Precast Concrete

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Concrete

Introduction:

- concrete itself is a composite material . The basic ingredients of the concrete mix are water , cement and aggregates(rock and sand).

Mechanical properties of concrete that are relevant to the prestressed concrete design:

- Compressive Strength
- Modulus of Elasticity
- Modulus of Rupture

The properties of concrete which one should be familiar with before attempting to make use Prestressed concrete design are:

- Compressive strength
- Character of the Stress-strain relationship
- Modulus of elasticity
- Creep and shrinkage
- Tensile strength

Compressive strength:

- The compressive strength of concrete is given in terms of the characteristic Compressive strength of 150 mm size cubes tested at 28 days .
- The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall. This concept assumes a normal distribution of the strengths of the samples of concrete.

Points to recall about reinforced concrete:

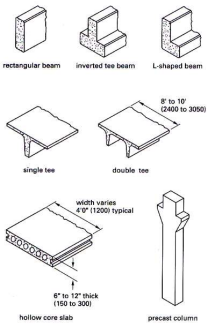
- Concrete is strong in compression but weak intension
- Steel is strong in tension (as well as compression)
- Reinforced concrete uses concrete to resist compression and to hold the steel bars in place, and uses steel to resist all of the tension
- Tensile strength of concrete is neglected (i.e. zero)
- RC beam *always* crack under service load

Defects in concrete:

Shrinkage: associated with the loss of moisture from gel particles of the paste
Creep: Time dependent increase in deformation due to sustained loading can occur in all types of loading-compression , tension and torsion . The earlier the age at which loading is applied larger the creep . Creep is higher in wet conditions than in dry conditions.

Precast Concrete

- Precasting is the casting of concrete members at a location other than its final position in the structure, as opposed to cast-in-place concrete.
- Precast concrete is usually cast in fabricating plants where conditions can be more carefully controlled and where work can proceed regardless of the weather.



Precast Concrete

- Precast concrete has the greatest economic advantage when there are many identical members to be cast, as the same forms can be used many times. Advantages of precasting:

1) Better quality control of concrete
2) Better control over curing
3) Members castable in all weather
4) Members erectable in all weather
5) Faster actual construction time

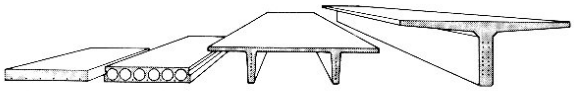
Precast Concrete

Disadvantages:

- Development of connections between elements is difficult and there is an inherent lack of continuity.
- Difficulty integrating other building systems (ducts, wiring).
- Often heavy and long adds difficulty in handling and transportation; cost of manufacturing must be offset by use of repetitive members.

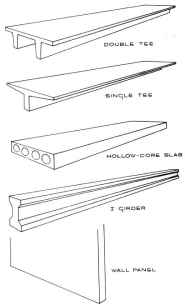
Precast Concrete

Typical Precast Concrete Members



Flat slab Hollow Core slab Double-Tee Single-Tee

Precast Concrete



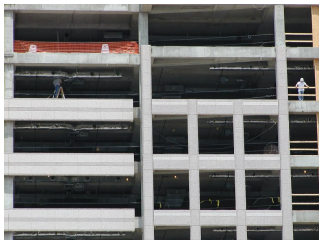
Typical Precast Concrete Members

Precast Concrete

Precast Concrete

Hollow core slabs

Hollow core slabs



Precast Concrete Cladding

INTRODUCTION:

- Every construction material & system has its own characteristics which to a greater or less extend influence the layout, span length, construction depth, stability system, etc.
- This is also the case for precast concrete , not only in comparison to steel, wood, & masonry structures, but also with respect to cast in-situ concrete.
- Theoretically, all joints between the precast units could be made in such a way that the completed precast structure has the same monolithic concept as a in-situ one.
- If the full advantages of precast concrete are to be realized, the structure should be conceived according to its specific design philosophy
- long spans, appropriate stability concept, simple details, etc. Designers should from the very outset of the project consider the possibilities, restrictions & advantages of precast concrete, its detailing, manufacturer, transport, erection & serviceability stages before completing a design in precast concrete.

Precast concrete

- Enables faster programme times - not affected by weather or labour shortages.
- Improves buildability - early enclosure of dry envelope enables follow-on trades to start sooner.
- Produces a high standard of workmanship in factory conditions - reduces potential for accidents, addresses on-site skill shortage.
- Has a high quality finish that can be left exposed - concrete's thermal properties can be exploited in low-energy buildings.

PRECAST BUILDING SYSTEM

- Precast concrete frame
- Precast concrete wall
- Precast concrete floor

Precast concrete frame

Description

- Precast concrete frames involve an entire structure being fabricated off-site.
- In addition, structural components can be supplied for incorporation into a structure on-site.
- Frames can simultaneously achieve both structural and decorative design requirements - a wide variety of mixes, colours and finishes can be accommodated.
- Architecturally-finished precast structures can be left exposed to exploit concrete's high thermal capacity in a building's "green" energy management system.

- **Process**

- Precast concrete frames are cast in the same way as precast concrete cladding, but as they are designed as structural elements have heavier reinforcement than is required for non-structural cladding.
- Elegant connections are required between columns and beams to transfer considerable forces without adversely affecting the visual appearance of the frame.

- **Benefits**

Precast concrete frames

- Enable faster programme times - not affected by weather or labour shortages.
- Improve buildability - structure is fabricated off-site for rapid erection on-site
- Produce a high standard of workmanship in factory conditions - reduces potential for accidents, addresses on-site skill shortage.
- Have a high quality finish that can be left exposed

Precast concrete wall

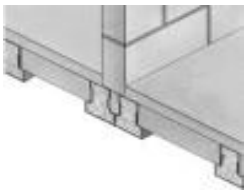
- Precast wall are used for internal & external walls, lift shafts, central cores etc.
- Precast wall system are mostly used in domestic construction, both for individual housing & for apartments. The solution can be considered as the industrialized from of cast in-situ walls or classical brick or block masonry walls.
- The precast walls can be load bearing or only partition walls. The surface of the elements is smooth on both sides & ready for painting or wall papering.
- Precast walls offer the advantage of speed of construction, smooth surface finishing, acoustic insulation & fire resistance.

Precast concrete Floor

- Hollow core floors
- Ribbed floors
- Concrete roof elements
- Massive slab floors

- The principle advantages of precast floors are speed of construction, absence of scaffolding, large variety of types, large span capacity, & economy.
- Precats floors can also be classified according to their manufacture into totally & partially precast floors.
- Totally precast floors are composed of units, which are totally cast at the plant. After erection, the units are connected to the structure & the longitudinal joints are grouted. In some cases a cast in-situ structural topping screed is added.
- Partially precast floors are composed of a precast part & a cast in-situ part. Both parts are working together at the final stage to achieve the composite structural capacity. The main totally precast floor & roof types are described hereafter.

PRECAST CONCRETE FLOOR



Advantages Of Precast Concrete

- Structural efficiency
- Flexibility in use
- Optimum use of materials
- Speed of construction
- Quality consciousness
- Adaptability
- Protection of the environment

Advantages of Precast Concrete

- Less expensive than real brick.
- Does not require an extensive footing like a real masonry wall. Can be reset should it ever shift.
- More durable than real masonry - no mortar joints to let water in.
- Installs quickly and easily - most can be done in one day.
- Maintenance free - No need to paint or periodically replace slats as you would with wood fences.

Disadvantage of precast concrete

- System building is less flexible in its design concept than purpose-mode structures
- Most design briefs can be fulfilled without too much modification to the original concept
- Structural connection between the precast concrete units can present both design & contractual problems

TYPES OF PRECAST SYSTEMS

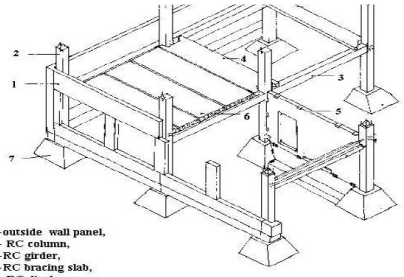
- Depending on the load-bearing structure, precast systems can be divided into the following categories:
  - Large-panel systems
  - Frame systems
  - Slab-column systems with walls
  - Mixed system

Large-panel systems

- Depending on wall layout , there are three basic configurations of large-panel buildings:
  - Cross-wall systems
  - Longitudinal wall systems
  - Two-way system

A large-panel concrete building under construction

FRAME SYSTEMS



1-outside wall panel,
2- RC column,
3-RC girder,
4-RC bracing slab,
5- RC diaphragm,
6- RC ceiling slab,
7- RC foundation

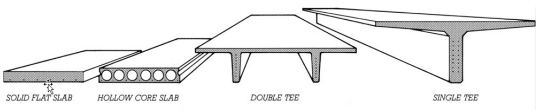
Slab-column Systems With Shear Walls

- These systems rely on shear walls to sustain lateral load effects, whereas the slab-column structure resists mainly gravity loads. There are two main systems in this category:
  - Lift-slab system with walls
  - Prestressed slab-column system

A lift-slab building

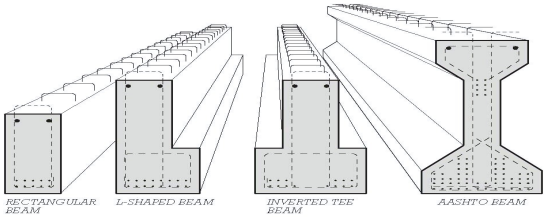
Precast Concrete Structural Elements

Precast Slabs



Precast Concrete Structural Elements

- **Precast Beam & Girders**



Precast Concrete Structural Elements

- Precast columns

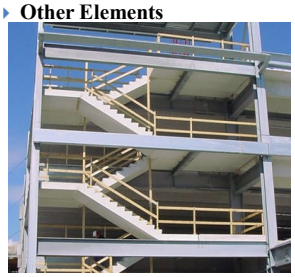
Inverted Tee beams supported Precast columns on precast columns

Precast Concrete Structural Elements

- **Precast Walls**

Precast Concrete Structural Elements

- **Other Elements**

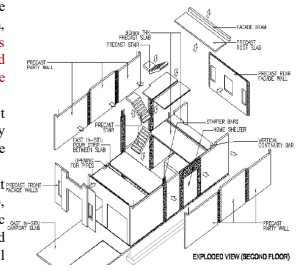


Precast concrete Stairs

Uniquely shaped structural elements for a sports stadium

Design Concepts For Precast Concrete Buildings

- The design concept of the precast buildings is based on the buildability, economy and standardization of precast components.
  - When precast members are incorporated into a structural system, the forces and deformations occurring in adjoining members and in the entire structure should be considered.
  - The structural behaviour of precast elements may differ substantially from that of similar members that are monolithically cast in place.
  - Design of connections to transmit forces due to shrinkage, creep, temperature change, elastic deformation, wind forces, and earthquake forces require special attention.

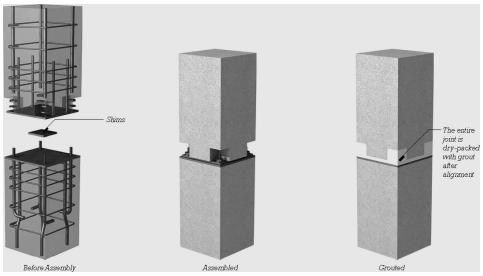


Precast Concrete Structural Elements

- Precast concrete structure consisting of solid wall panels and hollow core slabs.

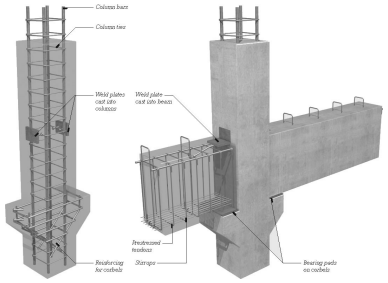
Typical Connection Of Precast Concrete Elements

- Column To Column Connection



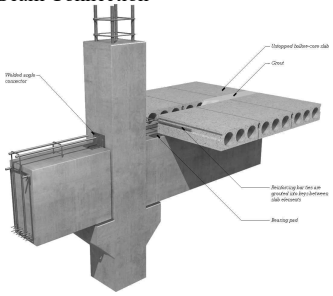
Typical Connection Of Precast Concrete Elements

- Beam To Column Connection



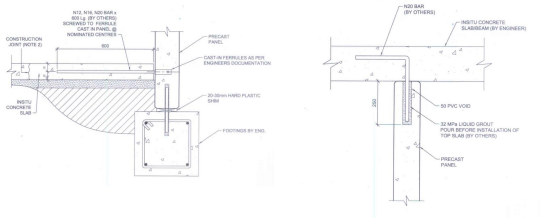
Typical Connection Of Precast Concrete Elements

- Slab To Beam Connection



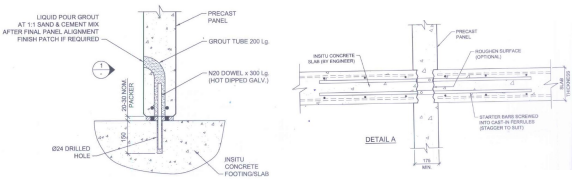
Typical Connection Of Precast Concrete Elements

WALLPANEL CONNECTED TO INSITU CONCRETE



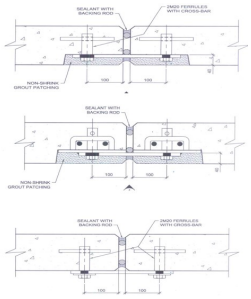
Typical Connection Of Precast Concrete Elements

- Wallpanel Connected To Insitu Concrete



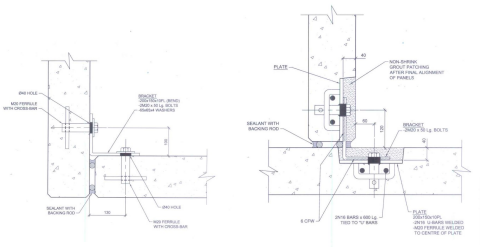
Typical Connection Of Precast Concrete Elements

- CONNECTION BETWEEN SLABS



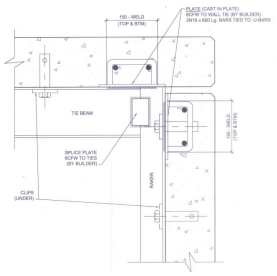
Typical Connection Of Precast Concrete Elements

- CORNER CONNECTIONS OF WALL PANELS



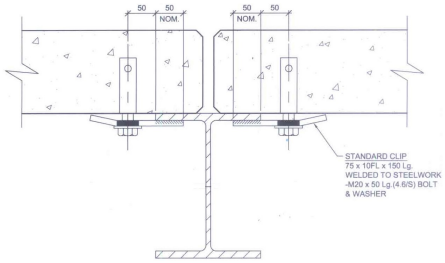
Typical Connection Of Precast Concrete Elements

CORNER CONNECTIONS OF WALL PANELS



Typical Connection Of Precast Concrete Elements

- CONNECTION OF WALL PANELS TO COLUMNS

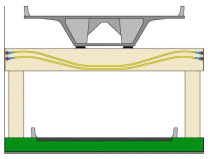


Prestressed Concrete by Posttensioning

- done on the building site

Bonded Post-tensioned Concrete

- Advantages
  - Tendons are less likely to de-stress in accidents
  - Tendons can be easily 'weaved' allowing more efficient designs
  - Higher ultimate strength due to bond generated between the strand and concrete
  - No issues with maintaining the anchor



Why Prestressed Concrete?

- Concrete remains un-cracked
- Reduction of steel corrosion
- Increases durability
- Good for pressure vessels
- High span to depth ratio (ex: 45:1 vs. 28:1)
- less dead load
- More economical

Applications of prestressed concrete:

- Bridges
- Slabs in buildings
- Water Tank
- Concrete Pile
- Thin Shell Structures
- Offshore Platform
- Nuclear Power Plant
- Repair and Rehabilitations