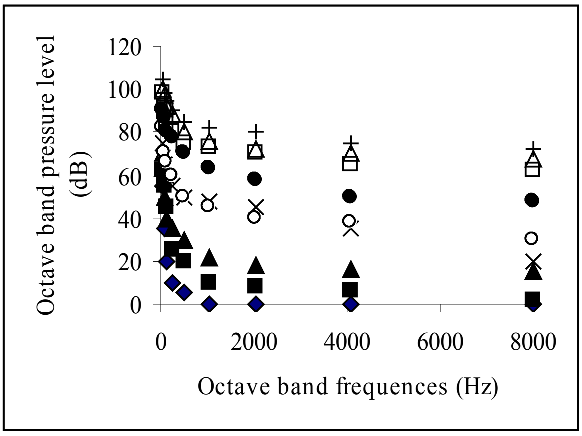

Fig. 2 NR curves (♦) – 10 Hz; (■) – 20 Hz; (▲) – 30 Hz; (x) – 40 Hz; (o) – 50 Hz; (•) – 60 Hz; (□) – 70 Hz; (Δ) – 80 Hz; (+) – 90 Hz

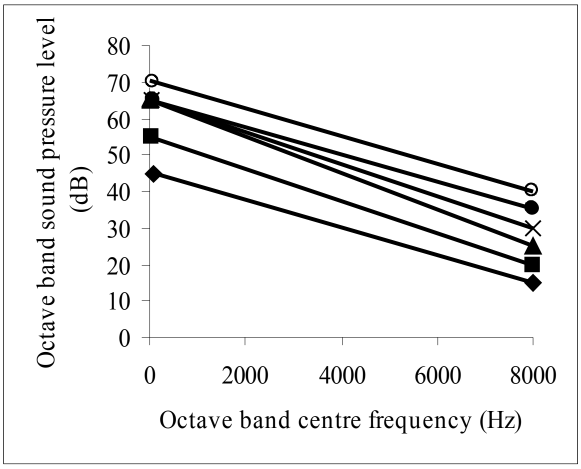

Fig. 3 RC curves: (♦) – 10 Hz; (■) – 20 Hz; (▲) – 30 Hz; (x) – 40 Hz; (•) – 50 Hz; (o) - 60 Hz

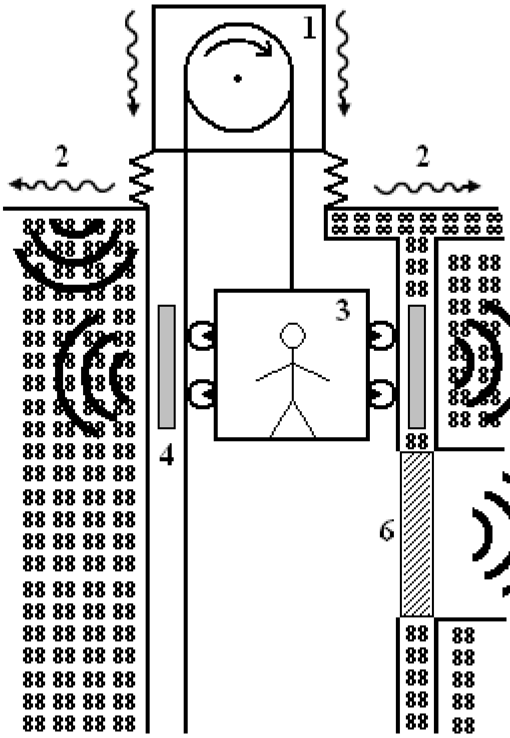

Fig. 4 Noise and vibrations sources in lifts (1) – lift machine; (2) – structure borne machine vibration; (3) – lift; (4) – guides and rollers; (5) – structure borne roller noise; (6) – door; (7) – noise though door gaps

3. Study of noise produced by elevators inside buildings

The noise level from lifts is easily attenuated by concrete slabs and walls which make up the lift motor room. Air-borne noise from lifts (fig. 4) is generally never a problem, typical noise levels in lift plant rooms being 75-80dB(A) for modern machines [3], [4], [10].

Structure-borne vibration from the lift car rollers has been substantially treated by the use of rubber tyres. Similarly, structure-borne noise from lift machines has largely been eliminated by the use of vibration isolation.

In office buildings, roller noise is not perceived as a problem at all. However, in residential buildings, lift noise in bedrooms common with the lift' shaft can be a problem, noise levels being in the range 35-40dB(A) from passing lifts [6].

The sound levels were measured in 2 cases: for an old office building and for a modern one.

The measurements were made in the hallways, near the elevator door, and also inside the offices, near the elevator party wall, at a distance of 3 and also 5 m from that wall. The results are shown in figures 5 and 6, where: ( ) - hall, near to lift; (■) - office, near to lift, (///) - office, 3m from the lift; (░) - office, 5m from the lift.

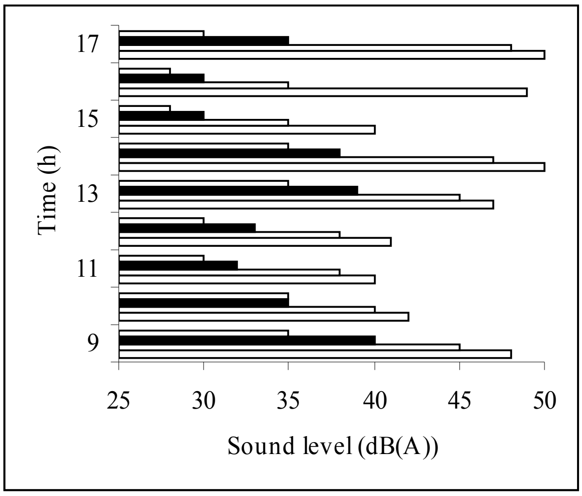

Fig. 5 The noise level dependence on the distance to an elevator inside a modern building

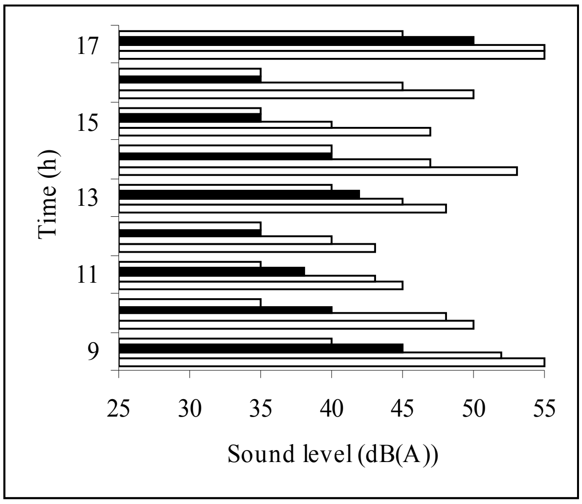

Fig. 6 The noise level dependence on the distance to an elevator inside an old building

It can be clearly seen from the figures the difference between a building where phonic isolations were used (the modern building-figure 5) as opposed to an old building (figure 6). Also, in both situations, there is a clearly difference between the sound levels measured near the elevator room and the levels measured inside the offices, at different distances (where the sound level decreased up to 18-20%, during the peak of the elevator usage).

As an illustration of this study it is obvious the need of new noise attenuation techniques usage (table 2).

Table 2 Lifts noise – attenuation techniques

Isolating material	The noise reduction
Use of sound absorption behind wall or ceiling	5 dB(A) if vibration isolated
Doubling the mass of the wall or ceiling	3-4 dB(A) if vibration isolated
Use of resilient furring channels on dry walls	6-10 dB(A)
Use of rubber clamps or similar material	6-10 dB (A) for structure borne noise. Effective in reducing structure borne noise if placed between duct clamps and lift wall.
Use of damping material	6-10 dB(A) if vibration isolated, otherwise 2-3dB(A)

4. Conclusion

The active noise and vibration control raises our interest when it comes to replacing passive silencing systems in buildings. There are a number of factors to be considered including system performance, cost and reliability.

Anyway, costs today would not make active noise control a viable option.

The silencers, mufflers, acoustic louvers and vibration isolation systems have remained relatively unchanged for decades. Only the design technology has changed.

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