Floor Systems - Reinforced Concrete Framing

1. One-Way Slabs on Beams or Walls
2. One-Way Pan Joists and Beams
3. One-Way Slabs on Beams and Girders
4. Two-Way Flat Plates
5. Two-Way Flat Slabs
6. Two-Way Waffle Flat Slabs
7. Two-Way Slabs and Beams.

Floor Systems - Steel Framing

1. One-Way Beam System
2. Two-Way Beam System
3. Three-Way Beam System
4. Composite Steel-Concrete Floor Systems.

Floor Systems

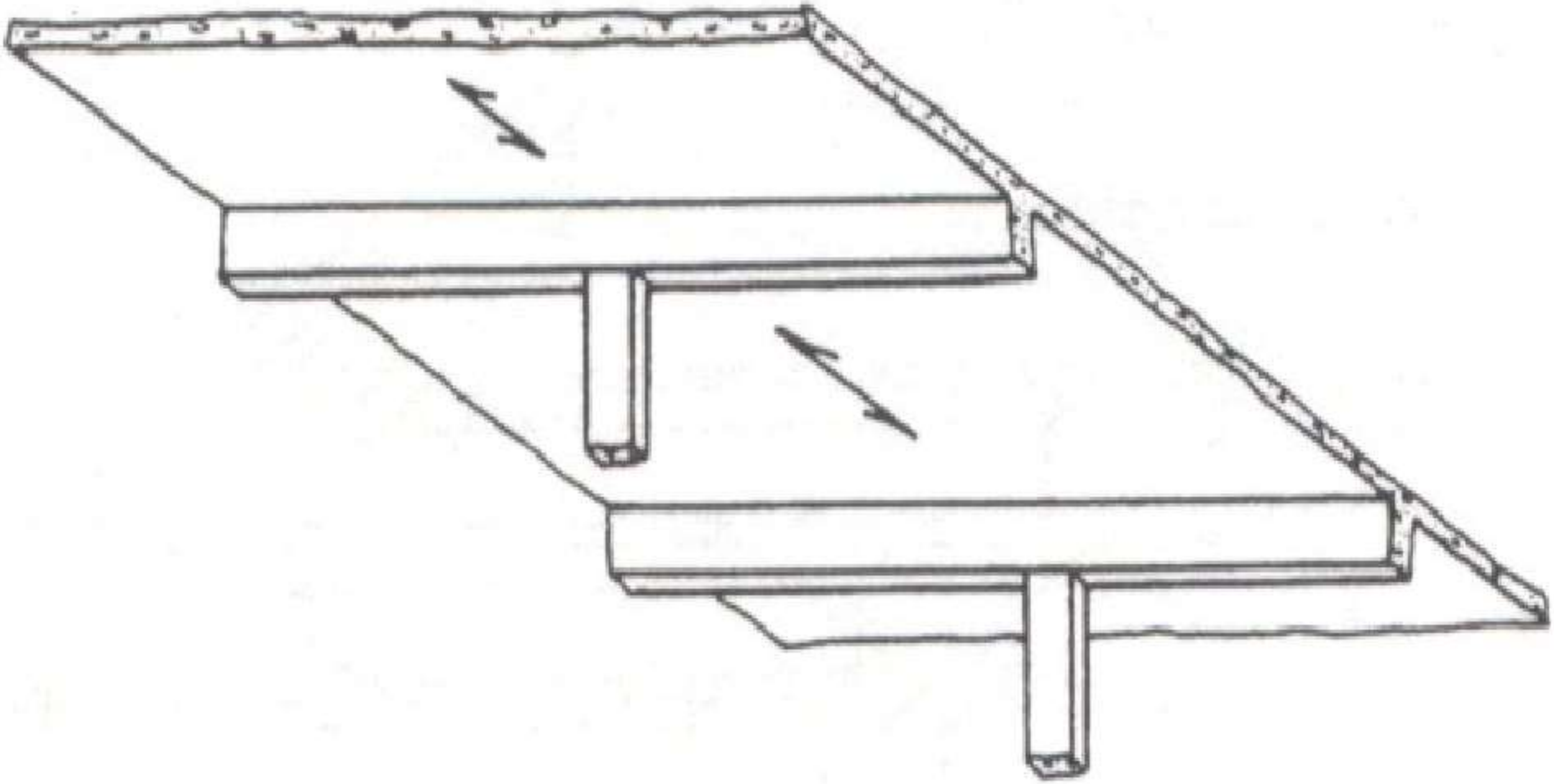
- The choice of a correct floor system is an important ***economic decision*** in a tall building.
- In ***residential buildings***, shorter spans are possible because smaller apartment units permit the placement of closer spaced columns and walls.
- In contrast to residential buildings, ***modern office buildings*** require large open spaces, sometimes entire areas must be devoid of structural elements.
- The ease and speed of construction also plays a role in the selection of the floor system. Some contractors may only be familiar with certain types of systems, or may have invested in expensive formwork for a particular type.
- The floor system may be required to assist in carrying ***horizontal loads***, in which case a ***floor slab*** may have to be replaced by a ***floor plate***.

Reinforced Concrete Floor Systems

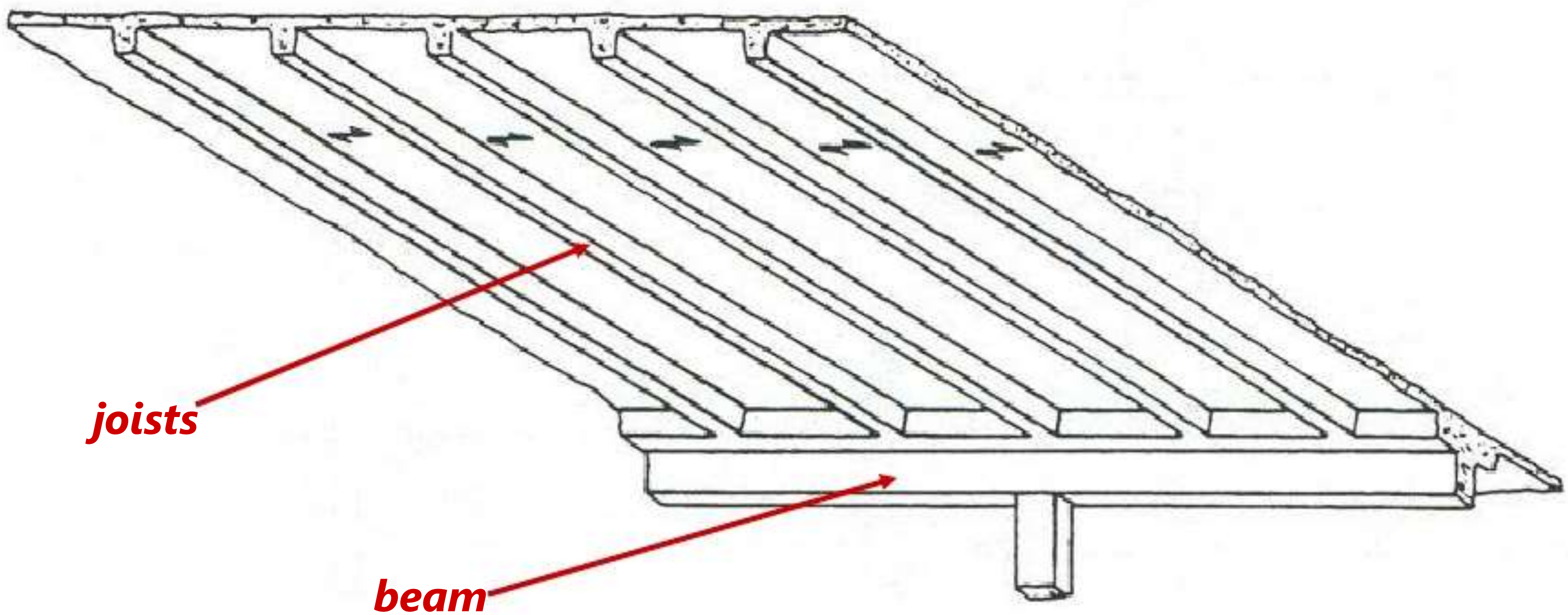
Reinforced concrete floor systems are grouped into two categories:

> ***One-way slabs*, in which the slab spans in one direction between supporting beams or walls.**
>
> ***Two-way slabs*, in which the slab spans in orthogonal directions.**

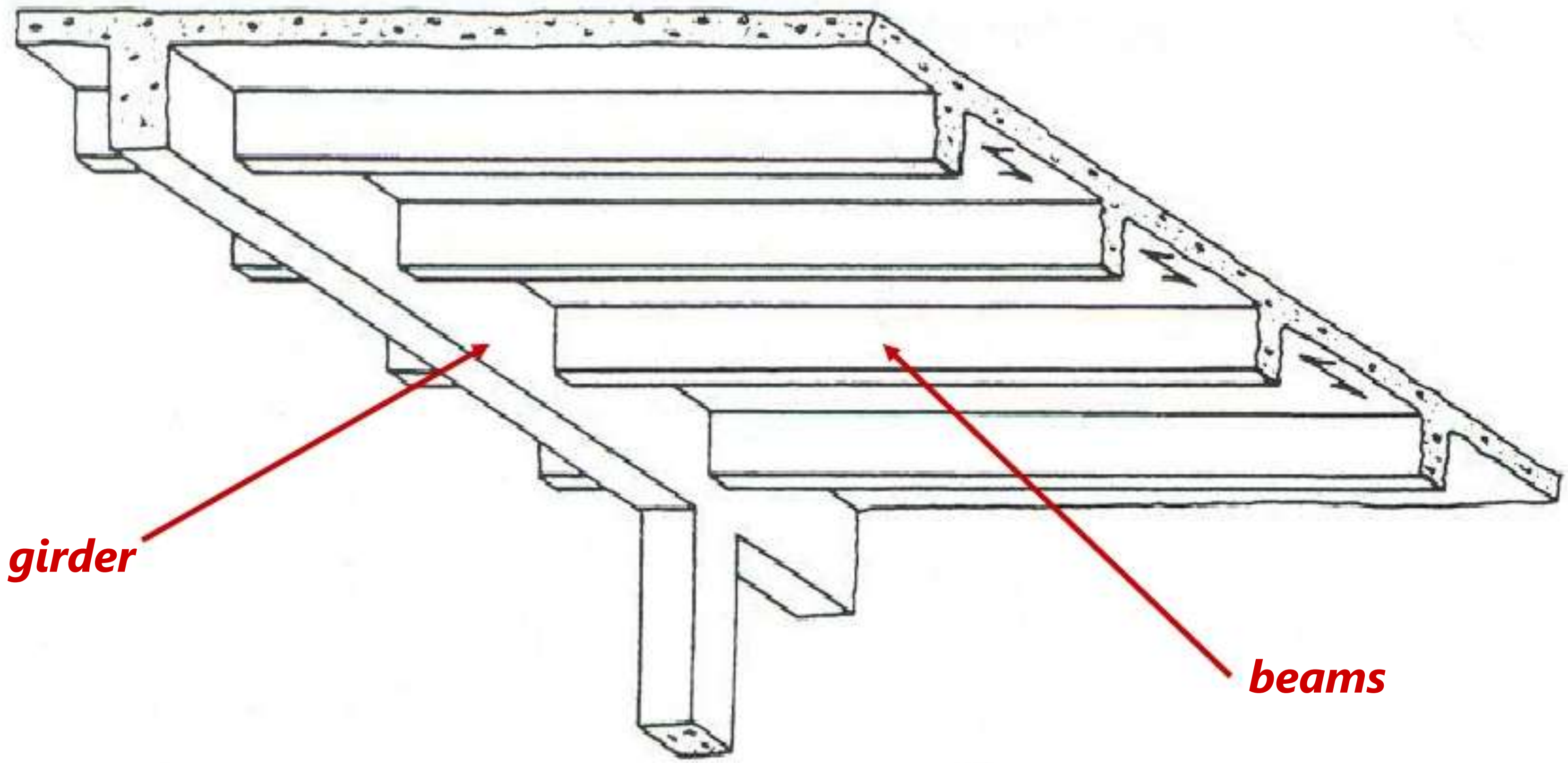
Both systems take advantage of continuity over interior supports by providing negative moment reinforcement in the slab.



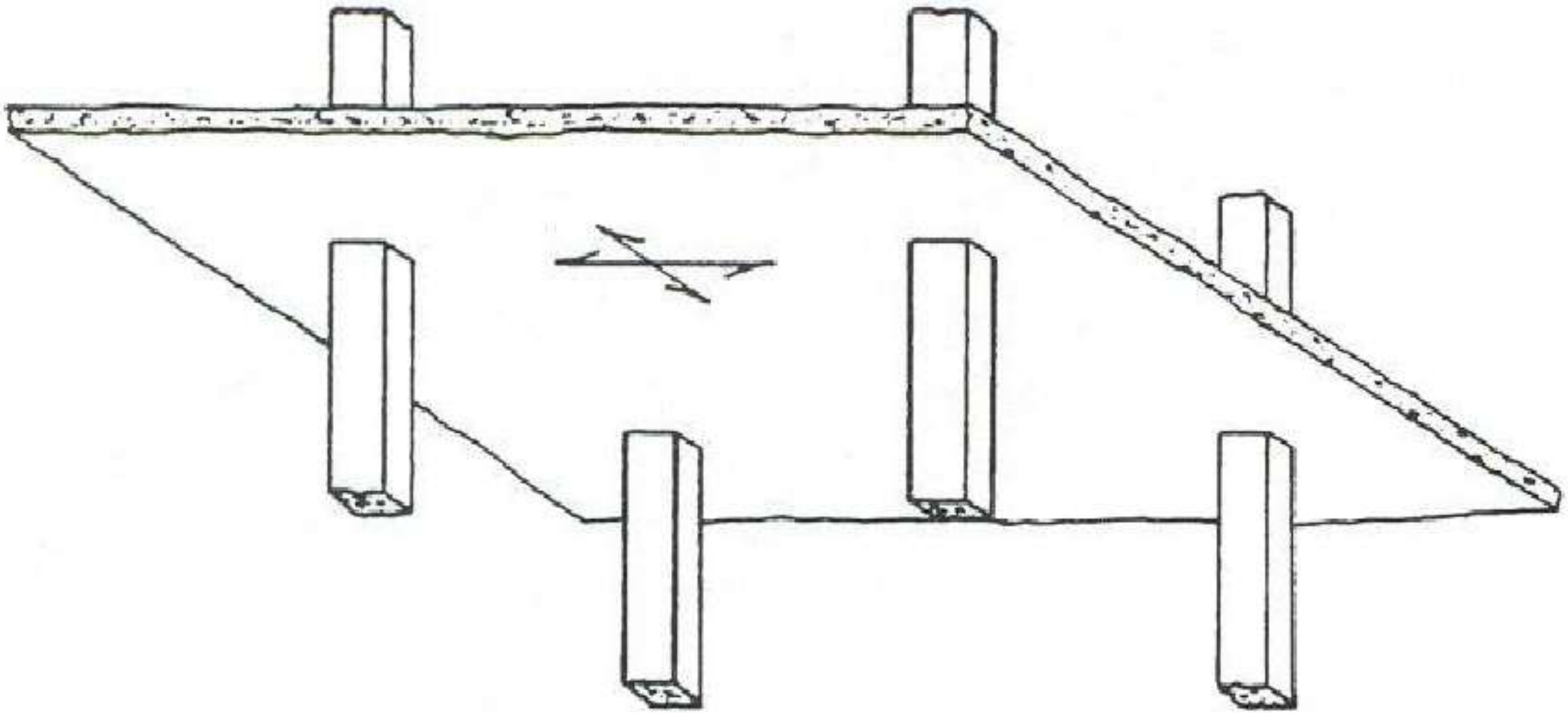
One-way slabs **span continuously over walls or beams up to 24 feet apart. These slabs are 7 to 8 inches thick, and require simple formwork, with simple reinforcement. They are suitable for flying formwork to speed up construction. This system is heavy and inefficient, but is appropriate for use in cross-wall residential high-rises when used wit post-tensioning.**



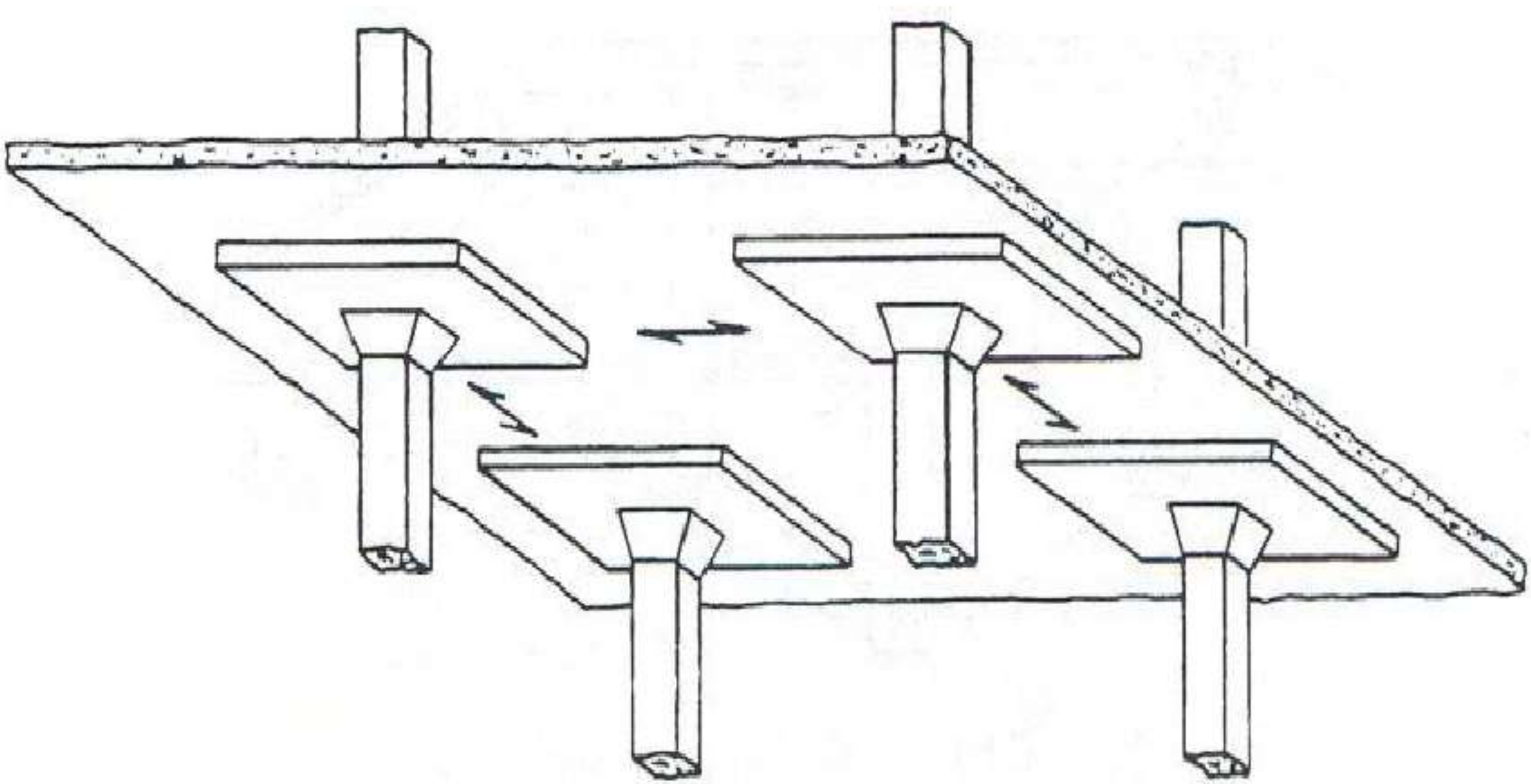
The *one-way pan joists and beam system* is a thin, welded wire mesh (wwm) reinforced slab that sits upon closely spaced cast-in-place joists spanning between major beams. Slabs may be as thin as 2.5 inches (6 cm) and the joists 6 to 20 inches (15 – 51 cm) in depth and spaced 20 to 30 inches (76 cm) on center. Their composite action, like closely spaced T-beams, permit 40 foot spans (12.3 m). The joists are formed between reusable fiberglass or steel pans.



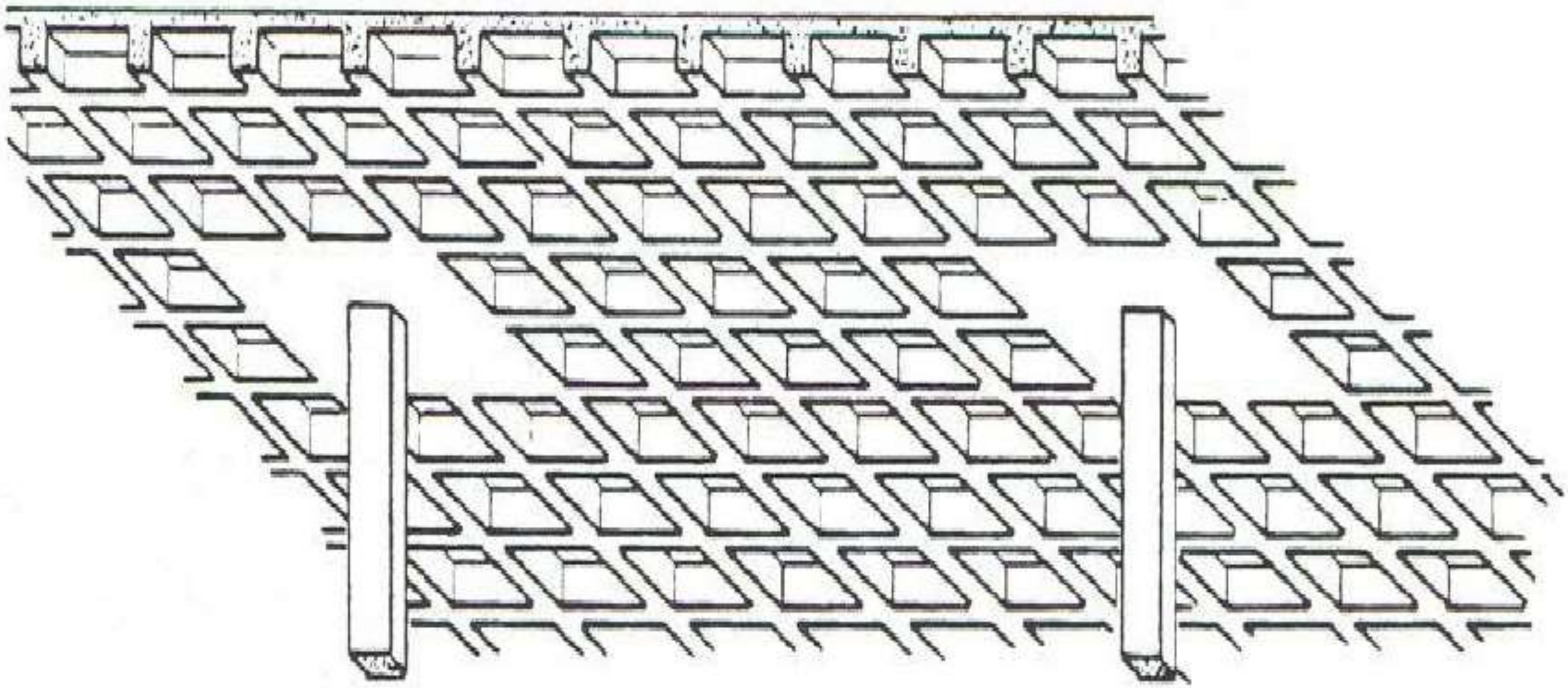
A *one-way slab spanned over closely spaced beams* and supported by girders, permits t use of a thin slab thickness, from 3 to 6 in (7.6 to 15 cm) and larger spans of up to 46 feet (14 m). Besides having longer span capabilities, the system is compatible with a two-way lateral load resisting rigid-frame structure.



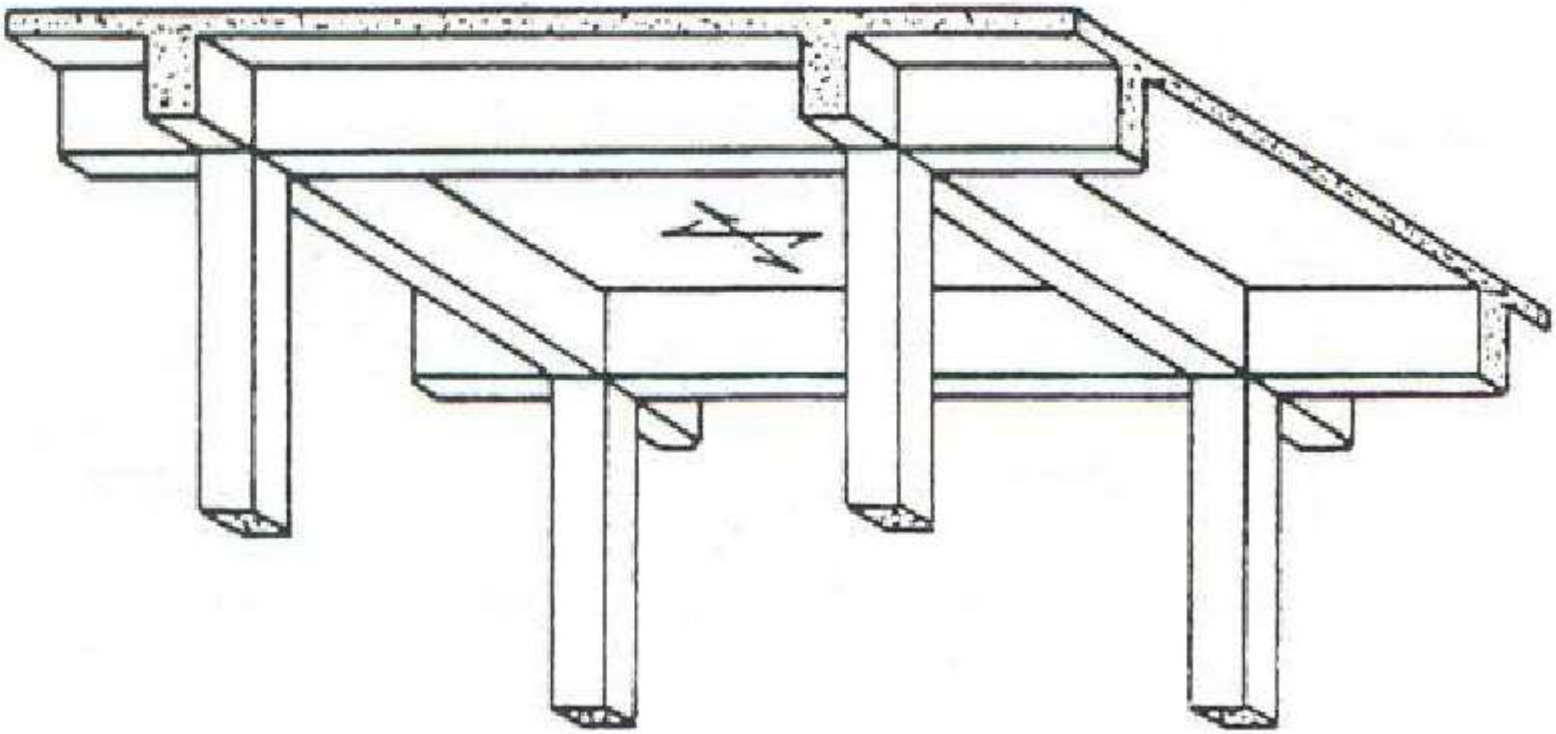
A *two-way flat plate* is directly supported by columns or short walls. It can span 26 fee (8 m) with conventional reinforcing, and 36 ft (11 m) when post-tensioned. It is the most economical system in terms of formwork and reinforcement. It also provides freedom to locate columns and provides a clear soffit, thereby resulting in minimum story heights.



A ***two-way flat slab*** **requires capitals or drop panels at the columns to increase their shear and negative moment capacities at the supports. This system is suited for heavier loads and longer spans, and when the bays are roughly square.**



A ***waffle flat slab*** system is supported by a square grid of closely spaced joists with fill
panels over the columns. The slab and joists are poured integrally over square and
domed plastic or steel forms up to 30 inches square (76 cm) and 20 inches deep (50 cm
An advantage is that the ceiling is usually left exposed.



The *two-way slab and beam system* spans two ways between orthogonal sets of beams that transfer the load to the columns or walls. This permits thinner slabs, and is economical in reinforced concrete systems. It is also compatible with a lateral load-resisting rigid-frame structures. The maximum effective length/width ratio is 2.

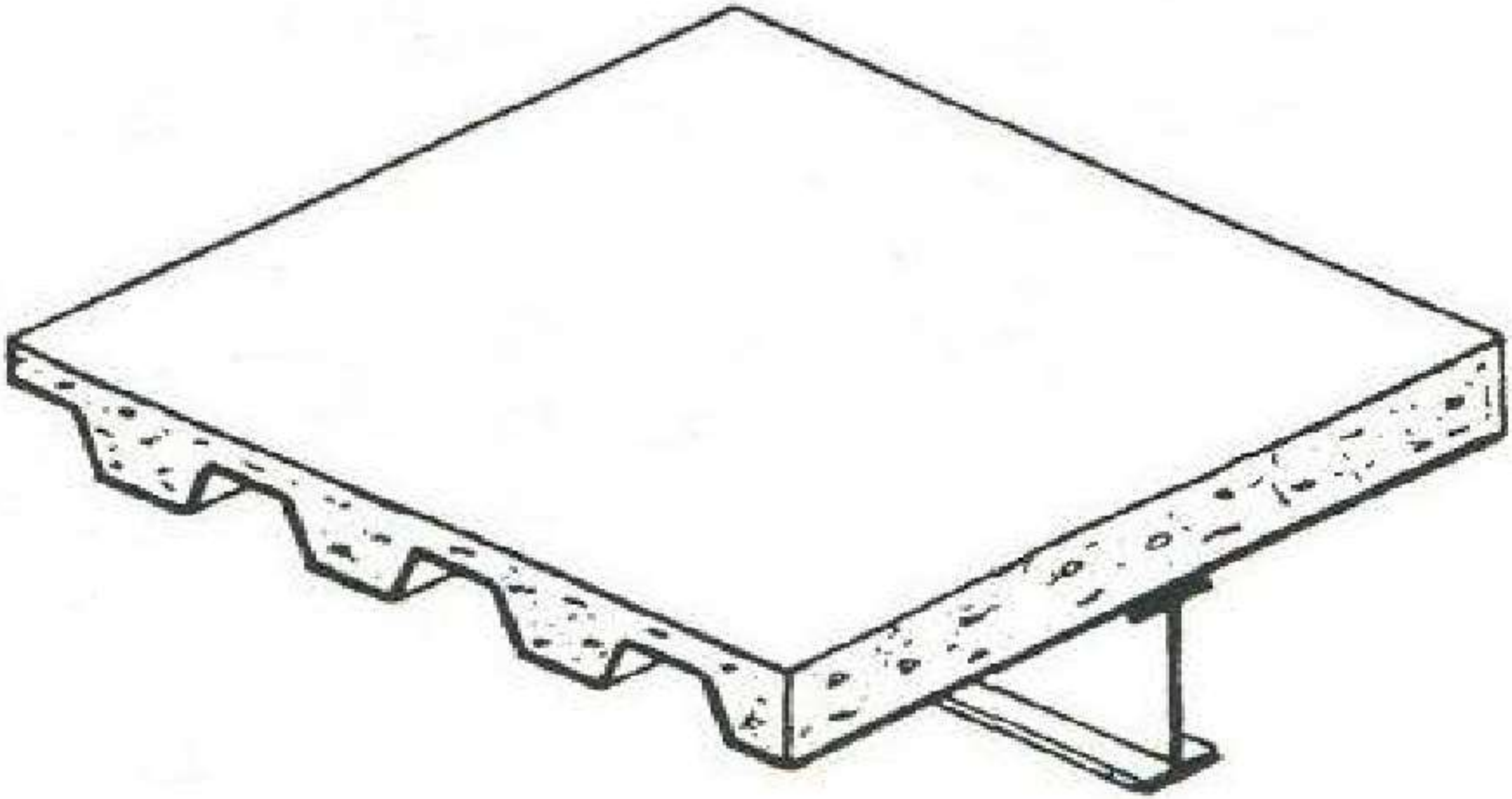
Steel Framed Floor Systems

Steel framed floor systems are grouped into three categories:

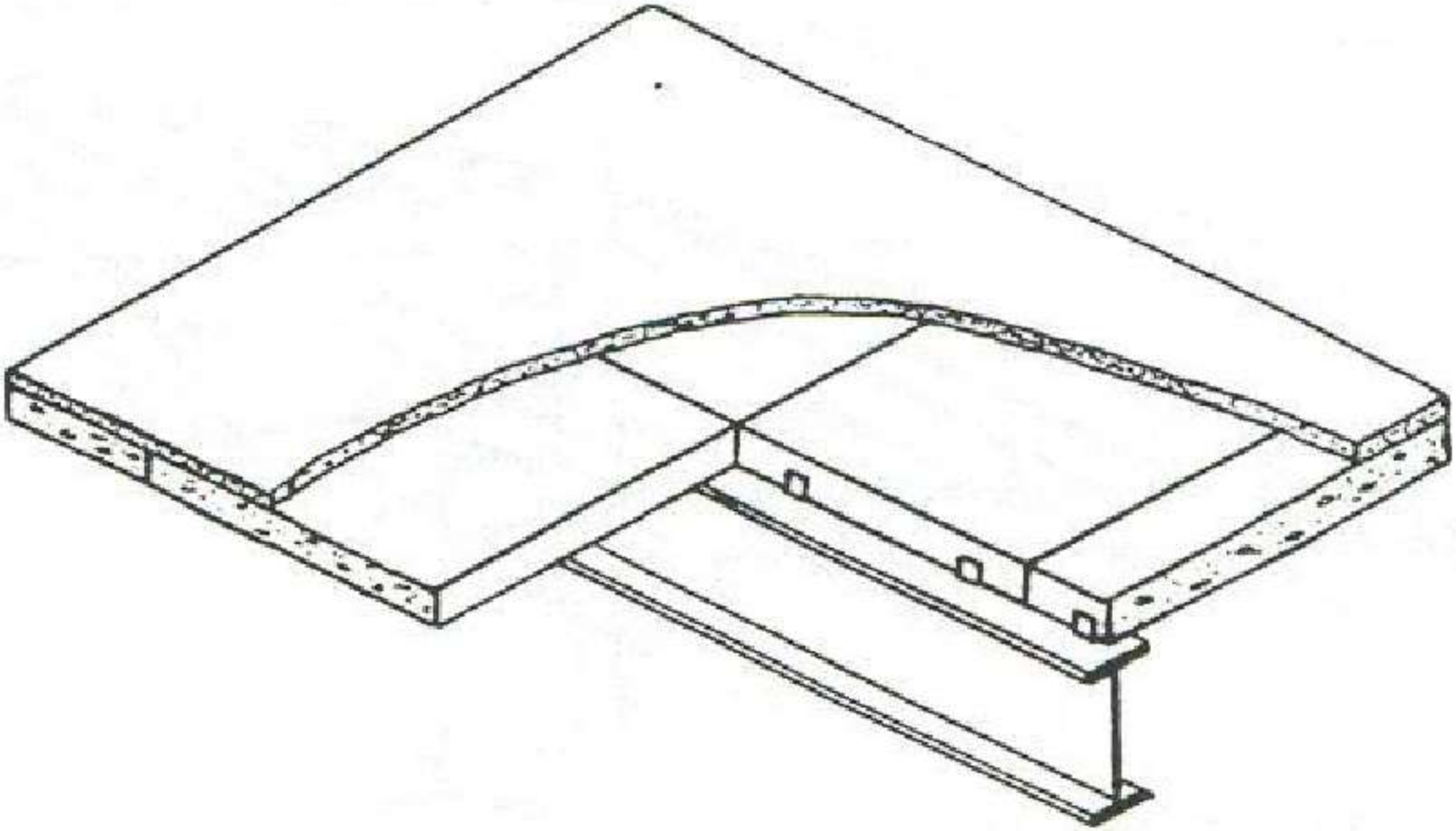
***One-way slabs*, in which the slab spans in one direction between supporting beams or walls.**

***Two-way slabs*, in which the slab spans in orthogonal directions.**

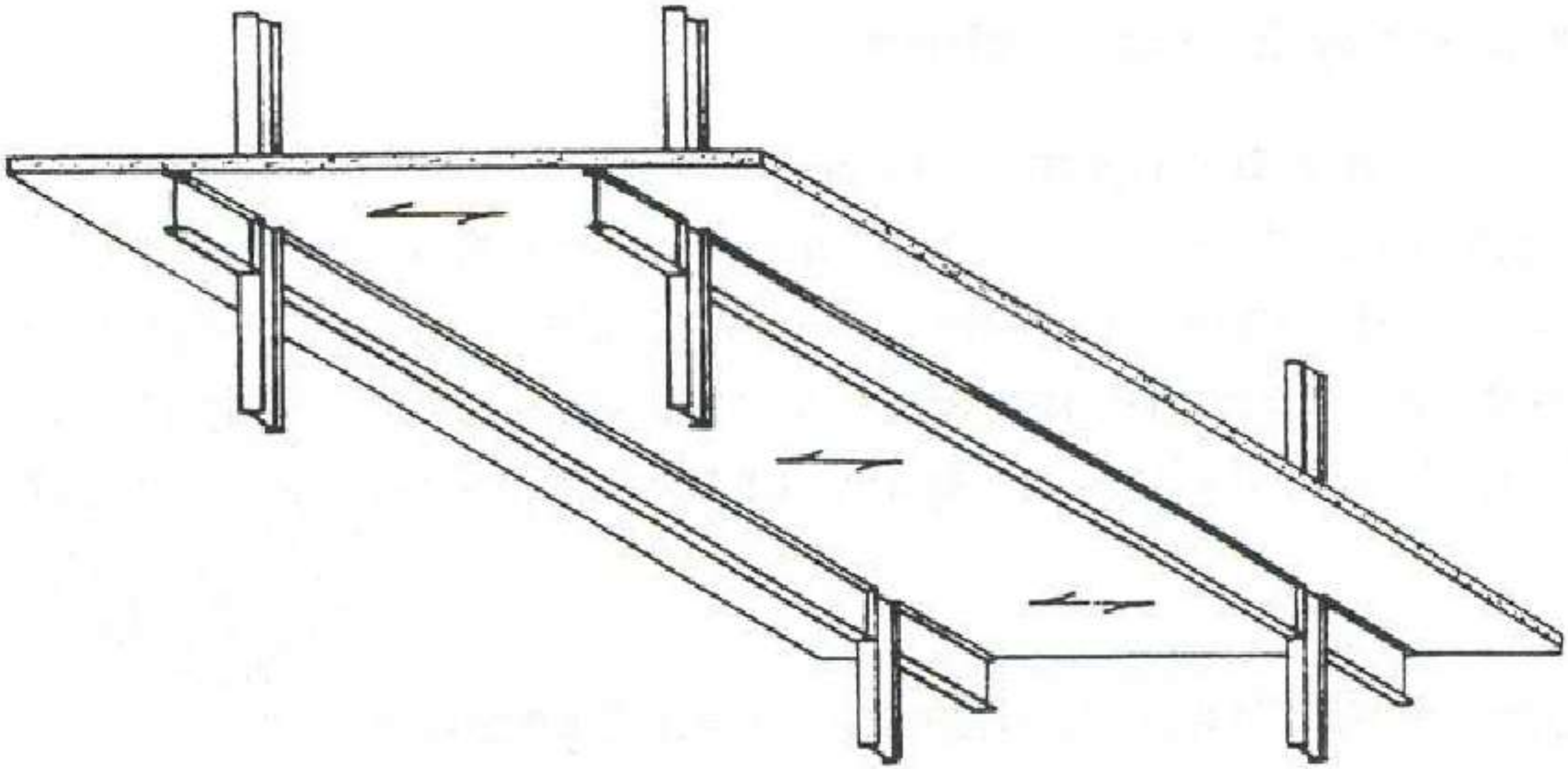
***Composite slabs*, where both steel and concrete are combined to use the advantages of both.**



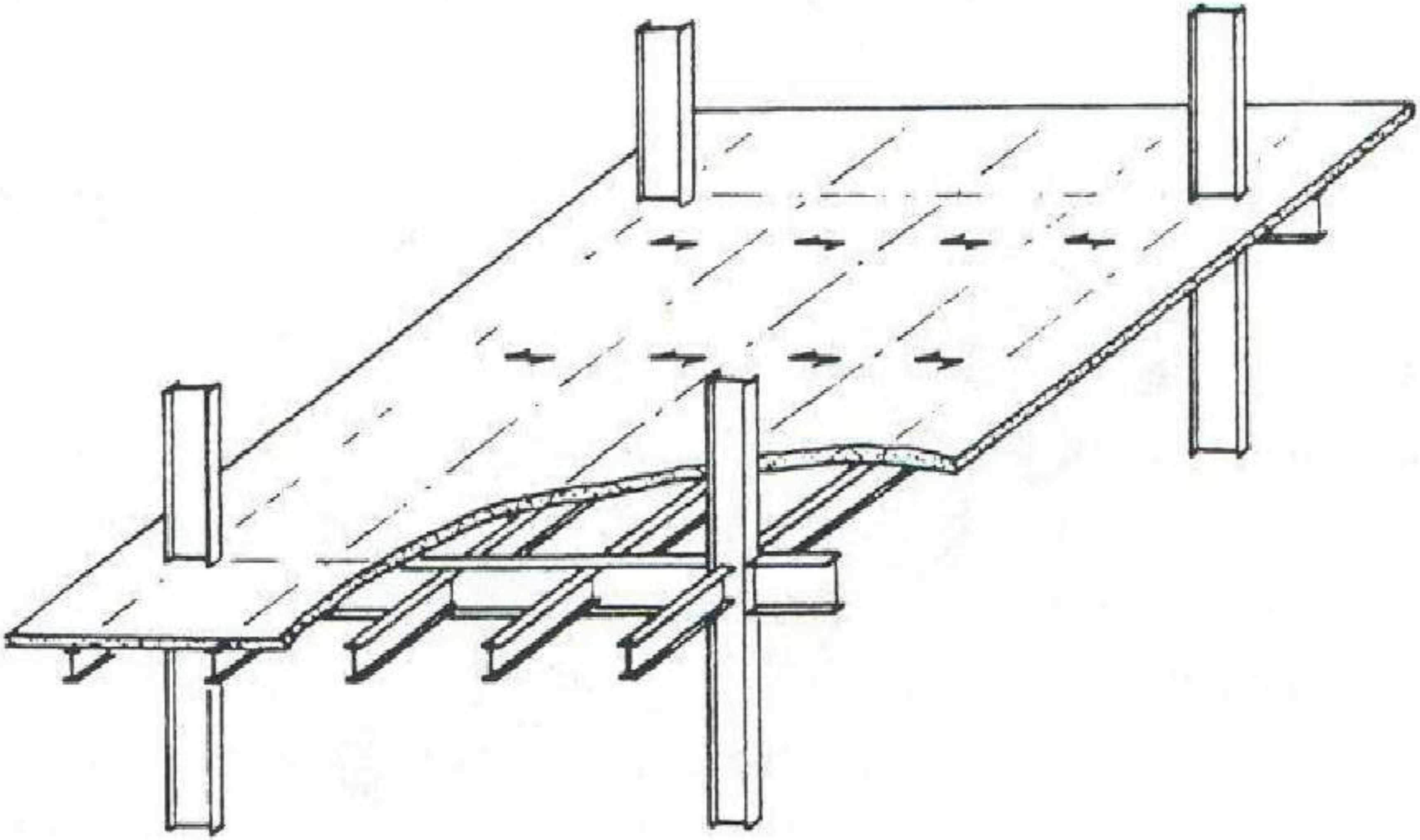
Steel framed structures also use reinforced concrete slabs placed upon the steel framing in various ways. A common method is the one-way reinforced concrete slab, either a cast-in-place, typically 4 in thick (10 cm) or *cast concrete on a metal deck* (as shown above) requiring only 2.5 in (6 cm) of concrete thickness.



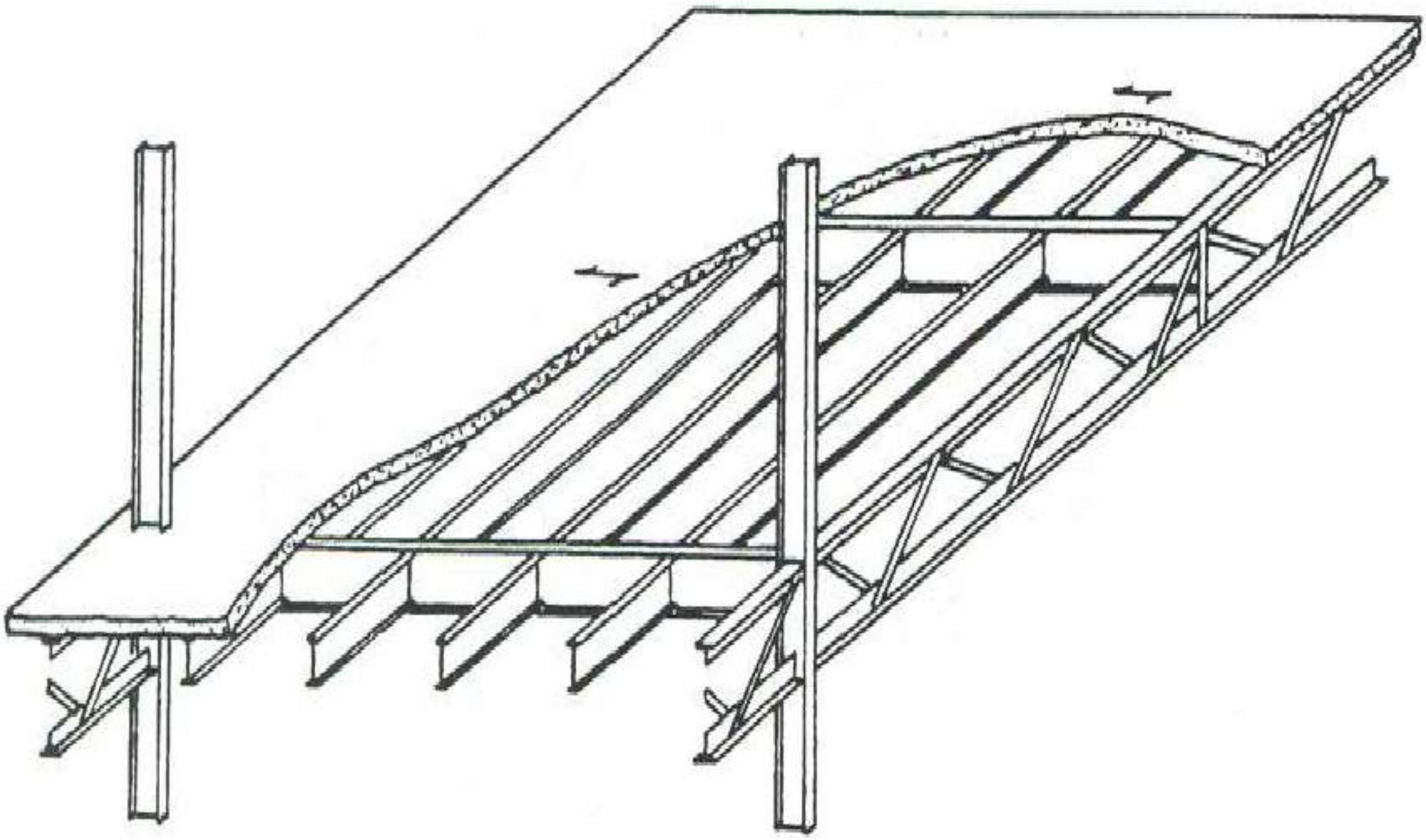
An alternative to the cast-in-place slab is the use of *precast concrete panels* laid directly upon the steel beams (shown above) and finished with a thin concrete topping such as *coreslab*.



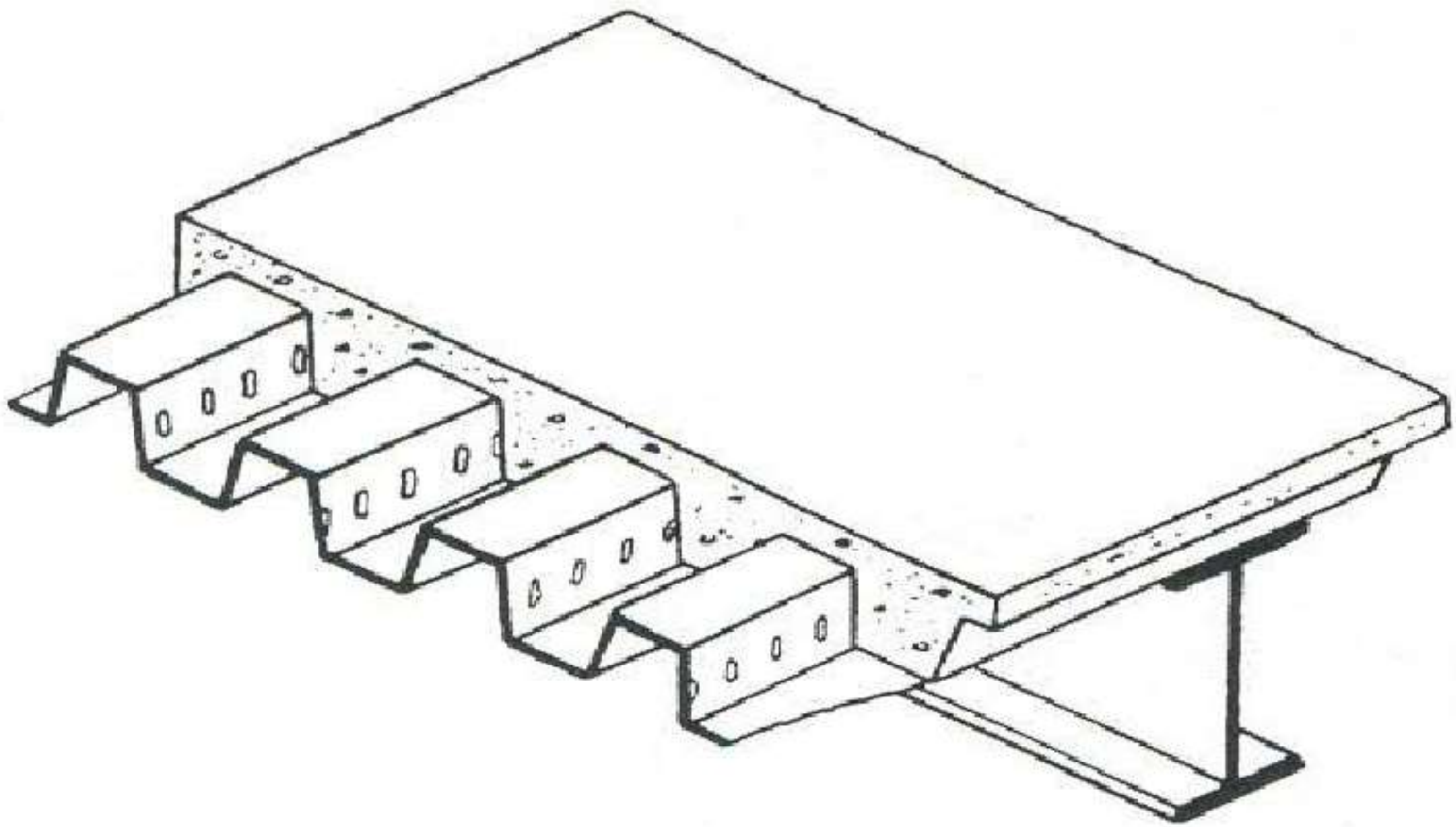
The *one-way beam system* consists of a rectangular grid of steel columns and steel bea running in the long direction, whilst using the reinforced concrete slab to span the shorter direction (transversely). In cross-frame structures, the beams at partition lines may be deepened to participate in lateral load resisting rigid frames or braced bents.



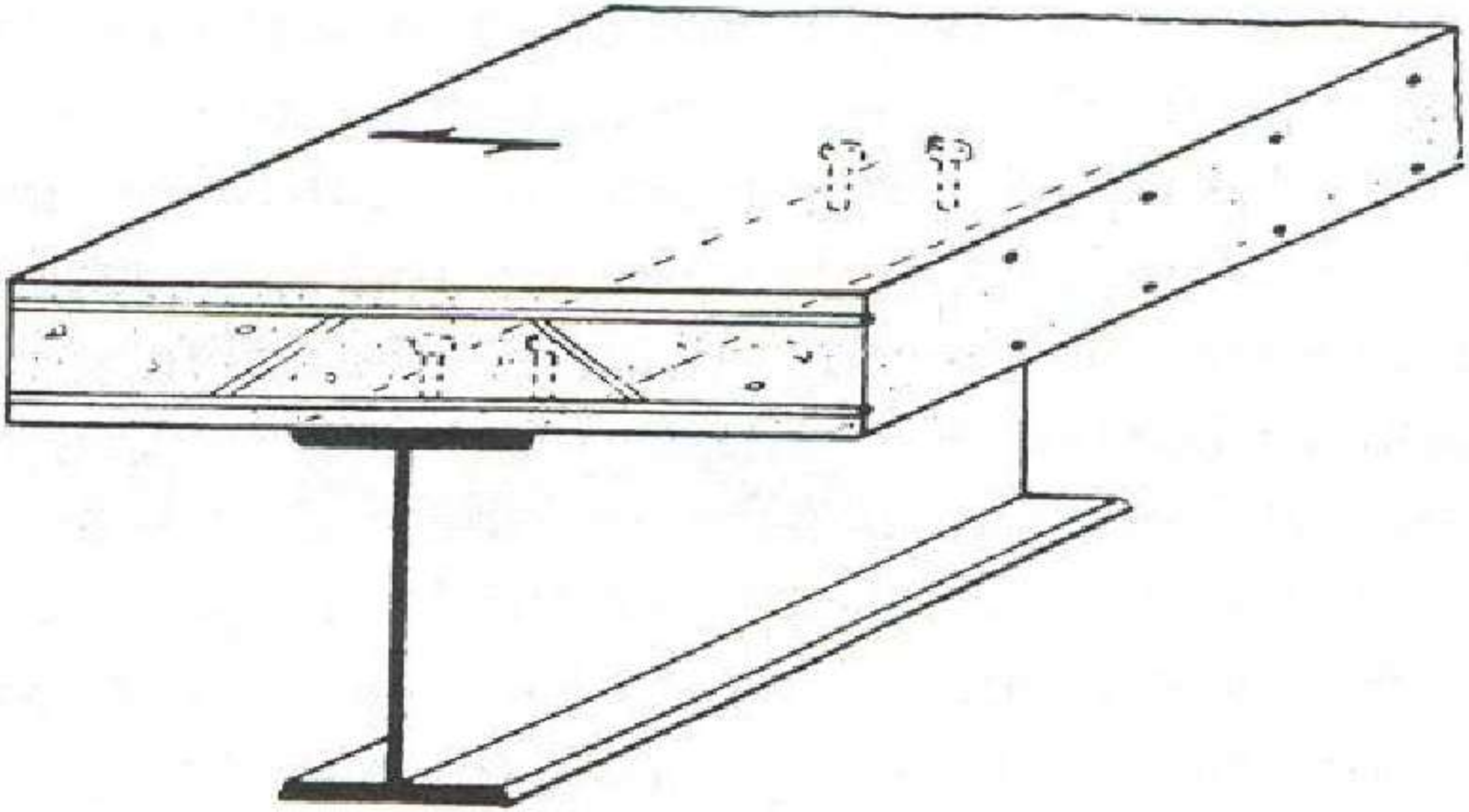
The ***two-way steel beam system*** is used in buildings where the columns are required to farther apart in both directions. A system of beams, supported by girders is used as shown above. The reinforced concrete slab spans transversely to the longitudinal axis. I order to minimize the depth of the floor frame, the heavily loaded girders are aligned with the shorter span and the relatively lightly loaded secondary beams are aligned wit the longer span.



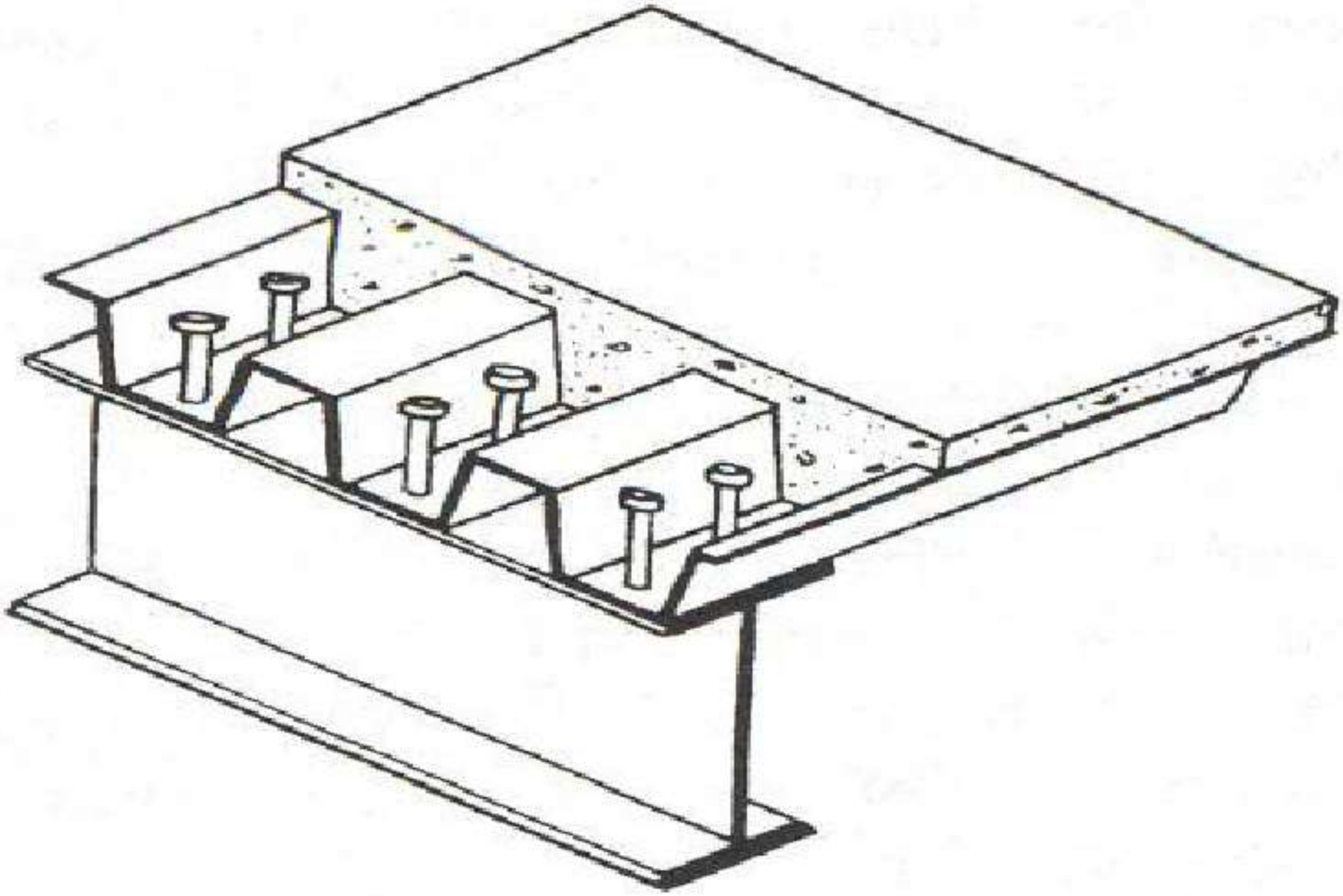
The ***three-way steel beam system*** is used in buildings where there is a need to have a large column-free areas. A deep lattice girder may form the primary component with beams or open web joists forming the secondary and tertiary systems. The reinforced concrete slab is set to span transversely to the tertiary steel beams.



When the steel frame support system is tied to the concrete slab via shear connectors, the slab becomes the compression flange of the new *composite system*. One method is shown above, called the *steel decking composite slab*. It has the convenience of using t steel deck for very rapid erection of the slab system, and permits the perforated and indented steel deck to serve as the shear connection.



When the reinforced concrete slab is tied directly to the supporting steel beam, the composite action comes from welded steel studs on the top flange of the beam. Other connectors are steel spirals, or short pieces of angles welded to the beam. This system is typically called the *composite frame*.



A combination of the two systems described above is shown above. This is the *composite frame and steel decking system*, that combines the quickly erected steel dec with the steel studs welded through to the supporting beam or truss.

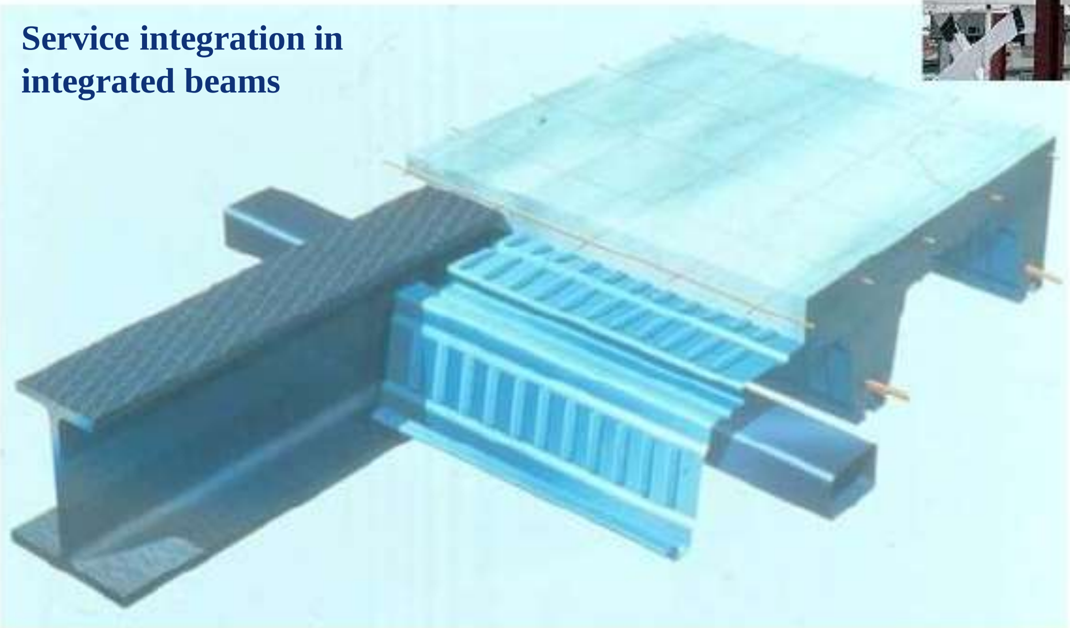
Commercial buildings require a range of specific technologies that have been developed to meet client needs:

Service Integration:

Cellular beams with regular openings for services

Fabricated beams with variety of shapes of openings

Service integration in integrated beams



Office buildings need large open spaces for flexible rental arrangements