Topic:

Framed Buildings

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Framed Buildings

Framed buildings are building structures formed by the framed elements usually in the form of columns and beams, as well as further strengthened as necessary by the introduction of rigid floor membranes and external walls.

Common forms of framed building structure subdivided into 2 main types

1. Insitu RC frame
2. Prefabricated frame
3. Structural steel frame (universal or tubular sections, hollow or composite elements)
Example of In-situ RC frame building
Example of prefabricated frame building

Headquarters building of Hong Kong Jockey Club

Podium – KCR Kowloon Station
Example of Structural steel frame building
Advantageous features of framed structure

1. Speedy construction due to simplicity in geometry – consist of only columns and beams (or partially by the floor slab) as the main structural elements

2. Very rigid and stable – able to resist tremendous vertical (dead load) and lateral loads (wind)

3. Reduced dead load – absent of thick shear wall etc.

4. Roofed over at an earlier stage – every floor slab being finished becomes an cover to protect the lower floors from sun and rain

5. Offer large unobstructed floor areas – without obstacle between columns

6. Flexible utilization of space
Advan. features of framed structure (continued)

7. Adaptable to almost any shape
8. Easily altered within limits of frame
   – regular or non-regular grid system is very adaptable in spatial arrangement
9. Offsite preparation possible – especially for prefabricated construction using precast concrete or structural steel elements
10. May be designed to accommodate movement
11. Acceptable distribution of natural light – window openings can be provided easily on eternal walls
12. Easy to design structurally including computer design – again, due to simple geometry
Principle factors affecting choice of frame

Production consideration
- Availability of materials, labour and plant
- Speed of construction
- Availability of mechanical plants

Architectural Design consideration
- Size and shape of site
- Conditions of site
- Integration of mechanical elements
- Architectural or aesthetic requirements
Principle factors affecting choice of frame

Structural Design consideration
- Foundation consideration
- Standardization of members or design
- Span and floor loads
- Fire resistance requirement
- Maintenance consideration
- Integration of architectural & structural elements
Features of In-situ concrete frame construction

Construction aspects

1. Insitu concrete is inconsistent in quality in performance – mixing, delivery, placing and compacting of concrete require very tight quality control

2. Overlapping formwork, steel fixing and concreting process make site operations more difficult – these works are to be done almost at the same time at the same location

3. Formwork erection is often timely, expensive, environmental unfriendly and labour intensive

4. Increase a lot of wet-work – difficult to maintain site in a clean and tidy environment
Features of In-situ concrete frame construction

Construction aspects – examples of problem

Improper placing and compaction will seriously lower the strength of concrete.
Features of In-situ concrete frame construction

Construction aspects – examples of problem

Finishing the concrete surface after placing – improper finish will affect the size and dimension of member.
Features of In-situ concrete frame construction

Construction aspects – examples of problem

Exterior environment

It is difficult to maintain a clean and tidy site using in-situ concrete structure for the casting process is wet and dirty

Interior environment
Features of In-situ concrete frame construction

Construction aspects (continue)

5. Easier to allow for dimensional discrepancy – formwork can relatively easy to provide any ready dimension and shape

6. Concrete is cheap, easy available and can be cast into complicated shape

7. Frame erection affected seriously by climatic condition – in windy day it is difficult to erect formwork nor to place concrete

8. Durability affect by heat, moisture or environmental factors – concrete is not so durable as most person think
Features of insitu conc frame construction (cont.)

Structural characteristics and design aspects

1. Conc design more flexible and accurate than steel because of non dependence on standard sections
2. Conc frame easily damaged by building movements
3. Problems of creep & shrinkage (cause damage to finishes)
4. Higher dead load and bigger structural elements
5. Better fire resistance
6. Durability sensitive to workmanship
7. Overloading cause irreversible structural damages
8. Flexible in layout and shape
Features of structural steel construction

Structural characteristics

1. Steel has lower dead load (unless encased in concrete)
2. Steel frame can easily to have the layout changed to suit new design than concrete, especially requiring alteration after completion of the building.
3. Easily accommodate building movements for steel is a relatively flexible material and have greater adaptability to take up strain and deformation
4. However, it is weaker in fire resistance for steel will lose strength and deform serious at higher temperature (at 600°C or above). This can be improved by applying fire resistant plaster
Features of structural steel construction

Structural characteristics (continue)

5. Beams usually shallower in size than for concrete Beams

6. Sections in various convenient type and size thus economical in design and uses – refer to standard steel sections

7. Produce larger deflection & deformation (Bend) under wind – this will cause discomfort to users of building

8. Steel has higher thermal expansion value

9. Rusting or corrosion problems – very strict anti-corrosion treatment has to be applied
Features of structural steel construction (cont.)

Construction aspects

1. Quicker to erect and can be prepared offsite – in workshop/factory environment with good production and quality control

2. Erection on site less affected by climatic conditions – without placing of concrete

3. Longer and highly coordinated planning – require long time to make structural design, fabrication and delivery

4. Higher requirement in the control of dimensional accuracy before and during construction (in fabrication and in erection)
Features of structural steel construction (cont.)

Construction aspects

1. Demand greater transportation or cranages provision
2. Complicated quality assurance procedures – especially in the control of welding connection
3. Difficult to make connection with rigid structures – especially in composite structure in which RC core structure is involved
4. More complex when building become more gigantic and taller – due to the huge number of structural members, some may be of very heavy section
5. Induce more works at higher altitude
Features of structural steel construction

Construction aspects – highlight of some problems

Delivery of structural steel member by ship

Large member delivery to site waiting to hoisting up for erection
Features of structural steel construction

Construction aspects – highlight of some problems

Hoisting of the structural steel member to the upper floor
Connecting steel members with RC element – an anchor frame may be required for making strong connection.
Features of structural steel construction

Construction aspects – highlight of some problems

Constructing the composite floor in steel/RC composite structure

To connect floor to core wall – starter bars are to be provided within the core structure
Features of structural steel construction

Construction aspects – highlight of some problems

Very large component often in complicated shape
Features of structural steel construction

Construction aspects – highlight of some problems

Huge amount of structural members make erection very complicated
Features of structural steel construction

Construction aspects – highlight of some problems

The existence of very complicated jointing in steel structure
Features of structural steel construction

Construction aspects
– highlight of some problems

Required to perform works at very high altitude
Features of structural steel construction

Construction aspects – highlight of some problems

Workers work at high altitude
Features of structural steel construction

Construction aspects – highlight of some problems

Connecting large and complicate shaped components can be very difficult
Features of structural steel construction

Construction aspects – highlight of some problems

Concrete has to be trimmed to allow steel to pass through

Examples of location where unmatched dimension causing problem
Features of structural steel construction

Construction aspects – highlight of some problems

Examples of location where unmatched dimension causing problem

Roof truss and the decking not on the same level