

Methodology of 3S Construction Method “Prefabrication Technology”

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Abstract - Nowadays as construction industry is growing rapidly, thus demand of consumers is also increasing. For fulfilling their demands in shorter time industry needs a faster construction method without compromising strength and safety. 'Prefabrication Technology' is solution for that. This is now widely used by MHADA (Maharashtra Housing and Area Development Authority). As this method involves casting of structural member off-site or yards it reduces the manpower involvement which results in minimum work at site as well as by using this technology construction doesn't get affected by bad weathering conditions. In this review paper, the most focused was gain knowledge about methodology involved in prefabrication Technology for installation of structural elements and its advantages/disadvantages.

Key Words: Prefabrication Technology, Precast Concrete Members, Fast Construction Method, 3S Technology

1. INTRODUCTION

In 'Prefabrication Technology' all major structural members are casted in yards or in fully automated manufacturing units with the help of steel moulds, thus the requirement of skilled labours is decreased and only few skilled technicians are required for smooth operation of manufacturing. This precasted elements then transported to site for proper erection. This saves overall construction time. The components are casted in such way that it meets required strength. It has been observed that it gives more strength than cast-in -situ components, therefore it is considered as 3S technology as it gives Strength, Safety, Speed.

In Mumbai, because of limited space it becomes difficult to carry out on site concreting. Prefabrication Technology offers an excellent solution to this problem as it takes minimum site work. However, In India this technology mostly used for construction of bridge, road, metro tunnels but not much popular for building constructions. In past few years some government authorities like MHADA & SRA are using this technology for low cost housing scheme as final product of this technology is less expensive than traditional method of construction. There are more advantages of this method will be discussed further in paper.

2. LITERATURE REVIEW

Evanjaline Libie (2016) conducted a study on prefab technology and concluded that the construction time and

overall cost reduced. The final product has sufficient strength and thus durability increases. Material use reduced and less wastage generates.

C. Sivapriya et al. (2016) carried a cost comparison between traditional cast-in-situ method and prefabrication technology and found that total formwork, scaffolding and wet concrete cost saving over cast-in-situ can be 75%, 75%-90% and 90% respectively.

P. Karthigai Priya et al. (2018) carried a comparative analysis between conventional method of construction and prefabrication technology, they found by using prefabrication technology the project completes 15.17% earlier than conventional method.

Dr. Jalindar Patil et al. (2019) conducted a study on effects of prefabrication technology on work cycle and environment. They found that prefabrication technology is more efficient when it comes to repetitive construction. Prefabrication saves time and material utilization also it reduces the wastage which make it less harmful for environment, thus it's more efficient and sustainable construction method.

3. PREFABRICATED COMPONENT UNITS

Prefabricated Structural Components are mostly casted in factories. These units are responsible for manufacturing of components, their designing, curing and transportation to the site. These factories use pre-designed steel moulds for which they take consideration of requirements from clients. Capacity of unit depends upon size of plant. For normal sized plant the production rates are as follows:

Casting/Day

- Column: 70 Nos
- Beam: 100 Nos
- Slabs: 80 Nos
- Shear Walls: 4 Nos
- Lift Walls: 2 Nos
- Staircase: 2 Nos

4. PREFABRICATED COMPONENTS

Following are the major vertical & horizontal prefabricated components which are casted in moulds.

4.1 Vertical Components

- Column:** Column is considered as most important structural member as it transfers huge loads from beams to foundation. Columns can be casted in square, rectangular or circular in shape. Columns are initially casted in the form of hollow section with arrangement of dowelled connections. Prefab columns can be erected 5 times faster than cast-in-situ columns. It has ability to achieve a high quality and uniform finish. Erection of column is silent process which can be take place at any time. (Ref: Fig-1)
- Shear Wall:** A Shear Wall is a structural system composed of braced panels also known as shear panels to counter the effect of lateral load acting on a structure. Shear Wall usually designed to carry the wind and seismic load. Shear wall resist in plane loads that are applied along its height. The applied load is generally transferred to the wall by a diaphragm or collector or drag member. Plywood or the wood are the conventional material used in shear walls, but nowadays with advanced technology and modern building methods other prefabricated options had made it possible to inject shear assemblies into narrow walls that fall at either side of an opening. Prefabricated Shear Walls are casted according to the design requirements. (Ref: Fig-2)



Fig-1: Precast Column Fig-2: Precast Shear Wall

4.2 Horizontal Components

- Beams:** Beam is the horizontal component transfers load from slab to the columns. It gives support to the slab by resting on the column. The sizes of the beams are such that they satisfy the structural requirements. They are designed according to the sizes and shapes of the columns provided. Typical depth of the beam is 16 to 40 inches and the Typical width provided is 12 to 24 inches. Prefab beams and columns provide flexibility in design, shape and application. They are extremely durable compared

to alternative building materials. Beams and columns are produced with high strength concrete. It provides clean, finished surface for structural aesthetic of the building.

- Slabs:** The prefabricated slabs are manufactured or casted in a factory and transported to the site by means of trucks etc. while erecting the slabs, silicon oil is spread over to its surface and metal mesh is placed over it which is covered by the layer of 40mm thick slurry of concrete of M 25-30 grade(Depending upon requirements). Mesh and concrete layer give the strength to the prefab slabs. The diameter of the mesh is 6mm and the dimensions of the mesh are 2500mm X 2500mm.



Fig-3: Precast Beam

Fig-4: Precast Slab

5. INSTALLATION OF COMPONENTS

Following steps are usually adopted while installation of structural member at site.

5.1 Installation of Vertical Components

- Setting Out**

- Set reference line & offset line:** Reference line and Offset line is set to determine the position of the prefab element to be installed. The accuracy of the offset line is then checked. For vertical prefab components.
- Provide level pods:** Level pods or shim plates are provided for setting the level of the elements, it is set in position using non-shrink mortar.



Fig-5: Level Pod

- Fix baker rod:** For prefab external wall and column, the compressible form or backer rod is fixed on the outer perimeter of the wall and column. The permissible form or backer rod are properly secured or not, is then checked.

- **Lifting and Placing**

1. Lift and rig: The vertical components such as columns, walls are lifted and rigged to its designated location with the use of wire ropes. The hoisting condition of the prefab elements is checked. The alignment and verticality of the components is also checked. The temporary propping is adjusted if necessary, to achieve the level and position of the prefab components.
2. Adjust components: The vertical components are adjusted while lifting with the help of cranes and these are secured with diagonal props. The stability and alignment of the erected props is checked before releasing the hoist cable.



Fig-6: Lifting & Adjusting the components

- **Grouting Cables**

1. Prepare and apply non-shrink mortar: Non-shrink mortar is prepared and then applied to seal the gaps along the bottom edge of the inner side of the components. The joint width between components are within design allowance or not is then checked, before grouting.
2. Pipe sleeve connection: For corrugated pipe sleeve or splice sleeve connection, prepare or pour non-shrink grout or proprietary grout into the pipe inlet provided. Non-shrink grout used at the interface with the prefab elements should be free flowing and self-compacting in nature so as to ensure good compaction at the joint and to minimise the risk of cracking. Non-shrink grout should be prepared in accordance with the specifications.
3. Keep installed components undisturbed: The installed components should be kept undisturbed for at least 24 hours. All the joints are properly sealed or not, is then checked. Collect sample test cubes of the grout mix used for critical elements such loading bearing walls for testing.

- **Joint Casting and Sealing**

1. Install the joint rebars: For components with cast-in-situ joints, the joint rebars are installed

as required. The joint rebars should be correctly placed according to the design specifications. For components with cast-in-situ joints, the joint rebars are installed as required. The joint rebars should be correctly placed according to the design specifications.



Fig-7: Joining of Bars

2. Remove forms: Forms provided to specific joints are removed after gaining sufficient strength.
3. Sealing: For joints between walls or between external columns with beams/walls element, approved sealant and grout will be installed at lateral stage. The joint gaps should be consistent to allow for proper installation of sealant or grout for better water tightness.

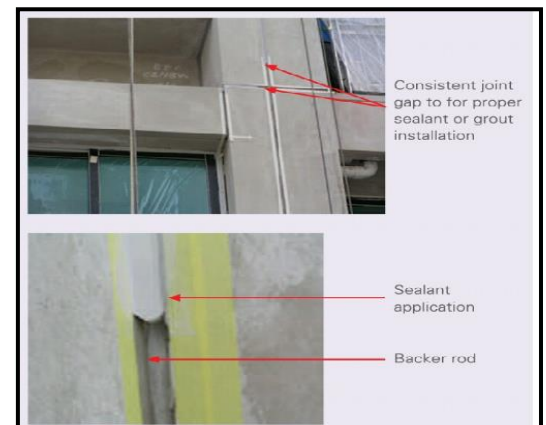


Fig-8: Sealing

5.2 Installation of Horizontal Components

- **Setting Out**

1. Set reference line and offset line: Reference line and offset line is set to determine the alignment and level of the horizontal prefab element such as slab and beam during installation. The accuracy of the offset line is then checked. For horizontal prefab components like beam, slab, etc. the position and alignment for the protruding bars are within specified tolerance

or not is also checked before hoisting for installation, to prevent any obstruction during the erection process.



Fig-9: Marking of Reference Line

• **Lifting and Placing**

1. Put the temporary props: Temporary props are put to support the prefab slab and beam elements. Beam elements should be supported at minimum two locations during hoisting.



Fig-10: Lifting and Temporary props

2. Lift and rig: The elements are lifted and rigged to designated location with the use of wire ropes. Balcony, planter ledge and slab should be supported at more than two locations, depending on the dimensions of the elements and design consideration.
3. Align and check the level: Level is aligned and checked to suit then required setting out before placement of prefab members to final position. It is important to check on the levelness of the prefab elements as well as between the elements before proceeding to do the jointing works.



Fig-11: Align and Check Level

• **Casting of Joints**

1. Place and lap the rebar: For components with cast in-situ joints, the rebars are placed and lapped as required. The joint rebar should be correctly placed according to the design specifications.
2. Setup & removal of formwork: Formwork is set up for casting of the joint. The formwork should be properly secured during casting of the in-situ joint. Supporting beams can be designed to form part of the formwork for the casting joint. Concrete casting is carried out. Forms are removed after sufficient concrete strength has been achieved.

6. ADVANTAGES OF PREBARICATION

The advantages of prefabrication over conventional method of prefabrication with respect to quality, speed, cost, site refuse can be summarized as:

1. Quality: In climate-controlled environment with efficient equipment which are operated by trained person, components achieve the best quality.
2. Speed: 70% work can be done in factory hence it is speedy construction.
3. Cost: less requirement of formwork and onsite labors can reduce the cost of construction.
4. Site refuse: less waste is generated at the site which can be recycled.

7. DISADVANTAGES OF PREBARICATION

The disadvantages of prefabrication over conventional method of prefabrication with respect to restricted design, high initial investment, transportation can be summarized as:

1. Restricted Design: Prefabrication can useful only for the repetitive structures or where the all the floors are casted in same dimension.
2. High initial investment: The prefab technology requires huge amount for its initial setup of manufacturing units.
3. Transportation: There will be always high-risk during transportation of structural member and cost of transportation is also high because there are lots of structural elements needed to transport at particular site at regular intervals.

8. CONCLUSION

Nowadays our construction industry is looking for some advantageous modern techniques for construction which will increase the quality of construction with less time as well as will cause less harm to environment. This method is best suitable for increasing demand of housing with less time and less cost. Prefabrication will continue to grow in India as the demand for the quick and affordable housing increases. As a part of larger trend toward the industrialization of construction prefabrication is a powerful strategy for reducing the cost, risk and waste.

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