IIT MADRAS

PRECAST CONCRETE CONSTRUCTION

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INTRODUCTION

*Precast concrete construction or Prefabrication*

- It is an industrialized method of construction
- This is an advanced & up to date method of construction
- This technique is used in Housing / Industrial projects by means of assembling precast components
- The improvement in technology has enabled architects & engineers to use this technique for building innovative and outstanding structures with economy and speed
INTRODUCTION

- Precast concrete construction or Prefabrication has been used extensively in industrial buildings by Larsen & Toubro Ltd. and others in India
- Site prefabrication chosen due to high transportation costs and taxation
- Proven to be economical, fast, high quality achievement, low material consumption, etc. (when compared to Steel and in-situ Concrete construction)
- Standardization only for particular project requirements
- Moulds and erection tackles inadequately utilized
- Unique, innovative and outstanding structures achieved
INTRODUCTION

Advantages of Precast concrete

- Structurally advantageous cross sections are possible bringing in savings in deadweight and consequently cement and steel consumption
- Variety of shapes possible with precast concrete to suit aesthetics.
- With use of standardized moulds it is possible to get high repetition and good quality as the concreting is at ground level under control conditions
- Technique of prestressing including use of pretensioning in manufacture more advantageous than in-situ concrete
- As they are prefabricated and only assembled at site, it brings in enormous savings in time like the pre-engineered steel structures
- Very high quality is possible due to manufacturing techniques being employed in factory like conditions
- Structures with precast concrete are gaining popularity in India due savings in time and superior quality
- Industry produced standard products would attract widespread usage in housing & Industrial projects
PREFABRICATION - INHIBITING FACTORS & SOLUTIONS

- No Standardization
- Initial application and doubts of success
- Industrialization of manufacturing process necessary – A long line of hollow core slab production needs only 7 people in Europe
- Differential application of VAT and Excise Duty between site and factory
- Factory wage and facilities cost more and add to problem of worker union activity
- Moulds take initially some time to plan and install – High quality with lower price only if more repetitions of casting is achieved
  - Rs. 50 to 120 per m² of shutter area
  - Rs. 500 to 800 per m³ concrete
- Erection by cranes – faster but expensive (Rs. 200-300 per tonne or Rs. 500 to 750 per m³)
INTRODUCTION

Indian Scenario

- Concrete construction in India having rapid growth as can be seen from the cement consumption in the country (approx. 200 MTPA)
- While conventional concrete is quite widespread, use of prefabricated concrete elements has been somewhat restricted in India mainly due to:
  - Lack of standardization and re-use of moulds
  - Lack of erection tackles essential for the success of precast concrete.
  - Taxation policies giving an unfair advantage to concrete made at site in a shoddy way over concrete made in a factory-like environment.
  - Excise duty, VAT, environment clearance and higher wages for workers, etc. applies to precast concrete as well.
  - The differential increase in cost due to taxation is nearly 20% and offsets the economy which is available in widespread use of precast concrete elements in all sectors of construction.
Concrete construction has generally proved to be economical compared to steel construction in India till pre-engineered structures in steel found wide acceptability due to economy and speed of construction.

Advantages for pre-engineered steel structures available for concrete construction as well if standardization and ready availability are ensured through factory production of precast and reinforced prestressed concrete elements.

The success and acceptability of ready mix concrete as well as pre-engineered structures in steel is an indicator for the scope of precast concrete to be acceptably economical and bring in the additional advantage of quality and speed of construction.
SCOPE OF THE LECTURE

- The presentation would include examples of projects successfully executed and have stood competition even though site prefabrication was used by L&T in some of the examples.

- The time has come to give a direction by removing inhibiting factors and providing incentives for precast concrete to be more widely applied than hitherto.

- This is essential from the viewpoint of the enormous infrastructure and building construction that has to be achieved in the 12th Five-Year Plan as well as for future growth of India with lower availability of skilled technicians for the construction industry in the days to come.
The sectors where precast concrete can become popular include:

- **Buildings**
  - Office Complexes and IT Parks
  - Hotels and Hospitals
  - Educational Institutions
  - Sports Complexes – Stadia
  - Factory Buildings and Sheds
  - Industrial Storage Structures
  - Precast Annular Driven Piles for Foundations

- **System Housing**
  - Urban residences and Apartments
  - Components for rural housing
  - Social Buildings and Shops / Malls
  - Façade Elements, Stairs and Toilet Cubicles
**PRECAST CONSTRUCTION - APPLICATION (Contd.)**

- **Urban Infrastructure**
  - Flyovers
  - Bridges and Culverts
  - Underground ducts
  - Pipes for water supply and sewage treatment
  - Poles
  - Towers

- **Bridges**
  - Culverts and bridges up to 30 m span
  - Precast segmental construction for larger spans using pre-stressing
  - Structures for expressways and grade separators
  - Segments for long span bridges

- **Ports, Harbors and Airports**
  - Precast piles, service ducts, interlocking blocks for pavements
  - Decks of jetties and wharves
  - Airport terminal buildings and other structures
PRECAST CONSTRUCTION - APPLICATION (Contd.)

- Railways
  - Pre-stressed concrete sleepers
  - Signaling and railway electrification masts
  - Culverts and bridges
  - Elements of ballast-less tracks
  - Segments for metro rail and mono rail structures
  - Elements for tunnels and underground structures required for metro rail

- Concrete Products for Agriculture and General Purpose use
  - Compound walls
  - Fencing poles
  - Conveyor ducts
  - Manhole covers
  - Road kerbs
  - Canal lining elements
  - Barrage structures
  - Storm water drains
OFFICE COMPLEXES AND IT PARKS
HI-TEC CITY AT HYDERABAD

- Basement + ground floor + 10 floor structure
- The total built up area is about 5,80,000 sq.ft
- Engineering & construction completed in 18 months time
The floor is designed as grid floor.

40 mm thick Precast waffle units are designed to serve as shuttering as well as to carry loads as composite member.

75 mm thick in-situ concrete on top as screed
INTERNATIONAL TECHNOLOGY PARK AT BANGALORE

- 2 level basement + office tower blocks of 12 and 14 storeys each, production block of six storeys & connecting block of 4 storeys
- The total built up area is about 11,41,776 sq.ft
Prestressed concrete hollow core slabs were used.

For various spans up to 11m, 300 mm to 350 mm thick hollow core slabs were used.

This resulted in considerable saving in time.
EDRC BUILDING AT L&T ECC CAMPUS CHENNAI

- 4-storeyed structure with stilt at ground floor
- Supported on pre-stressed cantilever beams (tree trunks) which in turn supported on central column
- Combination of in-situ & precast system
- The external curved fascia are of precast elements
ECC HEADQUARTERS IN CHENNAI

- 4-storied structure with stilted ground floor
- Combination of in-situ & precast system
- Precast components used
  - Waffle units for floor / roof
  - Hollow core slabs/ Rib slabs
  - Toilet Element
  - Wall Element
  - Façade elements
  - Mullions
EDUCATION INSTITUTIONS
36m x 39m x 10m high building
- Precast prestressed concrete roofing system
- “V” shaped folded plate - 36m long, 6.5m wide & 2.35m height
- Adopted mainly to save time
PREFABRICATED SCHOOL ROOMS AT GUJARAT

- 6000 school rooms spread all over Gujarat
- Each school room of 54 sq.m built up area

- Precast components used
  - Footings
  - Columns
  - Wall panels
  - Roof beams
  - Roof planks
  - Step units
PREFABRICATED SCHOOL ROOMS AT GUJARAT

- View of Casting Yard
- Wall Panels in the Curing Tank
PREFABRICATED SCHOOL ROOMS AT GUJARAT

Wall Panels in Stacking Yard

Wall Panels in Transit
SPORTS COMPLEXES - STADIA
NEHRU STADIUM AT CHENNAI

“Designed and Built in just 260 days”

40,000 Seating capacity

“Won RoSPA Birmingham, UK 1993”
JAWAHARLAL NEHRU STADIUM AT CHENNAI

- Multipurpose stadium of 40,000 capacity.
- Built in a record period of 260 days.
- 28 m high stadium
- Frames and the concourse slabs at +4.5m & +15.3m levels are in-situ.

- Upper gallery units - precast rib slabs.
- Lower gallery units - precast step units.
- Roof element - precast prestressed element of 20.175m length, 2.5m width and weighs 16MT.
Total built up area of 10,800 sq. m – Column free area 120m x 80 m Oval
Seating capacity of 4000.
Roof is an elliptical dome supported on ring beam over arch columns.
The elliptical roof is made up of 120 Nos. of V-type RCC folded plates of 40m span
KANTEERAVA INDOOR STADIUM, BANGALORE

- Supported On 443 Bored Cast–in–situ Piles
- Arched Columns Support Roof Elements
- Gallery Elements Partly Precast
- The central hub (compression ring) is of 16m x 36m size elliptical in plan
- Once all elements were erected, the hub was cast.
- After achieving the required strength, the supporting towers were progressively lowered to make the roof self-supporting.
FOOTBALL STADIUMS AT QATAR

- Two football stadiums at Doha, Qatar each of 25,000 capacity
- The Gallery is of precast concrete comprising of bleachers and raker beams supported on in-situ columns
- Maximum span of bleachers is 7.4m
- Total No. of bleachers is 7444
- Total No. of raker beams is 352
- Constructed in a span of 9 months
FACTORY BUILDINGS AND SHEDS
A view of precasting yard for Industrial sheds at Tirupur
Birds eye view of Industrial sheds at Tirupur
20m span precast prestressed concrete folded plate with north light glazing on one side for MICO – Bangalore. Construction technique first of its kind in India
20m span precast prestressed concrete folded plate at pearl distilleries, Ongole
40m span precast concrete A- Frame supporting trussed purlins as roofing system for silo for SPIC at Tuticorin
38 m span precast trough slab ‘A’ frame silo at state fertilizer manufacturing corporation, Colombo, Sri Lanka
FACTORY STRUCTURES USING PRECAST CONCRETE

Textile Mill at Pondicherry for Anglo – French Textiles
- Area 13,500 square meters
- Pre-cast columns with a ‘Y’ configuration
- Pre-tensioned steam-cured channel slabs (span 16 m)
- Slabs rest on the humidification ducts

Roofing System for Grindwell Norton Tirupati
- Area 2,405 square meters
- 28 M Span Pre Cast Purlins & Gantry Girders
- Precast Concrete 0.10 cum / m2
- In-situ Concrete 0.14 cum / m2
- Steel - Precast 50 kg / m2 & In-situ 15 kg / m2
INDUSTRIAL STORAGE STRUCTURES
43.5m precast pre-stressed concrete truss (in 3 pieces) & slabs as roof for silo at Kakinada - first of its kind in India
UREA STORAGE SILO FOR IGFL - JAGDISHPUR

TYPICAL SECTION

TYP. SECTION SHOWING THE ASSEMBLY OF ELEMENTS.
VIEW OF PRECAST COMPONENTS GIVING SHAPE TO A 55m SPAN UREA SILO AT JAGDISHPUR
ASSEMBLED VIEW OF UREA SILO
COMPLETED VIEW OF UREA STORAGE SILO
SYSTEM HOUSING
Sai Baktha Nivas
Project, Prashanthi Nilayam
PRECAST MANAGEMENT

- PRECAST ITEMS INVOLVED IN THIS PROJECT

  ✓ PRECAST FLOOR SLAB – 800 NOS (2 Tonnes each)
    - SIZE: (5.8MX1.61M)
    - CONCRETE: 0.89cu.m
    - REINFORCEMENT: 125KG

  ✓ PRECAST ROOF SLAB – 206 NOS (9.5 Tonnes each)
    - HP Shell element: (13.9MX2.65M)
    - CONCRETE: 3.85cu.m
    - REINFORCEMENT: 385KG

  ✓ PRECAST STAIRCASE – 60 NOS (5 Tonnes each)
    - CONCRETE: 2.08cu.m
    - REINFORCEMENT: 230KG
Erection Of Precast Roof Shell Element
Precast Roof Shell Element Erection in position
Precast Roof Shell Element - In Completion Stage
Precast Staircase element in completion stage
TISCO HOUSING AT JAMSHEDPUR

- 750 Dwelling units each of built-up area 70 sq.m
- Tunnel Form system & Precast concept

- Precast components used
  - Facade panels
  - Balconies
  - Sunshades
  - Landings
  - Stair flights
  - Cup boards
  - Kitchen platforms
  - Water tanks
Precast Fascia Panels

TISCO HOUSING AT JAMSHEDPUR
TISCO HOUSING AT JAMSHEDPUR

Bathroom elements Precast
Use of Tunnel form and Pre-fabricated building elements

Slabs & walls of a building are cast in continuous pour using room sized structural steel mould

Mechanized construction process

Ideal for a repetitive structure

For economy, speed & ease of construction
SOUTH CITY AT BANGALORE

- 1000 Dwelling units each of built-up area 90 sq. m
- 20 Storeyed with 13 cm thick concrete walls – Shear wall concept used
- Tunnel Form / Large Area formwork & precast concrete components used

No. of Flats : 2,360
Built up area : 313,410 sq. m
Floor Plan for 2 BHK Apartment
MOCK-UP FOR PRECAST HOUSING

- Ground + 4-floor structure
- 45 flats each of built-up area 28 square metre
- Total precast concept

- Precast components used
  - Footings
  - Columns
  - Floor / Roof beams
  - Floor / Roof planks
  - Wall panels
  - Stair flights
  - Cup boards
  - Kitchen platforms
  - Water tanks
URBAN INFRASTRUCTURE
SIRSI CIRCLE FLYOVER BANGALORE – SEGMENTAL CONSTRUCTION

- Length of flyover 2.65 Km
- Width of flyover 16 m
- 68 Spans of 37 m each
- Segmental Construction
- One span every 5 days (average)
SIRSI CIRCLE FLYOVER BANGALORE

Maximum Span: 37m
Minimum Span: 33m
Max. Pier Height: 7 M
Foundation Type: Bored Cast In-situ Pile
Period of Construction: 24 Months
SIRSI CIRCLE FLYOVER BANGALORE
TRANSPORTATION OF SEGMENT
LAUNCHING TRUSS - SIRSI FLYOVER
SIRSI FLYOVER, BANGALORE
SIRSI FLYOVER, BANGALORE
Underground works for DMRC in some of the busiest areas of Delhi
BRIDGES
2\textsuperscript{nd} NARMADA BRIDGE

Length: 1.4 Km
Width: 10.5 m (Two Lane Bridge with Footpath)
Foundation: Well foundation by Jack Down System
Superstructure: Precast Segmental Balanced Cantilever
Period of Construction: 32 Months
BRIDGES (Proposed Standardisation)

- Precast Slab Elements 3, 4.5 and 6m
- Culvert elements with precast prestressed inverted Tee elements to be erected and filled with in situ concrete for flat bottom and top surfaces (6, 7.5, 9, 12, 15 m)
- Precast Concrete Girders for Standard IRC Loadings (9, 12, 15, 18, 21, 24 m)
- Elements for Road Over Bridges for Railway Crossings
- 4 lane match cast segments for flyovers (24, 30, 36 m spans)

Other Products

- Precast annular piles for driven piles
- Spun poles and Masts
AIRPORTS
BANGALORE INTERNATIONAL AIRPORT (Master Plan & Terminal Bldg.)

- The design consists of a transparent, ecological building with natural light filtering through sky lights in the roof.
- The Passenger terminal building is modular, so as to accommodate the growing number of passengers.
- The terminal building is designed to cater to the peak hour capacity of 1850 passengers per hour.
Bangalore International Airport – Play Video
Precast Erection

Erection Gantry

Bangalore International Airport
Pre-cast Yard showing Shuttering, Rebar fixing & casting Activities

Mould Shuttering in Progress

Pre-cast Element

Gantry for Handling

S – Shaped Mould

Top Shutter by Gantry
PTB-Interior view

Bangalore International Airport
PORTS AND HARBOURS
PORTS & HARBOURS
ADANI PORT, Mundra
(Large diameter Precast Prestressed Annular Piles)

- Use of annular precast prestressed piles
- 42m long, 1200mm diameter, 127mm thick wall
- Precast Prestressed - 28 strands of 12.7mm diameter
- M50 concrete - Steam curing for 20 hours
- Driven in Open sea using floating craft - ‘RAMLIFT’ of C&N, UK
- End-on-Method used for some area
- Executed for the first time in India
PRECAST PRESTRESSED ANNULAR PILE
(MOULD & CURING HOOD DETAILS)
RAILWAYS
CONCRETE PRODUCTS FOR AGRICULTURE AND GENERAL PURPOSE USE
15M SPAN CONVEYOR GALLERIES IN PRECAST CONCRETE AT AWARPUR CEMENT WORKS - FIRST OF ITS KIND IN INDIA
20M SPAN, 3.3M HIGH PRE-CAST PRE-STRESSED CONCRETE PIPE BRIDGE ACROSS BUDAMERU DIVERSION CANAL FOR VIJAYAWADA THERMAL POWER STATION
Precast concrete trestles used for pipe rack structure at Kothari caustic soda project at Manali
20m span, 3.3m high pre-cast pre-stressed concrete pipe bridge across Budameru diversion canal for Vijayawada thermal power station
14M HIGH 2.5M WIDE PRECAST CONCRETE GROOVED WALL PANEL WITH PRECAST CONCRETE GUTTER FOR THE ASSEMBLY SHOP OF L&T POCLAIN – BANGALORE
TYPES OF MOULDS
TYPES OF MOULD

MOULD TYPES

STATIONARY TYPE
- TABLE MOULD
- FIXED MOULD
- BATTERY MOULD

SLIP FORMING TYPE
- TILTING MOULD
- VERTICAL MOULD

PRODUCTION LINE TYPE
TILTING MOULD
Technology used for Precast Production
(a) Tilting Table
Technology used for Precast Production

(a) Tilting Table
Technology used for Precast Production

(b) Gantry Cranes
SLIP FORMING
SLIP FORMING
Concrete Mould for a Truss
Concrete Mould for a Truss
PROCESS FOR PRECAST PRODUCTION
Process for Precast Production
Precast Manufacturing
De molding & Stocking & Curing

- Once the concrete is set, all the panels are cured by applying low pressure steam curing based on ACI Standards.
- Once the P.C. elements achieve 50% of its ultimate strength elements are de molded & stocked at the stock yard.
Process for Precast Production
Precast Manufacturing
Sand Blasting & Cosmetic Repair

- After completion of curing period the required panels are sand blasted with its required degree of sand blasting.
- Cosmetic repair will be done before dispatching to the site for installation.
Process for Precast Production

Precast Manufacturing

Finished Panels
Process for Precast Production
Precast Manufacturing
Finished Panels
LIGHTWEIGHT CONCRETE CONSTRUCTION
**Lightweight Concrete Construction**

- Density range from 650 - 1,250 Kg /cu. m as compared to 1,800 – 2,400 Kg /cu. m for conventional brick and concrete respectively
- Concrete having millions of tiny air filled cells
- **Advantages:**
  - Reduced need for structural steel reinforcement
  - Smaller foundation requirements
  - Better fire resistance
  - Serves as an insulation material
- **Lightweight concrete may be made by:**
  - Using lightweight aggregates
  - Use of foaming agents, such as aluminum powder, which generate gas while the concrete is still plastic
  - Heating clay, shale, slate, diatomaceous shale, perlite, obsidian, and vermiculite
- Natural lightweight aggregates include pumice, scoria, volcanic cinders, tuff, and diatomite
- Siporex (BG Shirke), Vayutan (HFF, Delhi), celcrete (TNHB) are examples in India
THANK YOU