

PRECAST IMPLEMENTATION IN SUBSTATION BUILDING AT IOCL BARODA – A CASE STUDY

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Abstract – Fast-track industrial infrastructure projects demand innovative construction methodologies to meet stringent timelines without compromising structural integrity, safety, and quality. This paper presents a comprehensive case study on the implementation of a hybrid precast construction methodology in the substation building at IOCL Gujarat Refinery, Baroda. The project, executed under a strict timeline of 19 months, required efficient planning and execution strategies to achieve timely completion.

A hybrid construction approach was adopted, consisting of cast-in-situ primary beams, precast secondary beams, and reinforced concrete slabs cast over steel deck sheets. This methodology ensured structural continuity while enabling faster construction through parallel activities and reduced dependency on on-site resources. The study elaborates on the project background, design considerations, evaluation of alternatives, approval procedures, precast yard setup, and construction methodology.

The implementation resulted in significant benefits, including approximately 70% reduction in staging requirements, 50% reduction in manpower, improved quality due to controlled casting conditions, and reduced environmental impact due to minimized timber usage. The case study demonstrates that hybrid precast construction is an effective solution for fast-track industrial projects and can be replicated in similar infrastructure developments.

Key Words: Precast Construction, Hybrid Construction, Substation Building, Deck Sheet, Fast-track Project, Construction Management.

1. Introduction

The construction industry is continuously evolving to meet the increasing demand for faster project delivery, improved quality, and efficient resource utilization. Traditional cast-in-situ construction methods, while reliable, often face limitations in terms of speed, labour dependency, and quality consistency, especially in large-scale industrial projects. Precast construction has emerged as a viable alternative, offering advantages such as reduced construction time, improved quality control, and enhanced safety. However, fully precast systems may not always be suitable for complex structures requiring monolithic behaviour and moment-

resisting frames & may not be cost effective due to costly joints.

To overcome these limitations, hybrid construction systems combining precast and cast-in-situ elements have gained prominence. These systems leverage the advantages of both methodologies, ensuring structural integrity while improving execution efficiency.

This paper presents a detailed case study on the implementation of a hybrid precast system in a substation building at IOCL Gujarat Refinery, Baroda. The study highlights the decision-making process, execution strategy, and benefits achieved through this innovative approach.

2. Project Background

The project was executed as part of a major infrastructure development at IOCL Gujarat Refinery, Baroda. The scope included the construction of RODM (Reverse Osmosis Demineralization) with Zero Liquid Discharge (ZLD) package and Condensate Polishing Unit (CPU) package.

Key Components of the Project:

- 3 × 250 m³/hr RODM Plant with ZLD Package
- 2 × 250 m³/hr CPU Package
- Multiple Effect Evaporator
- Substation Building

The project was classified as a fast-track project with a stringent timeline of **19 months**, necessitating the adoption of innovative construction methodologies to meet deadlines without compromising quality.

3. Description of Substation Building

The substation building was a critical component of the project, designed to house electrical systems and ensure uninterrupted power supply to various plant operations.

Key Features:

- Plan dimensions: 127 m × 35 m
- Structural configuration: Ground + 3 floors (G+3)
- Functional areas:
 - Two switchgear levels
 - Two cable cellar levels
 - HVAC and VAM rooms

- Firefighting systems

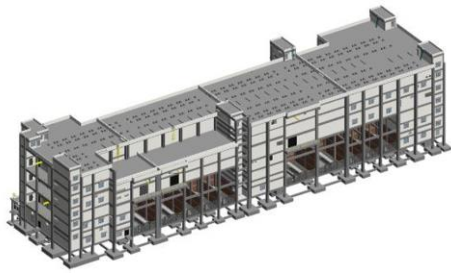


Fig. 1: Typical 3D view of Substation Building

The structure consisted of approximately **640 secondary beams of varying lengths**, making it highly repetitive yet complex.

4. Need for Alternate Construction Methodology

The following challenges necessitated the adoption of an alternative construction approach:

- Strict project timeline
- Large number of repetitive structural elements
- High dependency on formwork and staging
- Requirement for improved quality and precision
- Limited availability of skilled labour

Traditional construction methods were found to be inadequate in meeting these challenges efficiently. Therefore, a detailed study was conducted to identify a suitable construction methodology.

5. Evaluation of Construction Alternatives

Three major construction approaches were evaluated:

5.1 Fully Steel Structure

This approach involved the use of steel framing with RCC slabs cast over deck sheets.

Limitations:

- Not compliant with NIT requirements
- Higher cost implications
- Dependency on steel procurement
- Welders for fabrication at height

5.2 Fully Precast Concrete Structure

This approach proposed the use of precast beams and slabs.

Limitations:

- Difficulty in achieving monolithic behaviour
- Challenges in moment transfer at joints
- Structural performance concerns
- Requires expensive joints

5.3 Hybrid Precast system (selected option)

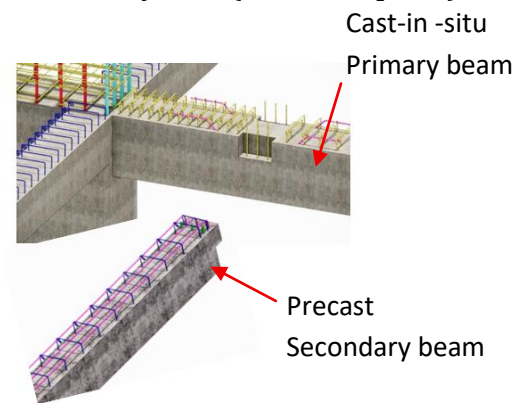


Fig. 2: Typical 3D view of beam junction

This approach combined cast-in-situ and precast elements:

- Cast-in-situ primary beams
- Precast secondary beams
- RCC slab over deck sheet

Advantages

- Ensures structural continuity
- Enables faster construction
- Reduces site workload
- Improves quality

6. Approval Procedure

The approval process involved multiple stages to ensure technical feasibility and stakeholder alignment:

1. Internal discussions between engineering teams
2. Presentation to consultant
3. Joint meetings with client and consultant
4. Site-level discussions and final approval

The structured approach ensured that all technical concerns were addressed before implementation.

7. Precast Yard Development

A dedicated precast yard was established to facilitate efficient production of precast elements.

Details:

- Casting yard area: 880 sqm
- Stacking yard area: 1000 sqm
- Distance from site: 3 km

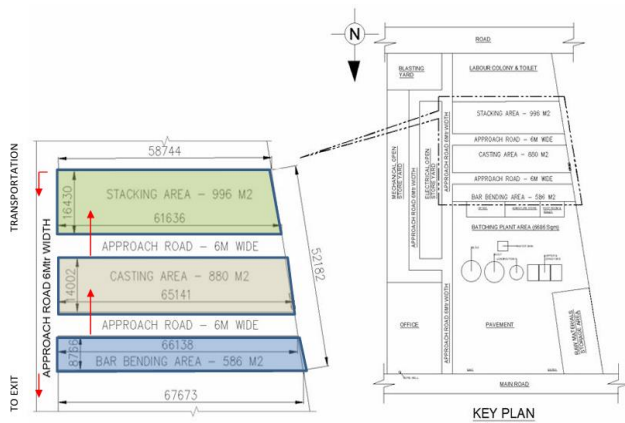


Fig. 3: Layout of Precast yard

Key Features:

- Continuous casting beds of 65m length
- Modular shuttering system (multiples of 5m)
- Adjustable stoppers for varying beam lengths

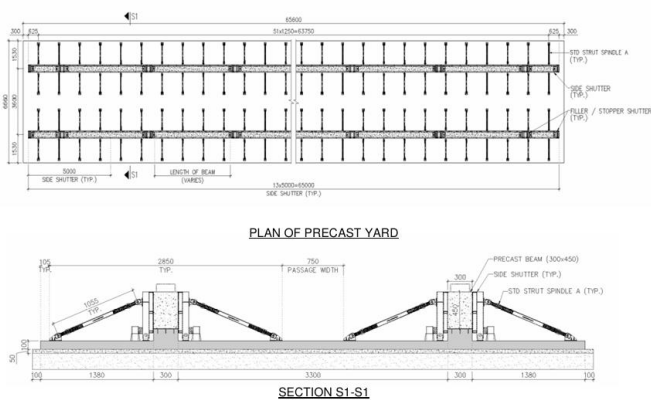


Fig. 4: Typical arrangement of Mould



Fig. 6: Stacking of cast components

This setup enabled efficient production and storage of approximately 640 precast beams.

8. Construction Methodology

8.1 Structural system

The adopted structural system included:

- Cast-in-situ primary beams with Recess provisions for secondary beams
- Precast secondary beams
- Steel Deck sheet
- In-situ slab

8.2 Sequence of Activities

1. Construction of foundations, columns & primary beams
2. Provision of recess in primary beams



Fig. 5: Beam moulds

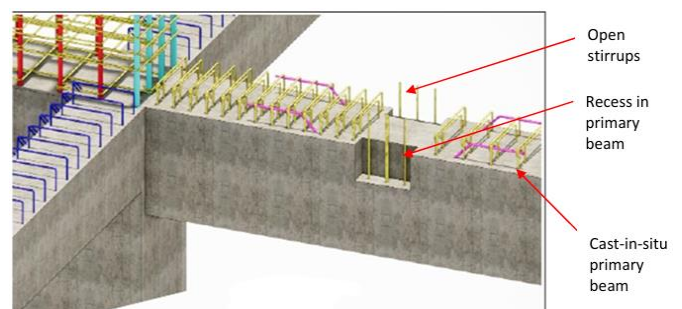


Fig. 7: Primary beam recess with open stirrups

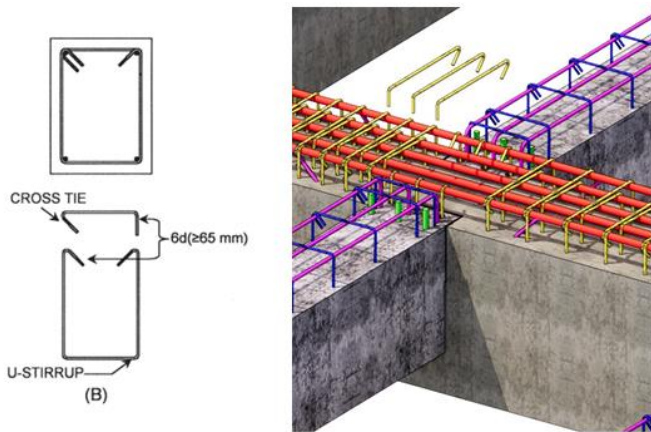


Fig. 8: Joint details at beam connection

- Erection of precast secondary beams using cranes

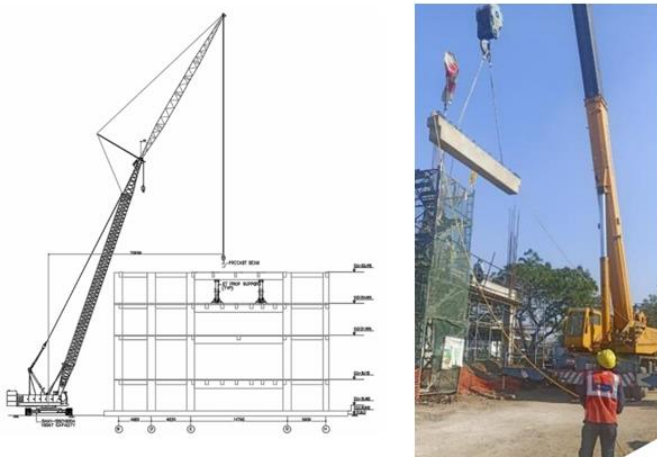


Fig. 9: Precast beam erection

- Fixing ISMC channels to secondary beams.
- Placement of deck sheets on ISMC channel supports



Fig. 10: Fixing ISMC channel & deck sheet

- Placement of reinforcement mesh



Fig. 11: Laying slab reinforcement

- Casting of slab concrete



Fig. 12: Concreting the slab

The process was repeated for each floor, enabling efficient workflow and reduced cycle time.

9. Results and Benefits

The Implementation of hybrid precast construction resulted in significant improvements:

9.1 Time Efficiency

- Faster construction due to parallel activities

9.2 Resource Optimization

- 70% reduction in staging requirements
- 50% reduction in manpower

9.3 Quality Improvement

- Controlled casting environment
- Better dimensional accuracy

9.4 Environmental benefits

- Reduced timber usage in formwork
- Lower carbon footprint

9.5 Cost Savings

- Reduced overhead costs
- Improved productivity

10. Comparison with Conventional Method

| Table-1: Comparison between Conventional & Hybrid method | | |
|--|--------------|-----------------|
| Parameter | Conventional | Advanced method |
| Construction time | High | Reduced |
| Manpower Requirement | High | Reduced |
| Quality Control | Moderate | High |
| Staging Requirement | Extensive | Minimal |
| Environmental Impact | High | Reduced |

11. Challenges Faced

Despite the advantages, certain challenges were encountered:

- Coordination between precast and in-situ activities
- Transportation of long precast elements
- Alignment and tolerance control during erection
- Requirement for skilled supervision

These challenges were effectively managed through proper planning and execution.

12. Conclusion

The case study demonstrated that hybrid precast construction is an effective solution for fast-track industrial projects. By combining the advantages of precast and cast-in-situ systems, the methodology achieves improved speed, quality and resource efficiency.

The successful implementation in the IOCL substation building highlights the potential for replication in similar projects, particularly where timelines are critical and repetitive structural elements are involved.

13. Future Scope

Future projects can further enhance the effectiveness of precast construction by:

- Integrating Building Information Modelling (BIM)
- Automating precast yard operations
- Using High-performance materials
- Developing advanced connection systems

14. References

1. PCI, Precast Concrete Structures, 2017.
2. ACI 318, Building code requirements for structural concrete.
3. IS 15916: Building Design using Precast Concrete.
4. Ervianto, W., Precast technology in Construction projects, 2019.

BIOGRAPHIES



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