



6.2 Load assumption

6.2.1 General

This chapter gives guidelines and numerical values for defining and calculating the structure of buildings intended for libraries.

More specifically it aims at establishing numerical values concerning live loads since this has a direct relation to the use of the building.

Buildings being converted for use as libraries require a more detailed study because many old buildings do not support such loads.

The following factors must be borne in mind when calculating the structure of a building:

- a) permanent actions (the structure's own weight and that of the flooring, the permanent walls, actions of the terrain, etc.);
- b) variable actions (live loads, partitioning elements, wind, thermal actions, snow, etc.);
- c) accidental actions (fire, seismic movements, etc.).

6.2.2 Live load

Live load is defined as the weight of all that which might rest upon each part of the building in the course of its use (people, furniture, stored materials, fixed installations, etc.).

The position of the objects whose weight constitutes live load is variable and, in general, indeterminate, but from the point of view of calculating the structure of the building, their effects can be simulated by applying a uniformly distributed load.

To determine this value the types of space within a library need first to be differentiated, so that the live load recommended for each of them can be indicated.

6.2.3 Types of space and recommended live load

In terms of their influence on calculating the building's structure, the following types of space should be considered:

- a) spaces with documents on shelves or any other sort of storage furniture;
- b) compact shelving areas;
- c) highly frequented areas;
- d) areas with fixed seating;
- e) areas with only tables and chairs;
- f) mobile library parking area;
- g) other areas.

6.2.3.1 Spaces with documents on shelves or in any other sort of storage furniture

Spaces with document storage include in the first place open or closed stack areas and all kinds of reading rooms, but also offices for administration where documents are kept on shelves or in other furniture.

In the majority of libraries, this type embraces most of the spaces that are counted as main usable area.

Live load: A specific number cannot be given, since it can vary according to the kind of material stored and to its distribution. So as to calculate the live load it is essential to establish a hypothetical distribution of the shelves.

In order to offer some guidance figures, the live load is calculated for two hypotheses:

Example 1 *Open access storage area (e. g. reading rooms with shelves)*

- Axis centre distance: 190 cm (aisle width: 130 cm).
- Maximum depth of shelving: 30 cm.
- Maximum height of shelving: 225 cm.
- Number of shelves: 6
- Information is stored on paper.

In many cases, different types of media will be stored in the stack areas. From the structural point of view, paper is the most unfavourable hypothesis (paper density ranges between 6 and 11 kN/ m³).

New building

- Live load: 5 kN/m²
This value could reach 7 kN/m² if, in a hypothetical case, the documents occupied an 80% of the total volume of the shelves.
- Reinforced compression layer in the floor slabs: 5 cm thick with mesh.

In floor slabs with the beams all running in the same direction, add reinforcing elements at right angles to the beams. These elements working together will compensate for the linear load of the shelving, equalising deformations and spreading the forces better.

Refurbishment

The load affects the floor slabs, the columns and the foundations. It is therefore necessary to analyse each element in order to determine how to proceed with each of them correctly.

In very general terms the following recommendations can be made:

- Uniform live load for all the structural elements: 3 kN/m² for columns and foundations reinforcement, and 5 kN/m² for floor slab reinforcement.
Add reinforcing elements at right angles to the beams. These elements working together will compensate for the linear load of the shelving. These reinforcing elements must resist 5 kN/m linear, with a gap between centres not exceeding 150 cm.
- Reinforced compression layer in the floor slabs: 5 cm thick with mesh.

Example 2 Open stacks

- Axis centre distance: 150 cm (aisle width: 90 cm).
- Maximum depth of shelving: 30 cm.
- Maximum height of shelving: 225 cm.
- Number of shelves: 6
- Information is stored on paper.

New building

- Live load: 6 kN/m²
This value could reach 9 kN/m² if, in a hypothetical case, the documents occupied an 80% of the total volume of the shelves.

6.2.3.2 Compact shelving areas

Live load: It depends on the type of shelving, on the shelf height and on the type of material stored.

Given that the load required is far superior to the rest of the library it is convenient to define these spaces at the beginning of the project. It is recommended to locate such shelving on the lower floors of the building, so that the structural reinforcement need not be applied at the upper levels.

In order to offer some guidance figures, the live load is calculated for two hypotheses, bearing in mind that the information is exposed on paper.

Example 3 Compact shelving of 150 cm height

- Live load: 10 kN/m²

Example 4 Compact shelving of 225 cm height

- Live load: 15 kN/m²

6.2.3.3 Highly frequented areas

Entrance areas, multipurpose halls, exhibition areas, area/rooms for meetings and events, etc.

- Live load: 5 kN/m²

6.2.3.4 Areas with fixed seating

Auditoria, etc.

- Live load: 4 kN/m²

6.2.3.5 Areas with only tables and chairs

Reading rooms without shelves, classrooms, etc.

- Live load: 3 kN/m²

6.2.3.6 Mobile library parking area

The vehicle's large size and the weight of the lending materials cause occasional large loads at the point of contact between the wheels and the pavement.

The floor slabs must be calculated depending on the size and design of the mobile library.

The following values may be used for reference:

- Approximate live load: 10 kN/m²
- Reinforced compression layer in the floor slabs: 8 cm thick with mesh with a diameter equal to or greater than 8 mm, with mesh cells no larger than 20 x 20 cm.

6.2.3.7 Other areas

Storerooms, automated storage areas, areas with specific machinery (machines for self-service charging, for transport of documents, binding, etc.), utilities management spaces for air conditioning or lift machinery, etc.

- Live load: The live load occasioned by the accumulation of material or of heavy equipment must be calculated on the basis of the type and quantity of material stored, as well as with consideration of the way the load is distributed and its effect on the structure.

6.2.4 Overview of live load (rounded)

Type of space	Live load (kN/m ²)
6.2.3.1 Spaces with documents on shelves or in any other sort of storage furniture	Depending on the kind of material stored and on its distribution.
- <i>Example 1 (axis centre distance: 190 cm)</i>	5
- <i>Example 2 (axis centre distance: 50 cm)</i>	6
6.2.3.2 Compact shelving areas	Depending on the type of shelving, on the shelf height and on the type of material stored.
- <i>Example 3 (150 cm height)</i>	10
- <i>Example 4 (225 cm height)</i>	15
6.2.3.3 Highly frequented areas Entrance areas, multipurpose halls, exhibition areas, area/rooms for meetings and events, etc.	5
6.2.3.4 Areas with fixed seating Auditoria, etc.	4
6.2.3.5 Areas with only tables and chairs Reading rooms without shelves, classrooms, etc.	3
6.2.3.6 Mobile library parking area	10
6.2.3.7 Other areas	A specific calculation would be necessary.

A safety coefficient must be applied to all these values. Although each country has its own coefficients for the calculation of building structures, in the case of live load it is reasonable to assume a value of 1.5.

Bearing in mind that in libraries flexibility and the ability to modify the functions of spaces and the distribution of equipment are essential, it is advisable to calculate most of the structure with a uniform live load appropriate for all forms of use. It is therefore recommended to apply the same live load necessary for the spaces with documents on shelves to all the spaces included in sections 6.2.3.1, 6.2.3.3, 6.2.3.4 and 6.2.3.5.