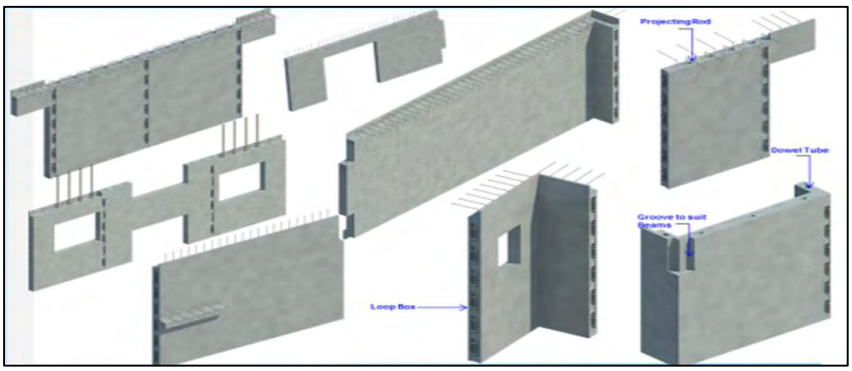
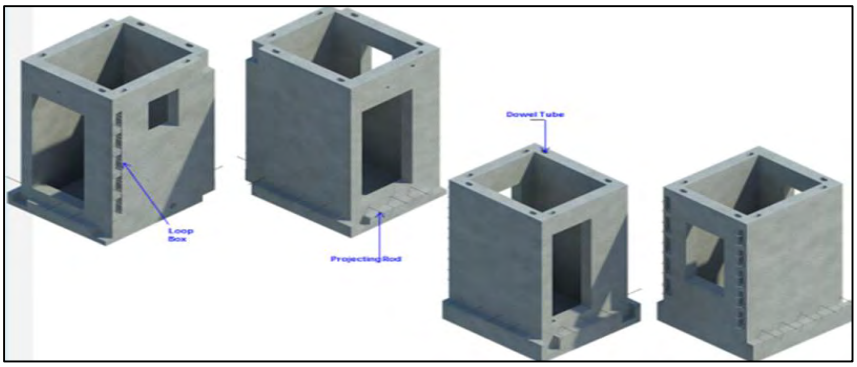
BMTPC
PACS
PERFORMANCE APPRAISAL CERTIFICATION

Name and Address of Certificate Holder:	Performance Appraisal Certificate No.
M/s Larsen & Toubro Ltd. **Landmark A, 5th Floor,** **Suren Road, Off Andheri Kurla Road, Andheri East,** **Mumbai – 400093**	PAC No **1027-S/2016** Issue No. **01** Date of Issue: **12.04.2016**





Precast Large Concrete Panel System

User should check the validity of the Certificate by contacting Member Secretary, BMBA at BMTPC or the Holder of this Certificate.

bmtpc

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PERFORMANCE APPRAISAL CERTIFICATE

FOR

Precast Large Concrete Panel System

ISSUED TO

M/s Larsen & Toubro Ltd.

STATUS OF PAC NO. 1027-S/2016

S.No	Issue No.	Date of Issue	Date of renewal	Amendment		Valid up to (Date)	Remarks	Signature of authorized signatory
				No.	Date			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	12-04-2016	12-04-2018	--	--	11-04-2018	--	

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PART 1 CERTIFICATION

1.1 Certificate 7older

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1.2 Description of system

1.2.1 Name of the System – Precast Large Concrete Panel System

1.2.2 Brief Description –Precast construction system is generally a large panel system, modular system or a combination of both. Precast Large Construction Panel (PLCP) system consists of various precast elements such as walls, beams, slabs, columns, staircase, landing and some customized elements that are standardized and designed for stability, durability and structural integrity of the building. Precast residential building construction involves design, strategic yard planning, lifting, handling and transportation of precast elements. This technology is suitable for construction of high rise buildings resisting seismic and wind induced lateral loads along with gravity loads. The building framing is planned in such a way that maximum number of repetitions of moulds is obtained. These elements are cast in a controlled factory condition. The factory is developed at or near the site which provides an economical solution in terms of storage and transportation.

1.3 Types of precast elements

1.3.1 Two main types of precast concrete elements, namely precast reinforced concrete elements and precast pre-stressed concrete elements are used as per the details given below:

Precast concrete elements – Concrete components of a building prefabricated in precast yard or site and shall be installed in the building during construction. (*See Fig. 1*)

i. Precast reinforced concrete elements

- These shall consist of reinforcement bars and/or welded wire meshes within the elements to provide the

tensile strength and resistance against cracks such as façade walls, beams, columns, slabs, refuse chutes, staircases and parapet walls

ii. Precast pre-stressed concrete elements

- These shall consist of pre-stressing tendons within the elements to provide a predetermined force needed to resist external loadings and cracks such as hollow core slabs, beams and planks.

Typical size of precast elements is given in Table 1*

Table 1

Sr. No	Precast Components	Typical Sizes
1	Wall Panels	5m X 2.85 m
2	Slabs	3m X 5m
3	PODS	1.52mX1.36mX2.83
4	Beam	0.20 X 0.40 X L
5	Staircase	-
6	Columns	0.90m X 0.35m X2.85m

***** Sizes of panel slabs may vary as per the architectural and construction requirement.

Wall Panels

Parapet Beams

Spandrel

Solid Slab Panels

Pod Elements

Staircase

Fig. 1 Precast Elements

1.3.2 *Site Prefabrication*

A typical fully functional factory shall be set up at site till the prefabrication work is over. The factory shall have complete testing facility and shall follow the prescribed QA/QC procedures. The overall production process shall be as per the typical manufacturing facility.

1.3.3 *Moulds*

Moulds for precast elements shall be of steel and concrete. For design of the moulds for various elements, special importance should be given to easy de-moulding and assembly of the various parts. At the same time rigidity and strength and water tightness of the mould are also important taking into consideration forces due to pouring of green concrete and vibration. The type of moulds used for pre-casting various elements with various methods is given in Table 2 *(see Fig. 2):*

Table 2

S. No.	Mould type	Uses
1.	Conventional moulds	Ribbed slabs, beams, window panels, box type units and special elements
2.	Battery moulds	Interior wall panels, shell elements, roof and floor slabs
3.	Tilting moulds	Exterior wall panels where special finishes are required on one face or for sandwich panels
4.	Long line prestressing beds	Double tees, ribbed slabs, piles and beams
5.	Extrusion machine	Roof slabs and hollow core slabs

A few more sketches of the moulds namely wall panels, POD, slab, beam, spandrel and column, staircase & landing are given in Annex III.

Battery Mould

Tilting Mould

POD Mould

Fig. 2 Moulds

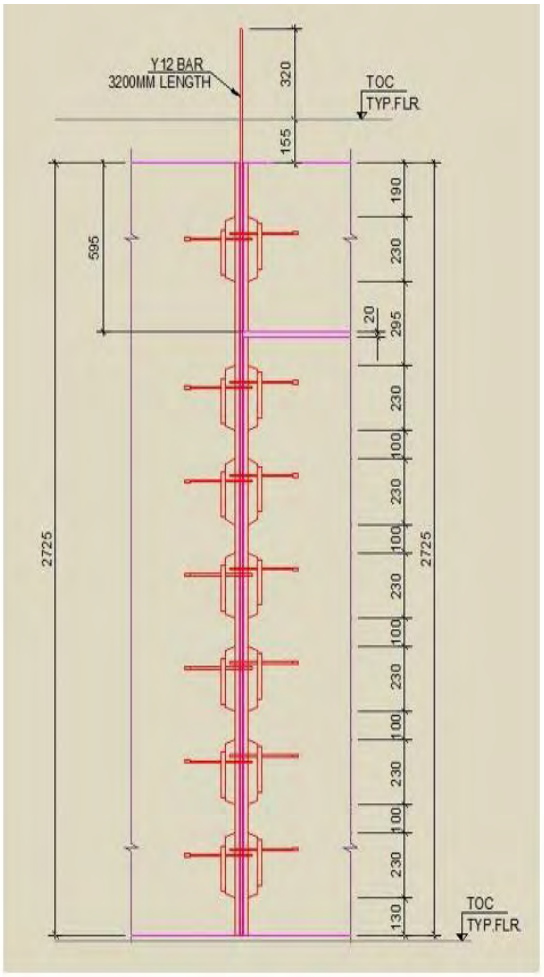
1.4 Installation

1.4.1 *Precast Installation*

Proper planning and preparatory works shall be required before the actual installation of precast concrete elements in order to ensure quality installation. The following items shall be planned in advance:

i. Method of sequence of assembly and installation: Precast elements should be identified based on their location number and the tagged.
ii. Method of providing temporary support: Elements should be supported temporarily before these get stabilized. Generally structural members with adjustable ends shall be used for securing the panels. Shims should be used to adjust the panels to ensure dimensional correctness.
iii. Installation tolerances: Installation tolerances should be based on codal provisions and design considerations should be clearly indicated.
iv. Handling and rigging requirements: Elements should be checked for handling stresses before lifting and the cranes should have sufficient capacity to handle the precast panels. At least 10% impact should be considered while calculating the lifting capacity of the crane.

At site locations, panels shall be first unloaded and stacked or directly lifted by the crane. The element shall then be installed on the site and supported by temporary jacks. The cranes shall be released for next lifting once the temporary supports are in place. Shims shall be used to carefully align the element before grouting. The panels shall be grouted after the final adjustments are done.



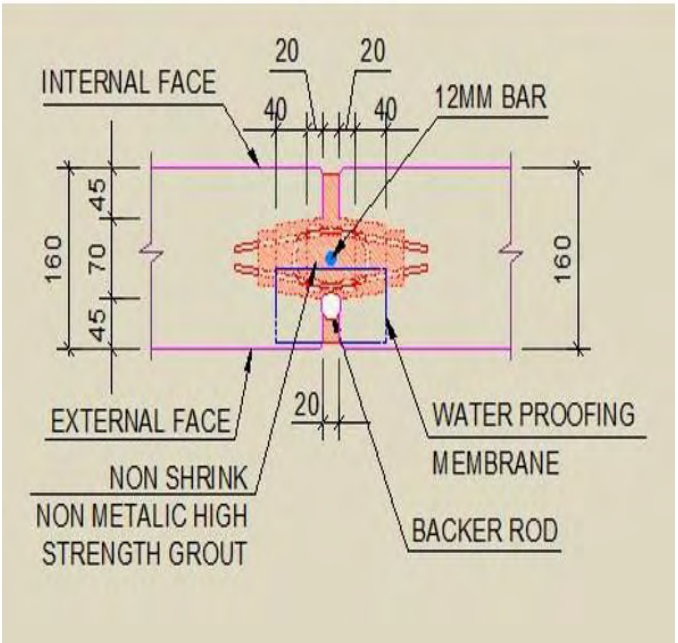
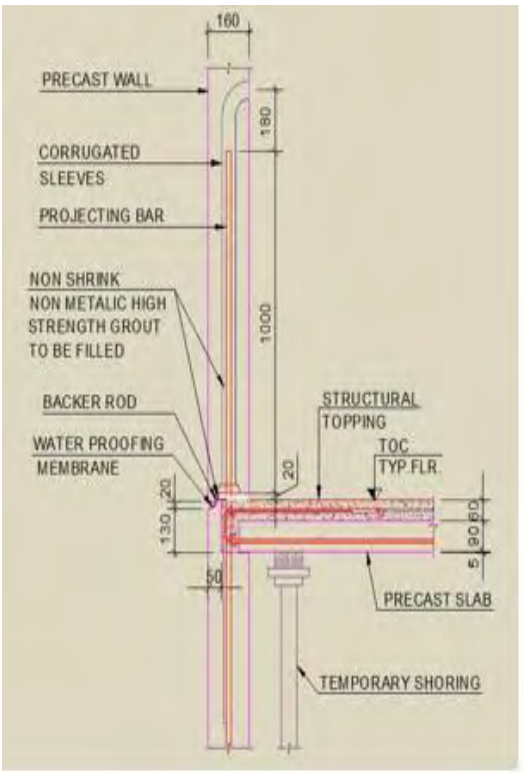


Fig. 3 Wall to Wall Connection Plan & Elevation



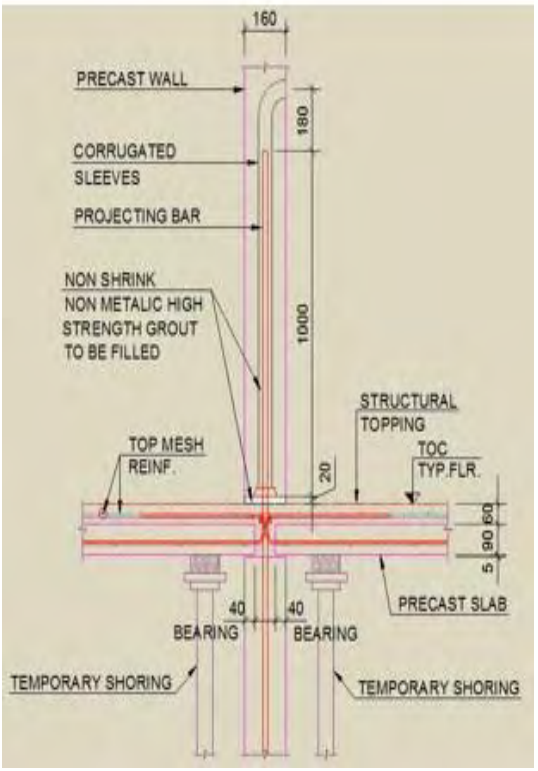
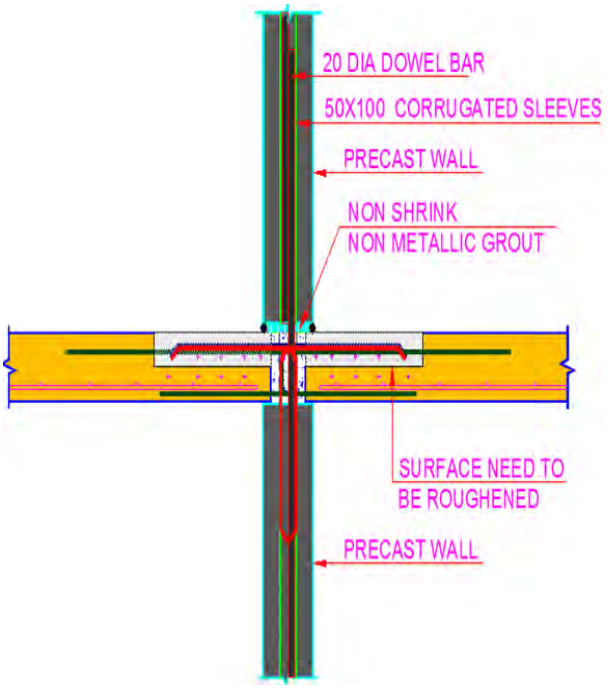
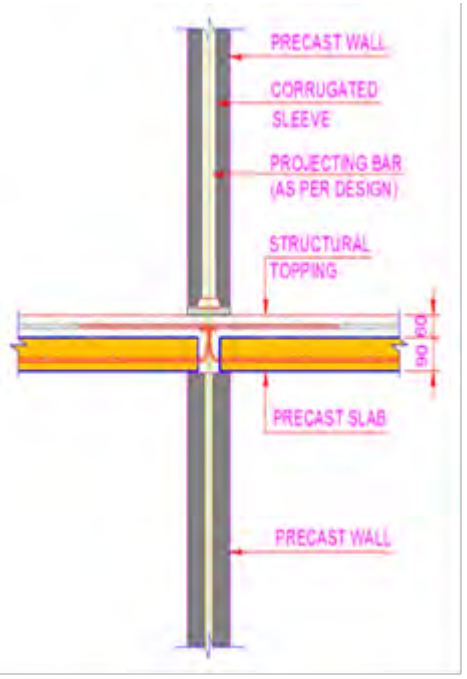


Fig. 4 & 5 External & Internal Wall Connection

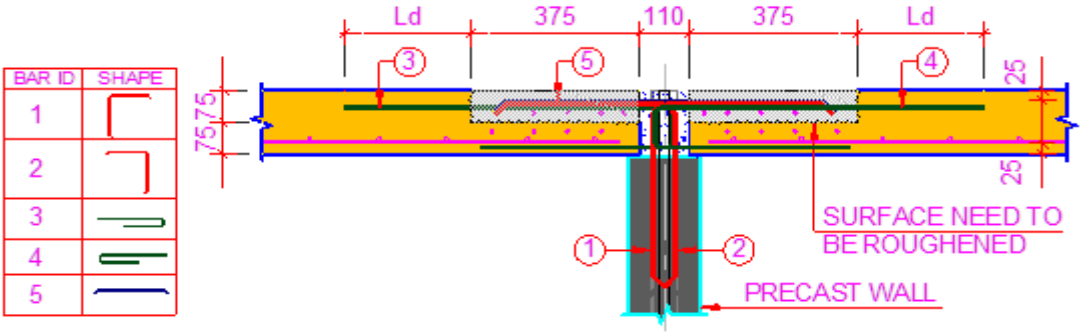


Option for Exposed Conduits

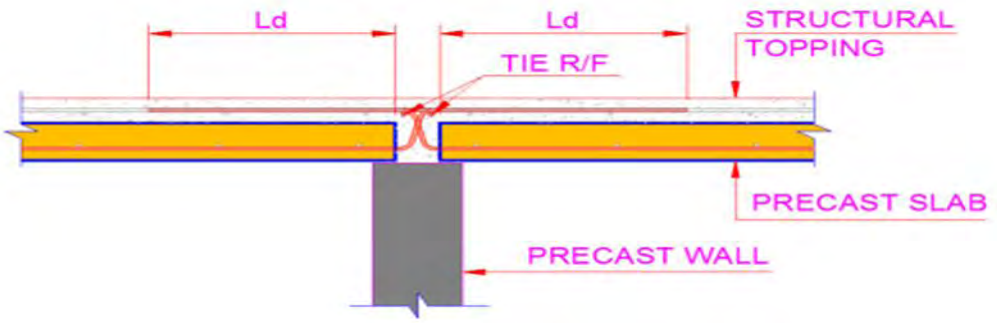


Option for Embedded Conduits

Fig. 6 Typical Horizontal Joint Detail Wall to Wall



Option for Exposed Conduits



Option for Embedded Conduits

Fig. 7 Typical Floor to Floor Diaphragm Connection

1.4.2 *Waterproofing*

External joints shall be sealed with baker rods and sealants after filling the joints with grout to avoid the leakage. Additional waterproofing treatment shall be provided at external joints and wet areas to ensure water tightness. (*See Fig. 8*)

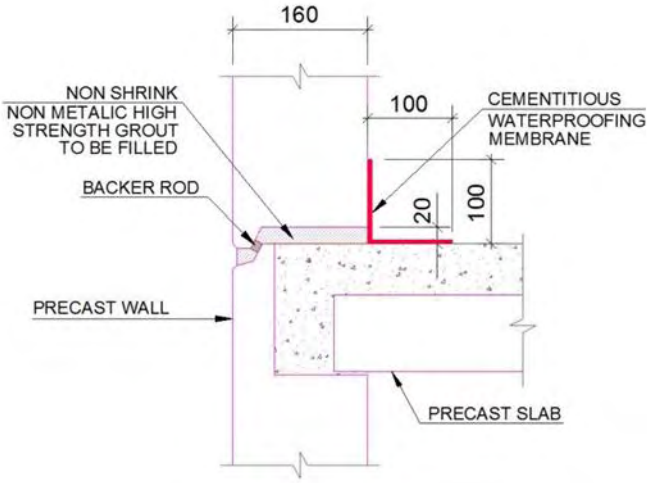
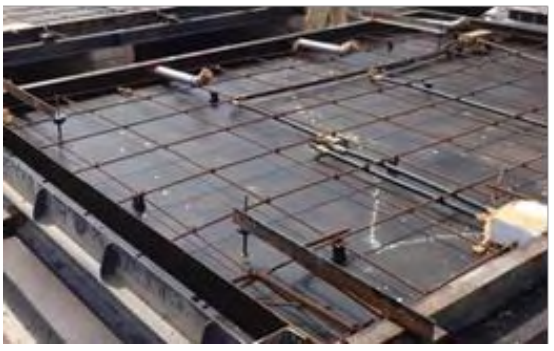


Fig. 8 Cementitious waterproofing membrane

1.4.3 *Mechanical, Electrical & Plumbing Fittings*

- Mechanical, electrical & plumbing fittings shall be kept open or concealed as per the requirements. For concealed fittings, provision for grooves, blockouts shall be made in casting moulds.
- The conduits and electrical boxes shall be embedded and fixed in moulds before casting. For open fittings, these shall be fixed after erection at site. (*See Fig. 9*)
- For firefighting systems, provision of National Building Code (NBC) and local body law shall be adhered to.



Fixing electrical conduits

Fixing electrical boxes and conduits

Laying conduits on slab **Plumbing**

Fig. 9 Mechanical, Electrical & Plumbing Fittings

1.4.4 *Fire Rating*

• Precast concrete shall be designed for fire rating of 1 to 2 hours based on codal requirements.

• Minimum precast concrete wall thickness of 120 mm shall be provided for 1 hour fire rating as per IS 456:2000.

1.4.5 *Finishes*

• Variety of shapes, colours, textures and finishes may be obtained with precast concrete.

• The surface treatments shall be done by rebating, grooving, surface coatings, cement based renders, oxide coloring etc.

• Precast concrete facades of various shapes, colours and textures may be moulded and installed.

1.5 Design Considerations and Requirements

1.5.1 *Structural Design Approach*

The overall behavior of a precast structure is dependent on the behavior of the connections which must provide:

- Resistance to all design forces
- Ductility in case of excessive deformation
- Resistance to volume changes and related forces
- Adequate durability
- Required fire resistance
- Feasible production considerations
- Feasible construction considerations

1.5.2 *Floor panels*

For reinforced concrete floors, concrete of minimum grade M 30 shall be used. Pre-stressed concrete floor units shall satisfy the strength requirements followed in usual design practice, namely, a minimum of M 35 for post-tensioned and pre-tensioned works. The thickness of the floor panel shall be such that the serviceability requirements are satisfied. The minimum thickness of concrete layer for cored slab is 50 mm. Panels shall be designed in accordance with the recommendations given in IS 456:2000 governing reinforcement and detailing.

1.5.3 *Walls*

Structural load bearing walls shall be designed as per codal provisions of IS 456:2000 and IS 13920:1993 as applicable. Internal non load bearing walls should be designed as plain concrete walls with nominal reinforcement for handling and erection stresses. Such walls may also be built using alternate partition wall systems. For concrete walls, minimum concrete grade should be M10.

1.5.4 *Connections*

The PLCP System is designed using the emulative detailing concept such that once the structure is completed it will behave similar to an equivalent RCC System and will provide necessary strength and ductility. Typically, wet connections are used to achieve the emulative behavior in the PLCP System.

1.5.5 *Design Philosophy*

The precast structure should be analysed as a monolithic one and the joints in them designed to take the forces of an equivalent discrete system. Resistance to horizontal loading shall be provided by having appropriate moment and shear resisting joints. The individual components shall be designed, taking into consideration the appropriate end conditions and loads at various stages of construction. The components of the structure shall be designed for loads in accordance with IS 875 (Parts 1-5):1987 and IS 1893 (Part 1):2002. In addition members shall be designed for handling, erection and impact loads that might be expected during handling and erection.

1.5.5.1 *Structural system*

The structural system of superstructure consists of precast construction of RCC wall, columns, slabs and beams. Floor slab

shall be considered to act as a rigid diaphragm to transfer the lateral forces to walls/column. Ground floors are mostly constructed by conventional method i.e. cast-in-situ construction. It shall be designed to take the cantilever load of the above floors. First floor to higher floors shall be constructed by precast technology i.e. precast wall and solid floor slab system.

1.5.5.2 *Fire rating*

Period of fire resistance of RCC buildings is based on NBC requirements. To meet the fire rating requirement, provision specified in IS 456:2000 shall be followed.

1.5.5.3 *Design loads*

1. Dead loads – the dead load shall comprise of self-weight of all the frames and shell elements modelled in the structure as well as self-weight of slabs.
2. Imposed loads – The imposed loads that are envisaged to act permanently (whichever applicable) are as follows:
   i. Waterproofing: Shall depend on the thickness, slope and kind of material to be used for waterproofing
   ii. False ceiling/Internal partitions: False ceiling load shall be calculated based on type of material and thickness using unit weights specified in IS 875(Part 1):1987. Partition loads shall be as per actuals.
   iii. All structural elements: Layout and size of elements shall be followed as per structural requirements.

1.5.5.4 *Wind load*

The wind pressure shall be calculated on the basis of data specified in clause 5.3 of IS 875 (Part 3):1987.

1.5.5.5 *Earthquake loads*

For seismic purpose, the PLCP System design shall be in compliance with the provisions of IS 1893:2002.

1.5.5.6 *Load combinations*

The various loads shall be combined as given below and as specified in IS 875 (Part 5):1987; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned shall be adopted:

Table 3

Load combination	Limit state of collapse			Limit state of serviceability		
	DL	**LL**	**WL/EL**	**DL**	**LL**	**WL/EL**
DL+LL	1.5	1.5	--	1.0	1.0	--
DL+WL	1.5/0.9*	--	1.5	1.0	--	1.0
DL+LL+WL	1.2	1.2	1.2	1.0	0.8	0.8
DL+EL	1.5/0.9*	--	1.5	1.0	--	1.0
DL+LL+EL	1.2	1.2	1.2	1.0	0.8	0.8

*To be considered when stability against overturning and stress reversal is critical.

Where DL -- Dead load, LL – Live load, WL – Wind load & EL – Earthquake load

Wind load and earthquake load shall be considered for both x and y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS 1893:2002 shall be used both for evaluating earthquake effect and for combined load effects used in such combination.

1.5.6 *Progressive Collapse*

In prefabricated construction, the possibility of gas or other explosions which can remove primary structural elements leading to progressive collapse of the structure, shall be taken into account. It shall therefore be necessary to consider the possibility of progressive collapse in which the failure or displacement of one element of a structure causes the failure or displacement of another element and results in partial or total collapse of the building. The building shall be designed to prevent progressive collapse as per the codal provisions of IS 15916:2010.

1.5.7 *Analysis Methods*

The analysis of the structure shall be carried out using ETABS software package. The entire superstructure shall be modelled using shell elements and membrane element as appropriate. Beams and columns shall be modelled as frame elements, walls as shell elements and slab as membrane elements. The slab shall be considered as diaphragm at the respective floor levels to transfer the lateral forces. Appropriate loads and its combinations as per provisions specified in IS 875:1987 and IS 1893:2002, for most unfavorable effects shall be chosen for design.

For Structural analysis of prefabricated elements including loads, analysis of shear walls, floors, walls, joints and accidental forces, reference may be made to IS 11447:1985.

1.5.8 *Design Methodology*

All structural elements shall be designed according to the Limit state method as specified in IS 456:2000.

For design of ties, key elements and joints etc. reference may be made to IS 15916:2010.

1.6 Production, Installation and Transportation Machinery

1.6.1 *Production Machinery*

1) Steel mould for wall/beam/slab panel/staircase
2) Batching plant
3) Transit mixers
4) Vibrators
5) Concrete buckets

1.6.2 *Transportation Machinery*

1) Lifting beam/ lifting clamps
2) Ropes & lifting hooks
3) Trailer – 20 MT capacity
4) Wooden runner of size 40 x 60 mm/ 100 x 125 mm

1.6.3 *Cranes and Loaders*

1) Tower crane of 5.7 MT, 6.9 & 7.2 MT load carrying capacity and operating radius of 40 to 45 m.
2) Gantry cranes of 10 MT, 20 MT & 30 MT capacity and span of 20 to 25 m.
3) Wheel loader of 1.9 cum capacity
4) Skid steer loader
5) Truck mounted knuckle boom crane of 7 MT capacity

1.7 Basis of Assessment

1.7.1 *Scope of Assessment*

1.7.1.1 Scope of assessment includes conformance of manufactured pre-cast concrete panels to the specified requirements for use in the building construction.

1.7.2 Assessment

Assessment of the suitability of the Prefabricated Large Concrete Panel System manufactured is based on:

i) Inspection of production and erection facilities at site during visit of some of TAC members and Officers of BMTPC.

ii) Indian Institute of Technology (IIT) Madras – Suitability of Precast Concrete Large Panel System for Mass Housing Projects.

iii) Indian Institute of Technology (IIT) Delhi – Concept Approval for Precast Technology for building construction.

iv) Veermata Jijabai Technology Institute (VJTI), Mumbai -- Concept Approval for Precast Technology for building construction.

v) Indian Institute of Technology (IIT) Madras – Design & Construction Methodology Review for Rehab Bhiwada Precast Project, Mumbai.

vi) Verification of Thermal Performance Reports – Evaluating RCC Wall apartments in Ahmedabad & Chennai by Indian Institute of Science, Bangalore.

vii) Quality Assurance System followed by the Certificate holder for quality control of the system. Quality Assurance Plan is given at Annex. I.

1.8 Use of the Prefabricated Large Concrete Panel System

1.8.1 The system shall be used for mass housing projects and commercial buildings, etc.

1.8.2 Special Aspects of use:

i) The building to be constructed using the System shall be in accordance with the specifications and manufacturing & construction process prescribed by the manufacturer and designed by competent structural Engineers.

ii) Plumbing & Electrical services, Doors & windows and Utilities etc. shall be governed by the provisions and details agreed between the manufacturer and developer.

iii) Buildings to be constructed with the System should be constructed only with technical support or supervision by qualified engineers and builders, based on structural designs and Seismic evaluation & Wind forces carried out to comply with prevailing standards; this is applicable even for low-rise and affordable mass housing to provide safety of structures.

iv) It is strongly recommended that structural engineers and building designers associated with precast construction should be thoroughly familiar with the various structural aspects. It is also recommended that Architects and

Construction Engineers who undertake such building design and construction gain familiarity with the properties and materials, characteristics of the System and its applications.

1.8.3 Experience in actual use

Provident Sunworth Project comprising of B+S+12 storey buildings having 62 towers and 5952 units at Kengeri, Bangaluru being constructed by the firm was inspected by a team comprising BMTPC Officers and some of TAC members in December, 2015. The quality of work was found to be satisfactory.

1. 9 C**onditions of Certification**

1.9.1 *Technical Conditions*

1.9.1.1 Raw materials and the finished precast elements shall conform to the requirements of the prescribed specifications.

1.9.1.2 The production capability and quality of the precast elements vis-à-vis requirements specified and competence of the technical persons for design and proper erection of the panels at site shall need verification for each plant/ establishment engaged in the production and execution of the system.

The design assumptions, detailed calculations, references to necessary and detailed design drawings shall be made available on demand, if required. The structural design calculations should clearly demonstrate structural integrity and stability including connection details.

1.9.2 *Quality Assurance*

1.9.2.1 The Certificate Holder shall implement & maintain a quality assurance system in accordance with Scheme of Quality Assurance (SQA) given in the Annex I attached with this Certificate.

1.9.2.2 Structures using the panels shall be designed as per Clause 1.4 and executed as per provisions of this PAC.

1.9.3 *Scope of Inspection*

Scope of inspection included the verification of production, performance and erection at site including competence of technical personnel and status of quality assurance in the factory.

1.9.4 *Manufacturing and Erection Facilities*

Manufacturing and erection facilities available were found to be suitable to produce and erect the precast concrete panels as per the specifications.

1.9.5 *Handling of User Complaints*

1.9.5.1 The Certificate holder shall provide quick redressal to consumer/ user complaints proved reasonable & genuine and within the conditions of warranty provided by it to customer/purchaser.

1.9.5.2 The Certificate holder shall implement the procedure included in the SQA. As part of PACS Certification he shall maintain data on such complaints with a view to assess the complaint satisfaction and suitable preventive measures taken.

1.10 Certification

On the basis of assessment given in Part 3 of this Certificate & subject to the conditions of certification, use & limitations set out in this Certificate and if selected, installed & maintained as set out in Part 1 & 2 of this Certificate, the system covered by this Certificate is fit for use set out in the Scope of Assessment.

PART 2 CERTIFICATE HOLDER'S TECHNICAL SPECIFICATIONS

2.1 General

The PAC holder shall manufacture the precast elements in accordance with the requirements specified in the Prefabricated Large Concrete Panel System.

2.2 Specifications for the System

2.2.1 *Raw Materials*

1. *Ordinary Portland Cement:* Shall be of 43 grade as per IS 8112:1989.
2. (i) *Fine aggregate (M Sand):* Shall be as per IS 383:1970 & IS 1542:1992 and 4.7 mm.
3. *Coarse Aggregates: S*hall be as per IS 383:1970 and of 20 mm, 40 mm size
4. *Steel reinforcement:* Shall be as per IS 1786:2008
5. C*oncrete:* The grade of concrete shall be M 30 and slump for walls, floors and roofs shall be as per IS 456:2000.

6. *Brick masonry:* Shall be as per IS 1905:1987
7. *Solid Block work*: Shall be as per IS 2185 (Part 1):1979
8. *Aluminium:* Shall be as per IS 733:1983
9. *Glass:* Shall be as per IS 2835:1987
10. *Non shrunk non-metallic grout:* Cement based flowable grout shall have compressive strength of 65 N/mm^2, flexural strength of 9 N/mm^2 at 28 days and E-modulus of 37000 N/mm^2. *(ASTM C 109 & ASTM C 293-79)*
11. *Water proofing membrane*: Fibre reinforced repair mortar shall have compressive strength of 45 N/mm^2 at 28 days and density 2250 kg/m^3 *(ASTM C 109).*
12. *Baker Rod*: Closed cell polymer based product shall have compressive strength of 0.45 kg/cm^2 min. at 25% deflection, density 22 kg/m^3 min. and water absorption 0.14 gm/cm^3 max.
13. *Corrugated sleeve*: Hot dipped galvanized prime steel sheet shall be as per IS 277:2003.

2.2.2 Inspections & Testing

- Shall be done at appropriate stages of manufacturing process and execution process.
- The inspected panels shall be stored carefully to ensure that no damage occurs during transportation.
- As part of quality assurance, regular in- process inspections shall be carried out by the trained personnel of the PAC holder.

2.3 Tolerances of Precast Elements

2.3.1 *Casting Tolerances of Precast Elements*

2.3.1.1 Casting tolerances of precast elements are given in Table 4:

Table 4

S. No.	Elements	Recommended tolerance
1.	*Length*	
1.1	Slab, plain wall panel & beam	± 5 mm or 0.1% whichever is greater
1.2	Large panel fabrication	± 0.1% subject to max. of + 5 mm to – 10 mm
1.3	Columns	± 10 mm
2.	*Thickness/ cross-sectional dimensions*	
2.1	Slab, plain wall panel & beam	± 3 mm or 0.1% whichever is greater
2.2	Large panel fabrication, floor/roof slabs	± 2 mm upto 300 mm wide ± 3 mm for > 300 mm wide
2.3	Columns	± 4 mm
3	*Straightness/bow*	
3.1	Ribbed/hollow slab,	± 5 mm or 1/750th of length whichever is

	large panel fabrication and ribbed/plain wall panel	greater
4	*Squareness* – While considering the squareness of the corner, the longer of two adjacent sides being checked shall be taken as the base line	
4.1	Concrete floor/roof slabs & plain wall panel	The shorter side shall not vary in length from the perpendicular by more than 5 mm
4.2	Large panel fabrication	The shorter side shall not be out of square line for more than + 2 mm to -5 mm
5	*Flatness* – The max. deviation from 1.5 m straight edge placed in any position on a nominal plain surface shall not exceed:	
5.1	Large panel fabrication	± 3 mm
5.2	Cellular concrete floor/roof slabs	± 4 mm or max. of 0.1% length

2.3.2 *Erection Tolerances*

2.3.2.1 Erection tolerances for interface design of precast and cast-in-place concrete components are given in Table 5:

Table 5

S. No.	Item	Recommended tolerance
1.	Variation in plan location (column/beam/any location)	± 13 mm for columns ± 25 mm for beams
2.	Variation in plan parallel to specified building lines	+ 0.625 mm per 305 mm (1 ft) for any beam less than 6.10 m (20 ft) long or adjacent to columns spaced less than 6.10 m (20 ft) apart. 13 mm max. for adjacent columns spaced 6.10 m (20 ft) or more apart.
3.	Difference in relative position of adjacent columns from specified relative position (at any check level)	± 13 mm
4.	Variation from plumb	10 mm for 3.05 m of height 40 mm max. for the entire height
5.	Variation in elevation of bearing surfaces from specified elevation (column/beam/any location)	Max. low - 13 mm Max. high - 6mm
6.	Variation of top spandrel from specified elevation	± 13 mm
7.	Variation in elevation of bearing surfaces from lines parallel to specified	+ 0.625 mm per 305 mm (1 ft) for any beam less than

	grade lines	6.10 m (20 ft) long or adjacent to columns spaced less than 6.10 m (20 ft) apart. 13 mm max. for any beam 6.10 m (20 ft) in length or for adjacent columns spaced 6.10 m (20 ft) or more apart.
8.	Variation from specified bearing length on support	19 mm
9.	Variation from specified bearing width on support	13 mm
10.	Jog in alignment of matching edges	13 mm

2.3.2.2 *Beam erection tolerances*

The primary control surfaces for beam erection tolerances are usually as given in Table 6, although this needs to be determined on a job-by-job basis: *(See Fig. 10)*

Table 6

S. No.	**Item**	**Recommended tolerance**
1.	Plan location for building grid datum	± 25 mm
2.	Bearing elevation from nominal elevation from support:	
2.1	Maximum low	13 mm
2.2	Maximum high	6 mm
3.	Maximum plumb variation over height of component	
3.1	Per 305 mm (1 ft) height	3 mm
3.2	Max. at rectangular or L beam	3 mm
3.3	Max. at inverted T beam	19 mm
4.	Maximum jog in alignment of matching edges—visually non-critical edges	13 mm
5	Joint width	
5.**1**	Hidden joints	± 19 mm
5.2	Exposed structural joints not visually critical	± 13 mm
6.	Bearing length (span direction)	± 19 mm
7.	Bearing width	± 13 mm

Note: When bearing pads are used at unarmed edges, there should be a set back of min. 12.5 mm from the face of support or at least the chamfered dimensions at chamfered edges.

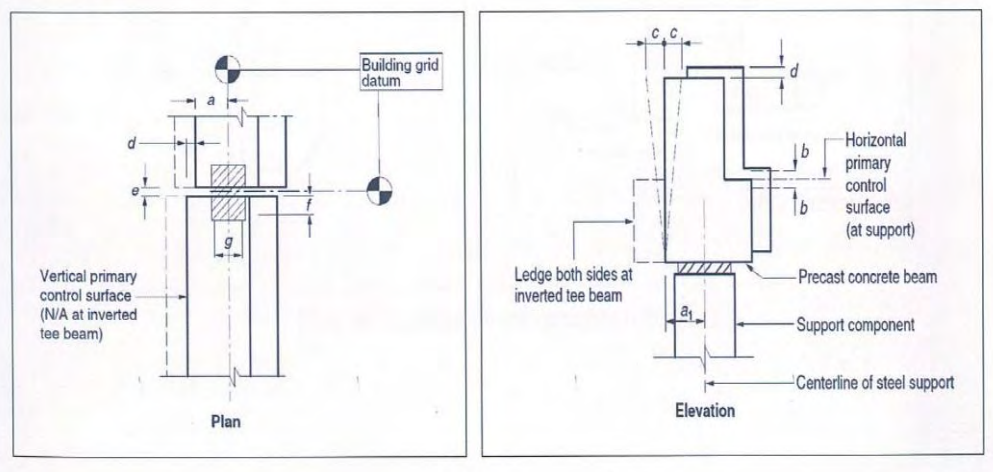


Fig. 10 Beam Erection Tolerances

2.3.2.3 *Floor and roof component erection tolerances*

The primary control surfaces for floor and roof component erection tolerances are usually as given in Table 7. Typically, there is no vertical, control surface and in some scenarios, there are no primary control surfaces at all. This needs to be determined on a job-by-job basis. *(See Fig. 11)*

Table 7

S. No.	Item	Recommended tolerance
1.	Plan location for building grid datum	± 25 mm
2.	Top elevation from building elevation datum at component ends—covered with topping	± 19 mm
3.	Maximum jog in alignment of matching edges (both topped and un-topped construction)	25 mm
4.	Joint width	
4.1	Off to 12.12 m component	± 13 mm
4.2	12.12 m to 18.28 m component	± 19 mm
5.	Differential top elevation as erected (for units of same design and length) – field topped	19 mm
6.	Bearing length (span direction)	± 19 mm
7.	Differential bottom elevation of exposed hollow-core slabs	6 mm

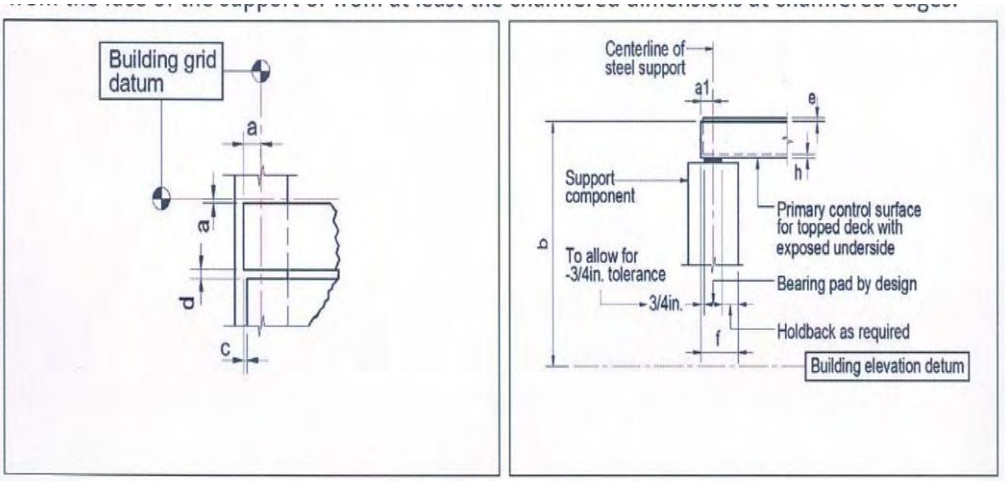


Fig. 11 Floor and Roof Component Erection Tolerances

2.3.2.4 *Column erection tolerances*

The primary control surfaces for column erection tolerances are usually as given in Table 8, although this needs to be determined on a job-by-job basis: *(See Fig. 12)*

Table 8

S. No.	Item	Recommended tolerance
1.	Plan location for building grid datum – structural applications	± 13 mm
2.	Top elevation from nominal top elevation:	
2.1	Maximum low	± 13 mm
2.2	Maximum high	± 6 mm
3.	Bearing haunch elevation from nominal elevation	
3.1	Maximum low	± 13 mm
3.2	Maximum high	± 6 mm
4.	Maximum plumb variation over height of element (element in structure of max. height of 30 m (100 ft)	40 mm
5.	Plumb in any 3 m (10 ft) of element height	10 mm
6.	Maximum jog in alignment of matching edges—visually non-critical edges	13 mm

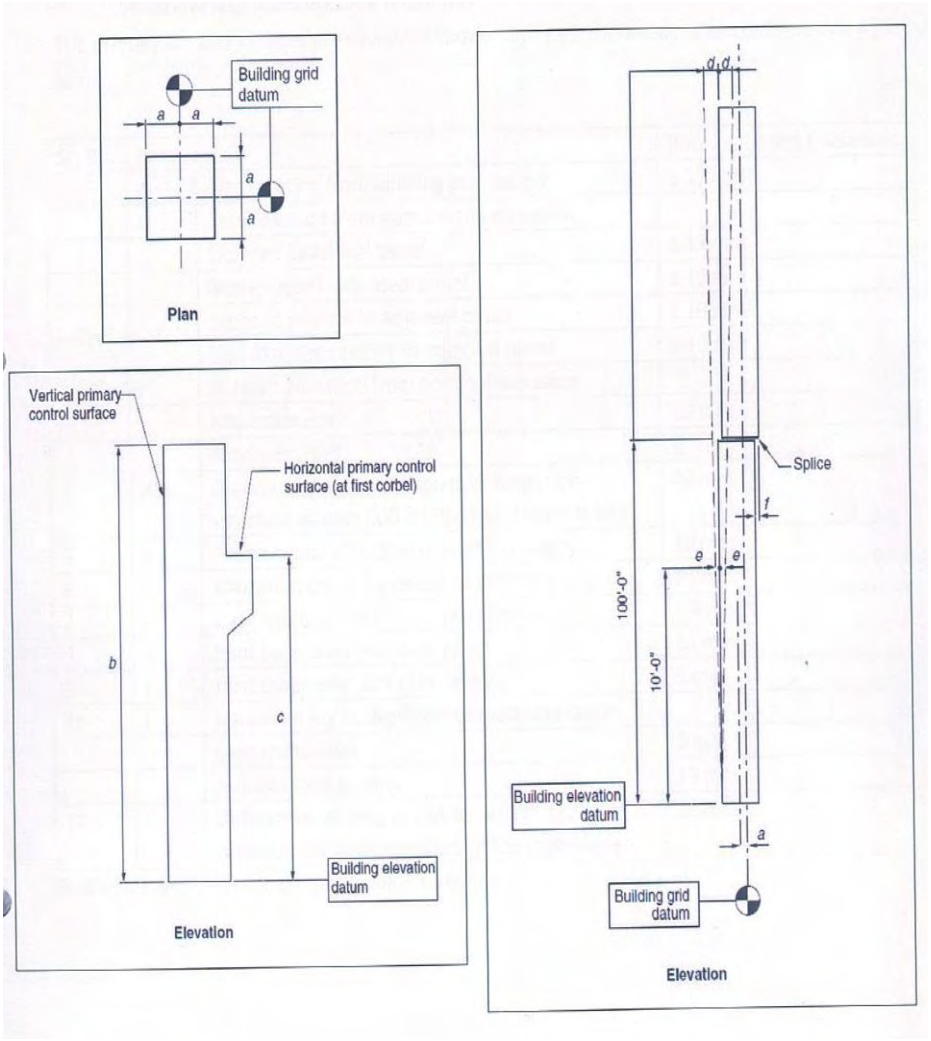


Fig. 12 Column Erection Tolerances

2.3.2.5 *Structural wall panel erection tolerances*

The primary control surfaces for column erection tolerances are usually as given in Table 9, although this needs to be determined on a job-by-job basis: *(See Fig. 13)*

Table 9

S. No.	Item	Recommended tolerance
1.	Plan location for building grid datum	± 13 mm
2.	Top elevation from nominal top elevation:	
2.1	Exposed individual panel	± 13 mm
2.2	Non exposed individual panel	± 19 mm
2.3	Exposed relative to adjacent panel	± 19 mm
2.4	Non exposed relative to adjacent panel	± 19 mm
3.	Support elevation from nominal elevation	
3.1	Maximum low	13 mm
3.2	Maximum high	6 mm
4.	Maximum plumb variation over height of	40 mm

	structure or over 30 m (100 ft), whichever is less	
5.	Plumb in any 3 m (10 ft) of element height	10 mm
6.	Maximum jog in alignment of matching edges	13 mm
7.	Joint width (governs over joint taper)	± 9 mm
8.	Joint taper over length of panel	13 mm
9.	Joint taper over 3 m (10 ft) length	9 mm
10.	Maximum jog in alignment of matching edges	
10.1	Exposed to view	9 mm
10.2	Non Exposed to view	19 mm
11.	Differential bowing or camber as erected between adjacent members of the same design	13 mm

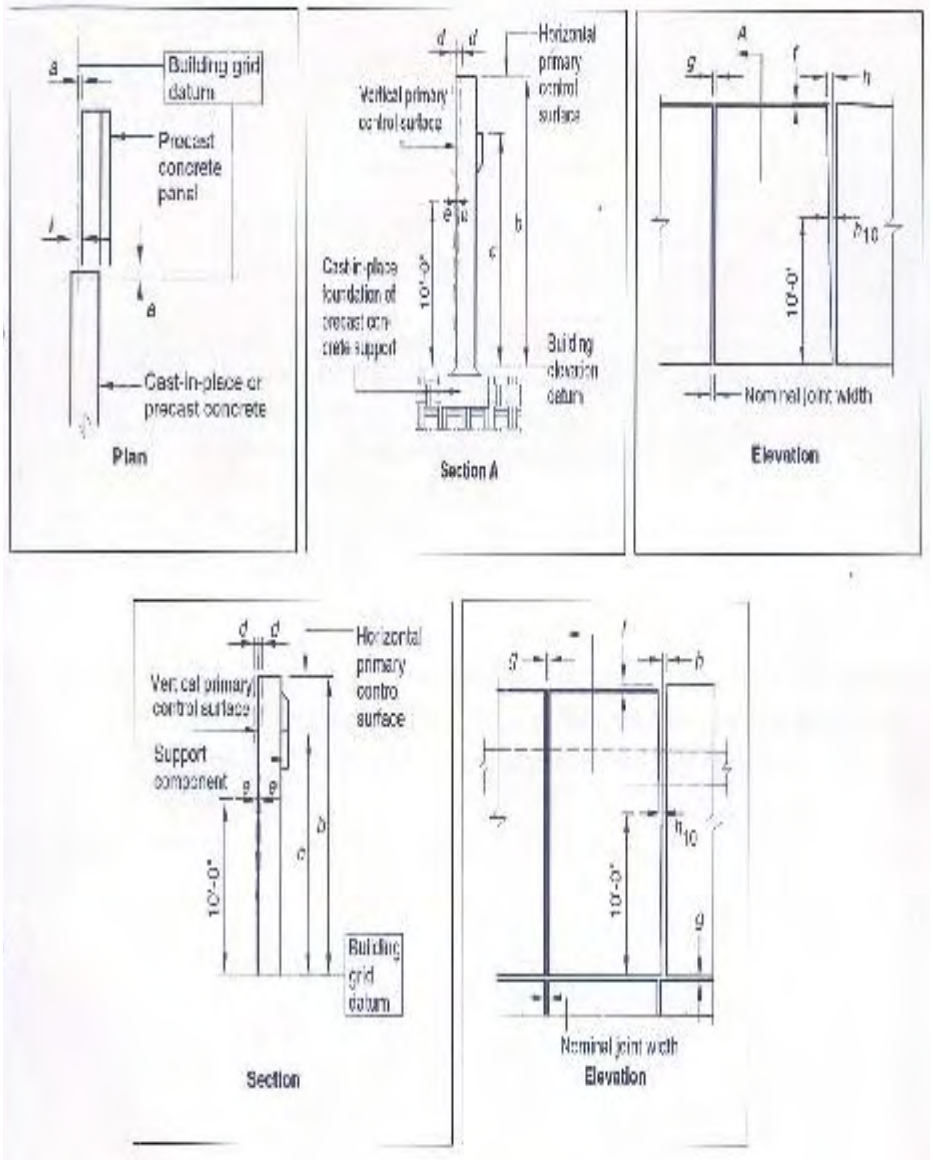


Fig. 13 Structural Wall Panel Erection Tolerances

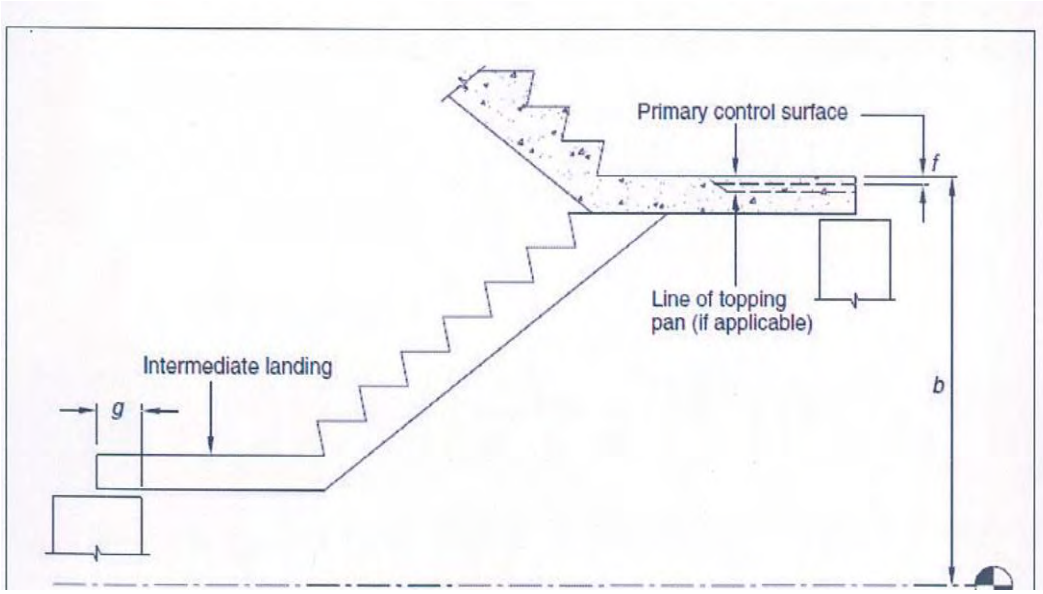
2.3.2.6 *Stair unit erection tolerances*

The primary control surface for stair units is the top of loading at floor levels. The tolerances listed in Table 10 are the same whether landings are monolithic or separate pieces. Local building codes may require more restrictive riser-height tolerance, which could also effect the product tolerance. *(See Fig. 14)*

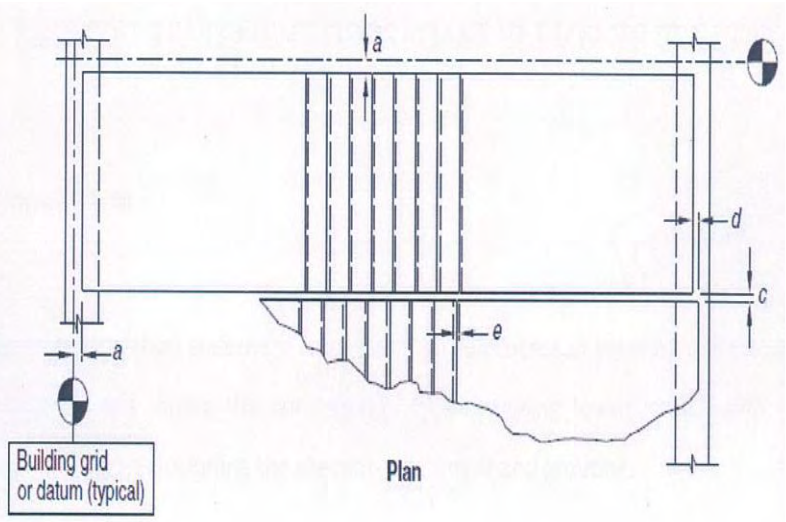
Table 10

S. No.	Item	Recommended tolerance
1.	Plan location for building grid datum	± 13 mm
2.	Differential elevation as erected	± 9 mm
3.	Joint width	± 19 mm
4.	Maximum jog in alignment of matching edges	25 mm
5	Maximum jog in alignment of stair tread nosing (this tolerance over rides 4, if required)	13 mm
6.	Maximum jog in alignment of matching edges at primary control surfaces*	9 mm
7.	Bearing (in span direction)	± 19 mm

* At stair units that have pre-topped precast buildings, the maximum jog between stair units as well as from stair unit to finish floor shall not exceed 6 mm. However, units which have landings that are topped have more leeway.



Elevation



Plan

Fig. 14 Stair Unit Erection Tolerances

2.4 Implementation of Precast Elements

2.4.1 *Casting Concrete*

The procedure for casting concrete shall be as follows:

i. Precast concrete elements shall be produced on horizontal/vertical, flat steel surfaced tilting tables.
ii. Prior to casting, electrical conduits and other required shall be fixed in position and the mould treated with mould release agent
iii. Steel reinforcement shall be kept in position using adequate spacers to ensure correct position and concrete cover.
iv. After that side shutter sides shall be fixed. The high quality concrete shall be transported from batching plant to the precast yard through transit mixer.
v. Thereafter, concrete shall be carried to mould by gantry crane with concrete bucket.
vi. During casting, table vibrators (as & when required) shall be used to achieve the best compaction. Top surface shall be finished with hand operated trowel which gives smooth finish.
vii. Care should be taken on embedded items while concreting.
viii. After casting, all exposed surfaces shall be covered with a tarpaulin (as and when required) to avoid vaporization. Casted elements shall be de-moulded once the strength meets the design requirements and the units are then shifted to the stockyard. Thereafter, curing shall be carried out for 5 days.

The details of the precast yard where casting of concrete is done are given in Annex. IV.

2.4.2 *Curing*

The curing of the prefabricated elements may be done by the normal methods of curing by sprinkling water and keeping the elements moist. This can also be done in the case of smaller elements by immersing them in specially made water tanks.

2.4.3 *Screed Concrete for Flooring*

The procedure for screed concrete shall be as follows:

i. The surface for screed concrete shall be clean, free from dust, loose materials, lumps and foreign material.

The screed shall generally be provided over the entire slab. In this case the entire slab shall act as a continuous structural diaphragm providing optimum load transfer mechanism for lateral loads. The screed shall be treated as a part of the compression zone for gravity loads on the slab. The design shall consider composite action between the slab & screed and compressive strength of screed in slab. Further, the interface shear between the slab & screed shall be checked for verifying adequate shear transfer capacity at the interface.

Screed on haunches may be provided, only if the conduits are exposed, with the mutual agreement between the project authority and the PAC holder. In such cases, additional water proofing treatment of a reputed company shall be provided at the precast slab and site concrete stitch.

ii. Electrical conduits or any other embedment shall be laid as per approved drawing before screed concrete flooring
iii. The reference level from main survey pillars shall be transferred and marked on side channels
iv. While marking level, sloping direction in flooring shall be taken care as per approved drawing
v. Before laying the concrete, cement slurry shall be spread on the slab surface for better bonding and filling of gaps between wall and slab soffit junction.
vi. The concrete should be placed from one end and shall be compacted immediately after placing and levelled uniformly.
vii. The vibrator should be applied smoothly and concrete compacted well.
viii. The concrete shall be allowed to set so as to be in dry condition.

ix. The trowelling shall start after concrete is set and reach dry condition.

x. Curing shall be done by using bunds over the screed surface /wet hessian cloth.

2.4.4 *De-moulding and Stacking*

The procedure for de-moulding and stacking shall be as follows:

2.4.4.1 *Lifting of elements from mould*

i. It must be ensured that all the elements should have identification mark.

ii. It must be ensured that all side shutters are loosened so that the elements may be lifted without any damages.

iii. Before demoulding, it must be ensured that compressive strength of the cubes should meet the specified requirements.

iv. The lifting clamps/clutches shall be fixed to lifting beam at proper positions.

v. Then the elements shall be lifted carefully to the stocking area.

2.4.4.2 *Stacking of elements*

i. The surface of stacking area should be horizontal.

ii. The wooden runner shall be placed perpendicular to lifting points and the elements placed over runner.

iii. Number of the elements per lot should not exceed man height.

iv. In case of vertical stacking, the gap between the elements should be 150 mm to 200 mm.

v. Stacking shall be done in such a way that slabs of longer span should be placed below that of shorter span.

2.4.5 *Transportation of Elements*

The process of transportation of precast elements from yard to site shall be as follows:

2.4.5.1 Loading of slab over trailer

1. It must be ensured that the identification mark on the slab should be the same as per dispatch list.
2. Any damage occurred during loading should be informed to the concerned authority.
3. The lifting clamps/clutches shall be fixed to the lifting beam at proper position.

4. The lifting beam shall be placed over the precast elements and ensured that the clutches are locked properly before lifting.
5. Instruction regarding loading height, positioning of precast elements over the trailer should be followed as per capacity of trailer.
6. The wooden rubber shall be placed in between the slabs at 500 mm from each end.
7. Some of precast elements should be placed vertically and transported through "A" frame fixed vehicle.
8. The slab shall not be overhanging from trailer.
9. The slab shall be tied firmly to the trailer by means of belt/rope as moving the load without proper tie will cause damage.
10. While transporting elements vertically, the vehicle should be loaded equally on both sides.

2.4.5.2 Unloading of slab from trailer and placing in site yard

1. Every slab shall be inspected for dimensions/identification mark and damages etc. prior to unloading at site.
2. The stacking area should be levelled and hard enough for stacking the elements.
3. There should be proper access for trailer movement.

2.4.6 *Erection*

The process of erection and installation of panels during the construction cycle by using tower cranes shall be as follows:

1. Before starting erection a survey of the area to receive precast elements shall be done to monitor any difference in dimensions or levels exceeding the tolerances. In case of unacceptable tolerances, necessary action shall be taken for rectification.
2. Installation shall be done by tower crane with sufficient capacity. Panels shall be shifted from the stack rack/truck from yard to the nearest point of construction site and shall be kept above the truck during the construction or inside the storage racks as per the site situation.
3. The necessary access for the truck to reach the nearest point of the tower shall be prepared before starting erection of the panels.
4. Once the truck reaches the tower, chain and lifting clutch with required capacity and guide rope shall be attached to the precast panels to allow the workers to control the load to its final place.
5. As the elements are lifted to its final position above the cast-in-situ slab/precast panel, vertical and horizontal alignment of the panel shall be adjusted. The gap between the element and

adjusted elements shall be maintained as per the drawings within the allowable tolerances. Shims and spacers shall be used for levelling and adjustment.

6. Temporary propping jacks shall be provided for restraining the walls laterally until grouting.
7. After completion of fixing, alignment of the panels shall be checked again.
8. Minor damages, if any to the precast panels shall be repaired by approved materials.
9. After completion of installation and alignment, elements shall be handed over for inspection.
10. The joints between the precast wall panels shall be filled with joint filler material.
11. Precast slab shall be erected above the wall panels without any scaffolding system. The electrical conduit/fitting shall be done. After electrical works are completed, screed concrete shall be laid over the precast slab.
12. Installation of the next floor shall start only after completion of screed concrete of the previous floor.
13. The sequence of erection shall be as follows:
    - Installation of precast wall panels above cast-in-situ slab
    - Provide temporary props/jacks for restraining of the walls laterally.
    - Grout the connection between the wall panels & ground floor slab and the joint between each wall panel.
    - Installation of precast slab panels above the erected precast wall panels.
    - Screed concrete above the slab after placing of electrical conduits/fittings
    - Installation of the wall panels over the floor slab.
    - Installation of the roof panels such as parapets etc.

The production flow chart is given in Annex. II.

2.5 Inspections & Testing

Inspections & testing shall be done at appropriate stages of manufacturing process of all the components. The inspected frames and panels shall be stored & packed to ensure that no damage occurs during transportation. As part of quality assurance, regular in process inspections shall be carried out by the trained personnel of the PAC holder.

2.6 Good Practices for Installation & Maintenance

Good practice as per requirement including Do's & Don'ts of working with Prefabricated Large Concrete Panel System of the manufacturer shall be followed for erection and maintenance of these sections.

2.7 Maintenance Requirements

It is assumed that no special maintenance is required during intended working life. Should repairs prove necessary, it shall ably be carried out by the trained persons using appropriate products and materials.

2.8 Skilled /Training Needed for Installation

Special training shall be required to get necessary skill set for assembly of prefabricated large concrete panels and their erection. Moreover, workers shall be trained/ oriented on handling and installation of modules, panels etc. and support system with all required safety measures taken including heavy hats, protective shoes etc. PAC holder shall arrange training of workers, as required in this regard.

2.9 Guarantees/Warranties Provided by the PAC Holder

PAC holder shall provide necessary guarantees/ warranties of the system to the client.

2.10 Responsibility

- Specific design using Prefabricated Large Concrete Panel System is the responsibility of the designer with the instructions, supervision and approval of L & T Ltd.
- Quality of maintenance of the building is the responsibility of the building owner.
- Providing necessary facilities and space for movement of machines and vehicles is the responsibility of the building developer.

PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE

3.1 Basis of Assessment

The technical assessment was done as per provisions of the Standards listed in Part 5 of this Certificate.

3.2 Site Inspections

Inspection of production, casting yard and erection process was done by some of the TAC members and Officers of BMTPC on the construction of Provident Sunworth Project comprising of B+S+12 storey buildings having 62 towers and 5952 units at Venkatapura Kengeri Hobli, Bangaluru. Firm has got necessary manufacturing, transportation and erection machineries and equipment at site as per the process description given for manufacturing and erection of the precast panels.

3.3 Approvals Obtained

3.3.1 *Concept Approval for Precast Technology for Building Construction from IIT Delhi and Veermata Jijabhai Technological Institute, Mumbai in November, 2011*.

The views given by the institutes are as follows:

1. It can be used for structures under anticipated type of lateral loads, if structural design is correctly carried out as per the relevant codes of practice in India.
2. It can be used in any seismic zone of India (i.e. seismic zone II to V as per IS 1893:2002); however, detailed design needs to be carried out for a specific project.
3. Buildings constructed by using this technology can resist design wind load; however, detailed design needs to be carried out for a specific project.
4. If it is constructed with proper care, the useful life (durability) can be assumed to be equal to its design life i.e. 50 years.
5. This technology can be used for high rise building construction in seismic zone II to V as per IS 1893:2002); however, detailed design needs to be carried out for a specific project.

3.3.2 *Concept Approval for Precast Technology for Building Construction from IIT Madras in June, 2012.*

The views given by the institutes are as follows:

1. Precast design concepts adopted are consistent with relevant provisions of international codes of practice such as ACI, PCI and FIB.

2. Connection details, load path as well as force transfer at the joints and detailed design calculations for the project, are found to be in order.
3. Similar design/detailing can be used for high rise building construction in other seismic zones. However, detailed design needs to be carried out for a specific project.

3.3.3 *Suitability of Precast Concrete Large Panel system for Mass Housing Projects by IIT Madras in March, 2015*

IIT madras has recommended the adoption of this technology in Mumbai.

3.4 Execution of Projects

The manufacturer has executed the following projects:

S. No.	Name of Project	Name of Client	No. of Dwelling units	Year of construction
1.	Pragati Towers, Parel, Mumbai	Omkar Realtors & Developers and L&T Reality Joint Venture	G+23 levels, 2024 units	February 2014
2.	Provident Sunworth Project, Bangaluru	Provident, Bangaluru	G+12/G+14 levels, 1200 units	March 2016

PART 4 STANDARD CONDITIONS

This certificate holder shall satisfy the following conditions:

4.1 The certificate holder shall continue to have the product reviewed by BMBA.

4.2 The product shall be continued to be manufactured according to and in compliance with the manufacturing specifications and quality assurance measures which applied at the time of issue or revalidation of this certificate. The Scheme of Quality Assurance separately approved shall be followed.

4.3 The quality of the product shall be maintained by the certificate holder. Complete testing facilities shall be installed for in-process control.

4.4 The product user should install, use and maintain the product in accordance with the provisions in this Certificate.

4.5 This certificate does not cover uses of the product outside the scope of this appraisal.

4.6 The product is appraised against performance provisions contained in the standards listed in Part-V. Provisions of any subsequent revisions or provisions introduced after the date of the certificate do not apply.

4.7 Where reference is made in this Certificate to any Act of Parliament of India, Rules and Regulations made there under, statutes, specifications, codes of practice, standards etc. of the Bureau of Indian Standards or any other national standards body and the International Organization for Standardization (ISO), manufacturer's company standards, instruction/manual etc., it shall be construed as reference to such publications in the form in which they were in force on the date of grant of this Certificate (and indicated in Part V to this Certificate)

4.8 The certificate holder agrees to inform BMBA of their clients with details of construction on six monthly basis.

4.9 The certificate holder agrees to provide to BMBA feedback on the complaints received, the redressal provided, and the time taken to provide redressal on complaint to complaint basis as soon as redressal is provided. BMBA agrees to provide the certificate holder the user feedback received by it, if any.

4.10 If at any time during the validity period, PACH is unable to fulfill the conditions in his PAC, he should on his own initiative suspend using the PAC and notify Chairman, PAC the date from which he has suspended its use, the reason for suspension and the period by which he will be able to resume. He shall not resume without the prior permission of BMBA. He shall also inform, simultaneously, his agents, licensees, distributors, institutional, government, public sector buyers, other buyers and all those whom he has informed about his holding the PAC. He shall also inform all those who buy his product(s) during the period of suspension. He shall provide to BMBA at the earliest the list of who have been so informed by him.

4.11 In granting this Certificate, BMBA takes no position as to:

(a) The presence or absence of patent or similar rights relating to the product;
(b) The legal right of the Certificate holder to market, install or maintain the product;
(c) The nature of individual installations of the product, including methods of workmanship.

4.12 BMTPC and the Board of Agreement of BMTPC (BMBA) take no position relating to the holder of the Performance Appraisal Certificate (PACH) and the users of the Performance Appraisal Certificate (PAC) respecting the patent rights / copy rights asserted relating to the product / system / design / method of installation etc. covered by this PAC. Considerations relating to patent / copy rights are beyond the scope of the Performance Appraisal Certification Scheme (PACS) under which this PAC has been issued. PACH and users of this PAC are expressly advised that determination of the Claim / validity of any such patent rights / copy rights and the risk of infringement of such rights are entirely the responsibility of PACH on the one hand and that of the users on the other.

4.13 It should be noted that any recommendations relating to the safe use of the product which are contained or referred to in this Certificate are the minimum standards required to be met with when the product is installed, used and maintained. They do not purport in any way to restate or cover all the requirements of related Acts such as the Factory Act, or of any other statutory or Common Law duties of care, or of any duty of care which exist at the date of this Certificate or in the future, nor is conformity with the provisions of this Certificate to be taken as satisfying the requirements of related Acts.

4.14 In granting this Certificate, BMTPC and BMBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the use of this product.

4.15 The certificate holder indemnifies BMBA, its officers and officials involved in this assessment against any consequences of actions taken in good faith including contents of this certificate. The responsibility fully rests with the certificate holder and user of the product.

4.16 The responsibility for conformity to conditions specified in this PAC lies with the manufacturer who is granted this PAC. The Board (BMBA) will only consider requests for modification or withdrawal of the PAC.

4.17 The PAC holder shall not use this certificate for legal defense in cases against him or for legal claims he may make from others.

Dr. Shailesh Kr. Agarwal
Chairman, TAC
& Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core 5A, Ist Floor, India Habitat Centre,Lodhi Road,
New Delhi-110 003

Place: New Delhi
Date of issue_____

Chairman TAC & Member Secretary, BMBA

for and on behalf of

PART 5 LIST OF STANDARDS & CODES USED IN ASSESSMENT

5.1 Standards - These Standards are referred for carrying out particular tests only and do not specify the requirement for the whole product as such.

5.1.1 IS 456:2000 – Code of Practice for Plain and Reinforced Concrete
5.1.2 IS 875 (Part 1):1987 – Code of Practice for Design loads (other than earthquake) of buildings and structures – unit weight of building and stored materials
5.1.3 IS 875 (Part 2):1987 – Imposed loads
5.1.4 IS 875 (Part 3):1987 – Wind loads
5.1.5 IS 875 (Part 4):1987 – Snow loads
5.1.6 IS 875 (Part 5):1987 – Special loads and load combinations
5.1.7 IS 1786: 2008 – High strength deformed bars and wires for concrete reinforcement
5.1.8 IS 1893 (Part 1):2002 – Criteria for Earthquake Resistant Design of Structures
5.1.9 IS 1904:2005 – Code of practice for design and construction of foundations in soils – general requirements
5.1.10 IS 2062:1992 – Hot Rolled Medium and High Tensile Structural Steel
5.1.11 IS 7215:1974 – Tolerances for Fabrication of Steel Structures
5.1.12 IS 9103:1999 – Specifications for Concrete admixtures
5.1.13 IS 11447:1985 – Code of practice for construction of large panel prefabricates
5.1.14 IS 13920: 1993 – Code of practice for ductile detailing of RCC structures subjected to seismic forces.
5.1.15 IS 15916:2010 -- Code of practice for design and erection using prefabricated concrete

CERTIFICATION

In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA), **Precast Large Concrete Panel System** bearing the mark manufactured by M/s Larsen & Toubro Ltd. is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No. 1027-S/2016** is awarded to **M/s Larsen & Toubro Ltd., Mumbai.**

The period of validity of this Certificate is for two years i.e. from 12-04-2016 to 11-04-2018. This Certificate consists of pages 1 to 47.

Dr. Shailesh Kr. Agarwal
Chairman, TAC
& Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core 5A, 1st Floor, India Habitat Centre,Lodhi Road,
New Delhi-110 003

Embossing Seal Of BMBA

On behalf of BMTPC Board of Agreement Chairman, Technical Assessment Committee (TAC) of BMBA & Member Secretary, BMTPC Board of Agreement (BMBA) Under Ministry of Housing and Urban Poverty Alleviation, Government of India, New Delhi, India

Place: New Delhi

Date: .....

PART 6 ABBREVIATIONS

Abbreviations

BMBA	Board of Agreement of BMTPC
BMTPC	Building Materials and Technology Promotion Council
CPWD	Central Public Works Department
ED	Executive Director of BMTPC
IO	Inspecting Officer
MS	Member Secretary of BBA
PAC	Performance Appraisal Certificate
PACH	PAC Holder
PACS	Performance Appraisal Certification Scheme
SQA	Scheme of Quality Assurance
TAC	Technical Assessment Committee (of BMBA)

PERFORMANCE APPRAISAL CERTIFICATION SCHEME - A BRIEF

Building Materials & Technology Promotion Council (BMTPC) was set up by the Government of India as a body under the Ministry of Housing &Urban Poverty Alleviation to serve as an apex body to provide inter-disciplinary platform to promote development and use of innovative building materials and technologies laying special emphasis on sustainable growth, environmental friendliness and protection, use of industrial, agricultural, mining and mineral wastes, cost saving, energy saving etc. without diminishing needs of safety, durability and comfort to the occupants of buildings using newly developed materials and technologies.

During the years government, public and private sector organizations independently or under the aegis of BMTPC have developed several new materials and technologies. With liberalization of the economy several such materials and technologies are being imported.

However, benefits of such developments have not been realized in full measure as understandably the ultimate users are reluctant to put them to full use for want of information and data to enable them to make informed choice.

In order to help the user in this regard and derive the envisaged social and economic benefits the Ministry of Housing &Urban Poverty Alleviation has instituted a scheme called Performance Appraisal Certification Scheme (PACS) under which a Performance Appraisal Certificate (PAC) is issued covering new materials and technologies. PAC provides after due investigation, tests and assessments, amongst other things information to the user to make informed choice.

To make the PACS transparent and authentic it is administered through a Technical Assessment Committee
(TAC) and the BMTPC Board of Agreement (BMBA) in which scientific, technological, academic, professional organizations and industry interests are represented.

The Government of India has vested the authority for the operation of the Scheme with BMTPC through Gazette Notification No. 1-16011/5/99 H-II in the Gazette of India No. 49 dated 4th December, 1999.

Builders and construction agencies in the Government, public and private sectors can help serve the economic, development and environmental causes for which the people and Government stand committed by giving preference to materials and technologies which have earned Performance Appraisal Certificates.

Further information on PACS can be obtained from the website: www.bmtpc.org

ANNEX I

(Clause 1.9.2.1)

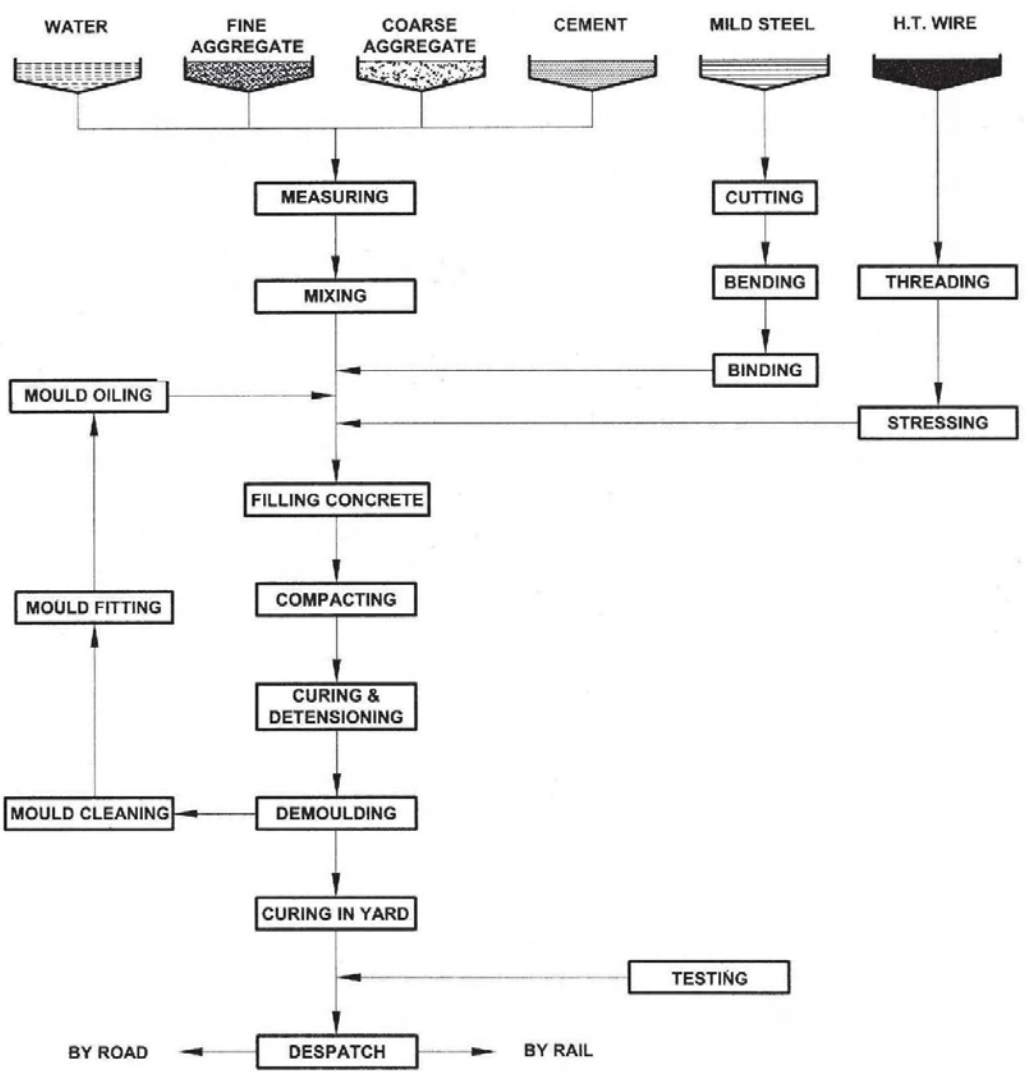
QUALITY ASSURANCE PLAN FOR PREFABRICATED LARGE CONCRETRE PANEL SYSTEM

S.No	Description	Test required	Result required	Frequency of Testing
I.	**Cement**			
1.	Setting time i) Initial ii) Final	50 --100 tonne – 2 100-200 tonne – 3 201-300 tonne – 4 301-500 tonne –5 501-800 tonne --6 801-1300 tonne -7	 Not less than 30 minutes Not greater than 600 minutes	50 --100 tonne 100-200 tonne 201-300 tonne 301-500 tonne 501-800 tonne 801-1300 tonn
2.	Fineness test	1 test per 5 samples	80% content should pass from 0 micron sieve	1 test per 5 sar
3.	Consistency	As per requirement		As per require
4.	Fineness test by specific surface	1 test per 5 samples	OPC=235cm/gm PPC+300cm/gm	1 test per 5 sar
5.	Chemical test	1 test per 5 samples	Magnesium Oxide < 6% Sulphur trioxide < 2.75%	1 test per 5 sar
II.	**Aggregate: Coarse and Fine**			
A	**Fine Aggregate**			
1.	Silt content	1 test per 150 cum (10 kg sample)	Shall not be more than 3%	1 test per 150 (10 kg sample)
B.	**Coarse Aggregate**			
1.	Gradation test	I test per 50 cum	As per IS 2386:1963	2 tests per seas
2.	Impact test	I test per 50 cum	As per IS 2386:1963	2 tests per seas
3.	Abrasion test	I test per 50 cum	As per IS 2386:1963	2 tests per seas
4.	Soundness test	I test per 50 cum	As per IS 2386:1963	2 tests per seas
III.	**Concrete**			
1.	Concrete cube strength	Upto 5 cum –1 set 6-15 cum -2 set 16-30 cum - 3 set 31-50 cum - 4 set 51 & above -5 set (for each 50cum or part thereof)	As per IS 456:2000	Upto 5 cum –1 6-15 cum -2 16-30 cum - 3 31-50 cum - 4 51 & above -5 (for each 50cu part thereof)
2.	Workability	Once per each shift	As per IS 456:2000	Once per each
3.	Slump test	Once per each shift	As per IS 456:2000	Once per each
4.	Hardened concrete	Cubes 7 & 28 days as directed	As per IS 456:2000	Cubes 7 & 28 as directed

ANNEX II

(*Clause 2.4.6*)

PRODUCTION FLOW CHART

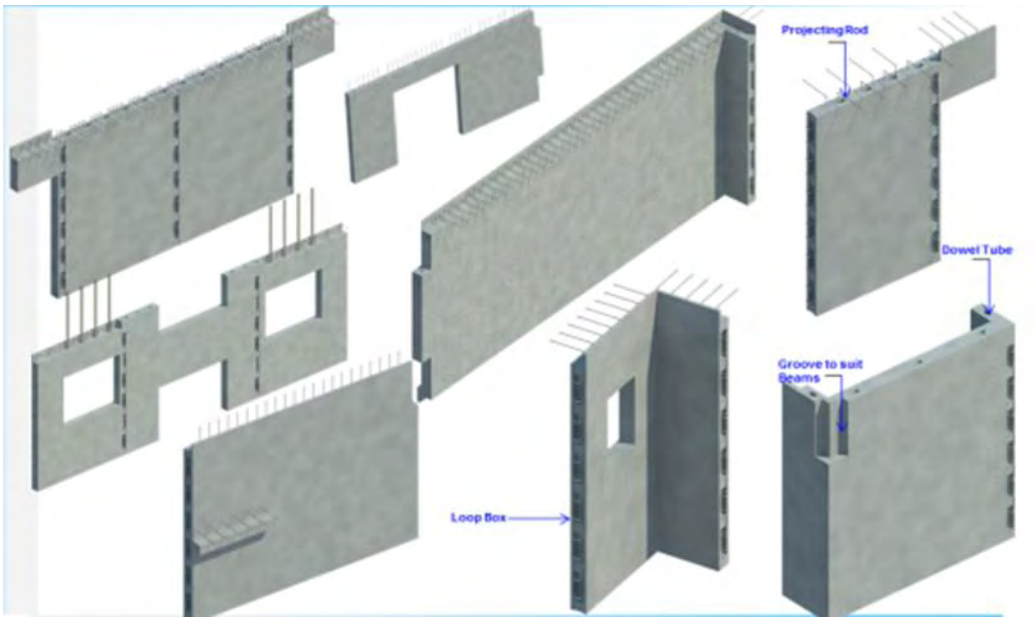


ANNEX III

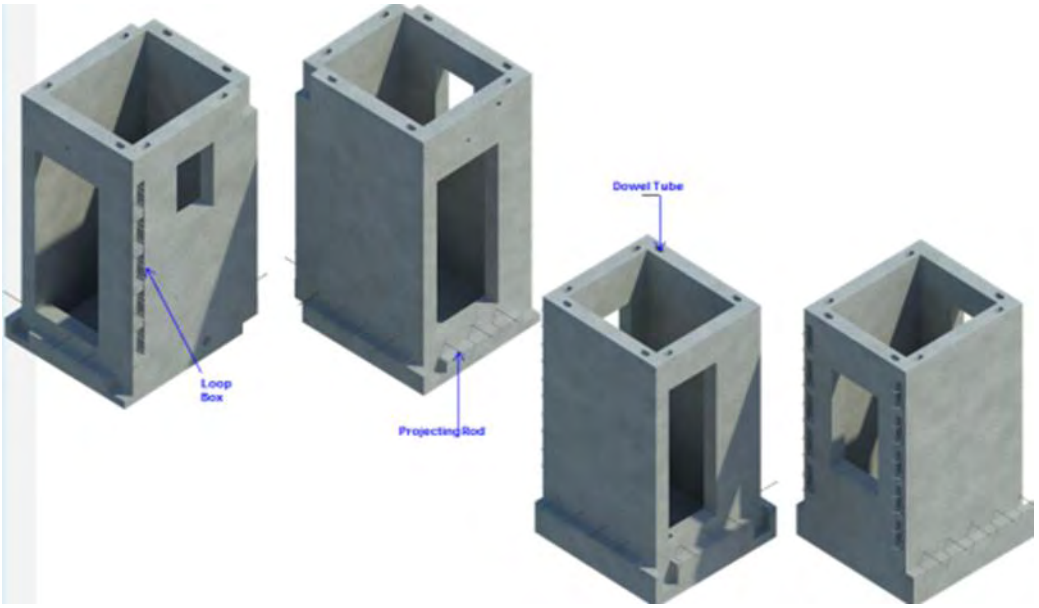
(Clause 1.3.3)

TYPICAL MOULDS

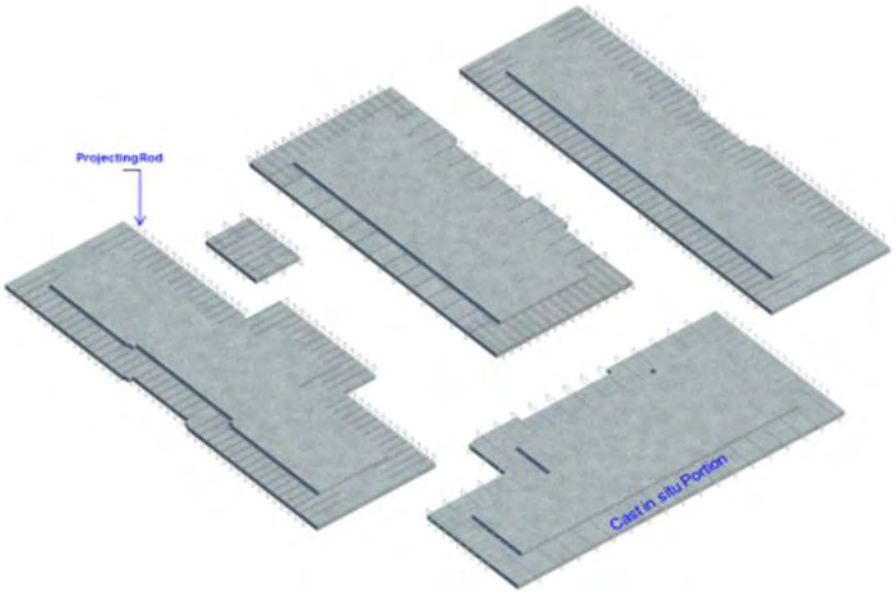
1. Walls



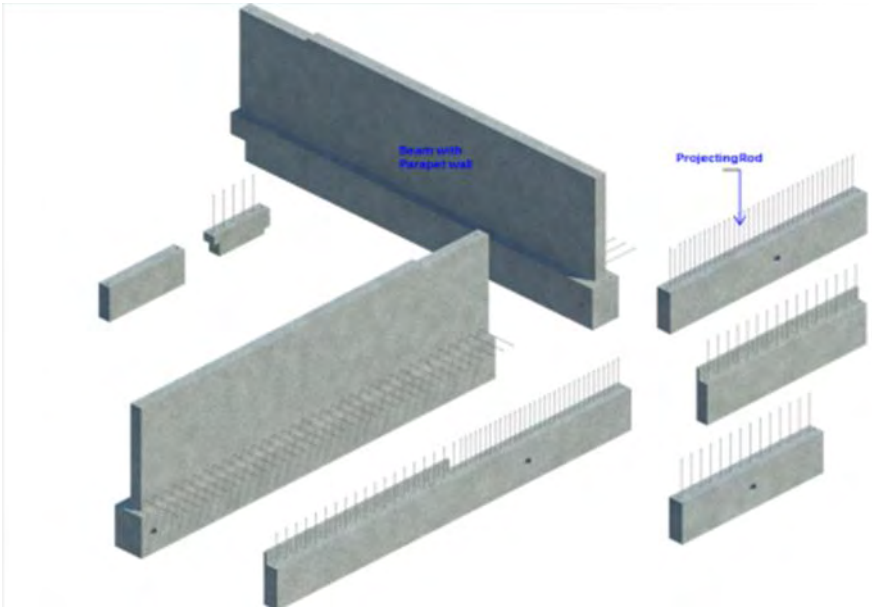
2. POD



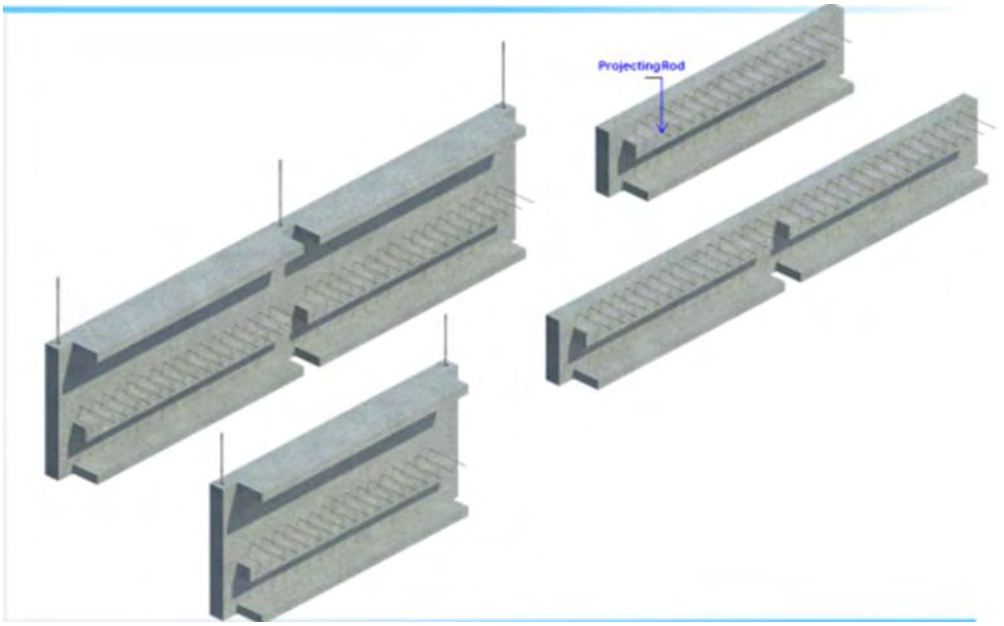
3. Slab


ProjectingRod
Cast in situ Portion

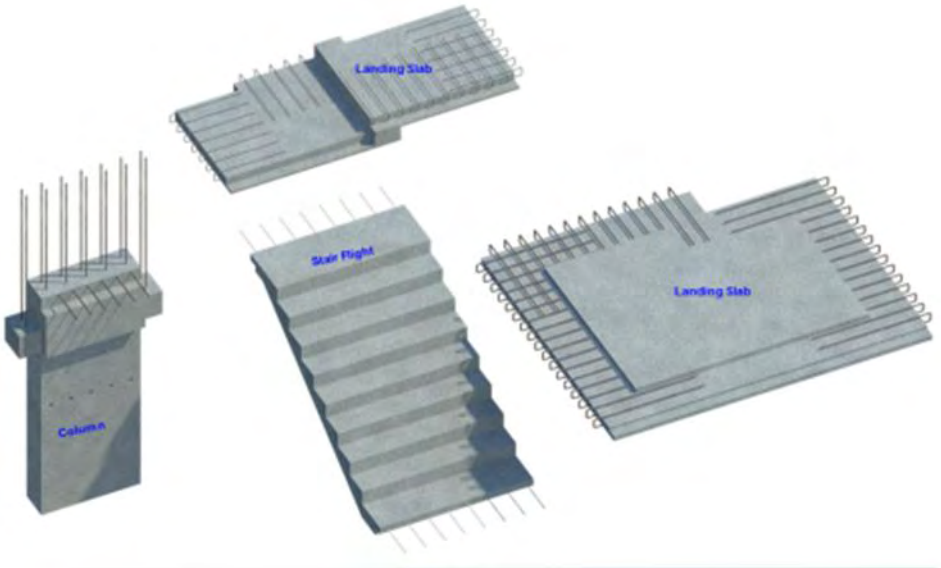
4. Beam


Beam with
Parapet wall
ProjectingRod

5. Spandrel



6. Column, Staircase and landing



ANNEX IV
(Clause 2.4.1)

TYPICAL PRECAST YARD

1. Slab Mould

2. POD Mould

➢ Deshuttering

➢ Lifting of POD

➢ Stacking

3. Spandrel Mould

4. Beam Mould

5. Battery Mould & Tilting Tables