



جامعة أبو بكر بلقايد

كلية التكنولوجيا

UNIVERSITÉ DE TLEMCEM

Faculté de Technologie



A3 ARCHITECTURE

SUBJECT: STRUCTURE IN ARCHITECTURE 1

CHAPTRE 4 : FLOORS

DR. TABET-DERRAZ MOULAY IDRIS

Email: moulayidriss.tabetderraz@univ-tlemcen.dz

INTRODUCTION

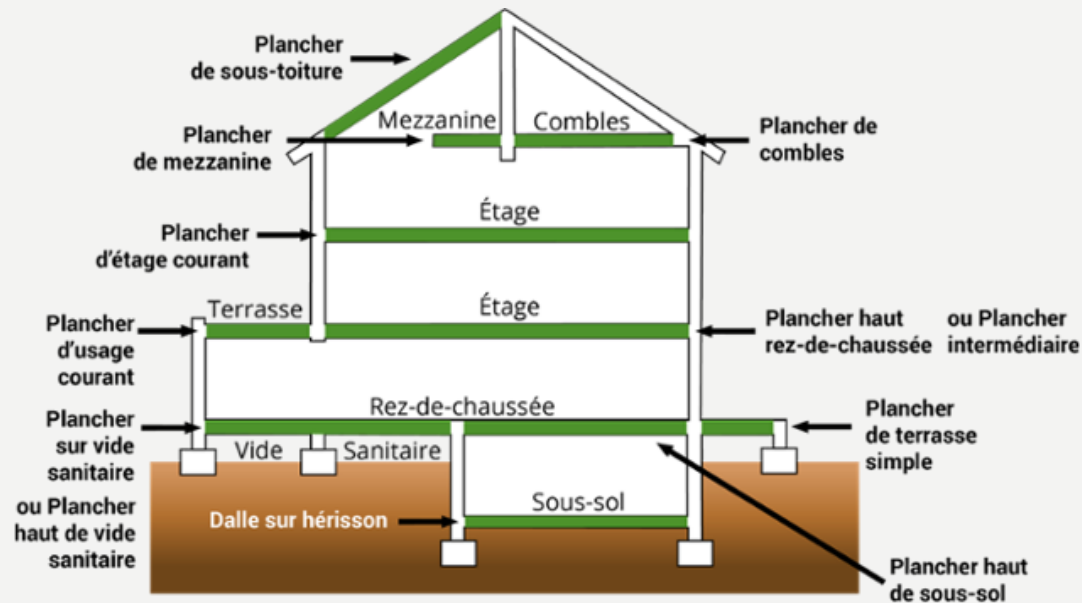
A floor is a horizontal structural element that provides a planar span, meaning it covers a space between supports on the same level. By separating two stories, it transmits vertical loads to beams, columns, or load-bearing walls while contributing to the overall rigidity of the building.



ROLE OF THE FLOOR

A floor is a horizontal structural element that:

- Separates two levels (floor-to-floor, floor-to-roof, floor-to-basement).
- Transmits vertical loads (self-weight + live loads) to beams, load-bearing walls, or columns.
- Provides overall building rigidity (resistance to wind, distribution of forces).
- Contributes to acoustic and thermal insulation depending on its configuration.



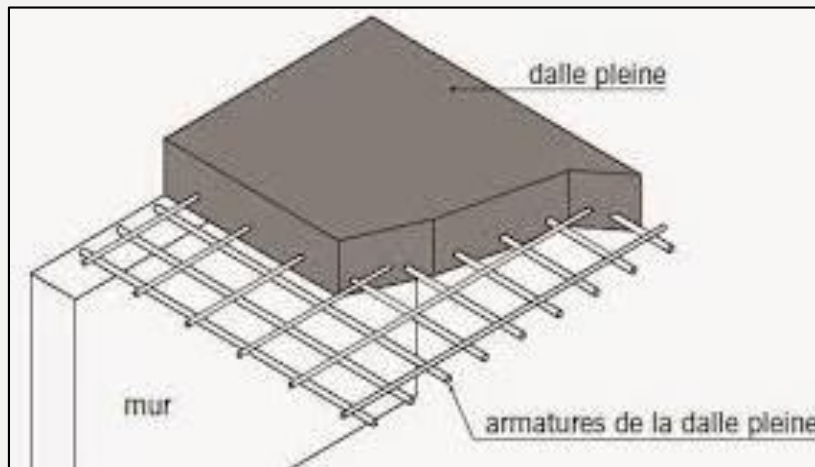
TYPES OF FLOORS

Floors are generally classified according to the materials used and the type of supports (on columns or on load-bearing walls):

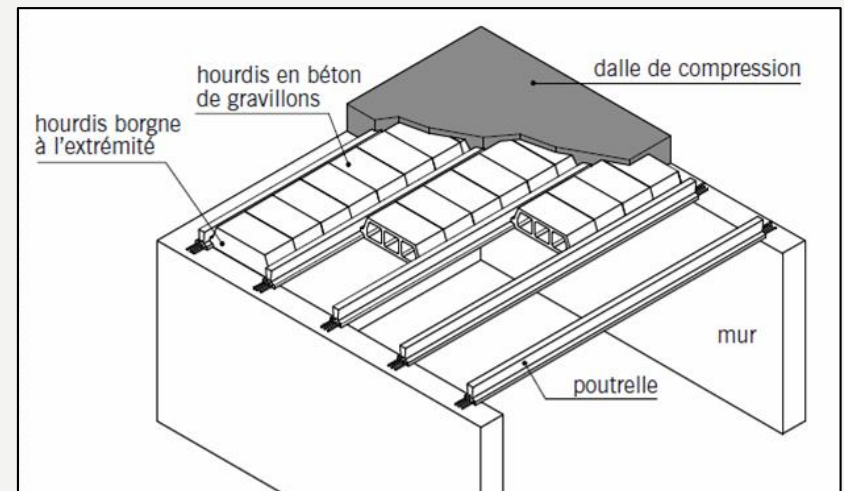
1 – Reinforced Concrete Floors

There are several types of reinforced concrete floors, but the most common are:

Solid Slabs



Hollow-Core Slabs



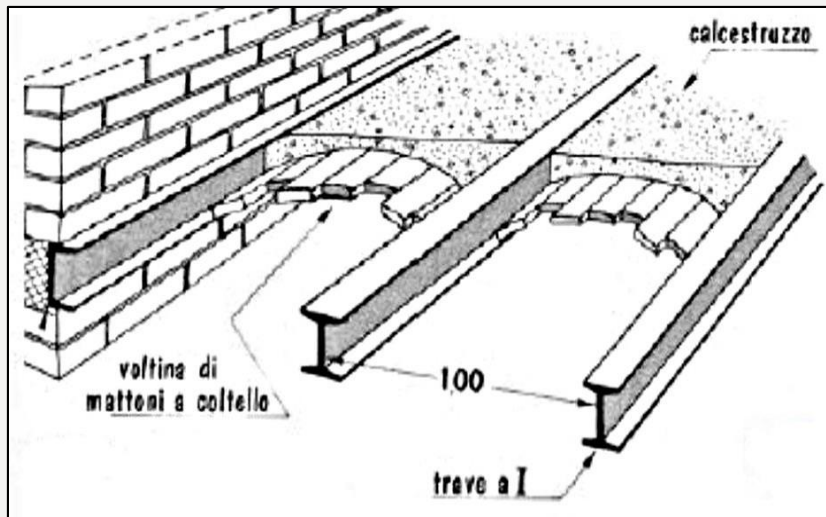
TYPES OF FLOORS

Floors are generally classified according to the materials used and the type of supports (on columns or on load-bearing walls):

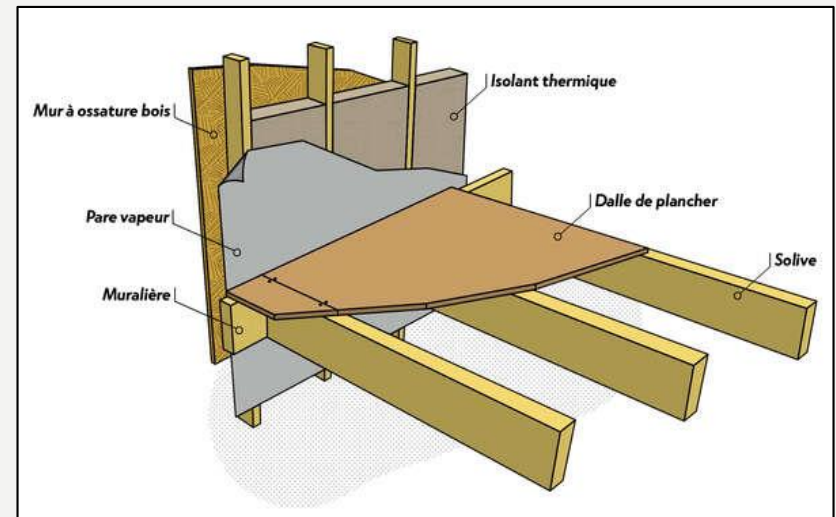
2 – Joist Floors (Wood or Steel)

In these floors, the joists serve as the load-bearing elements:

Steel Joist Floor



Wood Joist Floor



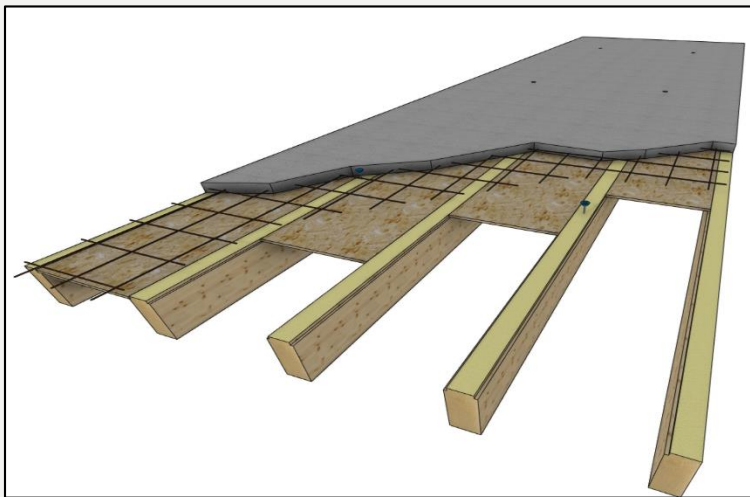
TYPES OF FLOORS

Floors are generally classified based on the materials used and the type of supports (on columns or on load-bearing walls):

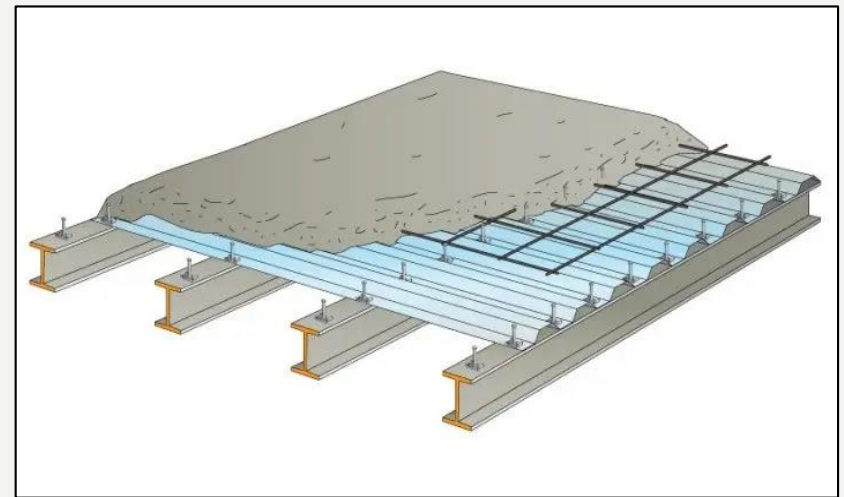
3 – Composite Floors (Wood-Concrete or Steel-Concrete)

These floors are combinations of two materials.

Wood-Concrete Composite Floor



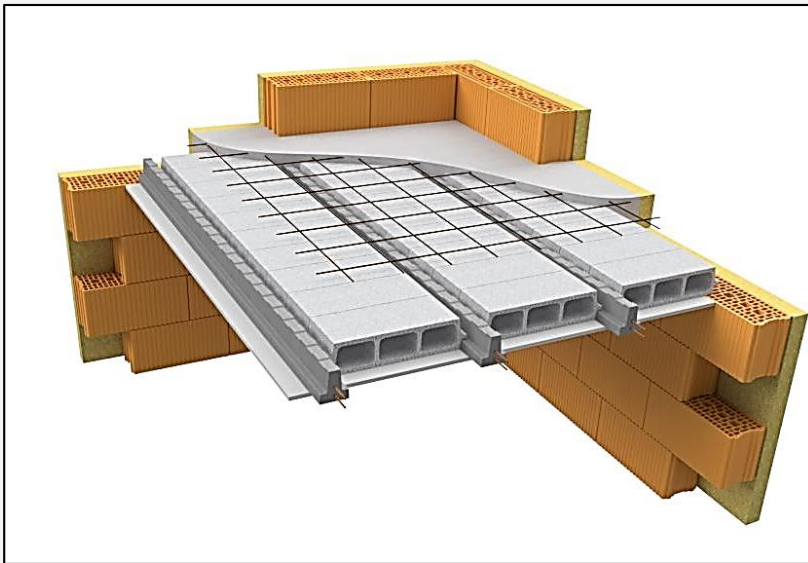
Steel-Concrete Composite Floor



REINFORCED CONCRETE FLOORS

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

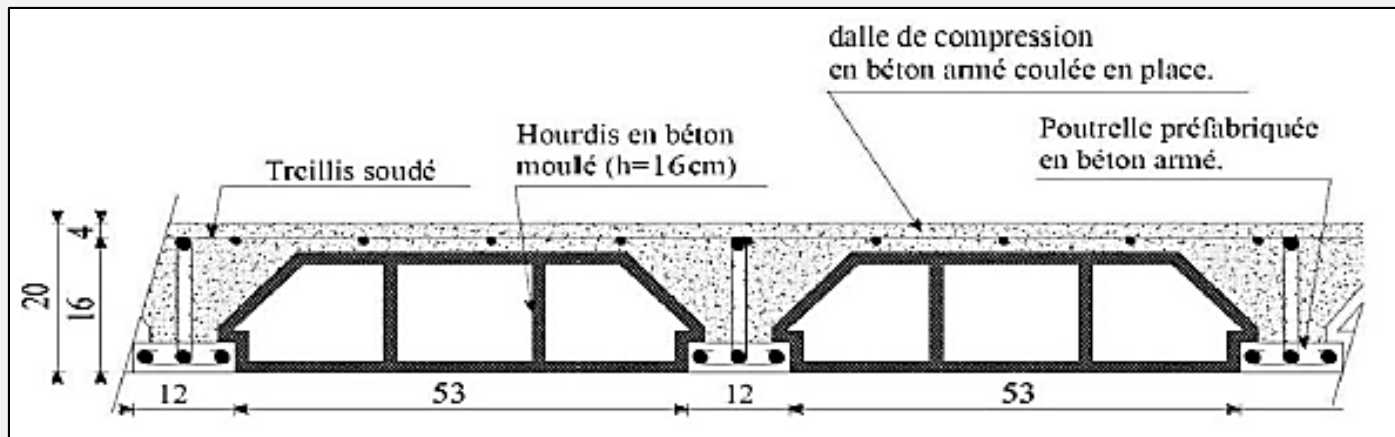
Definition : It is a thick (16 to 25 cm) yet lightweight slab composed of beams, a compression slab, and hollow elements (hollow blocks).



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Principle : The system spans in a single direction through the beams:

- The beam resists bending moments and shear forces, and it transmits the loads to the main beams.
- The compression slab provides cohesion, rigidity, and load distribution.
- The hollow blocks have no structural role but allow for the passage of utilities, such as electrical conduits.



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

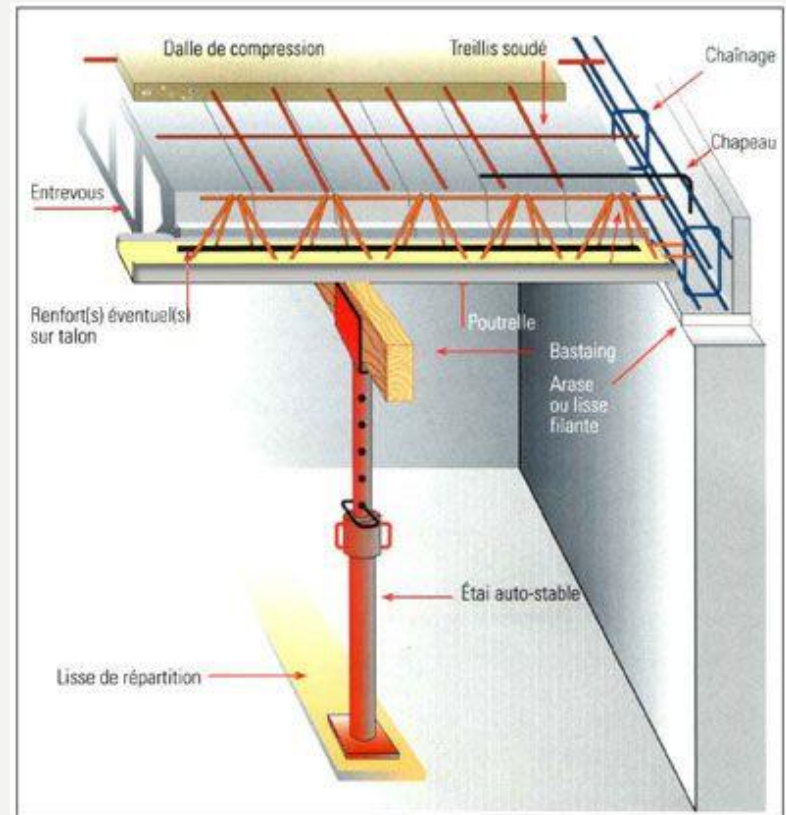
Implementation: The system spans in a single direction through the beams:

1-Installation of the components

- Setting up the support devices and shoring (formwork with props)
- Laying the reinforcement for the beams and joists
- Placing the hollow blocks / infill blocks
- Laying the welded mesh for the compression slab

Video :

https://www.youtube.com/watch?v=dVVa_I9donw



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Implementation: The system spans in a single direction through the beams:

2 – Pouring the concrete for the slab

- Pouring the concrete (beams, joists, and compression slab)
- Surface Finishing
- Curing and Protection of Concrete



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Implementation: The system spans in a single direction through the beams:

3 – Removing the formwork from the slab

- Removing the shoring and formwork
- Post-Installation Inspections



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

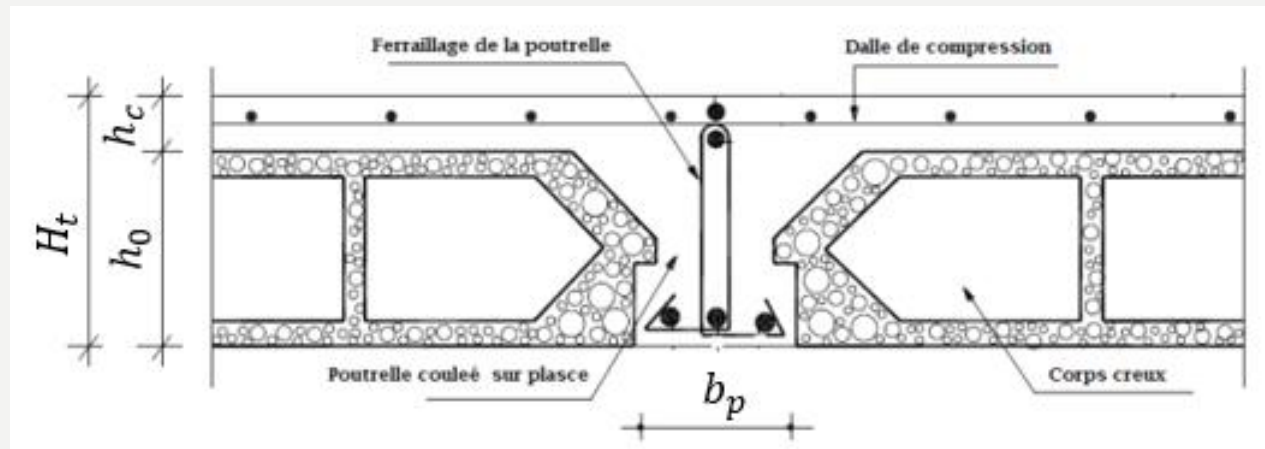
Advantages and Disadvantages

Advantages	Disadvantages
<ul style="list-style-type: none">- Reduced self-weight- Savings in concrete and steel- Rapid installation- Good thermal insulation (EPS)- Suitable for common spans- Simplified formwork	<ul style="list-style-type: none">- Lower rigidity compared to a solid slab- Spans in a single direction- Sensitive to punching shear- Difficult to make openings- Not suitable for long spans

Uses
<ul style="list-style-type: none">- Individual houses- Residential floors- Intermediate floors- Roof terraces- Small buildings and lightweight offices

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Preliminary Design: This is the initial estimation of the main dimensions of hollow-core slabs before detailed calculations. It allows defining a realistic initial height to ensure strength and prevent excessive deflection.



H_t : The total height of the hollow-core slab

h_0 : The height of the hollow blocks

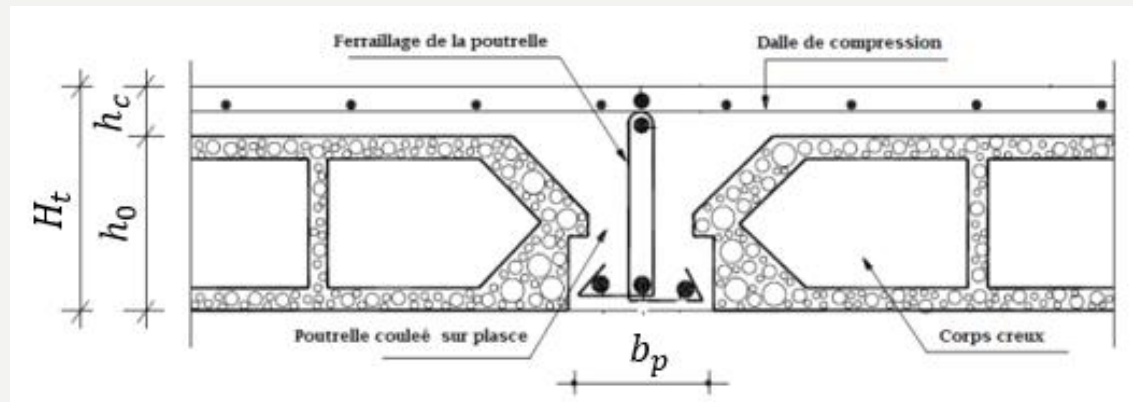
h_c : The thickness of the compression slab

b_p : The width of the beam

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Preliminary Design:

- According to CBA93 standards, the floor height must satisfy the following condition:



$$H_t \geq \frac{L}{22.5}$$

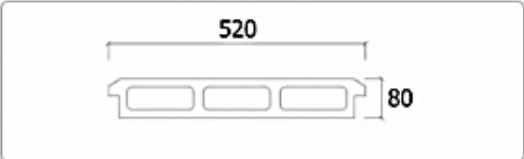
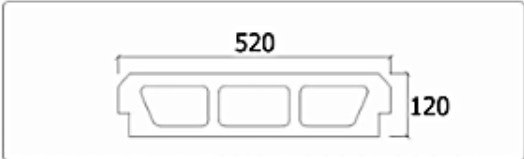
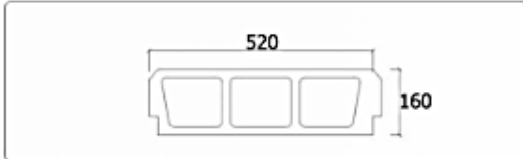
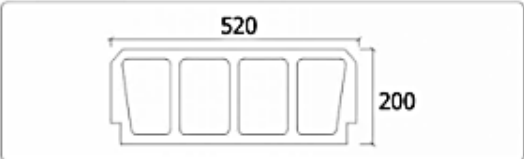
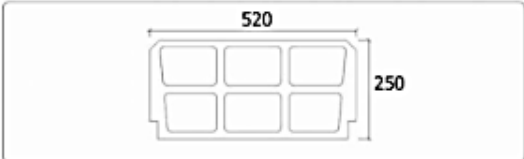
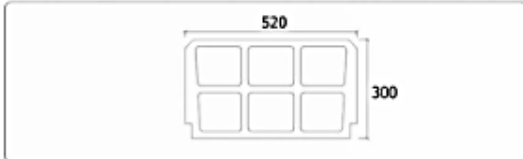
L : This is the maximum unsupported span of the beams.

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Preliminary Design: The total height of the hollow-core slab is

$$H_t = h_0 + h_c$$

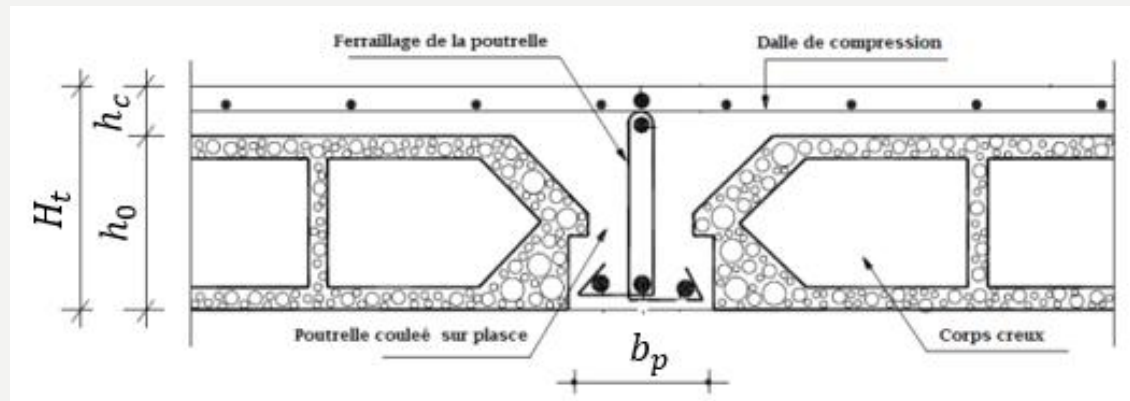
- According to the CBA93 recommendations, the thickness of the compression slab must be $h_c \geq 4 \text{ cm}$
- Furthermore, the hollow blocks have the following standard dimensions:

<p>Hourdis 08</p>  <p>520</p> <p>80</p>	<p>Hourdis 12</p>  <p>520</p> <p>120</p>	<p>Hourdis 16</p>  <p>520</p> <p>160</p>
<p>Hourdis 20</p>  <p>520</p> <p>200</p>	<p>Hourdis 25</p>  <p>520</p> <p>250</p>	<p>Hourdis 30</p>  <p>520</p> <p>300</p>

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Preliminary Design

- According to NF DTU 23.5 standards, the floor height must satisfy the following condition:



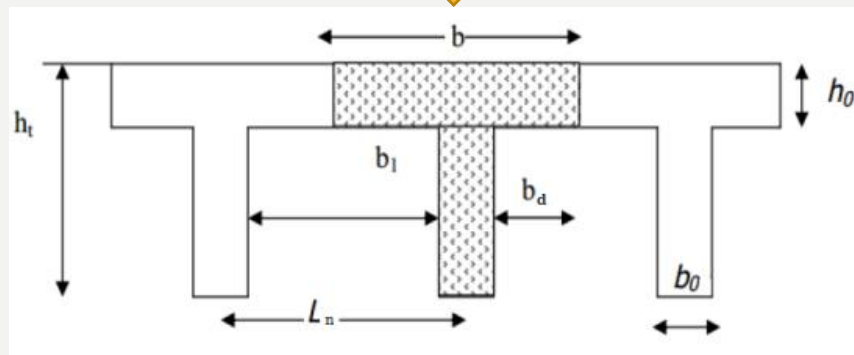
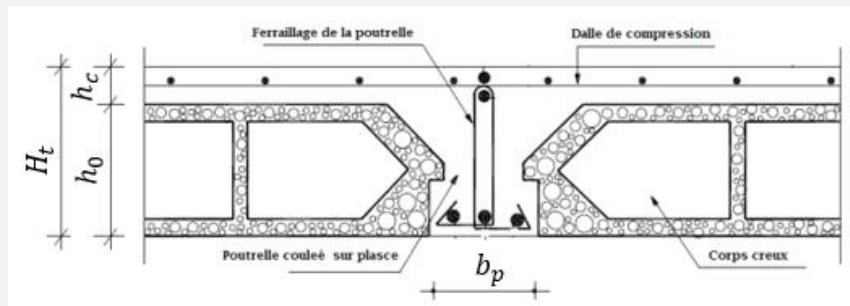
$$0.3H_t \leq b_p \leq 0.5H_t$$

H_t : The total height of the hollow-core slab

REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

Design of Steel Reinforcement

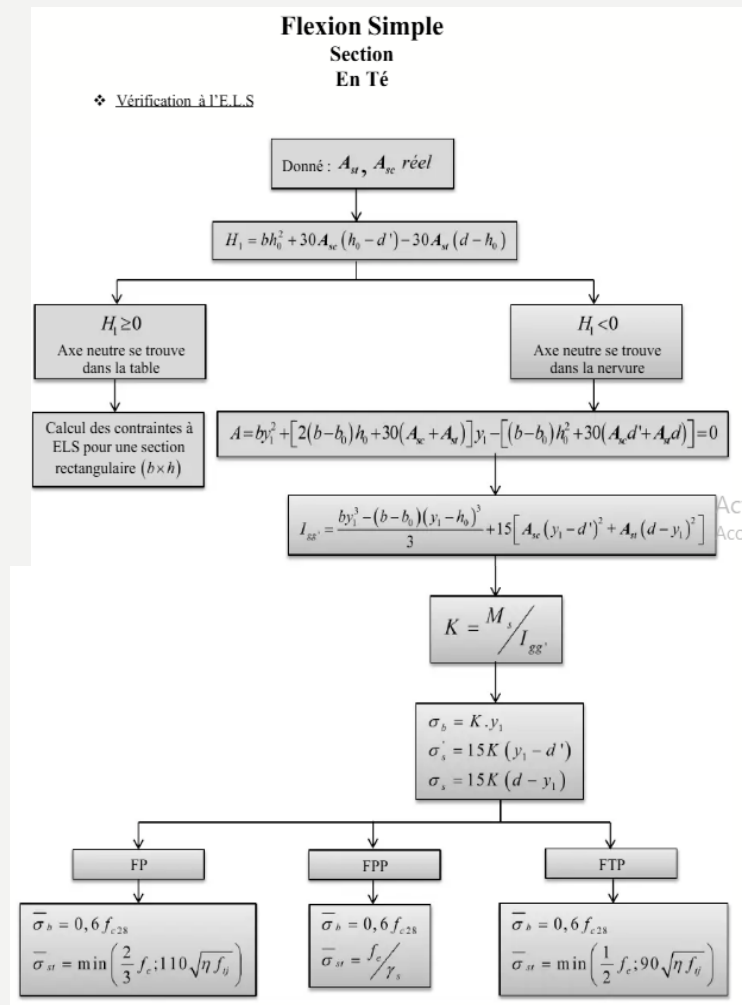
- The reinforcement calculation for the compression slab and the beam is performed as a T-section under simple bending.



REINFORCED CONCRETE FLOORS (HOLLOW-CORE SLABS)

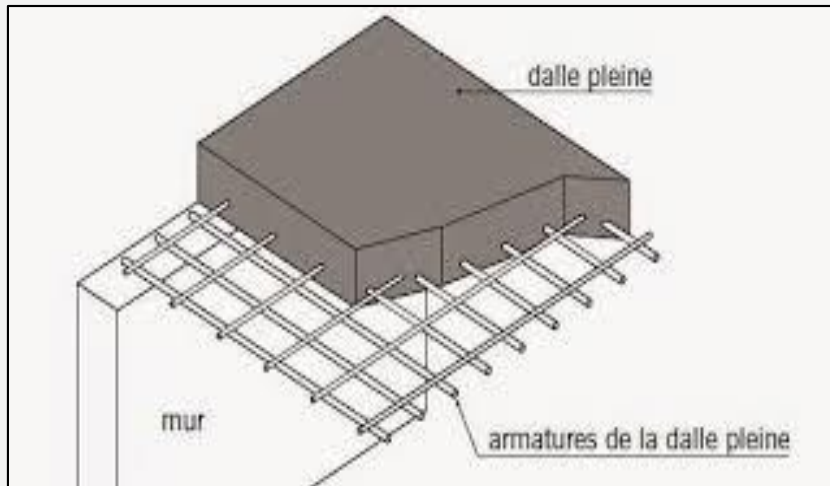
Design of Steel Reinforcement

- The required reinforcement section for the beams and the compression slab is calculated according to the following flowchart:



REINFORCED CONCRETE FLOORS (SOLID SLAB)

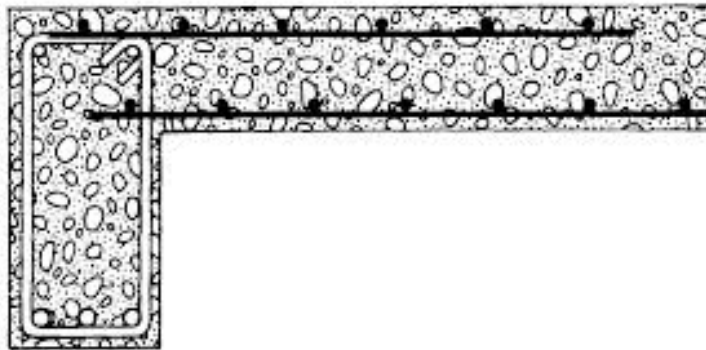
Definition : A solid slab is a horizontal reinforced concrete element with a fully solid rectangular cross-section, without voids or hollow cores. It primarily acts in bending and transfers loads to beams, walls, or columns.



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Principle : Install a fully reinforced concrete slab with:

- Uniform thickness across the entire surface.
- Solid concrete without any internal voids.
- High rigidity, allowing deflections to be limited.
- Reinforcement placed in a lower layer (tension zones) and an upper layer (negative zones near supports).



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Implementation : The system spans in one or two directions using a reinforcement mesh:

1- Installation of components

- Placement of support devices and shims (formwork with props)
- Placement of steel reinforcement in two directions and in two layers
- Place spacers under the bars to ensure proper concrete cover

Video :

<https://www.youtube.com/watch?v=3bl0PV2hNho>



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Implementation : The system spans in one or two directions using a reinforcement mesh :

2- Slab concreting

- Concrete pouring (beams and slab)
- Surface finishing
- Concrete curing and protection



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Implementation : The system spans in one or two directions using a reinforcement mesh :

3- Slab formwork removal

- Removal of props and formwork
- Post-construction inspections



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Advantages and disadvantages

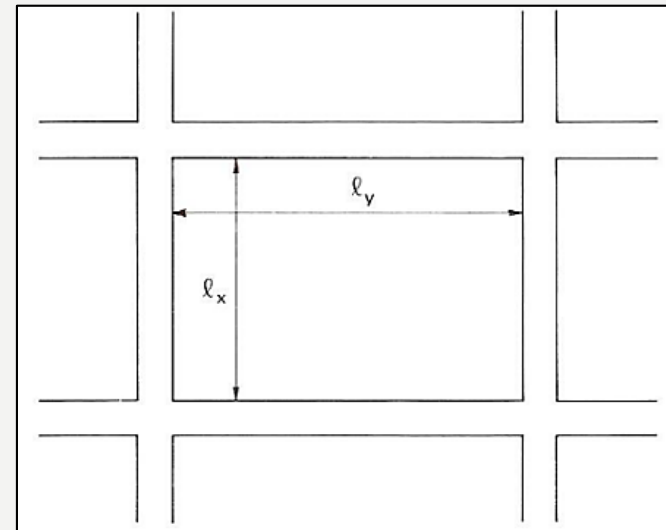
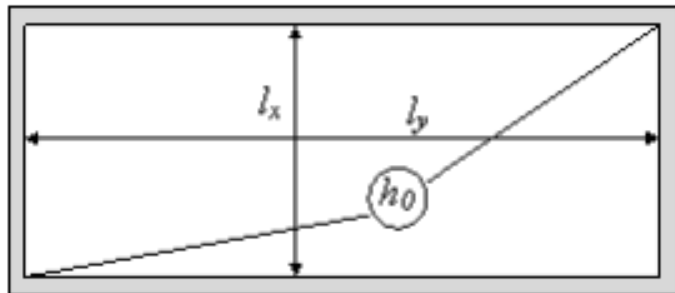
<u>Advantages</u>	<u>Disadvantages</u>
<ul style="list-style-type: none">- Very high rigidity- Good resistance to concentrated and heavy loads- Easy to construct (simple formwork and conventional reinforcement)- Good acoustic insulation (high mass)- Suitable for irregular shapes (flexible geometry on site)	<ul style="list-style-type: none">- High self-weight, increasing the permanent loads on the structure- Significant consumption of concrete and steel (higher cost)- Longer formwork removal time- Not economical for large spans

<u>Uses</u>
<ul style="list-style-type: none">- Residential, office, or industrial buildings- Terrace slabs, balconies, canopies- Raft foundation or foundation slab- Floors requiring openings or subjected to heavy concentrated loads

REINFORCED CONCRETE FLOORS (SOLID SLAB)

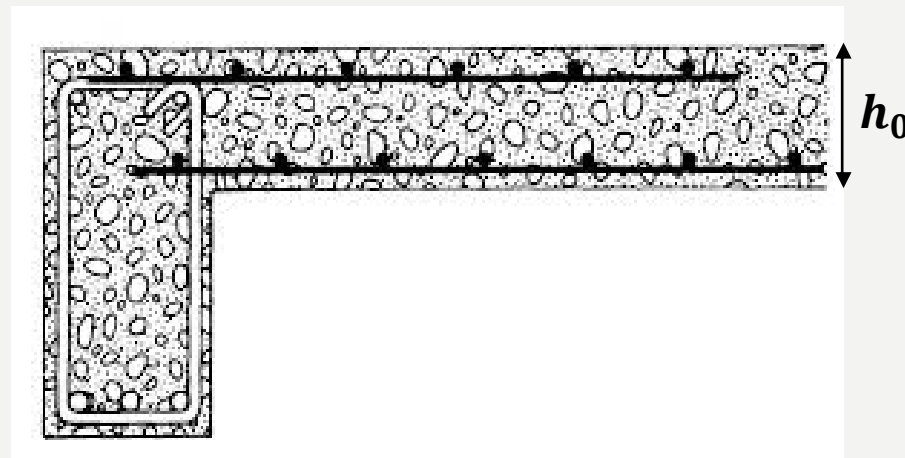
Behavior : Solid slabs act in one direction or in two directions:

- If $\frac{l_x}{l_y} \leq 0,4$ Solid slabs act in one direction (reinforcement in a single direction)
- If $0,4 \leq \frac{l_x}{l_y} \leq 1$ Solid slabs act in two directions (reinforcement in two directions)



REINFORCED CONCRETE FLOORS (SOLID SLAB)

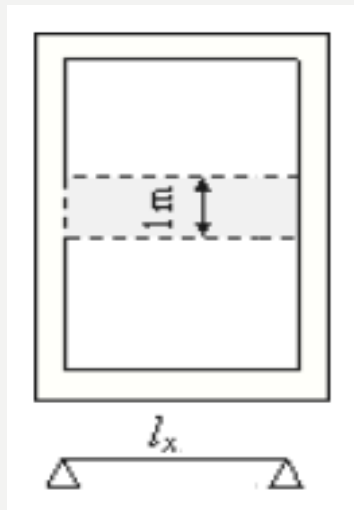
Preliminary Design: This is the initial estimation of the main dimensions of solid slabs before the detailed reinforcement calculation. It allows defining a realistic initial height to ensure strength and prevent excessive deflections.



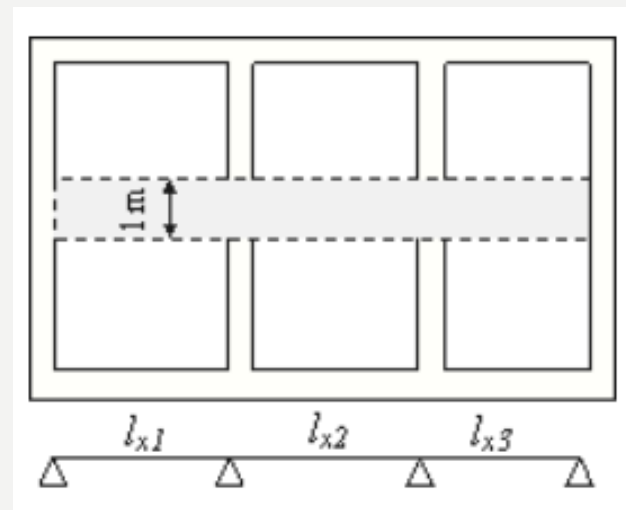
REINFORCED CONCRETE FLOORS (SOLID SLAB)

Predimensionnement : It is necessary to understand that the calculation is carried out on a 1 m wide strip for both cases of solid slabs.

1- One-way solid slab (reinforcement in a single direction)



Isolated panel

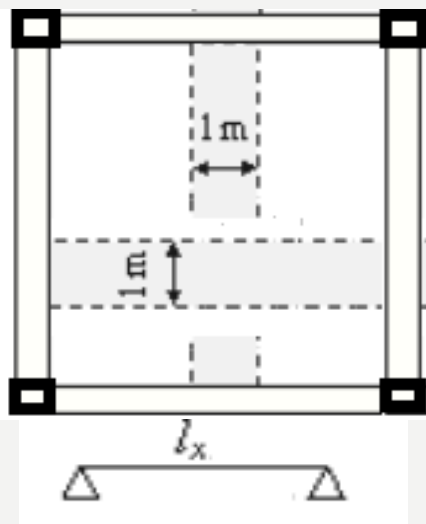


Continuous panel

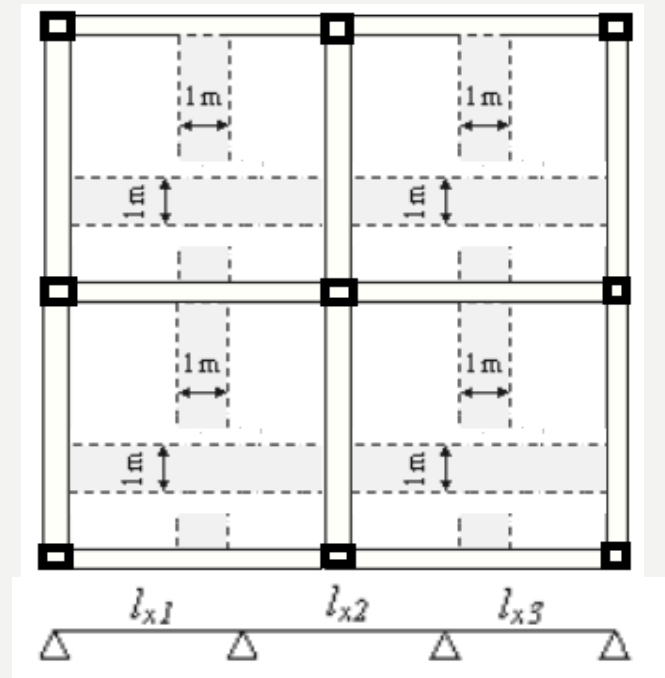
REINFORCED CONCRETE FLOORS (SOLID SLAB)

Preliminary Design: It is necessary to understand that the calculation is carried out on a 1 m wide strip for both cases of solid slabs.

2- Two-way solid slab (reinforcement in two directions)



Isolated panel

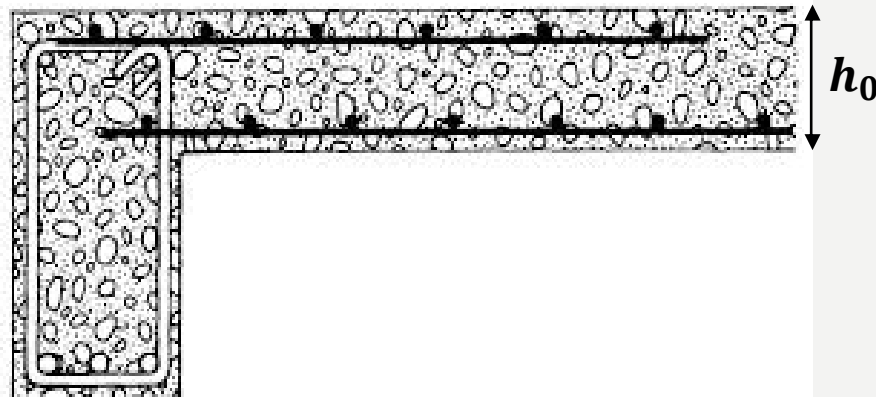


Continuous panel

REINFORCED CONCRETE FLOORS (SOLID SLAB)

Preliminary Design: The height of the solid slab is estimated by:

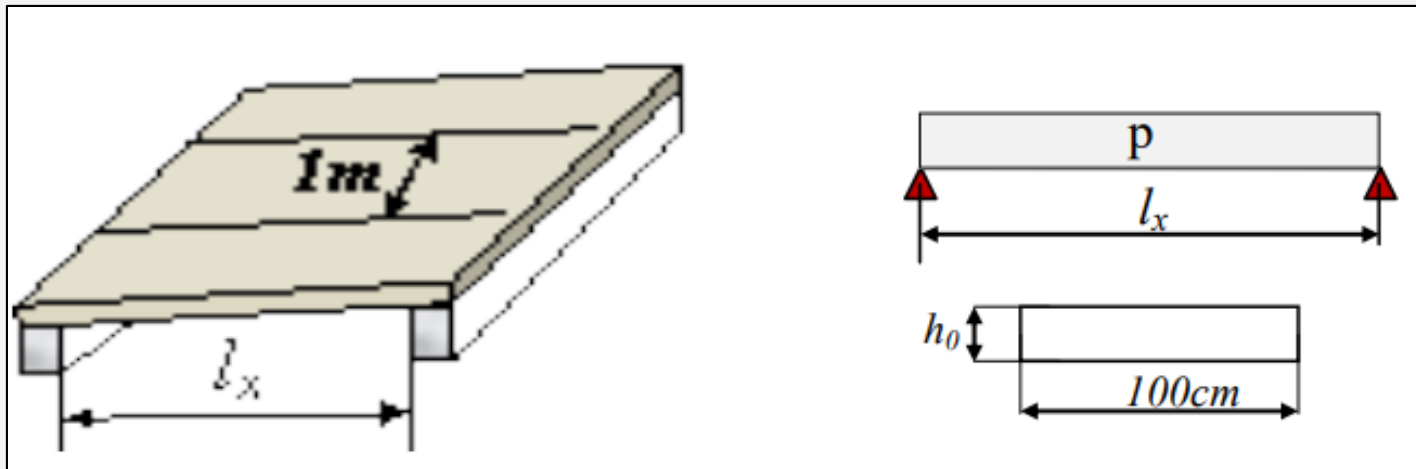
	One-way slab	Two-way slab
	$\frac{l_x}{l_y} \leq 0,4$	$0,4 \leq \frac{l_x}{l_y} \leq 1$
Slab on simple supports (without continuity)	$h_0 \geq \frac{l_x}{20}$	$h_0 \geq \frac{l_x}{30}$
Continuous slab	$\frac{l_x}{30} \leq h_0 \leq \frac{l_x}{35}$	$\frac{l_x}{40} \leq h_0 \leq \frac{l_x}{45}$



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Design of Steel Reinforcement:

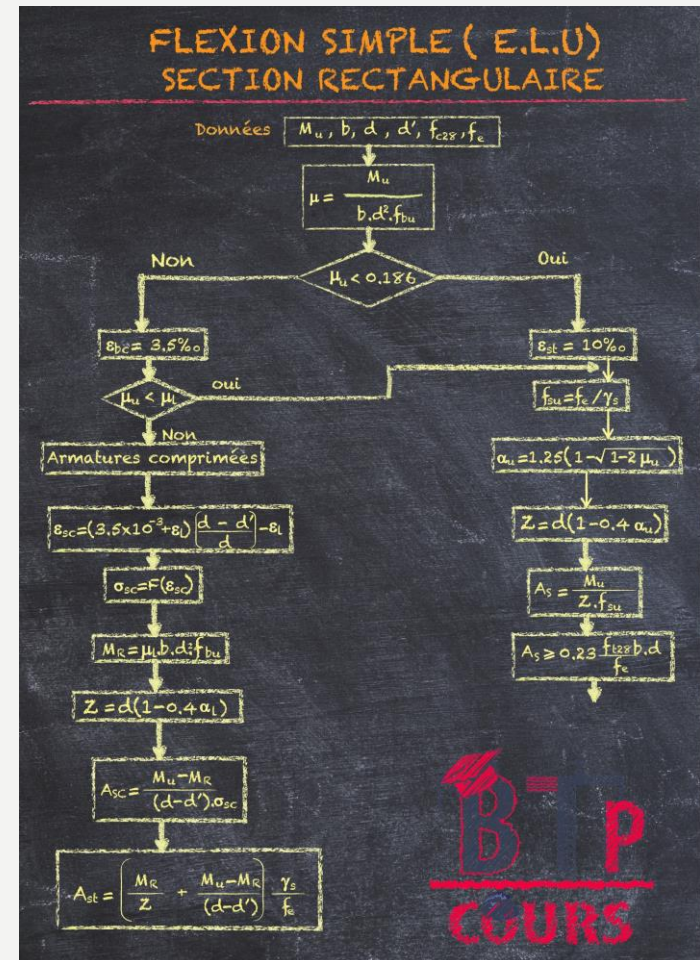
- The reinforcement area is calculated by considering a 1 m wide strip of the slab; it can therefore be treated as a rectangular beam subjected to simple bending.



REINFORCED CONCRETE FLOORS (SOLID SLAB)

Design of Steel Reinforcement:

- Thus, the calculation of the required reinforcement area is carried out by following the flowchart for a rectangular beam subjected to simple bending.



JOISTED FLOORS

JOISTED FLOORS (WOOD)

Definition :

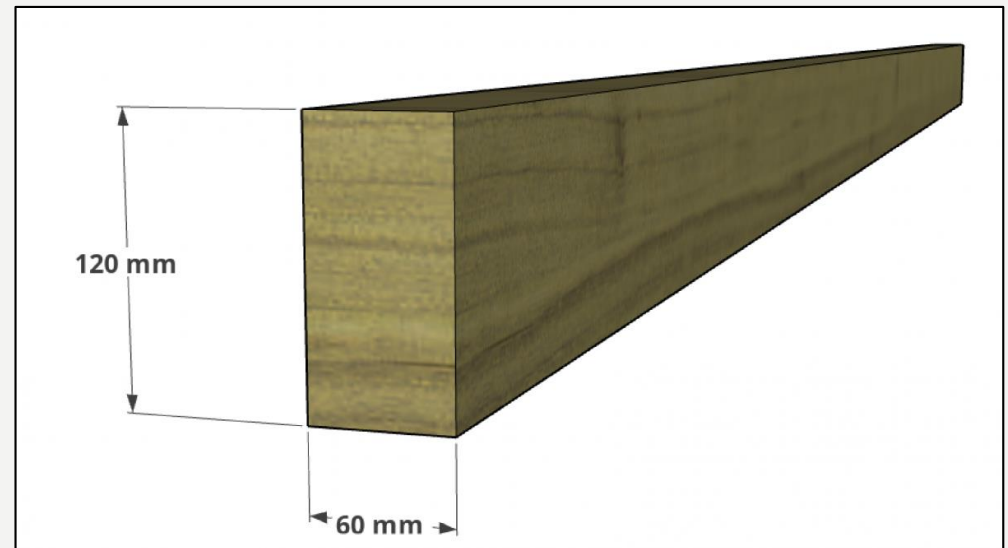
- A wooden joisted slab is a floor made of parallel wooden beams (joists) supporting a load-bearing floor (boards, OSB panels, plywood, etc.).



JOISTED FLOORS (WOOD)

Main components:

- **Joists:** load-bearing elements that resist bending
 - Beams with rectangular sections (e.g., 6×12 cm, 10×20 cm)
 - Solid wood, glulam, or engineered wood
 - Typical spacing: 40 to 60 cm



JOISTED FLOORS (WOOD)

Main components:

- **Supports:** to ensure the transfer of loads
 - Load-bearing walls (masonry, concrete)
 - Main beams (wood or concrete)



JOISTED FLOORS (WOOD)

Main components:

- **Load-bearing floor:** panels installed on the beams
 - Solid wood boards, or
 - Wood-based panels (OSB, plywood, particleboard)



OSB



Plywood

JOISTED FLOORS (WOOD)

Main components:

- **Supplementary elements:** ensure stability and insulation
 - Bracing (lateral stability)
 - Thermal and acoustic insulation
 - Dry screed or lightweight concrete (optional)



JOISTED FLOORS (WOOD)

Advantages, disadvantages, and uses

Advantages ✓	Disadvantages ✗
<ul style="list-style-type: none">• Lightweight• Quick installation• Good insulation• Environmentally friendly material	<ul style="list-style-type: none">• Sensitive to moisture• Limited spans• Possible vibrations• Fire protection required

Uses
<ul style="list-style-type: none">• Individual houses• Low-rise multi-family housing• Older buildings (renovation)• Converted attics

JOISTED FLOORS (STEEL)

Definition :

- A steel joisted floor is a floor system in which metal profiles (IPE, IPN, UPN, HEA, tubes, etc.) are arranged in parallel to carry vertical loads, on which a decking (steel deck, wood panels, masonry, etc.) rests.

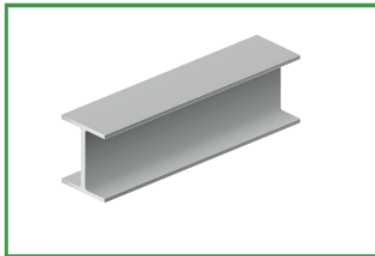


JOISTED FLOORS (STEEL)

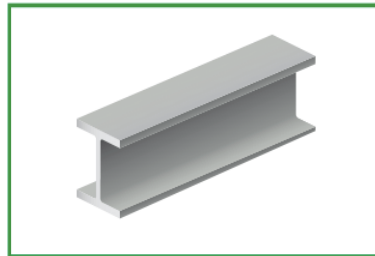
Main components:

- **Joists:** load-bearing elements that resist bending
 - Beams with standardized IPE, HEA, or UPN profiles
 - Typical spacing: 60 to 200 cm

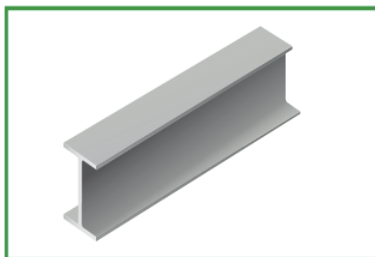
HEA



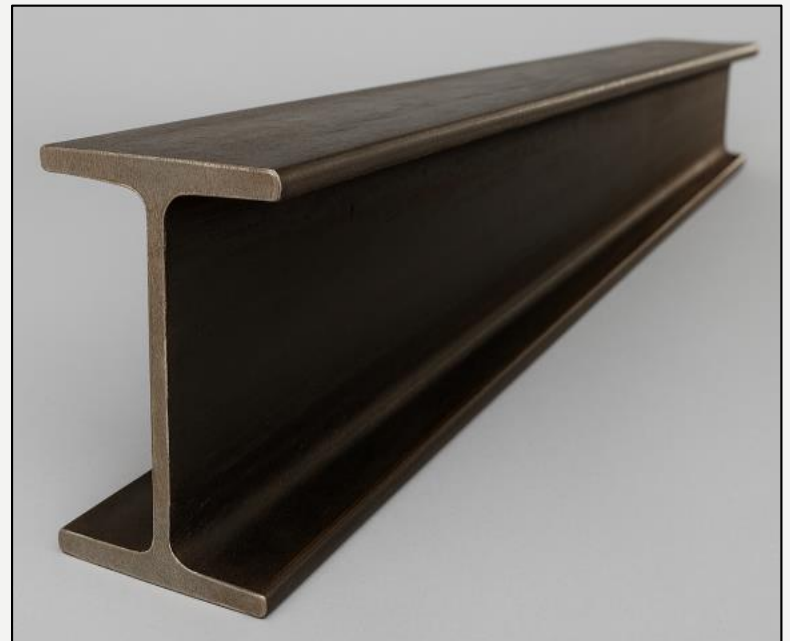
HEB



IPE



UPN



JOISTED FLOORS (STEEL)

Main components:

- **Supports:** to ensure the transfer of loads
 - Load-bearing walls (masonry, concrete)
 - Main beams (girders of a shed)



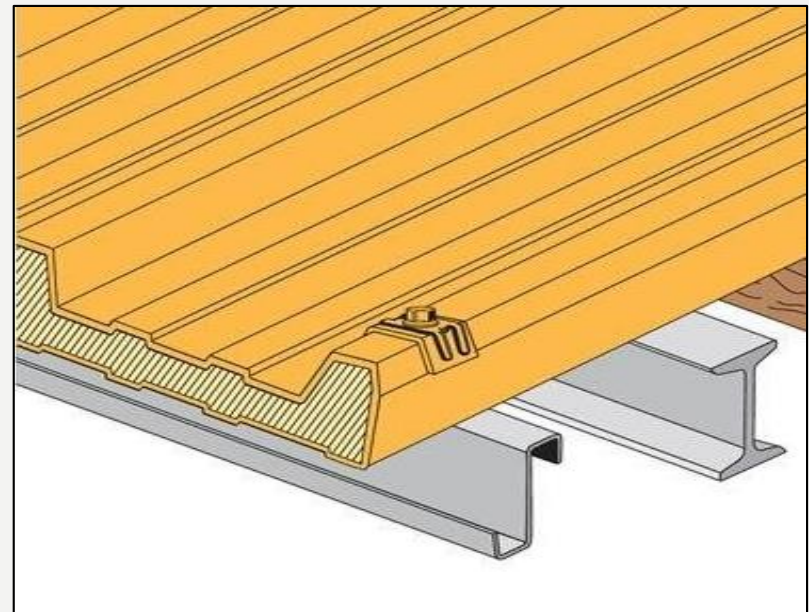
JOISTED FLOORS (STEEL)

Main components:

- **Load-bearing floor:** Panel or vault installed on the beams
 - Steel deck or sandwich panel
 - Masonry arch (vaulted floor)
 - Existing floor (renovation)



Vaulted floor

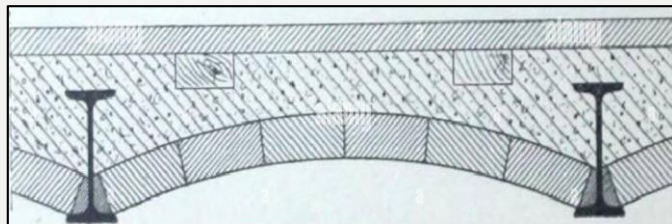
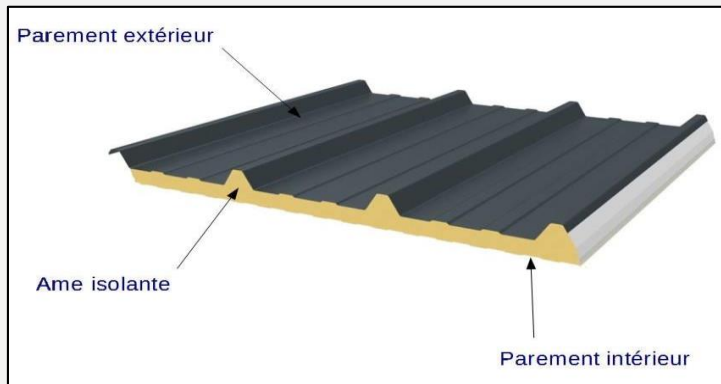


Sandwich panel on joists

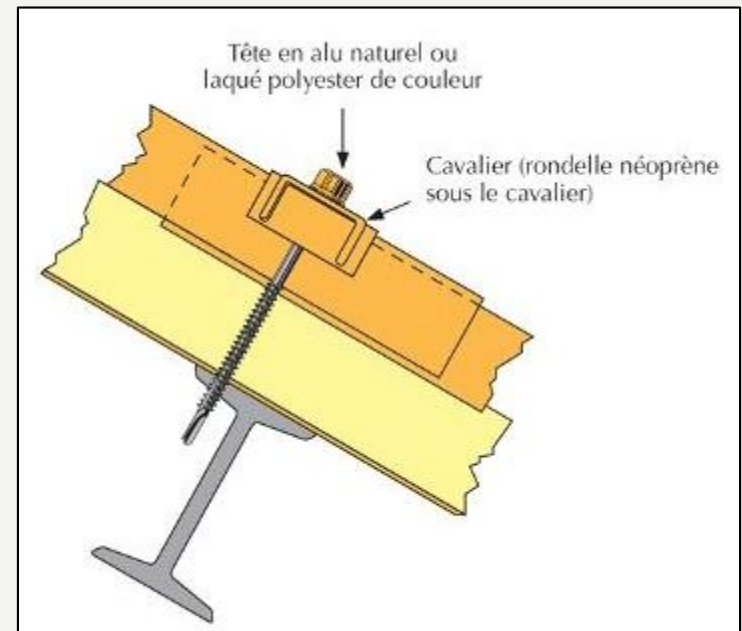
JOISTED FLOORS (STEEL)

Main components:

- **Supplementary elements:** ensure stability and insulation
 - Thermal and acoustic insulation
 - Assembly accessories



Thermal insulation



Assembly accessories

JOISTED FLOORS (STEEL)

Advantages, disadvantages, and uses

Advantages ✓	disadvantages ✗
<ul style="list-style-type: none">• Large spans• Low usable height• Quick installation• Removable/modular	<ul style="list-style-type: none">• Fire-sensitive• Prone to corrosion• Possible vibrations• Protection costs

Uses
<ul style="list-style-type: none">• Individual houses• Metal sheds• Older buildings (renovation)• Multi-family housing

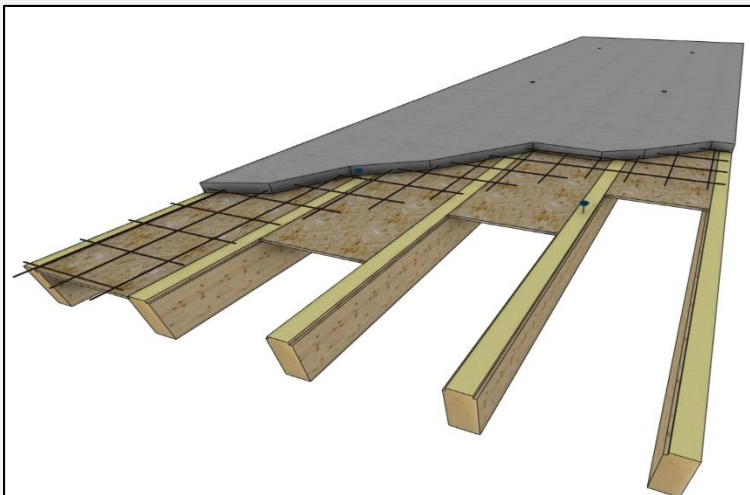
COMPOSITE FLOORS

COMPOSITE FLOORS STEEL-CONCRETE / WOOD-CONCRETE

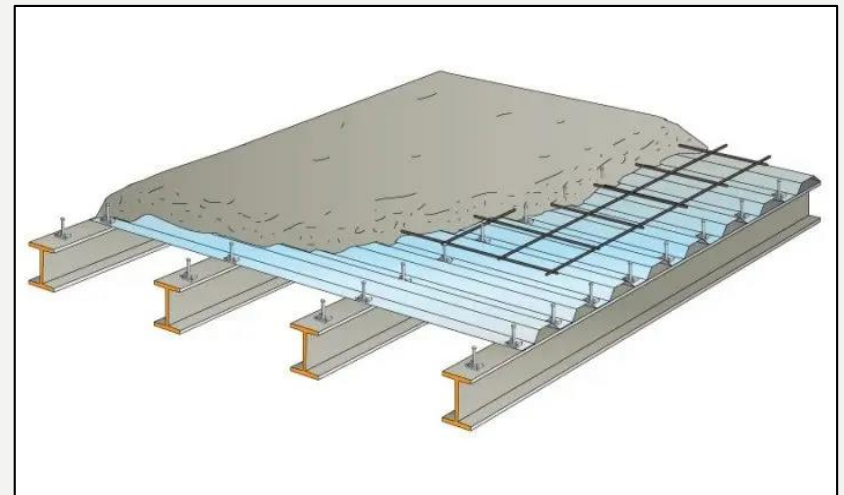
Definition :

- The composite floor is a joisted or structural system made of steel or wood, a profiled steel deck or plywood, and a concrete slab, designed to act together through mechanical adhesion and/or shear connectors.

Composite Floors Wood-Concret



Composite Floors Steel-Concret

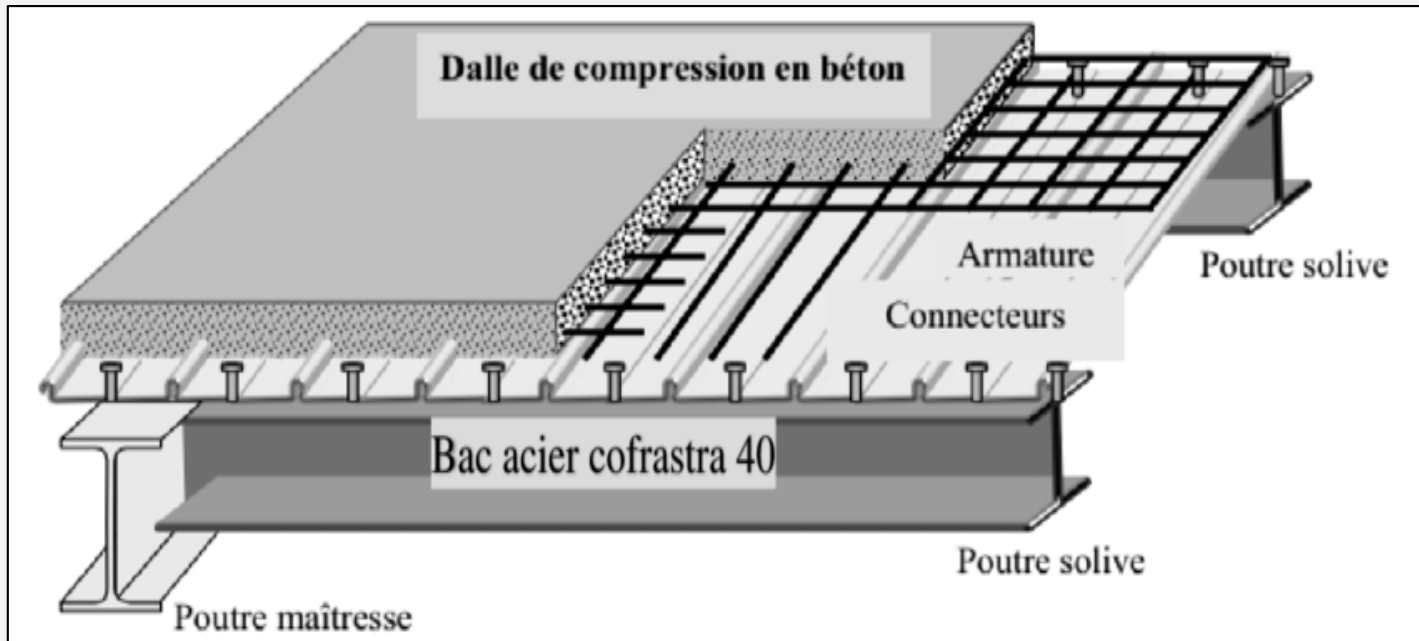


COMPOSITE FLOORS

STEEL-CONCRETE / WOOD-CONCRETE

Principle :

- The joists carry the main vertical loads and transfer the forces to the supporting structure (main beam), while the profiled steel deck or plywood acts as permanent formwork for the reinforced concrete.

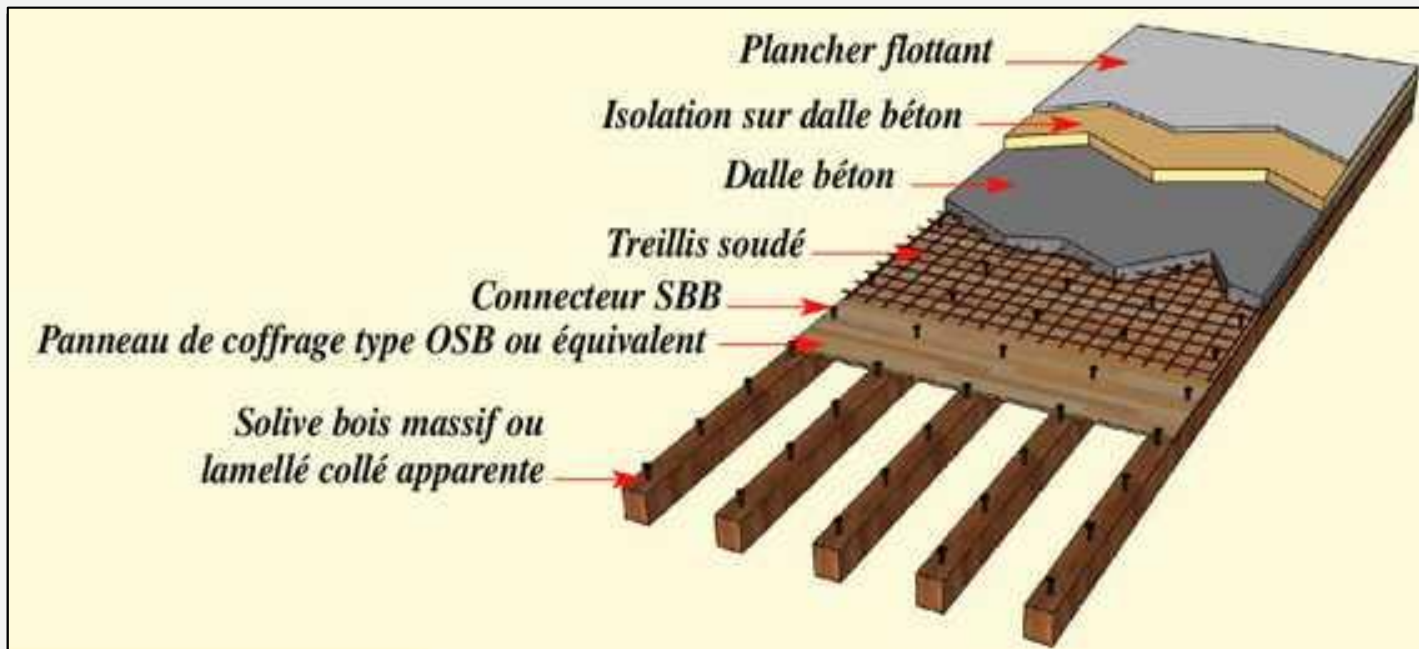


COMPOSITE FLOORS

STEEL-CONCRETE / WOOD-CONCRETE

Principe :

- The joists carry the main vertical loads and transfer the forces to the supporting structure (main beam), while the profiled steel deck or plywood acts as permanent formwork for the reinforced concrete.

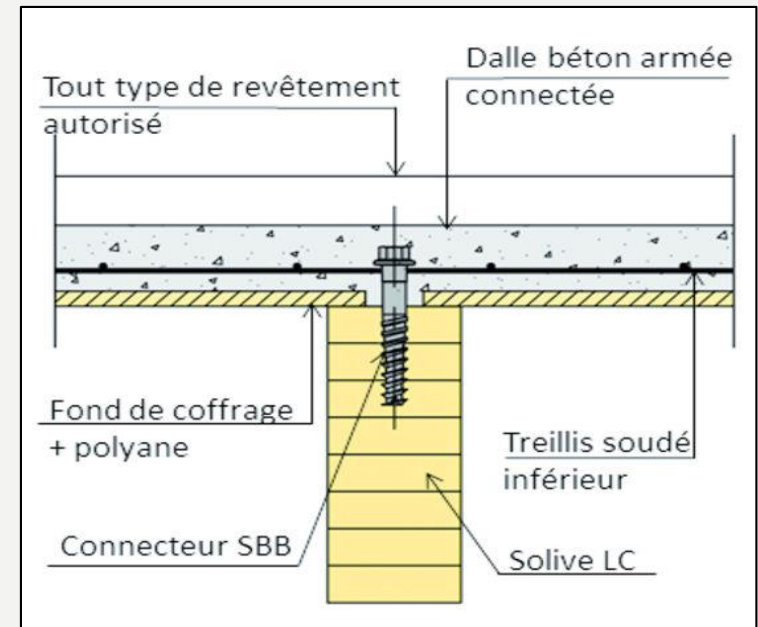
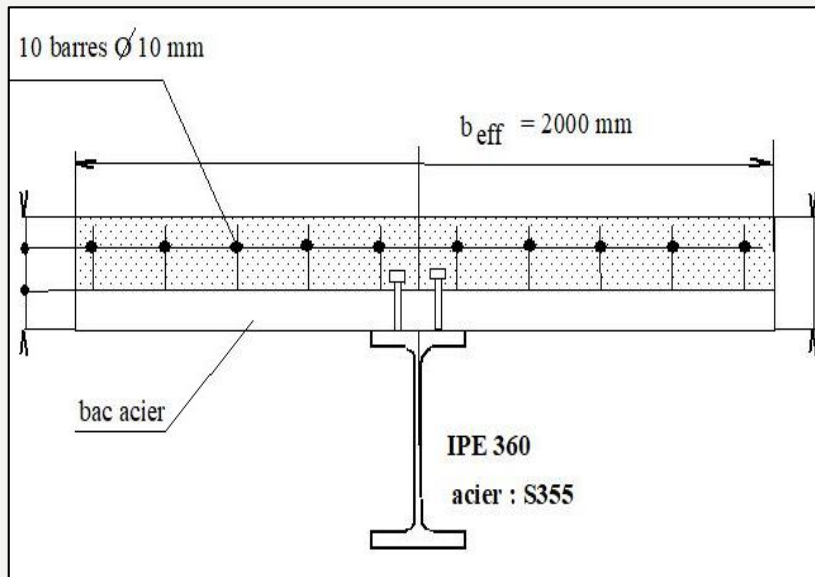


COMPOSITE FLOORS

STEEL-CONCRETE / WOOD-CONCRETE

Principe :

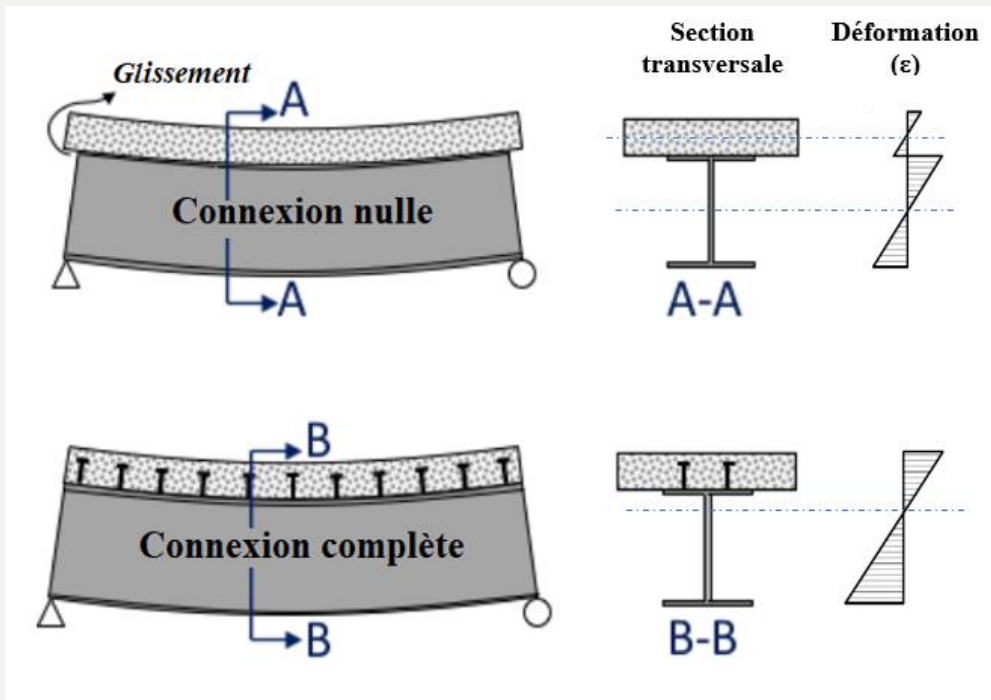
- The principle is to combine the strength of concrete with that of steel or wood. The concrete slab resists compression, while the steel or wood joist carries tensile forces. Connectors are added at the interface to ensure the connection between the two materials.



COMPOSITE FLOORS

STEEL-CONCRETE / WOOD-CONCRETE

The connection between the concrete slab and the steel beam:



➤ The two materials behave independently

➤ The composite beam behaves as a single material

COMPOSITE FLOORS

STEEL-CONCRETE / WOOD-CONCRETE

Advantages, disadvantages, and uses

Advantages ✓	Disadvantages ✗
<ul style="list-style-type: none">• Reduced self-weight• Quick installation• Good insulation• Suitable for large spans	<ul style="list-style-type: none">• Fire-sensitive• Prone to corrosion (Steel)• Possible vibrations• Complex calculation

Uses
<ul style="list-style-type: none">• Metal or wood buildings• Multi-storey parking• Shopping centers• Mezzanines