



ROBOMATIC HOLLOWCORE CONCRETE WALL PANELS

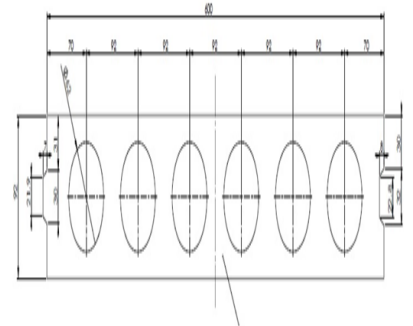
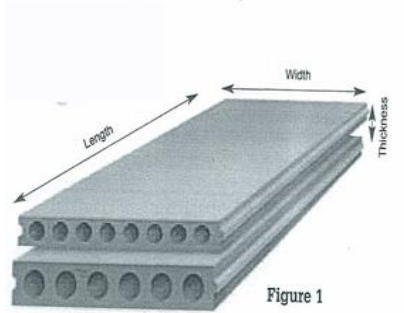
User should check the validity of the Certificate by contacting Member Secretary, BMBA at BMTPC or the Holder of this Certificate.

Name and Address of Certificate Holder:

M/s Robomatic Precon Pvt. Ltd.
ROBO House, 2nd Floor, Plot No. 82,
APHB Colony, Gachibowli
Hyderabad -- 5000082 (Telangana)
Phone: 09849496955
Email: apr@robomatic.in

Performance Appraisal Certificate

PAC No.:1040-S/ 2018
Issue No. 01
Date of Issue:
30-08-2018



Building Materials & Technology Promotion Council
Ministry of Housing & Urban Affairs
Government of India
Core 5A, First Floor, India Habitat Centre,
Lodhi Road, New Delhi – 110 003

Tel: +91-11-2463 8096, 2463 8097; Fax: +91-11-2464 2849
E-mail: bmtpc@del2.vsnl.net.in Web Site: <http://www.bmtpc.org>

PERFORMANCE APPRAISAL CERTIFICATE


FOR

ROBOMATIC HOLLOWCORE CONCRETE WALL PANELS

ISSUED TO

M/s ROBOMATIC PRECON PVT. LTD., HYDERABAD

STATUS OF PAC No.:1040-S/2018

S. No.	Issue No.	Date of Issue	Date of renewal	Amendment		Valid up to (Date)	Remark	Signature of authorized signatory
				No.	Date			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	30-08-2018	30-08-2019	--	--	29-08-2019	--	

PAC No. 1040-S/2018 Issue No. 01 Date of issue: 30-08-2018

CONTENTS

PART 1 CERTIFICATION	3
1.1 Certificate Holder	3
1.2 Description of Product	3
1.3 Uses & Limitations of the panels	5
1.4 Assessment.....	5
1.5 Manufacturing Machinery & Equipment	6
1.6 Manufacturing Process	7
1.7 Conditions of Certification	9
1.8 Certification	10
PART 2 CERTIFICATE HOLDER’S TECHNICAL SPECIFICATIONS	10
2.1 General	10
2.2 Specifications for the product	11
2.3 Production & Inspection.....	11
2.4 Selection and Installation	12
2.5 Storage handling and transportation	12
2.6 Installation Procedure.....	15
2.7 Critical details	16
2.8 Skills/ training needed for installation	17
2.9 Warranties provided by the PAC holder	18
2.10 Service provided by the PAC holder to the customer	18
2.11 Responsibility	18
PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE	18
3.1 Basis of Assessment	18
3.2 Laboratory tests done for assessment	18
3.3 Supply of the Products	19
PART 4 STANDARD CONDITIONS	20
PART 5 LIST OF STANDARDS AND CODES USED IN ASSESSMENT	22
CERTIFICATION	23
PART 6 ABBREVIATIONS	24
PERFORMANCE APPRAISAL CERTIFICATION SCHEME – A BRIEF	25
ANNEX I QAP	26
ANNEX II Flow Chart	27
ANNEX III Installation Manual	28

PART 1 CERTIFICATION

1.1 Certificate Holder: M/s Robomatic Precon Pvt. Ltd.
2nd Floor, Plot No. 82, ROBO House,
APHB Colony, Gachibowli
Hyderabad -- 5000082 (Telangana)
Tel: 09849496955
Email: apr@robomatic.in

1.2 Description of Product

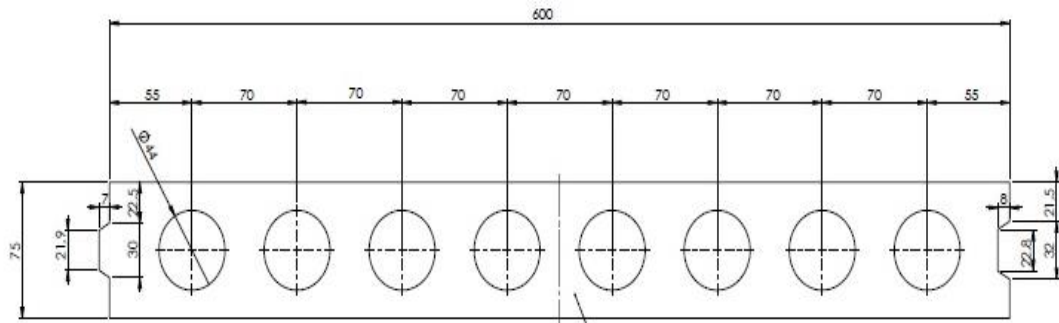
1.2.1 *Name of the Product* – Robomatic Hollowcore Concrete Wall Panels

1.2.2 *Brief Description* – Robomatic wall panels are extruded non-load bearing concrete hollowcore wall panels manufactured in fully automated machines. These wall panels are factory produced using light weight concrete made of manufactured sand, crushed stone aggregate and Ordinary Portland cement. The concrete are extruded and cut while still wet to the requisite length. Curing and sealing are followed for 24 to 48 hours by stacking and palletizing after which the walls are watered and cured for a further period of 7 to 8 days. After 15 days the panels are ready for transportation to site.

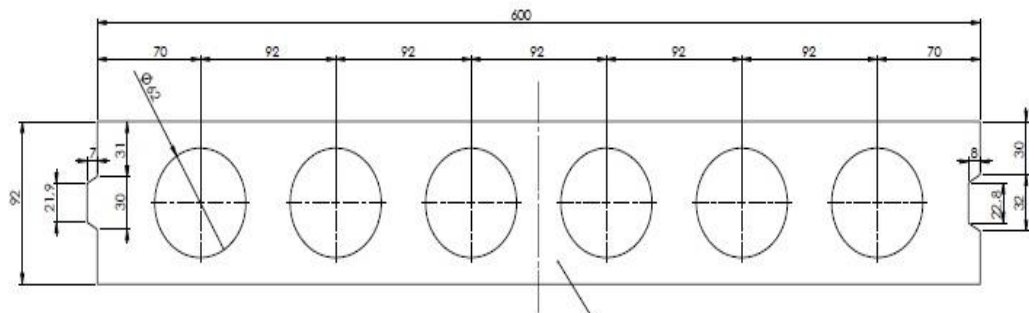
Wall panels have cylindrical hollow cores incorporated with 8 No. 44 mm dia voids in the 75mm thick, 6 No. 62 mm dia. voids for the 92 mm thick and 6 No. 74 mm dia. voids for the 120 mm thick panels. Hollowcores are incorporated in the walls to reduce dead weight, facilitate mechanical, electrical and plumbing services through hollows, thereby increasing sound and thermal insulate properties. The sides of all panels are tongued and grooved to facilitate positive jointing.

These wall panels do not require stone or wood sills/frames to level surfaces for windows and openings. Lintels need not be cast as panels may be placed horizontally as lintels wherever required. Wash basins, cup-boards, mirrors, paintings etc. may be hanged with regular plug screws.

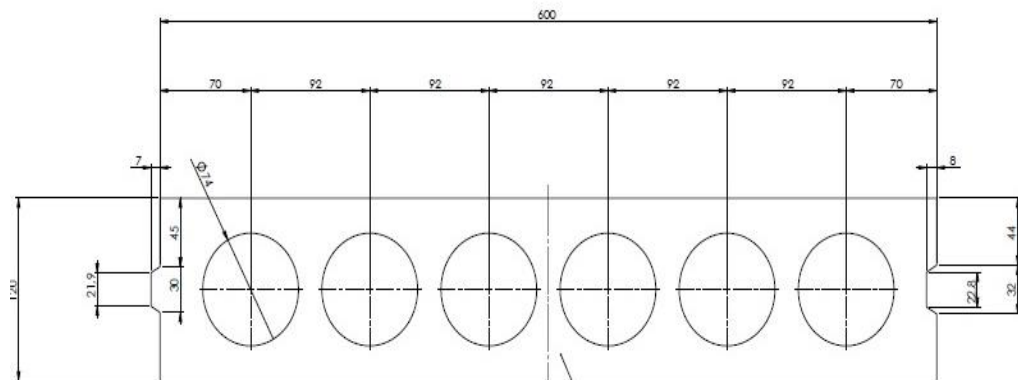
Details of the wall panels showing hollow cores are shown in Figs.1, 2 & 3.



75mm thick panel Fig. 1



92mm thick panel Fig. 2



120mm thick panel Fig. 3

1.2.3 Type and size

Robomatic walls are produced in standard lengths, widths & thickness and to suit room height as per the details give below and as shown in Figs. 4 & 5:

- Wall width : 600 mm
- Wall thickness : 75 mm, 92 mm & 120 mm
- Wall Height : 2.40 m to 3.30 m
- Weight : 120 kg/m² for 75 mm, 150 kg/m² for 92 mm and 190 kg/m² for 120 mm thick panels.

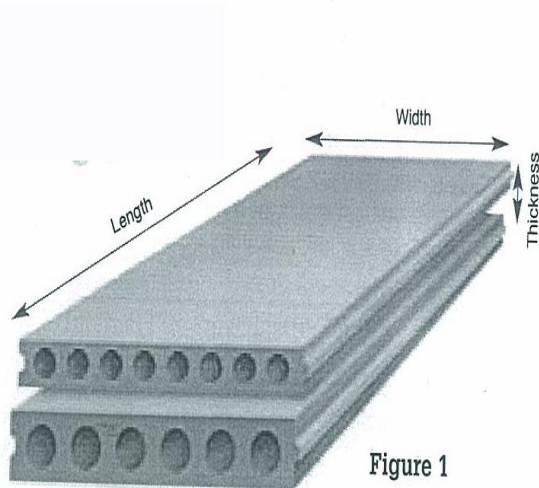


Fig. 4

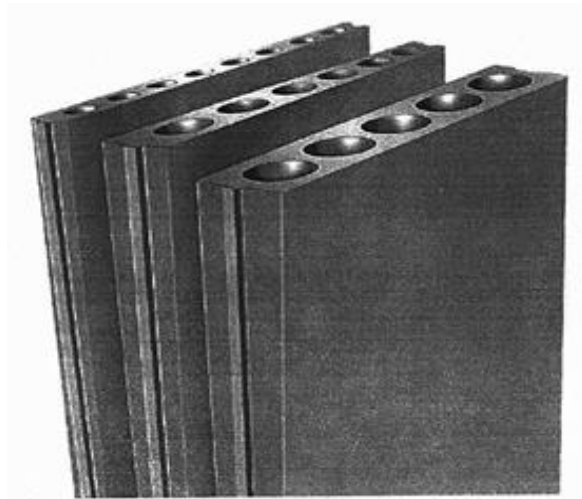


Fig. 5

1.2.4 Tolerances

The panels shall be produced in accordance with the following tolerances:

Length	: ±10 mm,
Width	: ±3 mm,
Thickness	: ±3 mm,
Squareness of end	: ±6 mm
Differential bowing between adjacent panels of the same length	: 15 mm

1.3 Use of the Robomatic wall panels & Limitations

1.3.1 Uses

These wall panels shall be used as non-load bearing walls/partition walls and compound/boundary walls in residential/ commercial/ industrial/ institutional buildings.

1.4 Assessment

1.4.1 Scope of Assessment – Suitability of Robomatic wall panels for use as non-load bearing walls, compound/boundary walls in residential and commercial buildings etc.

1.4.2 Basis of Assessment

The assessment is based on the results & reports of

- (i) Inspection of the manufacturing plant and equipment used
- (ii) Assessment of quality assurance procedures implemented for Quality Assurance Scheme followed by the Certificate holder for process control as per Quality Assurance Plan attached at Annex I.

- (iii) Reports of tests got done on 75mm, 92mm & 120mm thick wall panels from Bureau Veritas, Hyderabad by the manufacturer.
- (iv) Tests got done on the samples of 75mm, 92mm & 120mm thick wall panels collected by the IO during inspection of the plant from Bureau Veritas, Hyderabad.

1.4.3 *Scope of Inspection* – Scope of inspection included the verification of production, performance and testing facilities at the factory including competence of technical personnel and status of quality assurance in the factory.

1.5 Manufacturing Machinery & Equipment

The firm has got fully mechanized Acotec Production Line of Elematic make and Concrete Batching Plant of Schwing Stetter make, Truck mounted crane of Bharat Benz & Plafinger make, Forklifts of Godrej make, JCB Loader and Weigh Bridge. The components of these machines are given below:

I. Acotec Line

1. Concrete Feeder
2. Extruding, Cutting and Plate feeding – Plate feeder, Plate feeder conveyor, extruder, cutter & electrification
3. Trimmer
4. Tipper and Recycling – Belt conveyor and Tipper
5. Stacking -- Pallet conveyor, stacker & stack conveyor
6. Restacking -- Stack conveyor, Crossing station, Re-stacker, Roller conveyor, Transfer tables and Turning device
7. *Cleaning and oiling* – Plate conveyor and Cleaning and oiling
8. *Delivery* – Receiving conveyor and Chain conveyor

II. Batching Plant

1. Wet Mix Plant – capacity 30 m³/hr with 4 nos. in line bins of 16 m³ aggregate storage capacity
2. Planetary Mixer with compacted output of 0.5 m³/ batch
3. Aggregates weighing system – with load cells suspended at 4 points of the conveyor belt
4. Pneumatically operated batching gates – 4 nos. for aggregates
5. Electrically operated Vibrator for sand/powder bin and cement/filler weigh
6. Chevron Transfer conveyor with carrier rollers
7. Cement/filler weighing system
8. Water weighing and Pump pressure-discharge *system by* flow meter, water sprinkler pipe line
9. *Planetary Mixer with moisture sensor*

10. *Air compressor*
11. *Screw conveyor for cement – 1no*
12. *PLC based Control system, SCADA software*

1.6 Manufacturing Process

The manufacturing process of Robomatic wall panels is as follows:

1.6.1 *Raw Material*

Sieved manufactured Sand and 2-6mm stone aggregate shall be supplied to the plant where it shall be weighed and sieve analysis done & silt content checked as per the quality assurance norms. Cement shall be supplied in closed bulkers directly from the manufacturers' plant and fed into cement silo directly using blower.

1.6.2 *Concrete Mixing*

Concrete required shall be batched and mixed at an automatic batching and mixing plant with Planetary Pan Mixer and Moisture probes. The relatively dry aggregates shall be automatically weighed & batched into the mixer from Aggregate Bins. Two of the Aggregate bins shall be equipped with moisture probes to ascertain accurate weighing and water content calculation later in the final concrete mix. Afterwards cement and water shall be added into the mixture. A low water-cement ratio of about 0.3 ensures that concrete is zero-slump and gains about 70% of its design strength within 12-24 hours of casting. Moisture content of the mixed concrete shall also be automatically controlled and adjusted by the software thus ensuring consistent concrete mix at all times. The software auto adjusts for water content based on readings of the moisture probes. After mixing, the concrete batch shall be fed to the conveying system, which brings fresh concrete to the hopper of the Robomatic Wall – line where wall panels shall be cast, cut, trimmed, stacked, pre-cured, restacked and strapped into bundles.

1.6.3 *Extrusion*

Robomatic Wall elements shall be formed in a continuously operating extruder. The concrete shall be compacted onto thin base moulds, which support the products during the pre-curing time. Base moulds shall be automatically fed to the extruder as a continuous ribbon. The base mould length shall determine standard length of the products. There can simultaneously be maximum five plate lengths in the system. The extruder shall compact the concrete with extrusion screws against the packing bar and side walls. Top surface of the product shall be vibrated by a vibrating plate.

1.6.4 *Cutting*

After extruding, the products shall be cut according to the base mould length. A circular saw shall cut the fresh concrete on each base mould seam. Then the cut product together with the supporting plate shall be pulled to the stacker.

1.6.5 *Trimming*

When necessary, the fresh product shall be stopped at a specified point, where the manually adjusted circular saw cuts off the wanted trimming piece. Trimming length shall be max. 20 cm. The trimmed off concrete shall be recycled back to the extruder.

1.6.6 *Stacking*

Cut, fresh products shall be stacked into pre-curing stacks. Depending on the product thickness and weight each stack shall contain 4 to 10 products and base moulds. Stacks shall be supported by steel pallets, which are automatically fed underneath each stack.

1.6.7 *Pre-curing*

The stacks shall stay 12 to 24 hours in the pre-curing indoor storage area where natural pre-curing occurs for each stack which is covered with tarpaulin to stop any evaporation and moisture loss. The storage shall be an area where natural curing occurs. Product stacks shall be moved into and out from the stock area by a forklift.

1.6.8 *Restacking*

After pre-curing the products are strong enough to stand automatic handling. Products shall be separated from the base molds. Base molds shall be returned back to circulation through a cleaning and oiling unit. The products shall be restacked to form delivery stacks with 4 - 10 products on top of each other. The stack shall be pushed against a wooden delivery pallet and turned on its side. Delivery stacks shall be strapped before transportation to delivery storage. Stacks must stay in the delivery storage where they shall be kept moist by external manual water sprinkling for at least 7 days before transporting to a construction site after 15 days on a Truck or Flat-bed Trailer. Loading of trucks shall be done with Forklift or Hydraulic Cranes.

1.6.9 *Reusability of concrete materials*

➤ During manufacturing of Robomatic Hollowcore Wall panels, there is possibility of wastage with concrete due to machinery tune up in the beginning of every shift. But this should be taken as wastage because, the concrete which could

not be manufactured into wall panels are looped to a separate line, dismantled into concrete again and sent back to machine for casting of wall panels.

➤ Due to this, there is zero percentage wastage in the plant. The plant operational personnel are trained well to handle these situations and whatsoever the reason for not casting at any instance will be reused.

➤ The other possibility of wastage is during installation. In general, 3% of the total area of installation is allowed as wastage due to cuttings and left over small panels due to staggering installation of walls.

➤ Even this 3% of wall panels are transported back to the plant and is used as coarse aggregate. The well cured and formed panels left over at the site will be pulverized manually and mixed with the coarse aggregate in batches.

➤ While handling of panels inside the plant area there is a small percentage of breakage of panels is observed. During quality checks these panels are identified and sent to raw material dump yard and pulverized manually and mixed with the coarse aggregate of 2 – 8mm.

Manufacturing Process flow chart is given in Annex II.

1.7 Conditions of Certification

1.7.1 *Technical Conditions* – Raw materials and the finished product shall conform to the requirements of the prescribed specifications.

1.7.2 *Quality Assurance* – 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.

1.7.3 *Brochure/ Guidelines* – The Certificate holder shall provide detail instructions for laying of the walls.

1.7.4 *Handling of User Complaints*

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

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

1.7.5 Durability

Durability of the walls panels is defined as the capability to resist weathering action, chemical attack and abrasion while maintaining its desired engineering properties. It normally refers to the duration or life span of trouble-free performance. The panels are manufactured using M25 mix with design mix of coarse aggregates 3-5mm, manufactured sand 0-2mm, cement and optimum mix of water as per IS 10262:2009 & IS 456:2000.

As per the design of M25, it can withstand physical factors in general just like the regular concrete members and physical forces like percolation and permeability of water through its medium and temperature stresses. In the same way, M25 design mix concrete can withstand chemical attacks viz., sulphate and chloride attacks.

1.8 Certification

- 1.8.1** 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, Robomatic Hollowcore Concrete Wall Panels covered by this Certificate are fit for use as set out in the Scope of Assessment.

PART 2	CERTIFICATE	HOLDER'S	TECHNICAL
---------------	--------------------	-----------------	------------------

SPECIFICATIONS

2.1 General

- 2.1.1** The PAC holder shall manufacture Robomatic wall panels in accordance with the requirements specified in relevant Indian and other Standards (See Part 5). In addition it shall follow Company standards specifying requirements of these sections for various materials used in the manufacturing of the product.

2.2 Specifications of the Panels

2.2.1 Technical Specifications

2.2.1.1 Raw materials

- i) OPC 43/53 grade cement shall conform to IS 8112:2013/IS 12269:2013.
- ii) Sand 0-2mm shall conform to the manufacturers specifications.
- iii) Coarse aggregate 2-6 mm shall conform to the manufacturers specifications.

- (iv) Light weight aggregate shall conform to IS 9142:1979.
- (v) Fly ash shall conform to IS 3812 (Part 1):2013.
- (vi) Water shall conform to IS 10500-2012.
- (vii) MS-C Channel 100x50mm x 6m shall be manufactured from pre-galvanized high tensile steel conforming to IS 277:2018.
- (viii) Adhesive, glue & bonding agents shall conform to the manufacturer's specifications.

2.3 Production & Inspection

2.3.1 *Production*

Robomatic wall panels shall be machine made from sand, coarse aggregate and 53 grade Portland cement. These shall be free from crack and nodules of free lime. These shall have smooth rectangular faces with sharp corners and shall be uniform in colour.

Precast light weight hollow core wall panels shall be manufactured in Dry casting method. The units shall be made with tongue and groove joint. Section of the tongue rebate shall be 21.9 mm (top) x 30mm (bottom) x 7mm (deep) for entire thickness of 75mm, 92mm and 120mm on one end of the panel and on other end of the panel, the size of groove rebate shall be 22.8mm (top) x 32mm (bottom) x 8mm (deep). Panels shall have cylindrical hollow core incorporated with 8 No. 44 mm dia voids in the 75mm thick, 6 No. 62 mm dia. voids for the 92 mm thick and 6 No. 74 mm dia. voids for the 120 mm thick panels. Faces of panels shall be flat, rectangular and smooth.

2.3.2 *Adhesive*

High strength and tensile adhesion non-shrink cementations grout premixed compound/void filling expanding polyurethane foam (PU) shall be used for vertical and horizontal joints of precast hollow core wall panels. Butt joints at corners shall be fixed with special frame anchors.

2.3.3 *Plumbing & Electrical*

Robomatic wall panels shall have hollowcores of 44mm dia. in 75mm wall, 62mm dia in 92mm dia. and 74mm dia. in 120mm wall to allow the passage of water pipes, electrical wiring, HVAC and hydraulic installations without making holes/chases. Plumbing and Electrical service fittings shall be pre-planned and shall be passed through hollow portions of the wall panels.

2.3.4 *Painting, Tiling and Cladding*

Painting shall be done directly or after applying a 2mm wall putty coat. Texture paint coat shall be directly applied to external surface for decorative effect.

All tiling and cladding shall be directly fixed using regular cement mortar or tile adhesive.

- 2.3.5** *Inspection* -- Inspection shall be done at appropriate stages of manufacturing process as given in Clause 1.5 above. Wall panels shall be stored properly 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.

2.4 Selection & Installation

- 2.4.1** The user is responsible for the proper use of the product at site. PAC holder shall provide required guidance and instructions for usage of the product at site.

- 2.4.2** *Good practice for installing the product at site* – Robomatic wall panels shall be used at site in accordance with the applicable specifications, instructions and guidelines of the manufacturer. The user shall also follow the Brochure of the product supplied by the manufacturer.

2.5 Storage, Handling and Transportation of the panels

2.5.1 *Storage*

- As soon as the panels are cast, these are moved using fork lifts along with the base plates inside the plant area and allowed to cure for 24 hours. After that the panels, along with the base plates are moved to packing area where the base plates are separated and depending on the thickness, four (120 mm) or five (92 mm or 75 mm) of the panels are bundled mechanically using ribbon tapes.
- The bundled panels are then moved out into stock yard/storage yard/curing yard for further curing and they will not be touched until 15th day. Batch number and date of casting will be written on the panels to identify whether they are in curing period or ready to ship status. The pattern of arrangement in the stocking yard is also well organized so that from one location newly, cast panels will be placed and at other end of the stockyard, the panels that completed the curing period will be shipped to the customer.
- Typical stock yard is having an area of 5500m² and arrangements shall then be made to sprinkle water on the panels whenever it is necessary during curing period. Panels can be stocked one over the other in three tiers. In total panels can be stored up to 12000m² or approximately 6000 panels at a time.



2.5.2 *Transportation*

After complete curing and at the time of shipping of the panels to the site, type of the truck is decided based on the volume of the load being handled. Capacity of the truck is decided varying from 8T to 27T. Wooden logs for buffering are placed on the platforms of the trucks and bundles of panels are placed on them to avoid sudden forces generated during movement of truck in adverse conditions of the road. Only two-tier arrangement (bundle over bundle) is allowed during transportation to safe guard the bottom panels. Proper packing between the bundles with the thermocol is provided for sudden horizontal movement in any eventuality. After loading the trucks with proper layout matching to its carrying capacity and optimum utilization of area/space, the load is tied with heavy duty ribbons arresting the movement of the panels in any direction. UPVC sheets or tarpaulin sheets are used to cover the panels to avoid soaking in rain.

The photos given below explain the transportation of panels from casting to shipping out of the plant to the customer sites.





2.5.3 Handling

Right from casting of the panels from the machine to initial setting with base plates and subsequent movement of the panels to the stock yard, pallets are used to handle them with care. This is very essential because the self-weight of the panels will distort the alignment of the panels if not taken care before the initial setting period. The pallets are moved using fork lifts with 2T capacity and shall be of suitable make. While stocking in stock yard, these fork lifts which has vertical movement are used to arrange the bundles in three tiers and while moving these, the same fork lifts are used with last-in-first-out method. There is a Paul Swinger crane mounted truck and it is used to load the panels into the carrier trucks.

This operation is further described in detail in the photos given below.





2.6 Installation Procedure

- Only two stacks shall be put on top of each other during stocking and transportation.
- Panel stacks shall always be lifted from under wooden pallet with a lifting fork or belt.
- The panel stacks shall be moved by forklift or trolley to construction site. Individual panel may easily be moved by a simple wheel. Panels can also be moved manually by inserting a short tube (500mm) into the second hollow as handle. These shall always be transported sideways.
- Gluing agents (cement based adhesives) as per IS 9103:1999 shall be mixed as per the manufacturer's instructions.
- The line of wall shall be marked on the floor and ceiling before start of installation.
- Guiding boards shall be fixed on the floor and ceiling. The guiding support will automatically align the wall when lifting the panels straight into upright position.
- The gluing agent shall be spread on the side of the already installed panel.
- Before the panel shall be lifted to upright position, it should be moved so that the panel bottom is as close as possible to its correct position. After that the panel shall be lifted to upright position.
- This panel shall be pushed against the previous panel (and move up and down) so that tongue and groove are carefully positioned against each other and gluing agent is squeezed out. Correct thickness of joint between two panels shall be 1 to 2 mm.
- The panel shall be positioned to correct level by using wooden wedges at the bottom and top of the panel erected earlier. The height of the panel should be about 10 to 50 mm shorter than free-room height.

- The top joint shall be filled with polyurethane foam. Correct thickness of joint shall be 5 to 10 mm.
- Alternatively, when same gluing agent as in sides is used for top joint, the panel shall be pushed against ceiling so that gluing agent is squeezed out. Correct thickness of joint shall be 1 to 2 mm. The surplus gluing agent shall be removed from joints after installation.
- Bottom joint of the panel shall be filled with mortar or concrete. Correct thickness of joint shall be 10 to 40 mm.
- ‘Shoulders’ shall be sawed or flat steel bar for door top portion fixed to the panels next to the door. The door top piece shall be glued by using polyurethane foam or gluing agents. The joints should be as thin as possible.
- All corners shall be strengthened with nail plugs (3 per corner).
- Paper or fibre tape shall be glued on to the corner joints and to the joints at a door top portion before plastering.
- Flexible joints between panels shall be built after each 5 – 6m. Polyurethane foam or mineral wool may be used as elastic joint material.
- The hollow boxes may be used for the cables and electrical boxes shall be fixed at the desired points after drilling.
- The panels need only a very thin skin coating (1-2 mm) before surface finishing. It may be easier to do with a wide trowel.
- All kinds of drilling and sawing can be easily made in the panels.
- The necessary tools required for installation shall be hammer, saw, screw driver, level, meter rule, trowel, drill, trolley concrete cutter, steel bar, buckets and lifting bars.

Installation/ Instruction/Construction Manual along with the sketches is given in Annex III.

2.7 Critical Details for Use of Robomatic Wall panels and Main Causes of Defects

2.7.1 *Critical Details for Use of Precast Panel Walls*

One of the critical problems faced by precast panel systems is the occurrence of hairline cracks at the joints between adjacent wall panels. Some of the precautions are listed below to reduce such defects:

- Installation with freshly cast concrete panels shall be avoided. This is because hydration of cement and evaporation of water create the stress within the young concrete, causing shrinkage.
- Gaps shall be provided between the walls and structures:

20 mm for top, 20 mm for bottom and 10mm for each side.

- It shall be ensured that the mix proportion of grout and water is according to suppliers' recommendations.
- Partial grouting to the horizontal gaps of the panels at the top and bottom shall be carried out immediately after the installation of wall panels to ensure the panels are temporarily secured.
- Grouting of the vertical gaps between the wall panels immediately after installation shall be avoided. Grouting shall be carried after sufficient loadings from upper floors are added.
- Inspection shall be done to ensure that alignment of walls is in order before proceeding to grout the vertical joints and horizontal gaps.
- It shall be ensured that proper surface preparation is carried out with cleaning of the sides of wall panel and the face of structure that receives the wall panels.
- It shall be ensured that face of the structure is saturated before grouting to avoid rapid absorption of water during grouting.
- A layer of fiber mesh shall be provided over the joints as additional precaution against cracks, if required.
- Vibration of the surroundings shall be minimized.

2.7.2 *Main Causes of Defects*

The main causes of cracks in the precast wall panels are:

- a) *Failure of jointing compound*
 - Actual shelf life of product has expired
 - Incorrect mixing proportion of grout and water
 - Surface area of the structure and the panels not properly cleaned
 - Insufficient grout at joints
 - Incorrect grout
- b) *Improper supervision/workmanship*
 - Correct method statement not followed
 - Opening not grouted properly after chasing for services
- c) *Structural movement*
 - Vibration during construction
 - Excessive loadings from the floors above

2.8 Skills /Training needed for Installation

No special skills other than normal skills of a mason shall be required for installation of these wall panels also. However, the PAC holder shall provide on request necessary guidance to the users at site, if required.

2.9 Guarantees/ Warranties provided by the PAC Holder

The manufacturer shall furnish a guarantee up to installation of the wall panels, if it is in the scope otherwise the guarantee shall be up to delivery of the wall panels. A brochure giving relevant warrantee details shall be made available to the client.

2.10 Services Provided by the PAC Holder to the Customer

2.10.1 The PAC holder shall provide pre-sale advisory regarding the product. Customer/user may obtain from the PAC holder details of the advice that may be provided to him.

2.10.2 Users/Customers should ascertain from the PAC holder the type of service, the PAC holder is prepared to provide.

2.11 Responsibility

- Specific design using Wall Panels is the responsibility of the designer with the instructions, supervision and guidance of the PAC holder.
- Quality of installation/construction of the system on site is the responsibility of the trade persons engaged by the building owner under the guidance of the manufacturer.

PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE

3.1 Basis of Assessment

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

3.1.2 *Plant Inspection*

The manufacturing plant was inspected by Officer of the Council and TAC member. During inspection the entire manufacturing process along with the equipment was inspected. The in-process inspection and the inspection of the finished panels were in accordance with the SQA approved as a part of the requirements for grant of this PAC.

3.2 Tests Done for Assessment

3.2.1 Various tests got done on 75mm, 92mm & 120mm thick wall panels from Bureau Veritas, Hyderabad as per relevant Indian Standards by the manufacturer in 2018 as per the remarks given below:

The compressive strength of the concrete tested in the wall panels are varying in the range of 23 to 45 N/m² and by and large in conformity with the furnished design of concrete (M25).

- 3.2.1** *Testing of samples* -- The performance tests for Robomatic wall panels have been carried out by Bureau Veritas, Hyderabad on samples of 75mm, 92mm and 120mm thick panels collected by the IOs during inspection of the plant. However, test results of 92mm thick panel is given below: (Test results awaited)

S. No	Parameters	Test Method	Test Result
1.	Dry density (kg/m ³)	IS 516:1959	1452
2.	Compressive strength (N/mm ²)	IS 516:1959	12.1
3.	Flexural strength (N/mm ²)	IS 516:1959	2.8
4.	Moisture content (%)	IS 516:1959	1.7
5.	Drying shrinkage	IS 2185 (Part1):2005	0.045%

3.3 Supply of the wall panels

The manufacturer, as reported, has supplied the wall panels of size 3100 x 600 x 92mm and 3100 x 600 x 120mm and quantity of 60 sqm each to M/s KEF Infrastructure India Pvt. Ltd., Bangalore in May 2018.

PART 4 STANDARD CONDITIONS

The 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.
- 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 distributors / licensees whenever appointed by him and agrees to provide to BMBA a six monthly updated list thereof.
- 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, TAC 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:
- The presence or absence of patent or similar rights relating to the product;
 - The legal right of the Certificate holder to market, install or maintain the product;
 - 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.



Place: New Delhi
of

Date of issue _____

Chairman TAC &
Dr. Shailesh Kr. Agarwal
Chairman, TAC

for and on behalf

Member Secretary, BMBA

Building Materials and Technology Promotion
Ministry of Housing & Urban Poverty Alleviation
Core 5A, 1st Floor, India Habitat Centre
New Delhi-110 003

PART 5 LIST OF STANDARDS AND CODES USED IN ASSESSMENT

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

5.1.1 IS 383:2016 – Specifications for coarse and fine aggregates for concrete

5.1.2 IS 516:1959 (Reaffirmed 2013) – Method of test for strength of concrete

5.1.3 IS 2386 (Part 1 & 3):1963 (Reaffirmed 2016) – Method of tests for aggregates for concrete

5.1.4 IS 3346:1980 (Reaffirmed 2017) – Method of determination of thermal conductivity of thermal insulation materials

5.1.5 IS 3812 (Part 1):2013 – Specifications for pulverized fly ash for use as pozzolana in cement, cement mortar and concrete

5.1.6 IS 9103:1999 (Reaffirmed 2013) – Specifications for concrete admixtures

5.1.7 IS 9901:1981 (Reaffirmed 2007) – Measurement of sound insulation in buildings and building elements

5.1.8 IS 9142:1979 (Reaffirmed 2011) – Specifications for light weight aggregate

5.1.9 IS 10500:2012 – Specifications of drinking water

5.1.10 IS 8112:2013/12269:2013 – Specifications for 43/53 grade ordinary Portland cement

5.1.11 IS 16700:2017 – Criteria for structural safety of tall concrete buildings

5.1.12 IS 15916:2011 – Code of practice for building design and erection using prefabricated concrete

5.1.13 ISO 179-2:1997 – Determination of Charpy impact of plastics

5.2 Company Standards of the PAC holder – The branded design & specifications of the raw materials and finished product are as submitted by the manufacturer. The PAC holder has to make available the company standards to the consumers according to which testing have been done.

5.3 References

5.3.1 Reports of tests got done on 75mm, 92mm & 120mm thick wall panels from Bureau Veritas, Hyderabad as per relevant Indian Standards by the manufacturer in 2018.

CERTIFICATION

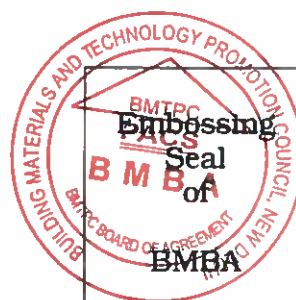
In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA), **Robomatic Hollowcore Concrete Wall Panels** bearing the mark manufactured by M/s Robomatic Precon Pvt. Ltd. is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No. 1040-S/2018** is awarded to **M/s Robomatic Precon Pvt. Ltd., Hyderabad.**

The period of validity of this Certificate is for a period of one year i.e. from 30.08.2018 to 29.08.2019 as shown on Page 1 of the PAC.

This Certificate consists of a cover page and pages 1 to 37.



Dr. Sharesh 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 Mahila Centre, Lodhi Road,
New Delhi 110 003



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 Affairs, Government of India

Place: New Delhi, India

Date: 30.8.2018

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

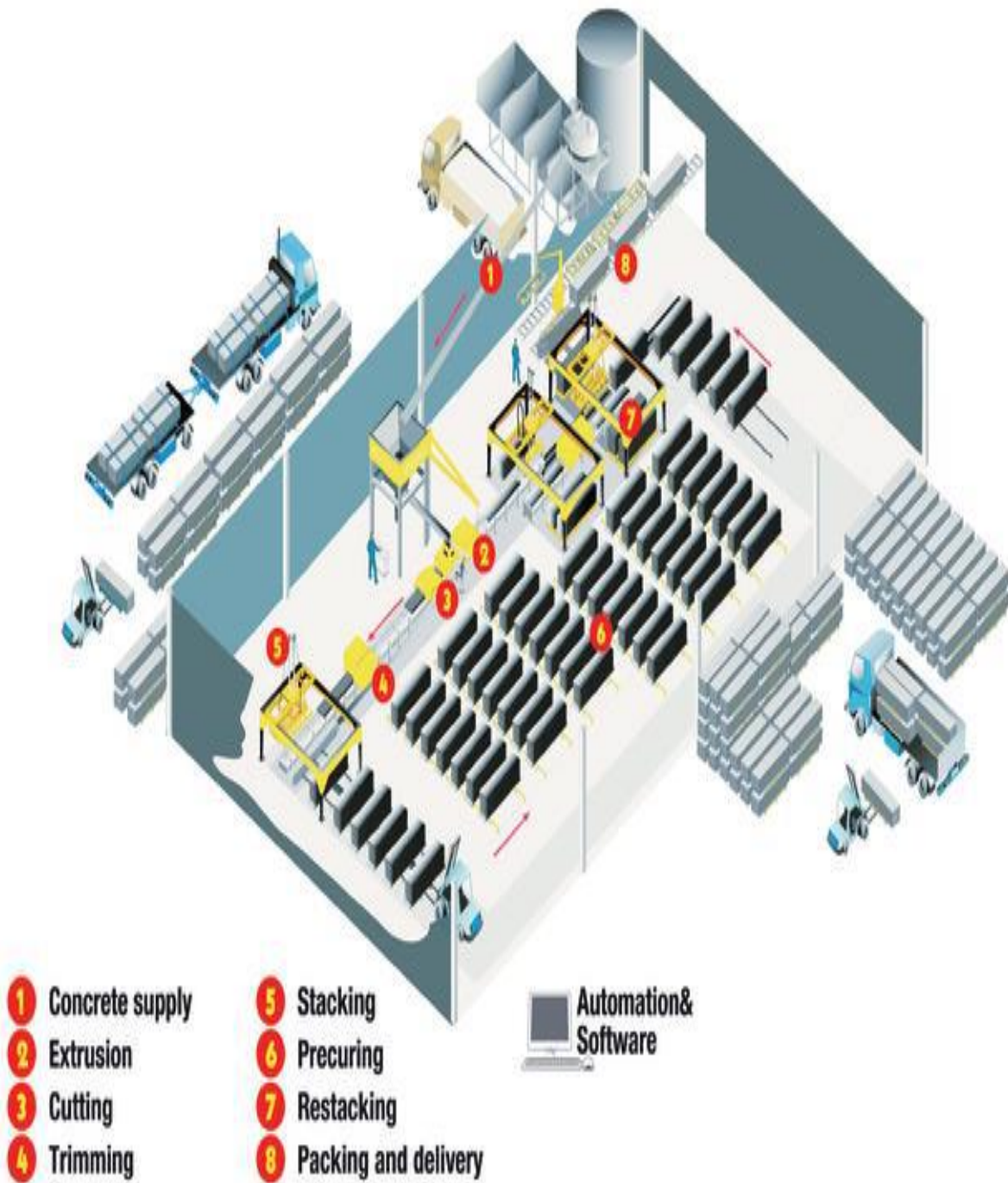
ANNEX I
(Clause 1.4.2)

Quality Assurance Plan of Robomatic Hollowcore Concrete Wall Panels

S. No.	Parameters to be inspected	Requirement Specified	Test Method	Frequency of Testing
I. Raw Materials				
1.	O P Cement 43/53 Grade	As per IS 8112:2013 /12269:2013	Manufacturer's test report	Every batch/lot
2.	Sand 0-2 mm	As per IS 383:2016	Manufacturer's test report	Every batch/lot
3.	Coarse Aggregate 2-6 mm	As per IS 383:2016	Manufacturer's test report	Every batch/lot
4.	Light weight aggregate	As per IS 9142:1979	As per IS 9142:2003	Every batch/lot
5.	Fly ash	As per IS 3812 (Part 1):2013	As per IS 3812 (Part 1):2003	Every batch/lot
6.	Water	As per IS 10500:2012	As per IS 10500:2012	Yearly
7.	Adhesive/Glue	As per manufacturer's specifications	Manufacturer's test report	Every batch/lot
II. Robomatic Concrete Hollowcore Wall				
1.	Dry density	1400-2000 kg/m ³	IS 516:1959	For every project
2.	Compressive strength	4 N/mm ² min.	IS 516:1959	For every project
3.	Flexural strength	1.5 N/mm ² min.	IS 516:1959	For every project
4.	Moisture content	5% max.	IS 516:1959	For every project
5.	Impact strength (N)	5N min.	ISO179-2:1997	For every project
6.	Drying shrinkage	0.04% max.	IS 2185(P-1):2005	For every project
7.	Thermal conductivity	0.4 m ² .k/W min.	IS 3346:1980	For every project
8.	Sound transmission Class	42 dB	IS 9901:1981	For every project

ANNEX II
(Clause 1.6.8)

Manufacturing Process Flow Chart



ANNEX III
(Clause 2.6)

Installation/Instruction/Construction Manual

1. Conditions for installation: Before installing the Robomatic Hollowcore Wall Panels, the conditions available at the site are to be studied in detail and then decide what format to be used to install the wall panels. The major issues that are to be considered are:

- a. Horizontal – Vertical Support Prerequisites
- b. Top – bottom Support Prerequisites
- c. Maximum Height Restrictions
- d. Procedure for installation when height is > 3m

1.1 Horizontal – Vertical Support Prerequisites:

- In standard installation procedure, the wall panels should be installed between column to column or column to wall or wall to wall.
- Open ended walls should be avoided. In case of open ended walls, precautions should be taken for proper anchoring both at top and bottom of the panels.
- Additional support mechanism to be implemented through C Channel placement where there is no support horizontally.
- If the length of the wall is more than 5 meters in the abovementioned scenarios, provision of expansion joints through PU foam or mineral wool to be provided with thickness of 5mm.
- Alignment of the wall panels to be checked with the existing members of the structures viz., columns and beams.
- If the vertical members viz., column or wall are not in plum the wall panels cannot be placed in perfect position and lot of filling up either through PU Foam or Concrete to be applied. To avoid that insist client to have perfect plumb and alignment of the structural members.

1.2 Top - Bottom Support Prerequisites:

- In standard installation procedure, the wall panels are to be installed between the bottom slab and top slab or bottom slab and top beam.
- If top beams or slabs are not available as in few cases, I or C section iron members are to be placed where ever the walls are placed.
- Installation of walls with plumb is the main essential component.
- Electrical, Mechanical and plumbing conduits connectivity either at bottom or top of the wall panels to be planned before installation. As per the requirement, connectivity with the hollow cores to be established.
- Bottom slab or top beams with too much undulations to be avoided and should be taken up with client for rectification before installation of the wall panels.

1.3 Maximum Height Restrictions:

- Robomatic Acotec Hollow core Wall panels can be installed as non-load bearing internal walls for maximum height of 4.5 m. It is not advised to construct above this height.
- Robomatic panels are manufactured with maximum height of 3.3m.

1.4 Procedure to install when the height is > 3 M:

- Robomatic wall panels are manufactured with a maximum height of 3.3 Meters.
- It is suggested to construct walls maximum ranging up to 4.5m.
- The walls are to be constructed in staggered mannered as shown in the below diagram.
- Cutting of the panels for bottom and top placements are to be planned to avoid wastage of material.

Photos of wall panel installation are given below:



Only two stacks be placed on top of each other



Unloading of panel



Panel are fixed to the floor & ceiling



Tongue and Groove to be carefully positioned against each other



Gluing agent spreaded on side of the panel



Top joint filled with PUF



Drilling and cutting being done on Panels



Panel installed

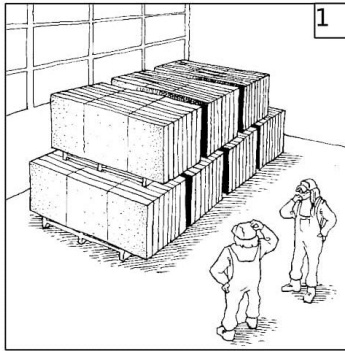


Fixing of Plumbing fittings

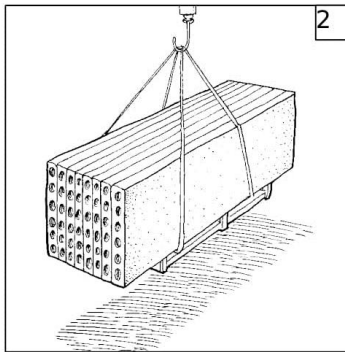


Fixing of Electrical fittings

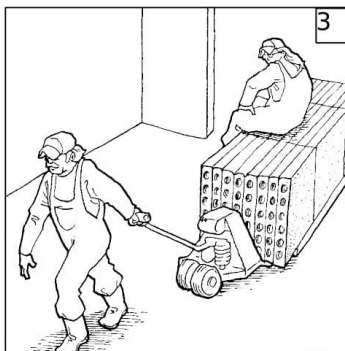
Details of Pictorial installation procedure given in order of work as given below may be followed:



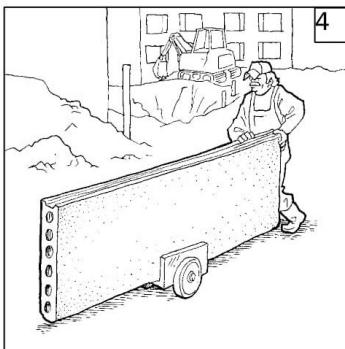
During stocking and transportation time it is possible to put only two stacks on top of each other. Stock yard should be level and panels should be protected against rain during stocking.



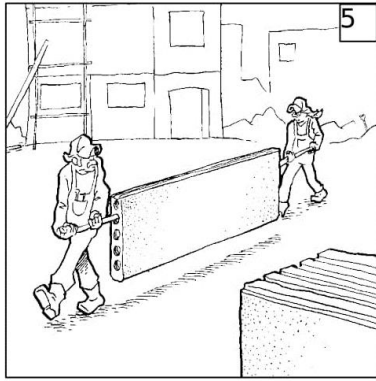
Panel stacks should always be lifted from under wooden pallet with a lifting fork or belt.



The ROBOMATIC PANELS stacks can easily be moved at construction site by a forklift or a trolley.



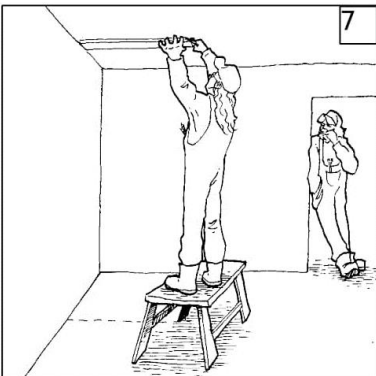
Individual ROBOMATIC PANELS can easily be moved by a simple wheel.



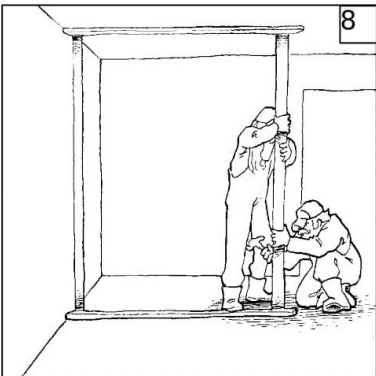
Panels can also be moved manually by inserting short steel tube (500 mm) into the **second** hollow as handle. Panels should always be transported sideways.



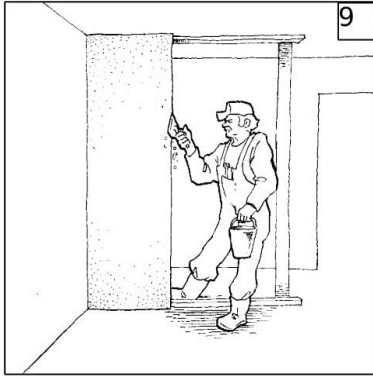
Gluing agents should be mixed carefully as according to manufacturer's instruction.



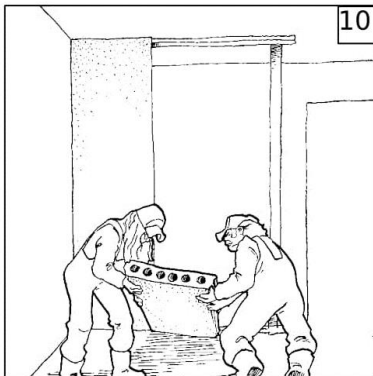
The line of wall is marked to the floor and ceiling before start of installation.



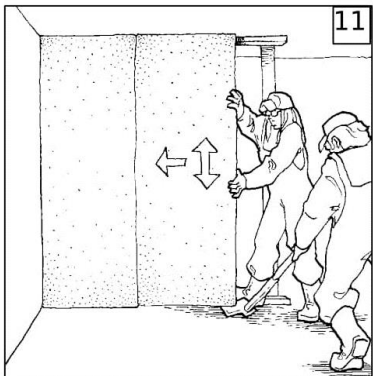
Guiding boards are fixed to the floor and ceiling. The guiding support will automatically align the wall when lifting the panels straight into upright position.



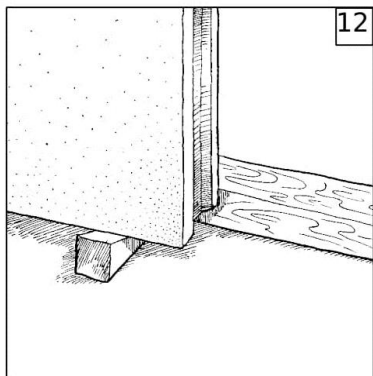
9 The gluing agent is spread on the side of the already installed Robomatic-Panel.



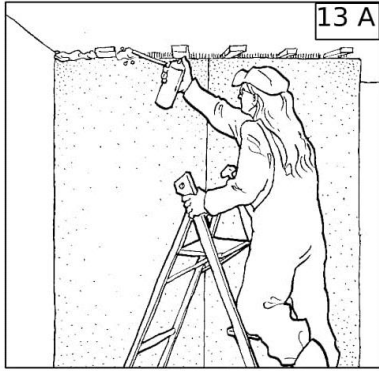
10 Before the Robomatic-Panel is lifted to upright position it should be moved so that the panel bottom is as close as possible to its correct position. After that the Robomatic-Panel is lifted to upright position by two men.



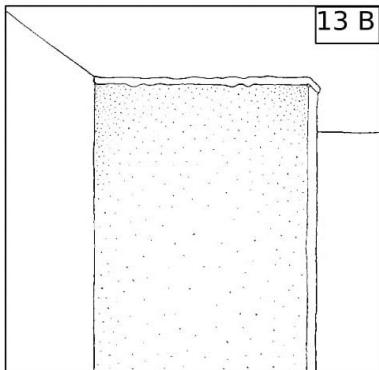
11 The Robomatic-Panel should be pushed against the previous Robomatic-Panel (and moved up and down) so that tongue and groove are carefully positioned against each other and gluing agent is squeezing out. Correct thickness of joint between two panels is 1-2 mm.



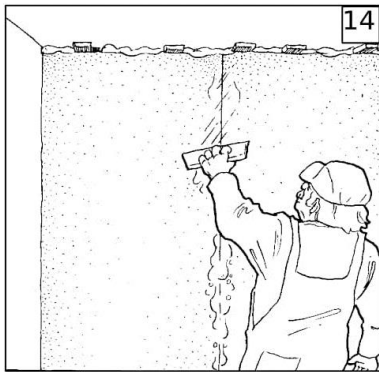
12 Robomatic-Panel is positioned to correct level by using wooden wedges at the bottom and top of the Robomatic-Panel . The height of Robomatic-Panel should be about 10 - 50 mm smaller than free room height.



The top joint is filled with polyurethane foam. Correct thickness of the joint is 5 - 10 mm.



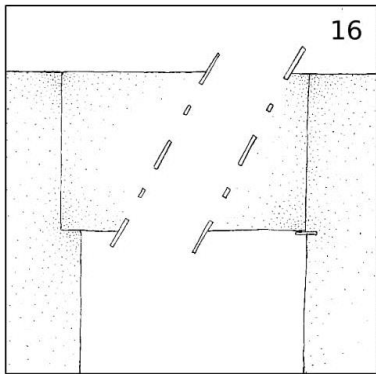
Alternatively, when same gluing agent as in sides is used for top joint, Robomatic panel is pushed against ceiling so that gluing agent is squeezing out. Correct thickness of joint is 1 - 2 mm.



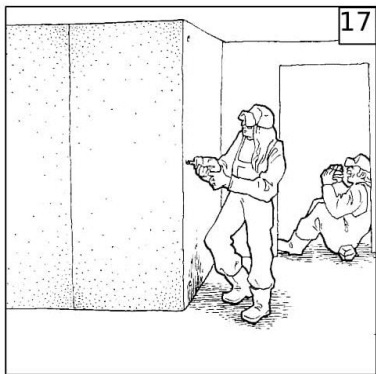
The surplus gluing agent is removed from joints right after installation.



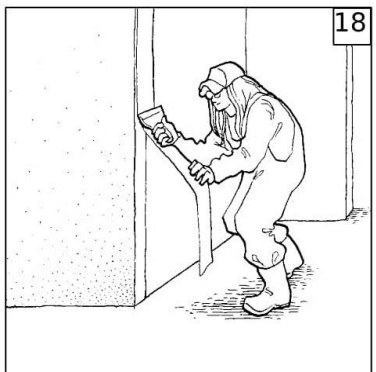
Bottom joint of Robomatic panel is filled with mortar or concrete. Correct thickness of joint is 10 - 40 mm.



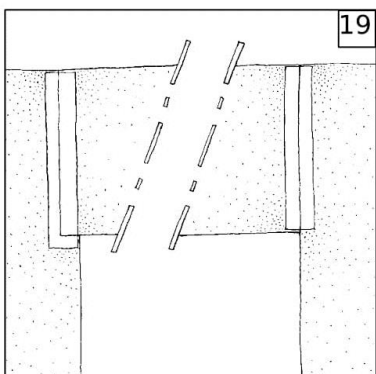
To the panels next to the door 'shoulders' are sawed or flat steel bar for door top piece fixed. The door top piece is glued by using poly urethan (PU) foam or gluing agents. Joints should be as thin as possible.



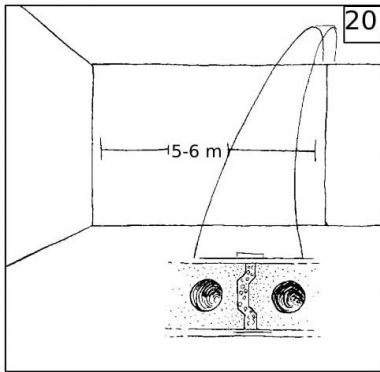
All corners should be strengthened with nail plugs (3/corner), for example HILTI HRD-H.



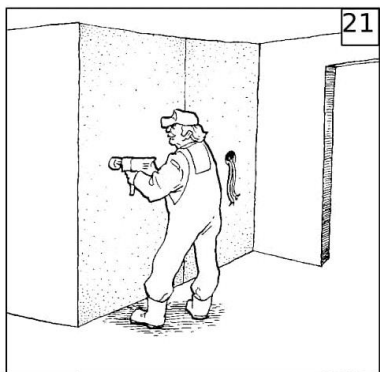
On to corner joints paper or glass fiber tape should be glued before plastering.



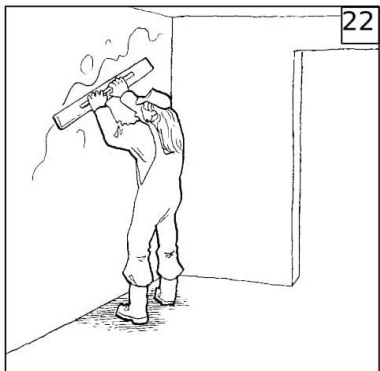
On to the joints at a door top piece paper or glass fibre tape should also be glued before plastering.



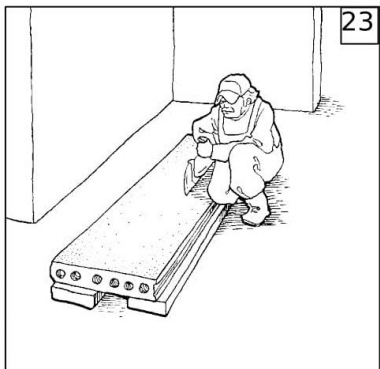
20 Flexible joints between Robomatic panels should be built after each 5 - 6 m. PU-foam or mineral wool can be used as elastic joint material.



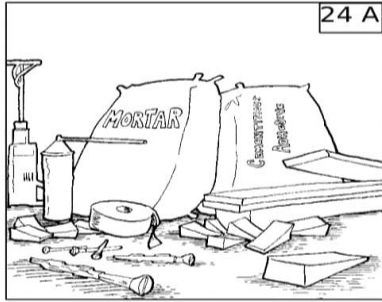
21 The hollow cores are used for leading through the cables and electrical boxes are drilled to any desired point.



22 Robomatic walls needs only a very thin skim coating (1 - 2 mm) before surface finishing. It is easiest to do with a wide trowel.

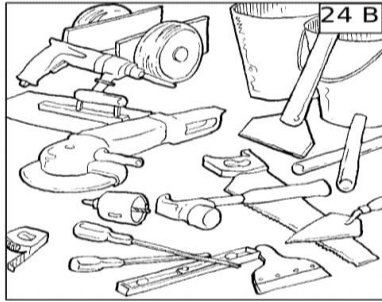


23 All kinds of sawing and drilling are easy to make to the Robomatic-Panels.



24 A Installation materials and accessories

Mortar, cementitious adhesive, lumber, nail plugs, wooden wedges, paper tape, PU-foam and mortar mixer.



24 B Installation tools

Hammer, saw, screw driver, level, meter rule, trowel, drill, trolley or ACO-wheel, concrete cutter, installation steel bar, drill for electrical boxes, buckets and lifting bars.