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Chapter 6.6 (former 11)

6.6 Acoustic conditions

6.6.1 General

In order to provide suitable acoustic conditions for reading and working in libraries, the appropriate steps must be taken to control both the noise from outside and the noise produced within the building.

This chapter

- explains some technical aspects,
- specifies levels for acoustic comfort,
- describes systems for insulation and acoustic correction that can be used as a guide for library projects.

6.6.2 Types of noise

In the architectural context there are two types of noise:

a) airborne noise;

b) impact noise.

6.6.2.1 Airborne noise

This is transmitted through air and can also be reproduced through solid elements. It is originated in the air and the noise source can be both outside and inside the building. External airborne noise comes from the noise sources around the building (traffic, schools, industries, etc.). Internal airborne noise is produced by users and staff, by equipment (photocopiers, computers, etc.) and by utilities management (lifts, air conditioning, etc.).

Airborne noise is measured in A-weighted decibels (dBA).

6.6.2.2 Impact noise

Impact noise is caused by object dropping, vibrations and bangs, by contact of shoes with flooring, etc. It is transmitted very quickly by solid elements.

Impact noise is normally caused on floor structures. It can be prevented by building floating floors, consistent in a rigid basis separated from the floor structure by elastic joints.

Impact noise is measured in decibels (dB).

6.6.3 Architectural acoustics

Architectural acoustics is the set of techniques that allows to enables the control of acoustic characteristics and the attainment of the level of acoustic comfort desired in the premises.

There are two types:

a) acoustic insulation (the capacity of the building elements to reduce noise transmission from one part to another and between the outside and the inside);

b) acoustic absorption (the property of the building materials to absorb acoustic energy and diminish the reflection of sound waves produced inside the buildings).

When a sound wave reaches a surface, one part is reflected, another is absorbed by the surface, and the remainder is transmitted to the other side. If the sound source and the receiver are in different rooms, the reduction is made by acoustic insulation of the building elements that separate them. When the sound source and the receiver are in the same room, possible disturbing noises can be reduced by acoustic absorption.

6.6.4 Recommended acoustic comfort levels

In order to achieve acoustic comfort, a series of parameters must be controlled. The principal ones are:

a) Sound level: For each type of space a sound level must be established, which permits to carry out a specific activity in a comfortable way.
Sound level is measured in A-weighted decibels (dBA).

b) Reverberation time: A sound originated in a place with reflective walls is still perceived during a fraction of time after it is produced. The ideal reverberation time is the value that limits the duration of noise to an acceptable length. It is directly proportional to the volume of the space and inversely proportional to the capacity of absorption of the covering.
The reverberation time is measured in seconds (s).

Table 1: Recommended acoustic comfort levels for functional areas

Type of space	Sound level (dBA)	Reverberation time (s)
Entrance area and circulation spaces	< 50	1
Auditorium	A specific acoustic study should be done to establish the optimum values required for the activities planned.	
Recreation/communication area for users	< 50	0.9
Training rooms and area/rooms for meetings and events	< 40	0.8 – 1
Reading rooms, open stacks and reception/loan desks and information points	< 40	0.8
Quiet study areas	< 35	0.7
Children's library	< 40	0.8 – 1
Reprography space	< 45	1
Offices for administration	< 40	0.8 – 1

For offices there will often be local or national regulations as to noise limits.

To achieve these acoustic comfort levels, enclosures and dividing walls must be insulated against noise generated both in adjoining premises and external to the building.

6.6.5 Insulation and acoustic correction systems

The following recommendations should be considered already in the start of a building project, as they can facilitate the performance of the acoustic comfort levels stated before.

6.6.5.1 Location

It is very important to bear in mind the acoustic characteristics of the building plot and its surroundings (intense traffic, schools, industries, etc.). In some occasions it can be more effective to find another location than to adequately isolate a building placed in a difficult acoustic environment.

6.6.5.2 Distribution of functional areas

It is necessary to know the type of use of every room, as well as to localize and recognize the noise sources of the building. From here, the different spaces should be distributed in a way that the sources of noise and the noisier areas are away from the quiet rooms.

It is advisable to place the areas where there is greater traffic and greater noise near to the entrance areas (reception/loan desk and information point, reprography space, children's library, etc.), in order to minimize acoustic interferences with areas which need silence (area for reading and studying, etc.).

Utilities management spaces for air conditioning, lift machinery, etc., are large noise generators, so they must be concentrated and separated from the areas which need silence. This way it will not be necessary to design many heavily insulated partitions.

It is also important to pay attention to the volume of some areas. Staircases, entrance halls and, in general, areas with double or triple heights increase reverberation a lot. In these cases, coverings with a high coefficient of acoustic absorption must be used.

6.6.5.3 Facades and roofs

All facades must be insulated for sound, bearing in mind that the openings are the weakest and most difficult elements to insulate.

The interface of the openings with the facades must be done through hermetic joints and the opening mechanisms must not cause vibrations.

Roller blind boxes are an acoustic bridge which should be avoided. It is recommended that other types of solar protection be provided.

It is preferable that the access doors have an inner door (double door) to reduce the transmission of exterior noise. Likewise, automatic and revolving doors are preferred to folding doors.

Lightly constructed roofs cause acoustic problems, mainly due to impact noise caused by rain or hailstones. A double layer incorporating insulating materials is required.

6.6.5.4 Flooring

Impacts generated on the flooring are transmitted to the floor structure, causing airborne noise in the lateral and lower premises. Therefore, the chosen surface should minimize or eliminate this problem.

It can be solved by using light flooring and floating floors. Light floorings avoid impact noise. Floating floors, which consist of a rigid basis separated from the floor structure by elastic joints, separate the source point of impact noises from the building structure, decreasing in this way its transmission. Therefore, from the acoustics point of view, the ideal solution is the floating floor with a light flooring finish.

(See also Chapter 6.7)

6.6.5.5 Ceilings

It is recommended that ceilings be covered with absorbent materials in order to reduce reverberation time. Bearing in mind that the majority of absorbent materials are soft and fragile, it is recommended that they are out of arms reach.

6.6.5.6 Vertical dividing walls

It is very important to achieve a continuity of enclosure insulation of the premises to avoid acoustic bridges. It is especially relevant in vertical walls which end at the false ceiling and do not reach to the upper floor structure, as well as in ducting for building services.

To improve insulation in entrances to some premises, inner doors (double doors) are recommended, as well as installing mechanisms that avoid noise produced by slamming, opening and closing doors.

6.6.5.7 Utilities management space

A very important aspect to bear in mind is the noise coming from utilities management space for air conditioning, lift machinery, etc. The majority of these utilities generate airborne noise and impact noise. Therefore, it is transmitted both through the air and the solid elements.

Premises which provide space for utilities management must be acoustically insulated and machine fulcrums must be separated from the building structure by bedplates, springs or elastic elements.

Installation routes, pipes and tubes must be fixed on the building elements (walls and floor structures) in an elastic way to avoid vibration transmission.

Machines and elements that are placed in or enter every room (motors, fans, air vents, etc.) should not cause disturbance (incorporation of silencers, control of fluid circulation velocity, etc.).

Installations related to the systems of automated transport and automated storage should also be well insulated.