# AS Unit 1: Our Built Environment

## 2.1.2: LOW-RISE and HIGH-RISE STRUCTURES (2 of 2)

### SKELETON FRAMES

Skeleton frames are used for the construction of multi-storey buildings and comprise a system of columns and connecting beams that support the internal floors and external walls of the building and carries all loads to the foundations. Floor areas will generally be free of immovable internal walls resulting in more flexible spaces.

Skeleton frames of high-rise structures can be constructed using structural steel, or pre-cast concrete and may be cast insitu using reinforced concrete. Steel is the most frequently used because:

- steel frames are quick to erect on site, as a lot of work can be prefabricated
- steel has a high strength to weight ratio, resulting in reduced loadings
- steel is flexible and can bend or deflect without cracking
- a range of standard sections and sizes is readily available
- alternative jointing methods can be used, such as bolting, welding, and riveting
- the frames can be designed to any shape and be clad with a wide range of materials.

Disadvantages of steel frames that are less relevant to concrete structures include loss of strength at high temperatures, which may cause collapse in the event of a fire, and possible corrosion in humid or marine environments.

A **braced frame** is a development of the skeleton frame used in structures subject to high lateral loads, such as wind pressure. Other elements that can be used to resist horizontal loads include stairwells, lift shafts and shear walls (which are essentially very wide columns).

### TIMBER FRAMES

A structural system where walls and floors are constructed from timber studs, clad with board products. Most are platform frames, where each storey is formed by floor-to-ceiling timber panels.

**Comparison with brick and block construction:**

✓ **Speed of construction.** A prefabricated timber frame can be erected on site faster, enabling following trades to begin work earlier.

✓ **Improved quality.** Due to off-site fabrication in controlled conditions.

✓ **Better thermal performance,** reduced wall thicknesses.

✗ **Poor sound insulation,** but acoustic performance can be improved using double layer plasterboards and sound absorbent materials, such as mineral wool.

✗ **Condensation.** Timber frame structures must include a vapour barrier between the lining of the inner wall and the insulation, to prevent vapour passing through.

✗ **Fire risk.** Fire protection is required and can be provided by suitable cladding and with the use of fire stops to prevent spread through the cavity.

✗ **Strength.** Although properly-built timber frames are strong and robust and, if well designed, will use the optimal amount of material for the required strength.

✗ **Subject to rot and infestation.** Although a properly built and well maintained timber frame should prevent the conditions required for rot and infestation.

✓ **Sustainability.** If the balance between felling and planting is maintained, the supply of timber will be sustainable.

### STRUCTURAL INSULATED PANELS (SIPs)

SIPs are a form of composite sandwich panel system that has an insulating core (polyurethane foam or expanded polystyrene) sandwiched between two structural facings, usually oriented strand board (OSB).

SIPs have many of the advantages of a timber frame and can prove cost-effective due to reduced waste and inherent strength, being up to six times stronger than a standard timber frame.

The maximum length of a SIP is typically 7.5 m for walls and roofs, with floor panels spanning up to 4m.

**Cost.** Timber frames and SIPs will involve similar, but higher costs than masonry construction, although their factory costs are more predictable than the cost of building on site.

### APPLICATIONS

Single storey industrial and agricultural buildings with wide spans will often use portal frames.

Single story and low-rise residential buildings (typically up to 4 storeys) are likely to be timber framed, use SIPs, or have structural cavity walls.

Low-rise commercial and industrial buildings and high-rise buildings (typically over 7 storeys) are likely to have a skeleton framed structure, constructed in steel, or possibly concrete.

Skyscrapers, supertall buildings (300m+) and megatall buildings (600m+) will have composite steel structures, based on specialised frames. The Burj Khalifa In Dubai, the world's tallest building in 2020, has 163 floors and is 828m tall.