



## BAUPANEL SYSTEM

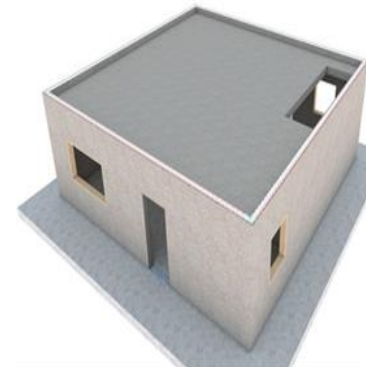
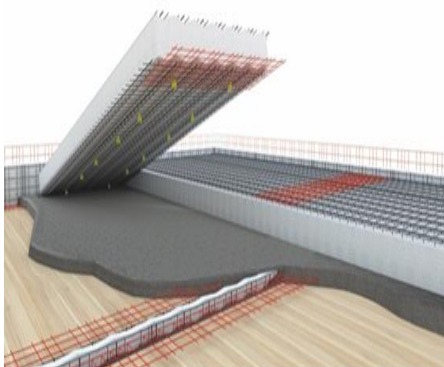
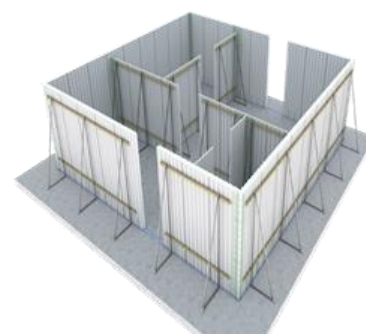
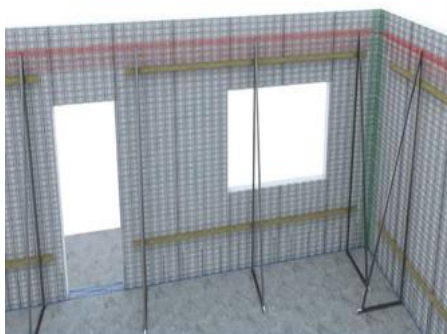
User should check the validity of the Certificate by contacting Member Secretary, BMBA at BMTPC or the Holder of this Certificate.

### Name and Address of Certificate Holder:

M/s Bau Panel System India Pvt. Ltd.  
Flat No. H 1002, "Bloomfield"  
Sr. No. 59, Near Express Highway,  
Ambegaon, Pune – 411046.  
Phone No.: 09811156812  
Email: [ag@bau.holdings](mailto:ag@bau.holdings)

### Performance Appraisal Certificate

PAC No.: **1041-S/ 2018**  
Issue No. **01**  
Date of Issue:  
**04-09-2018**



**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](mailto:bmtpc@del2.vsnl.net.in) Web Site: <http://www.bmtpc.org>

# PERFORMANCE APPRAISAL CERTIFICATE


FOR

**BAUPANEL SYSTEM**

ISSUED TO

**M/s BAU PANEL SYSTEM INDIA PVT. LTD., PUNE**

**STATUS OF PAC No.: 1041-S/2018**

S. No.	Issue No.	Date of Issue	Date of renewal	Amendm ent		Valid up to (Date)	Remar ks	Signature of authorized signatory
				No.	Dat e			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	04.09.2018	04.09.2019	--	--	03.09.2019	--	

**PAC No.:1041-S/2018**

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## PART 1 CERTIFICATION

- 1.1 Certificate Holder:** M/s Bau Panel System India Pvt. Ltd.  
Flat No. H 1002, “Bloomfield”  
Sr. No. 59, Near Express Highway,  
Ambegaon, Pune – 411046  
Phone No.: 09811156812  
Email: [ag@bau.holdings](mailto:ag@bau.holdings)

### 1.2 Description of System

**1.2.1** *Name of the System*– BauPanel System

**1.2.2** *Brand Name* – BauPanel

**1.2.3** *Brief Description* – BauPanel System consists of panels of expanded polystyrene (EPS) and steel wire mesh which are applied with concrete at site. The system comprises of a layer of steel mesh on either side of EPS core welded together by steel trusses (orthogonal) which penetrate through EPS core. The panels are joined together in a configuration on site and sprayed on both sides with shotcrete to form a sandwich panel type construction.

The exterior of the panels shall be finished with weather proof coating or lined with conventional lining material while interior surfaces (walls) and ceilings shall be finished with water/ solvent based coating or lined with conventional lining material.

The system is suitable for walls and floors of residential and commercial buildings.

The technology by the name BauPanel System was originally developed by Bau Panel System S.L., Spain and Bau Panel System India Pvt. Ltd. is a sister concern of the parent firm.

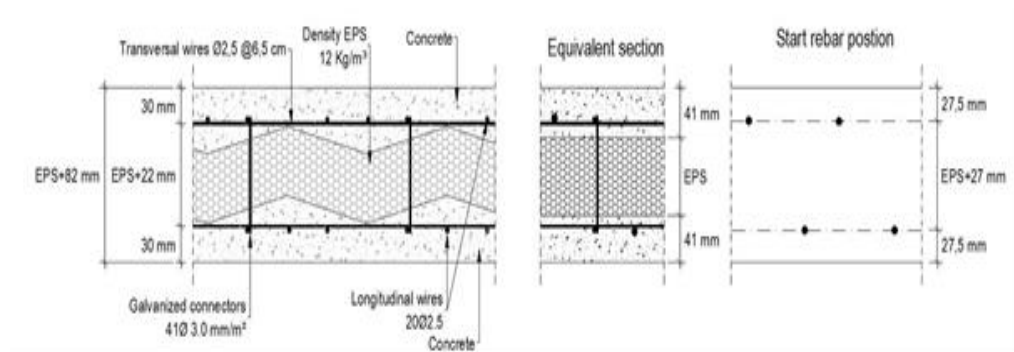
The Certificate holder proposes to install the plant in India shortly for manufacture of the panels. If required, the firm will import the panels from Spain for any construction activity in India.

### 1.3 Components of Bau Panel System

The structural enclosure panel is made up of a straight undulation of expanded polystyrene plate with a density not less than 15 kg/m<sup>3</sup> and a standard width of 1100mm. On both sides, it is covered with steel mesh grids connected to each other on both sides of the EPS panel, through a minimum of 40 steel bars of 3 mm dia. per square meter of panel surface.

**1.3.1 Load Bearing Wall Panels: BauPanel System – Reinforced (BSR) and BauPanel System – Normal (BSN) –** These panels are manufactured with EPS core of thickness varying from 30mm to 330mm, after concreting the final thickness for BSR panels will be from 112 to 412 mm and for BSN panels will be from 101 to 401 mm. The resultant enclosure reinforcement mesh grid measures 6.11 x 6.50 cm for BSR panels and 9.17 x 6.50 cm for BSN panels. Once the structural enclosure panels have been installed and concreted, these can be used vertically (BSR or BSN) as load bearing walls in buildings. However, selection of panels out of BSR & BSN shall depend upon the structural requirements as per calculations/design.

#### 1.3.1.1 BSR Panel



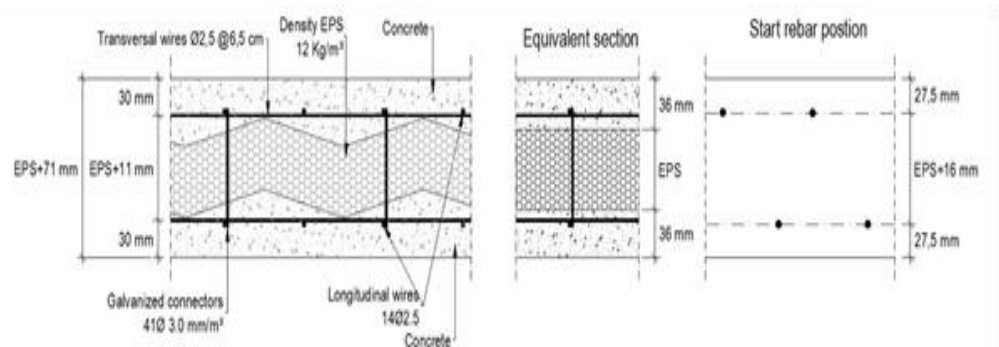
**Fig. 1**

#### Galvanized steel wire mesh

Longitudinal wires : 20 Ø 2.5 @ 57 mm c/c  
 Transverse wires : Ø 2.5 @ 65 mm c/c  
 Cross wire : Ø 3.0 mm (41 per m² approx.)  
 EPS thickness : 30mm to 330mm (according to design calculations)  
 Finished wall thickness : 112mm to 412mm (according to design calculations)

These are load bearing panels and similar to the BSN panel except for its structural capacity due to greater thickness of concrete (41mm each side) and greater number of steel bars (20 each side).

#### 1.3.1.2 BSN Panel



**Fig. 2**

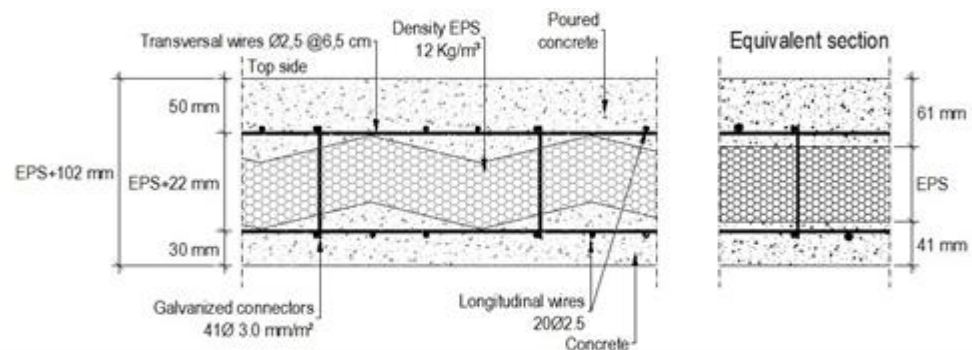
*Galvanized steel wire mesh*

Longitudinal wires	:14 $\varnothing$ 2.5 @ 84 mm c/c
Transverse wires	: $\varnothing$ 2.5 @ 65 mm c/c
Cross wire	: $\varnothing$ 3.0 mm (41 per m <sup>2</sup> approx.)
EPS thickness	: 30mm to 330mm (according to design calculations)
Finished wall thickness	:101mm to 401mm(according to design calculations)

For the structural use of these panels, polystyrene core shall be at least 30mm thick and an average quantity of traditional or pre-mixed cement based plaster shall be sprayed on each side of 30mm min. thick of M25 grade or above as required from environmental exposure conditions. These panels shall also be used for internal partitions and external curtain walls.

**1.3.2** *Slab Panel BSF (BauPanel System – Floor)*

BSF panels are also manufactured in EPS of thickness varying from 30mm to 330mm according to design calculation and after concreting the final thickness for BSF panels will be from 132 to 442 mm.



**Fig. 3**

*Galvanized steel wire mesh*

Longitudinal wires	:20 $\varnothing$ 2.5 @ 65 mm c/c
Transverse wires	: $\varnothing$ 2.5 @ 65 mm c/c
Cross wire	: $\varnothing$ 3.0 mm (41 per m <sup>2</sup> approx.)
EPS thickness	:30mm to 330mm (according to design calculations)
Finished wall thickness	:132mm to 442mm (according to design calculations)

These panels are used for floors and roofs and are completed at site with concrete on the upper side and structural plaster sprayed on the lower side. These panels are generally used for slabs with a maximum span up to 5m. However, in some cases additional reinforcement of the panels with additional meshes shall be required as per the design of the particular structure.

The panels placed horizontally are capable of resisting flexure and shear forces. They are also intended to withstand the vertical loads that originate in the slab of each floor or roof. They also fulfil the function of transmitting and distributing the horizontal loads to the vertical supporting elements.

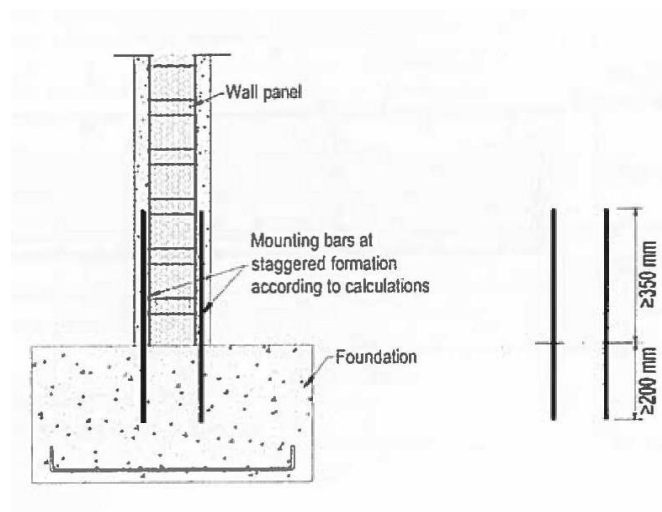
Those elements can also be placed inclined, flat or curved to adapt to different situations of the building cover.

The concrete cover thickness over the steel shall be at least 30mm on each side. In slabs, the minimum concrete compression layer thickness shall be 50mm. These concrete cover refer to the distance from the outside of the expanded polystyrene wave to the end surface.

### **1.3.3** *Joints and reinforcements*

#### **1.3.3.1** *Foundation joint*

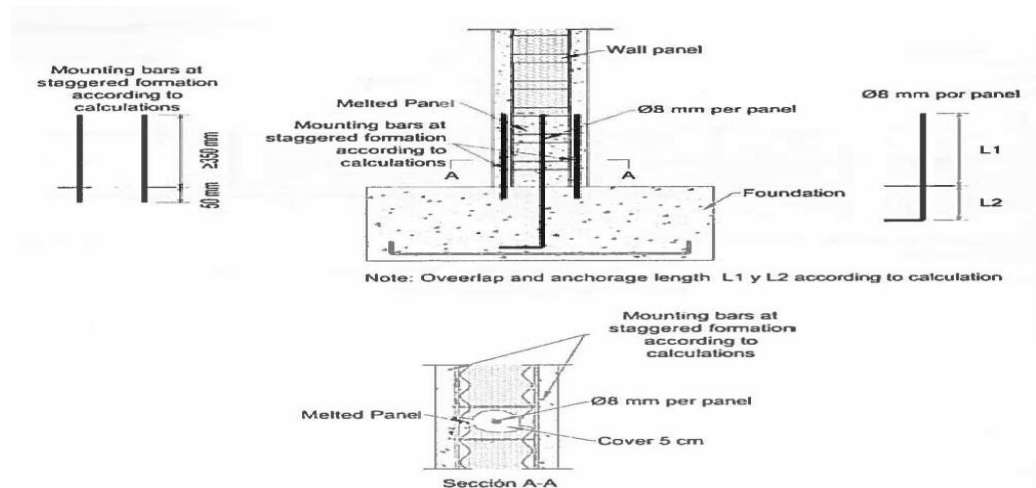
The panel joint with the concrete foundation is made through starter steel bars in staggered formation of minimum 8mm. dia., alternating in the faces of the panel. This basic mounting rebar and the rest of the necessary anchorage shall be defined by design calculations. (Fig. 4)



**(Fig. 4)**

#### **1.3.3.2** *Vertical joint between panels*

The steel mesh of each panel exceeds 50mm on opposite sides, so that when joining two panels they overlap each other ensuring continuity by overlapping, without the need to place additional overlap elements. (Fig. 5)



**Fig. 5**

#### **1.3.4 Reinforcement mesh**

For the attachment or reinforcement of other auxiliary points, the following connecting steel meshes are used.

- For the joining of enclosures that form an angle to each other, the continuity is solved by the angular mesh (MA), made with the same steel as the panel mesh (galvanized steel with a diameter of 2.5mm at 6.11cm c/c).
- To ensure continuity on both sides of the panel without overlap and to reinforce the corners of wall openings, flat mesh shall be used made of the same steel used in panels mesh with dimensions 260mm x 1150mm.
- The continuity of a panel with another on top is solved by the use of flat mesh (MP) and angular mesh (MA) always according to the manufacturer instructions.

More jointing and construction details are given in Annex D.

### **1.4 Use of Bau Panels**

**1.4.1** Bau panels may generally be used as load bearing walls and non-load bearing walls, partition walls and floor/roof slabs in residential and commercial building.

#### **1.4.2 Special Aspects of use:**

- The building to be constructed using the panels shall be in accordance with the specifications prescribed in Technical Manual of BauPanel System and designed by competent structural Engineers.
- Plumbing and Electrical services shall be governed by the



provisions and details given by the manufacturer. Good practices of plumbing services should be followed.

- BauPanel System should be constructed only with technical support or supervision by qualified engineers and builders, based on structural designs complying with prevailing standards and specifications; this is applicable even for low rise and affordable mass housing to provide safety of structures.
- It is strongly recommended that structural engineers and building designers associated with BauPanel System construction should be thoroughly familiar with the various structural aspects. It is also recommended that architects and construction Engineers who undertake BauPanel System building design and construction gain familiarity with the properties of material, characteristics of BauPanel System, and its application and construction system.

## **1.5 Design Considerations**

### **1.5.1 General**

1. BauPanel System can be designed using any appropriate framework calculation software. The system can be used as an alternative solution to a design using conventional masonry and traditional reinforced concrete ceiling.
2. The system is intended for use where architectural drawings are available to meet different requirements. The Architects and the designer team of the developer (client) is responsible for ensuring that the plans and overall design comply with the various regulatory requirements applicable to the area.
3. The structural design of any project must be done by the engineer trained by BauPanel System India Pvt. Ltd. The said firm's engineer will also contact the developer's engineer and provide the necessary loading information for the design of the foundation.
4. The system shall be designed to provide the required performance against the loads to be taken into account in accordance with IS 875 (Parts 1-2):1987 and the data given by the manufacturer for various panels. It shall also provide the required bearing resistance for earthquake and wind forces as per IS 875 (Part 3):2015 and IS 1893 (Part 1):2016, wherever applicable.
5. Foundation shall be specifically designed in accordance with provision given in IS 1904:1986. Panels must have start bars from the foundation or ground floor slab. The safe bearing capacity and soil properties (soil investigation report)) shall be provided from

the site after soil investigations. Foundation shall be designed based on the soil investigation report. All foundations should be designed by experienced engineer with appropriate reference.

6. 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.

7. In addition, any other requirement regarding safety against earthquake need to be ensured by the designer as per prevailing codal requirements.

#### **1.5.2**     *Structure*

The BauPanel System receives its outer plane strength and rigidity by truss action where the shotcreted layers are the chord members. The design of BauPanel System shall follow the requirement of relevant Indian standards where applicable. Design requirements and requirements set out in the Technical literature provided by BauPanel System India Pvt. Ltd. shall be followed.

#### **1.5.3**     *Wind Uplift*

The design of roof to wall connections shall be of a specific design to ensure that the roof structure is properly restrained against uplift.

#### **1.5.4**     *In-fill Wall*

When used as in-fill wall in framed RCC structure, the structure shall be designed in accordance with IS 456:2000. The fixing of the panels shall be done in accordance with the details provided by the manufacturer.

#### **1.5.5**     *Water Tightness*

Externally the walls shall be protected by an approved render applied to 30mm sprayed 25MPa concrete. DPC shall be provided at ground level to prevent rising damp. DPC shall also be provided around window sills and a sealant applied around window/door frames.

#### **1.5.6**     *Durability*

As BauPanel system may be used in different parts of the country, different situations may arise. IS 456:2000 specifies exposure conditions, concrete strength and cover requirements. Exterior

coating may be applied to provide additional protection to the reinforcement against corrosion in aggressive environment.

## **1.6 Assessment**

### **1.6.1** *Scope of Assessment*

Suitability of BauPanel System for use as load bearing walls and in-fill internal or external walls to build residential and commercial buildings.

### **1.6.2** *Basis of Assessment*

Assessment of the suitability of BauPanel System is based on:

- (i) Performance tests conducted on the model house for the Pilot Project using BauPanel System in the premises of Police Quarters at Adugodi, Bangalore by Civil-Aid Techno clinic Pvt. Ltd., Bangalore in 2013;
- (ii) Technical Conformity Document No. 558R/17 for Load Bearing System of Reinforced Concrete Panels with Expanded Polystyrene (EPS) Core of Bau Panel System S.L., Spain by The Director of the Eduardo Torroja Institute of Construction Sciences, Spain in 2017;
- (iii) Classification of reinforced concrete according to Reaction to fire by AFITI, Licof, Spain in 2014;
- (iv) Test report for Fire Resistance Report by Sirim QAS International SDN, BHD, Malaysia in 2014;
- (v) Test on Prefabricated reinforced concrete panel system with EPS by CSIC, Spain
- (vi) Quality Assurance Scheme followed by the Certificate holder for process control as per Quality Assurance Plan given in Annex A.

## **1.7 Conditions of Certification**

### **1.7.1** *Technical Conditions*

1. The Certificate holder shall inform BMTPC as and when any plant is set up in India. BauPanel System India Pvt. Ltd., shall provide full details of design, manufacture and erection of the panels to the agency who may be engaged for production and construction.

2. BauPanel System India Pvt. Ltd. shall also provide necessary training to the technical persons of the agency engaged for production, design and construction.

3. The Certificate holder shall provide a detailed Quality Assurance System for production and execution of the system in

the field.

4. BauPanel System India Pvt. Ltd. shall submit evidence of performance of the G+3 or higher structure against earthquake forces as per IS 1893 (Part 1):2016 before undertaking project using load bearing wall panels for structures G+3 or more.

5. The Certificate is being issued provisionally for a period of one year and will be reviewed after one year when more information and experience is available in India.

#### **1.7.2**     *Handling of User Complaints*

**1.7.2.1** 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.

**1.7.2.2** 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.

### **1.8**            **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 Parts 1 & 2 of this Certificate, the 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 the panels in accordance with the requirements specified in the PAC. In addition it shall follow the requirements of these sections for various materials used in the manufacturing of the panels.

### **2.2**            **Specifications of the Panels**

#### **2.2.1**        *Specifications*

Specification for the raw materials and finished product shall be as per performance criteria when tested in accordance with the relevant Indian Standards listed in Part 5 of this Certificate.

#### **2.2.2**        *Technical Specifications*

### **2.2.2.1 Raw materials**

1. *Zinc Coated Cold drawn Steel Wire* – Standard wire mesh shall be of 2.5/3.0 mm dia. and zinc coating galvanizing shall be of 60gm/m<sup>2</sup> with a tolerance of  $\pm 5$  gm/m<sup>2</sup>

#### *1.1 Mechanical characteristics*

Yield strength (2.5mm dia) : >700 N/mm<sup>2</sup>

Breaking load : >750 N/mm<sup>2</sup>

Elongation : > 8%

#### *1.2 Chemical characteristics*

% C : < 0.24

% P : < 0.055

% S : < 0.055

% Ceq : < 0.52

2. *Expanded Polystyrene* – Self-extinguishing type EPS in accordance with IS 4671:1984 (UNI EN 13163:2012) having density not less than 15 kg/m<sup>3</sup>.

## **2.3 Manufacturing Machinery & Equipment**

As reported, the parent firm Bau Panel System SL, Spain has got various machines and equipment for manufacture of these panels and the PAC holder shall also install similar machines and equipment while installing the plant in India.

A sketch of the complete plant for production of the panels followed by the parent firm Bau Panel System SL, Spain is given in Annex B.

## **2.4 Manufacturing Process**

These panels will be manufactured using raw materials of specified quality as per the relevant Standards and specifications to obtain the desired configuration and following the appropriate Quality Assurance Plan.

Process Flow Chart for the panels followed by the parent firm Bau Panel System SL, Spain is given in Annex C.

## **2.5 Storage and Transportation of Panels**

### **2.5.1 Storage**

The collection of panels should be made in horizontal stacks on wooden straps or EPS directly supported on the ground. The wooden straps or EPS boards shall be at least two per stack and shall be separated by a maximum of 2.80 meters from each other.

Each pile should not be higher than 35 panels. The piles should be protected from the wind, as they could fly and cause an impact against any object due to their light weight.

### **2.5.2** *Transportation*

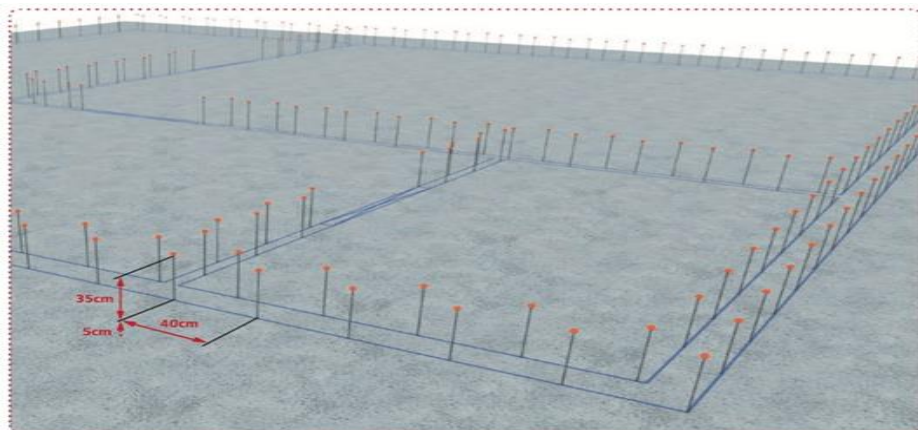
Panels shall be transported on horizontal piles resting on supports strips a maximum of 2.00 meters apart. Each pile can be up to 4 meters high.

Panels may be handled by means of forklift truck with two forks or by using cranes or other lifting devices. The panels will be attached at two points for lengths up to 6 meters and at three points for lengths between 6 and 8 meters.

## **2.6** **Installation Procedure**

### **2.6.1** *Layout and starter bars installation*

- The panels shall be fitted on a reinforced continuous foundation in accordance with conventional calculations. The dimensions shall depend on the permissible ground bearing capacity. (Fig. 6)



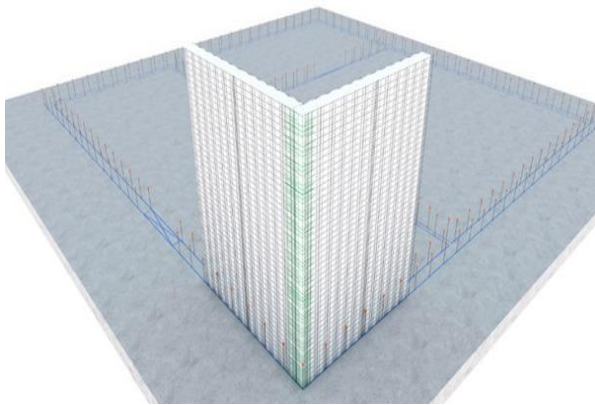
**Fig. 6**

- The foundation shall have basic assembly bars, consisting of corrugated steel bars of diameter 8mm. The number of starter bars shall come from the structural calculations corresponding to each project and shall be in staggered position, i.e. placed on alternate sides of the panels. The distance between these rows of starter bars shall be the same as the distance between the mesh, i.e. the thickness of the expanded polystyrene core plus 27mm. These bars shall be straight and must be embedded in the foundation no less than 5cm. They must stick out from the upper surface for a minimum length of 35cm. They shall simply be attached to the panel meshes by simple bonding.
- Another possible solution before pouring concrete into the

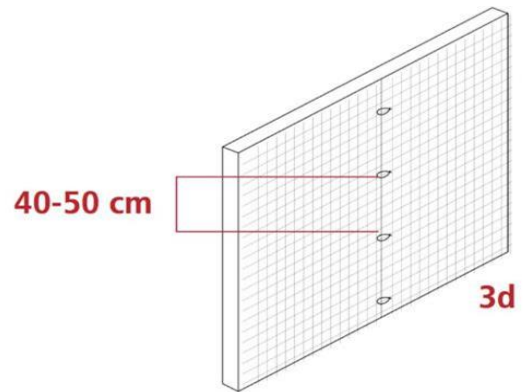
foundation is to place waiting bars in the line of the panel axis, with a diameter equal to or greater than 8mm and a maximum separation of 1.10m (one per panel), in addition to the basic assembly armature of dia. 8mm with the number and separation defined in the previous paragraph, which will be anchored to the foundation in a length of 25cm. In this case, the EPS core shall be completely removed by 5cm around those bars.

### 2.6.2 *Panel installation*

- The series of panels joined together over the foundation base makes up all the enclosure surfaces in the building structure: exterior walls and interior walls; over them it shall be placed floor slabs and roof slabs. (Fig. 7)

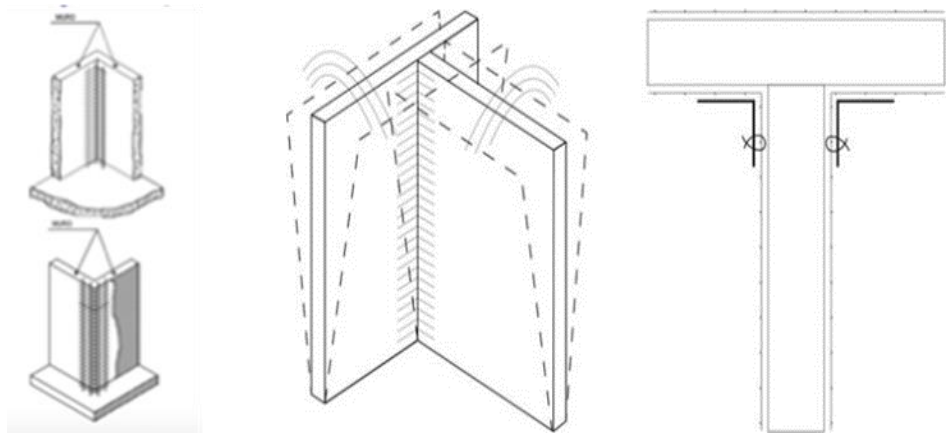


**Fig. 7**



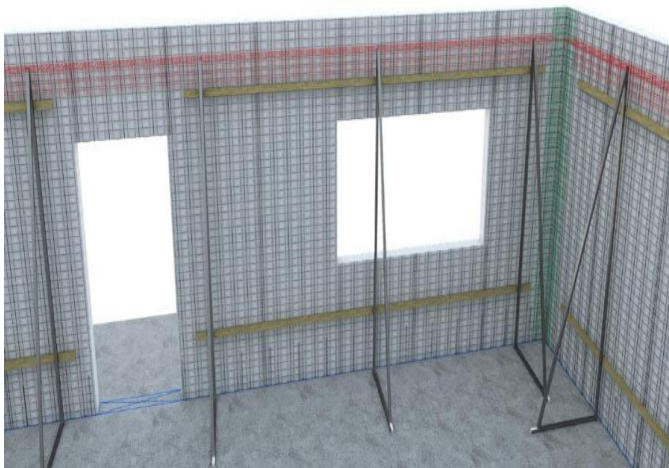
**Fig. 8**

- The panels shall be linked together via an overlap of 60 mm, which the meshes have on opposite sides of panels; these overlaps shall be interlinked by simply attaching the steel wires together at distances of about 50cm apart. (Fig. 8) Alternatively, the panels can be joined together using staples with an automatic or manual staple gun.
- The joint between panels where horizontal and vertical edges come together must be reinforced using angular meshes (MA) placed along their length and each of their sides. (Fig. 9)

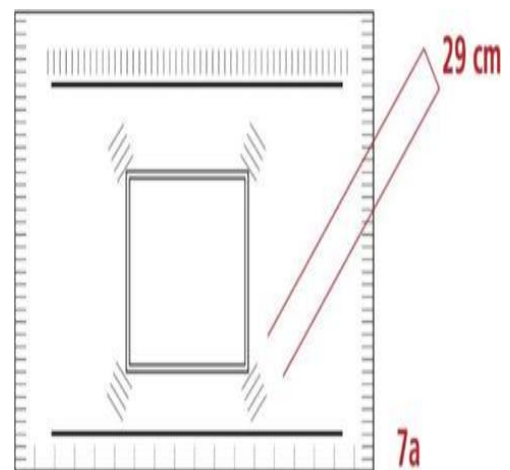


**Fig. 9**

- The openings for windows and doors shall be made by cutting the panel while leaving a minimum clearance gap to prevent thermal bridge breakings (about 10 to 20mm). The frames shall be attached to the meshes with staples. (Figs. 10 & 11)



**Fig. 10**

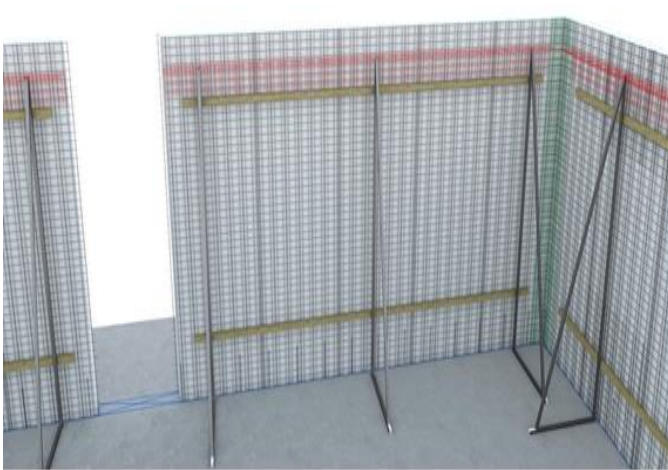


**Fig. 11**

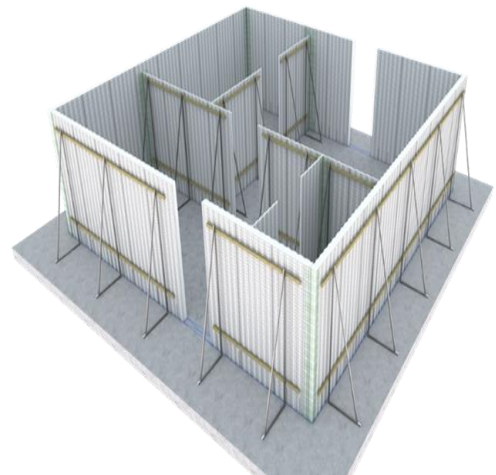
- The openings must have reinforcements at 45° at the Vertices thereof and longitudinal reinforcements obtained by calculation. These reinforcements shall be made with  $\frac{1}{4}$  of flat mesh (MP) supplied together with the Bau panels, for these purposes.
- When previously cut panels have to be spliced and therefore, do not have mesh overlays of opposite faces, the mesh type MP shall be used for these joints, which shall allow a joint by juxtaposition. The same special mesh shall be used in every case when, for different work reasons, the pre-determined Bau panel meshes must be cut. (Fig. 12)
- It is important to ensure that the enclosure walls are properly aligned and plumb. This can be achieved by using tie rods, metal rulers, telescopic struts or any other



element suitable for that purpose. (Fig. 13)

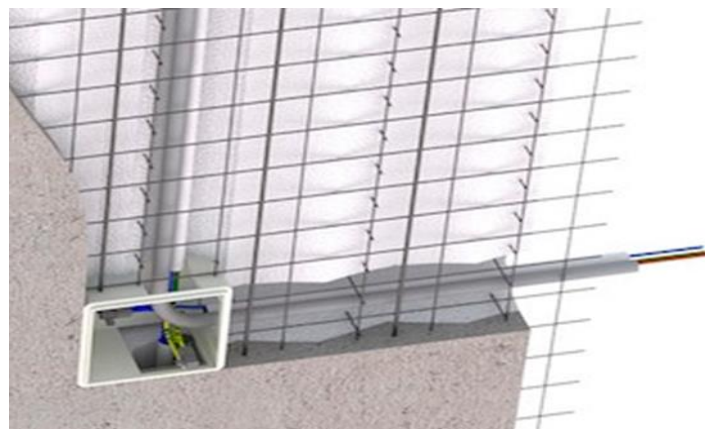


**Fig. 12**



**Fig. 13**

- Subsequently, the conduits of the electrical and plumbing installations can be placed in channels made in the EPS core, by means of a hot air jet gun. Subsequently, the conduits can then be run on the expanded polystyrene by melting it with a hot air gun. The conduits shall leave the corresponding spaces for the pipes that have been determined. (Fig.14)



**Fig.14**

- The upper wall panels, if applicable, must be installed as for the ground floor wall panels. Any built-in hold down or fixing devices required shall be attached in the correct position before concreting commences.
- When the vertical panels are assembled on site, the verticality of the walls shall be checked and the bracing meshes positioned on all the corners.
- The horizontal bracing meshes are then put to connect the floor/ roof to the vertical panel. After checking of bracing meshes, the floor/roof panels are positioned on them.
- The reinforcement of the panel shall be integrated during the panel assembly by additional reinforcing bars –

following the design inside the joists. The arrangement is for floor slab having span up to 8.50 m and with live loads up to 5KN/m<sup>2</sup>. For large spans, steel stiffening ribs in the pods of the panel may be used. These shall be verified by the design engineer.

- Doors and windows shall be fixed in the panels as per the guidelines issued by the manufacturer. (For details of the joints, bracings and application of the panels see figures 9 to 11).

### **2.6.3**     *Services*

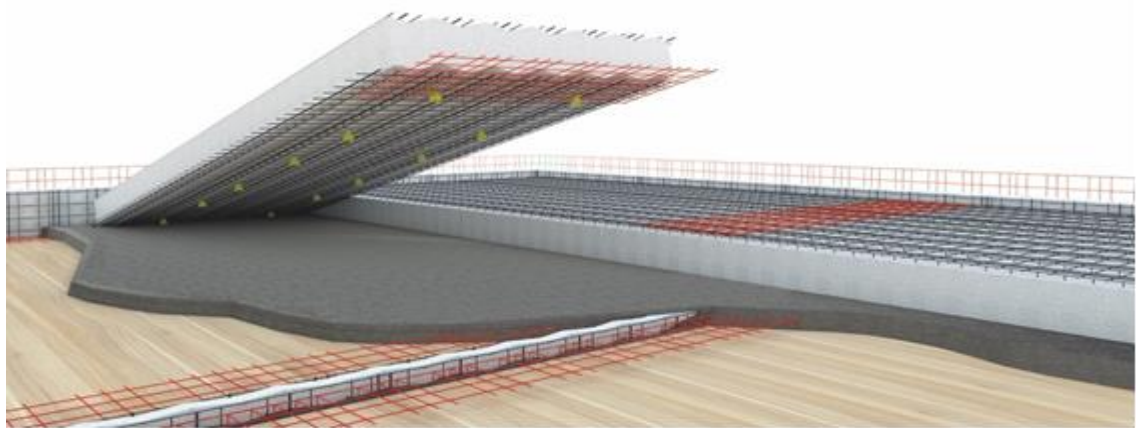
- The laying of pipes for plumbing, electrical installation, heating services etc. takes place after the panels have been erected and before spraying of concrete takes place.
- Services may be concealed within the panels by installing them behind the welded wire fabric. The chases in the polystyrene shall be carried out by a hot-air gun or similar tools. If insufficient space exists between the welded-wire fabric and polystyrene, the polystyrene may be cut away sufficiently to form the chase for the services. The area surrounding the cut should be restored by the addition of extra mesh connected to the meshwork of the panel. Copper pipes, if used, should be insulated from the mesh work with felt PVC or similar protection.
- No props greater than 50mm dia. should be installed in the Polystyrene. Service pipes or ducts 100mm in diameter or more should be placed outside the structure or in ducts within them. The location of services should be as per the service drawing for the structure. Any alteration or change should be addressed to Bau Panel System and noted in the service drawings.
- PVC sheet and electric cables shall not come in contact with EPS and shall, therefore be contained within a conduit or be laid without conduits away from EPS. Where services penetrate the external panels, the penetration shall be made watertight on the outside. Clearances for service movement shall be made in accordance with the service element providers' specifications.

### **2.6.4**     *Concreting*

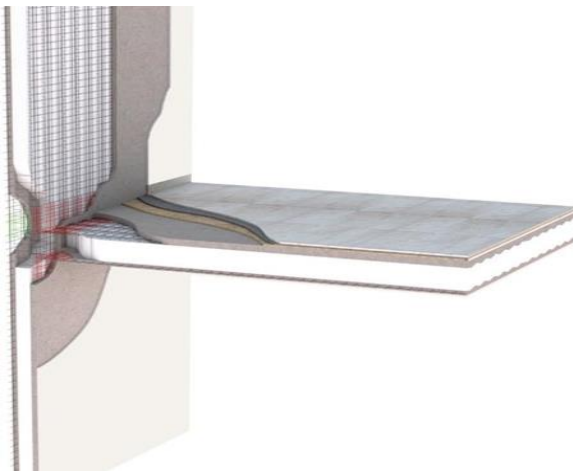
- All concreting work shall be done in accordance with IS 456:2000 with regard to workmanship and materials.
- Concrete shall be sprayed on the walls and ceiling using shotcrete pumps and pumped in place for floor topping slabs. Upper level floor toppings slabs shall usually be placed before internal walls and ceilings to upper levels and allowed to cure to give a platform for spraying the interior.
- For shotcreting, reference may be made to IS 9012:1978.

Some supports under slabs may be removed after 3 days but critical supports such as those at mid-span shall be left in place until the slab is fully cured. The structural engineering design shall provide the appropriate details for supports and sequence and timing of removal.

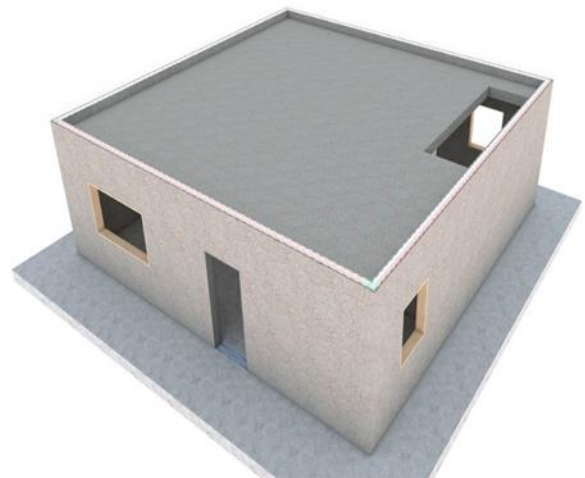
- Concrete shall be of correct strength and mix design as required by the structural engineering design. The pneumatic spray operation can be carried out in one or two phases.
- The first layer will be 2cm thick and cover the steel mesh. It shall be left rough so as to give adequate key to second layer. Correct concrete thickness shall be measured as work proceeds. Screed points of concrete shall be used as gauges to give correct thickness and lines. Hand trowel finishing of the second layer shall be required to give the appropriate finish and surface tolerances. The ability to provide concrete finishes to the tolerances required by the designer shall be dependent on the skill and workmanship of the concrete finishes.
- The second layer is a finishing layer applied until the final required thickness of a minimum 3cm is reached. To do so, guides could be used which may be just steel rods with square or rounded cross sections of 25mm or longer based on the required covering. These shall be used to divide the shotcreted thickness of the concrete. The architectural designer shall be free to choose the type of plastering from conventional materials (plastering and paint on finished surfaces, plaster, spray-on plastic coating, elastomeric paint, etc.).
- Formwork with braces and props should be used to fit Horizontal or sloped surfaces using any of the following procedure. A horizontal or inclined formwork is made with phenolic boards on which a layer of fluid concrete shall be applied to the panel supported in separating blocks that maintain the thickness of 3cm of minimum lower coating; the underside of the panel shall be immersed in the poured concrete. The task shall continue until the entire slab surface is completed. The correct compaction of the lower layer must be ensured.
- Once this task is finished, a 5cm thick compression layer shall be poured. The removal of formwork and uncasing shall be carried out following the standards. (Figs. 15, 16 & 17)



**Fig. 15**



**Fig. 16**



**Fig. 17**

- The concrete application can be carried out by using a pneumatic spray gun “hopper gun” type connected to a suitable air compressor, or with a plastering machine. The Hopper gun type, it uses as vehicle for the drive of the fresh mixture, a compressed circulation of air through a compressor that must operate at a constant air pressure of 500 to 600 KPa. This compressor must supply between 300 and 350 liters of air per minute for each of the devices used and connected to it.
- Concrete spraying makes a continuous and monolithic element out of the enclosures and slabs made up of panels as well as their joints.

Door and window fixing details and other joining details are given in Annex D

#### **2.6.5** *Precaution*

If the panel is cut during erection and its meshwork has no wire-crossing points, panels should be joined with flat meshwork (min. width 225mm).

### **2.6.6**     *Finishing*

After joinery installation is completed using the details set out in the Technical literature, the interior and exterior finishes may be applied to the concrete surfaces. Interior surfaces walls and ceiling) may be finished with a thin coat interior plaster applied in accordance with the Technical literature. Alternatively, any other suitable lining system may be applied.

### **2.6.7**     *Fixing object to walls*

Light weight object: 2.5mm screws, pins or similar devices may be used.

Heavy object (shelves, water tanks etc.): Plastic pins with 45mm screws or similar devices are recommended.

Very heavy object: During erection, metal pins may be inserted in plaster pallets.

Alternatively, threaded pins fastened with epoxy resin may be used.

### **2.6.8**     *Choosing size and thickness*

Appropriate size and thickness of the panels shall be chosen to suit the structural, fire, acoustic and thermal requirements of the structure.

### **2.6.9**     *Health and Safety*

The technical literature of Bau Panel System shall be consulted for guidance for health and safety requirements such as personal protective clothing, protective glasses etc.

## **2.7            Inspections & Testing**

Inspections & testing shall be done at appropriate stages of manufacturing process. The inspected 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.

## **2.8            Maintenance Requirements**

A proper maintenance guide shall be given by the PAC holder to the client. When building is to be repainted with fresh coat of paint after scraping existing paint, check for joint sealant, pipe joint, sun shade etc. and carry out required maintenance and apply primer before paint is applied.

## **2.9 Skills /Training Needed for Installation**

Workers shall be trained/ oriented on handling of panel and its erection, support system, clamping system, infilling of reinforcement and concrete etc. with all required safety measures taken including heavy hats, protective shoes etc. PAC holder shall arrange training of workers, as required.

## **2.10 Guarantees/Warranties Provided by the PAC Holder**

PAC holder shall provide necessary guarantees/ warranties. A brochure giving relevant details of the Bau Panel System India shall be made available to the client in this regard.

## **2.11 Responsibility**

- Specific design using Bau Panel System is the responsibility of the designer with the instructions, supervision and guidance of Bau Panel System India Pvt. Ltd.
- Quality of installation of the system on site is the responsibility of the trade persons engaged by the agency
- Quality of maintenance of the building is the responsibility of the building owner.
- Providing necessary facilities and space for movement of cranes and vehicles is the responsibility of the building developer.

# **PART 3 BASIS OF ASSESSMENT AND BRIEF DESCRIPTION OF ASSESSMENT PROCEDURE**

## **3.1 Assessment**

**3.1.1** The assessment of the system is based on the panels manufactured, used, installed and maintained as per statement given in the PAC.

### **3.1.2 Visit to Site**

The following sites at Bangalore constructed using the panels were visited by the TAC member and Officer of the Council:

- i) 2 Police Constables Quarters (G+1) building for Karnataka State Police Housing Corporation Ltd.
- ii) Infill walls for two flats on third floor of Shriram Summit City, Electronic City I.

### **3.2 Tests performed for assessment**

#### **3.2.1 Testing of Samples by Foreign Laboratories/ Institutes**

##### **3.2.1.1 By SIRIM QAS International Sdn. Bdh., Malaysia**

###### *(i) Fire resistant wall panel*

The fire resistant wall panel satisfied the performance requirements specified in Clause 8 of BS 476 (Part 21):1987 for a load bearing wall system for 130 minutes in load bearing capacity, integrity and insulation.

#### **3.2.2 By Indian laboratory – Civil-Aid Techno clinic Pvt. Ltd., Bangalore – NABL Accredited in 2013**

##### **3.2.2.1 Performance tests conducted on a model house constructed using Bau panel system at Audugodi, Bangalore**

###### **I. Main features of model house**

Two-storey super structure has been made-up of proprietary Bau panels from Spain. All the required panels required for construction of model house were manufactured and shipped from Spain. The panels are used as load bearing as well as flexural members.

The stair case was also constructed using similar type of wall panels. Water and electric lines were concealed within the panel at pre-determined locations. Flexible conducts will used for water supply lines. Sanitary lines were provided by using 150mm dia PVC pipes.

###### **II. Performance Tests**

###### **1. Load test on slab**

In order to study the behavior of floor slab under live load, a load test was conducted as per IS 456:2000 and IS 875(Part 1):1987.

The test load 250kg/m<sup>2</sup> was imposed on first floor slab by placing pre weighed sand bags uniformly over the entire area of living room area of first floor. The test load was retained on the floor slab for 24 hrs and the maximum deflection was recorded. Further, the percentage of recovery was measured during next 24 hrs on removal of test load. The maximum deflection was observed to be 0.1mm and 0.03mm at the end of 24 hrs of loading, at measured locations. The corresponding percentage of recovery was 87.6% & 99% which is within the permissible limits. Further, the existing cracks didn't widen and no new cracks were observed.

## **2. Ponding test on roof slab:**

In order to check the water proof performance of roof during rains, test was carried out by ponding water to a height of 250mm directly on the first floor roof slab (terrace) for about 24 hrs by providing masonry bund all round. During the period of 24 hrs, there was no dripping or leakage of water through slab except for damp patches on the junction of wall and slab were observed at a few places.

## **3. Rain simulation test on wall surface:**

Rain simulation test was carried out by water jetting on the external surface of wall continuously. Jetting was carried out for about 30 min and after a gap of 30 min, again the water was sprayed over the surface continuously over the surface for 30 min. was carried out for 12 hrs period. The inner face of wall was observed to be free from dampness or sweating, after the test.

## **4. Nailing test on wall surface:**

Nailing test was carried out, at random, on walls as per the standard practice. Out of 20 nails of varying diameters and lengths, 8-10 nails penetrated up to their half-lengths and rest of the nails could not be penetrated as they buckled at the beginning itself. The findings of the test indicate that the existing wall is hard enough and it can hold the nails effectively.

## **5. Door shutter tests:**

In order to check the performance of the door system provided for the housing unit, the tests namely dimensional measurement, edge loading, slamming, misuse and shock resistance were carried out as per IS 2202(Part 1):1999 and IS 4020:1998. The results indicate that the door shutter provided for the housing unit performed satisfactorily under all the tests.

## **7. Acoustic comfort test:**

Sound intensity was measured outside and inside the unit to know the difference in sound levels using sound level meters. The results showed reduction of sound level by 27dB indicating a good acoustic comfort.

## **8. Thermal comfort test:**

The reduction in outside and inside temperature was recorded up to 4°C indicating that the unit has a good thermal comfort.

## **9. Suggested measures**

However, considering the durability, performance, comfort level of occupants and cost effectiveness, Civil-Aid Techno clinic has suggested to adopt following measures during mass construction:



- (i) Effective water proofing treatment on roof top
- (ii) MS hand rails in place of SS hand rails be provided
- (iii) Clear width of main door shall be atleast 900mm in place of 750mm,
- (iv) It is preferable to shift meter box/electric panel to stair case region in place of rear side of the building where it has been presently provided without covering on top.
- (v) Since the accessibility (steel ladder) has been provided for roof from first floor, from the point of safety, it is preferable to maintain height of parapet wall atleast 900mm.
- (vi) Width of sun shade provided from first floor balcony should be atleast 900mm and it should be continuous up to windows on the front to avoid splashing of water during rains.

### **3.3 Usage of the System**

As reported, Bau Panel System India Pvt. Ltd. has constructed a two storey model housing unit and two flats in Bangalore and one villa in Chennai using panels brought from Spain. However, Bau Panel System SL, Spain has constructed various residential & commercial buildings, offices, hospitals & hotels etc. from 2003 to date in many countries namely Spain, Portugal, Great Britain, Holland, Russia, Antigua y Bermuda, Malaysia, Ghana, Ivory Coast, Cameroon, Gabon, Mozambique, Morocco, etc.

## **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, 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:

- (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.



Place: New Delhi

Date of issue: 4/9/18

Chairman, TAC & for and on behalf of  
Member Secretary, BMBA

& Member Secretary, BMBA  
Building Materials and Technology Promotion Council  
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)  
Core 5<sup>th</sup>, 1<sup>st</sup> Floor, India Habitat Centre, Lodhi Road,  
New Delhi-110 003

## **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 383: 2016** – Specifications for coarse and fine aggregates from natural resources

**5.1.2 IS 456:2000 (Reaffirmed 2016)** -- Code of practice for plain and reinforced concrete

**5.1.3 IS 516:1959** – Method of tests for strength of concrete

**5.1.4 IS 875 (Parts 1 & 2):1987 (Reaffirmed 2008)** -- Code of practice for design loads for buildings and structures

**5.1.5 IS 1893 (Part 1):2016** – Criteria for Earthquake Resistant Design of Structures

**5.1.6 IS 1904:1986 (Reaffirmed 2007)** – Code of Practice for design and construction of foundations in soils: General requirements.

**5.1.7 IS 2062:2011 (Reaffirmed 2016)** – Specifications for hot rolled medium & high tensile structural steel

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

**5.1.9 IS 4671:1984 (Reaffirmed 2017)** – Specifications for expanded polystyrene for thermal insulation purposes

**5.1.10 IS 4759:1996 (Reaffirmed 2016)** – Hot Dip Zinc Coating on Structural Steel Products

**5.1.11 IS 9012:1978 (Reaffirmed 2011)** – Recommended practice for shotcreting

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

**5.1.13 BS 476 (Part 21):1987** – Method for determination of fire resistance of load bearing elements of construction

**5.1.14 BS EN 13163:2012** – Thermal insulation properties of materials

**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 has been done.

### **5.3 References**

**5.3.1** Performance tests conducted on the model house for the Pilot Project using Bau Panel System in the premises of Police Quarters at Adugodi, Bangalore by Civil-Aid Techno clinic Pvt. Ltd., Bangalore in 2013;

**5.3.2** Technical Conformity Document No. 558R/17 for Load Bearing System of Reinforced Concrete Panels with Expanded Polystyrene (EPS) Core of Bau Panel System S.L., Spain by The Director of the Eduardo Torroja Institute of Construction Sciences, Spain in 2017;

**5.3.3** Classification of reinforced concrete according to Reaction to fire by AFITI, Licof, Spain in 2014;

**5.3.4** Test report for Fire Resistance Report by Sirim QAS International SDN, BHD, Malaysia in 2014;

**5.3.5** Test on Prefabricated reinforced concrete panel system with EPS by CSIC, Spain

## CERTIFICATION

In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA), **BauPanel System** bearing the mark manufactured by M/s Bau Panel System India Pvt. Ltd. is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No. 1041-S/2018** is awarded to **M/s Bau Panel System India Pvt. Ltd., Pune.**

The period of validity of this Certificate is for a period of one year i.e. from 04.09.2018 to 03.09.2019 as shown on Page 1 of the PAC.

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

Dr. Shailesh Kr. Agarwal  
Chairman, TAC

& Member Secretary, BMBA

Building Materials and Technology Promotion Council

Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)

BMBA Board of Agreement, 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: **4th September 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](http://www.bmtpc.org)



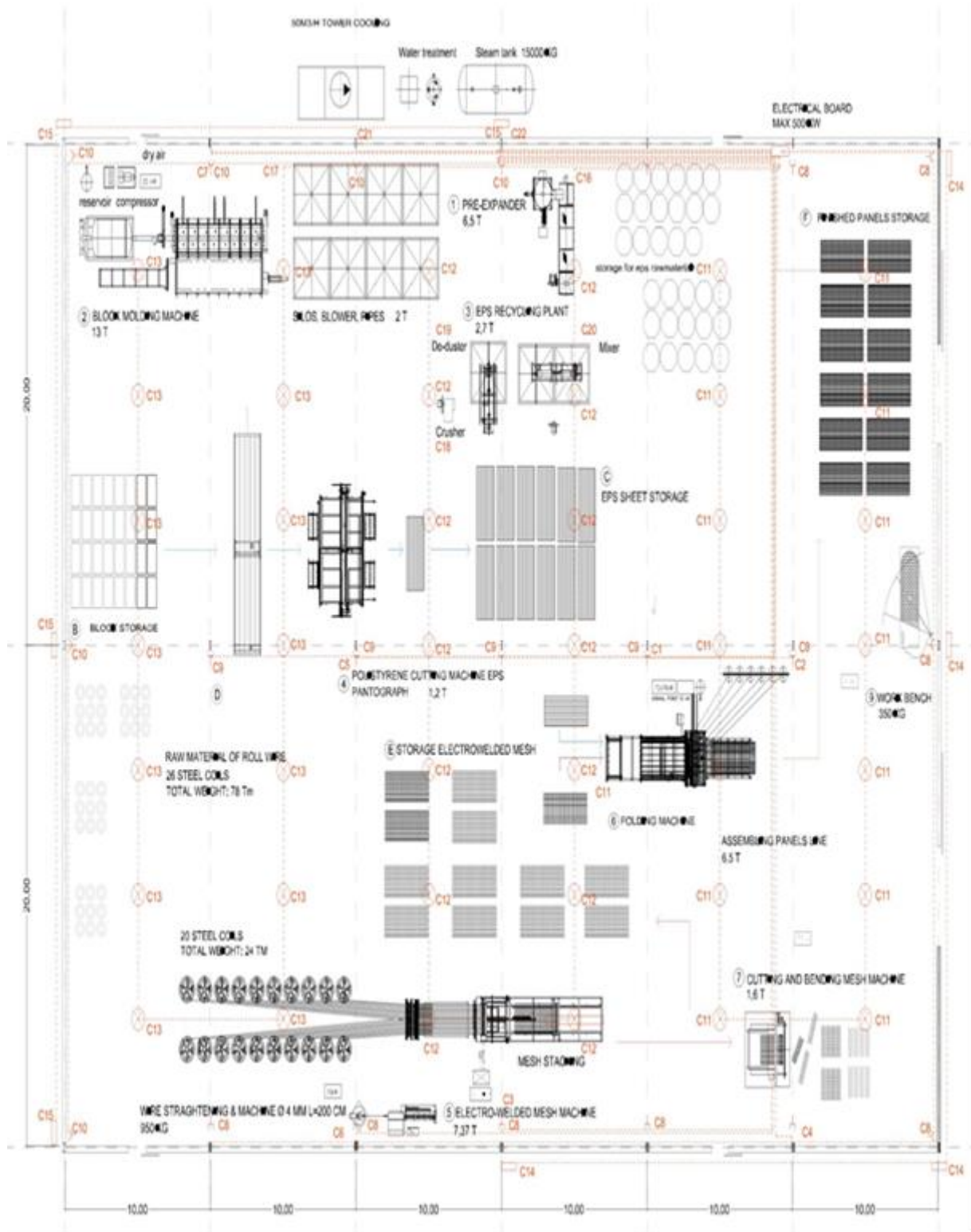
**ANNEX A**  
(Clause 1.6.2)

*Quality Assurance Plan for BauPanel System*

<b>S. No.</b>	<b>Parameters to be inspected</b>	<b>Requirement specified</b>	<b>Test Method</b>	<b>Frequency of Testing</b>
<b>A. Raw Materials</b>				
1.	Zinc Coated Cold drawn Steel Wire Mesh	Steel mesh 2.5/3.0 mm dia	As per manufacturer specifications	Every Lot
2.	Expanded Polystyrene (EPS)	Density shall not be less than 15 kg/m <sup>3</sup>	As per IS 4671:1984	Every Lot
<b>B. Welded Mesh / BauPanel System</b>				
1.	Acceptance of the raw materials i) Steel Mesh ii) Polystyrene (EPS)	Quantity, Appearance, Dimensions	Visual, Vernier Caliper and measure tape	Every Lot
2.	Straightening and cutting wire	Dimensions and Condition of material	Visual and Tape measure	Every Length
3.	Electro welding	Dimensions and Orthogonally	Tape measure	Every dimension
4.	Shaping polystyrene	Dimensions	Tape measure and Vernier caliper	Every dimension of the panels
5.	Welding/Assembling panels	Dimensions and Orthogonally	Tape measure and Vernier caliper	Every dimension of the panels

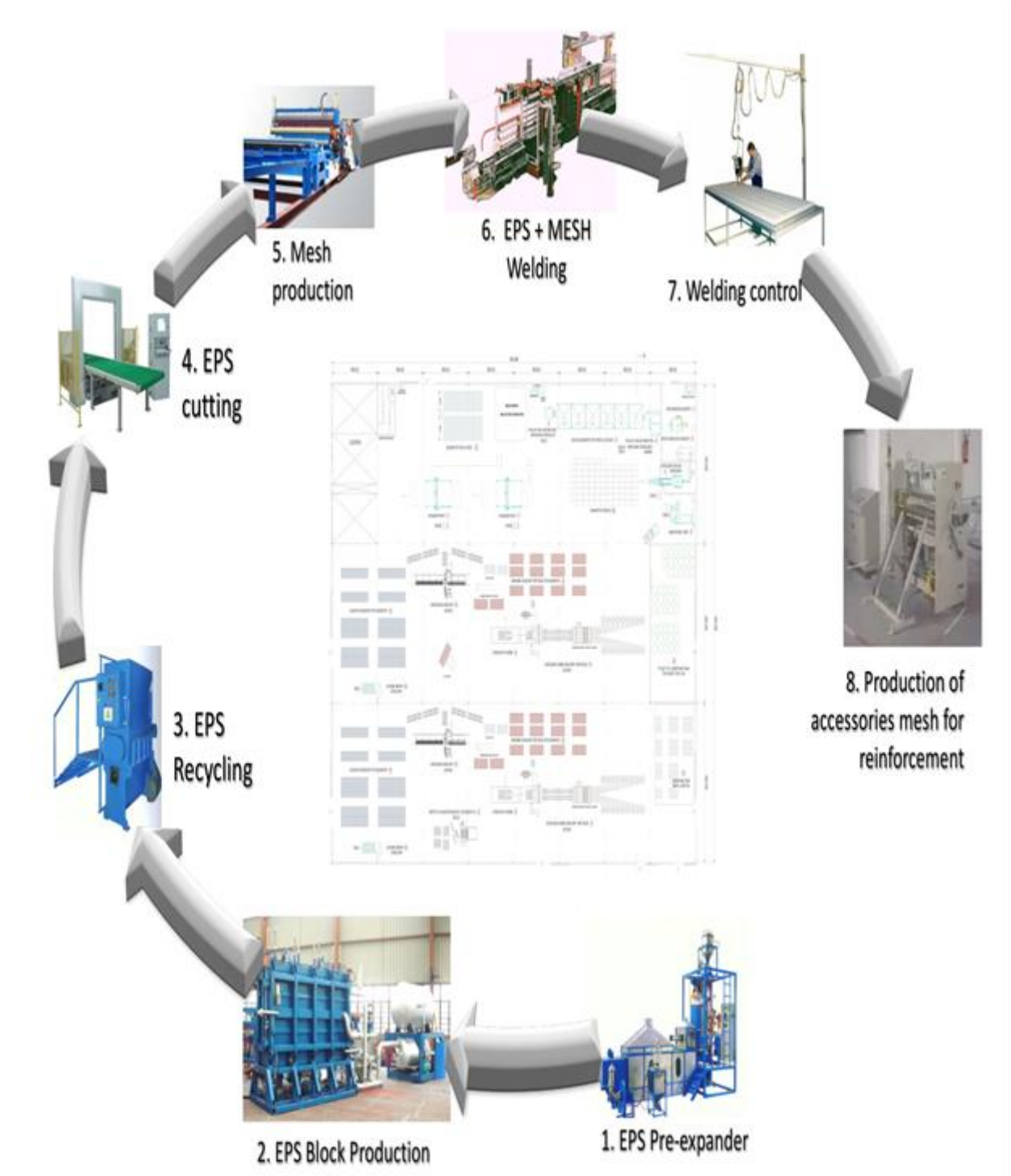
## ANNEX B (Clause 2.3)

### *Manufacturing Process Layout of the Plant*



**ANNEX C**  
(Clause 2.4)

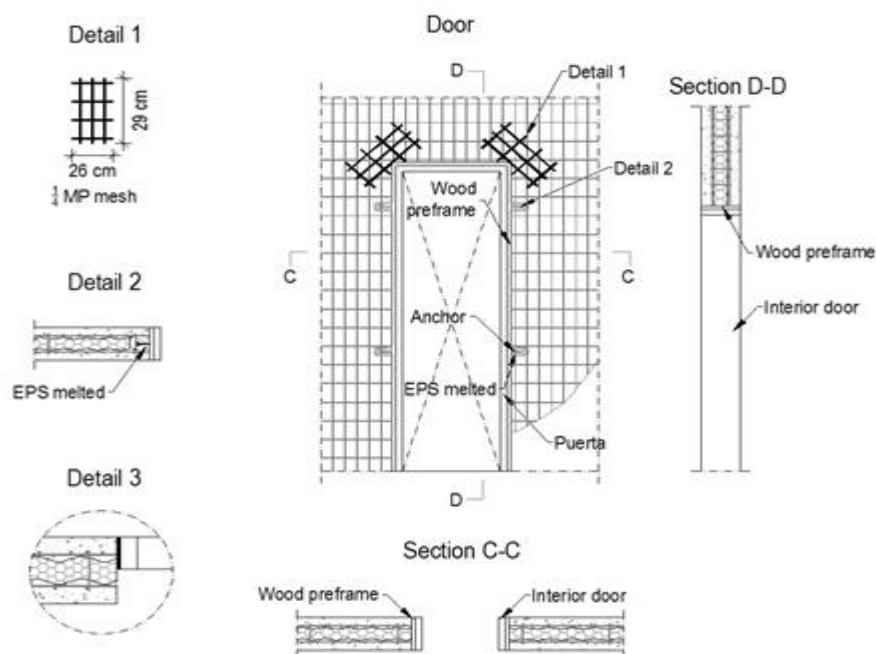
*Manufacturing Process Flow Chart of the Panels*



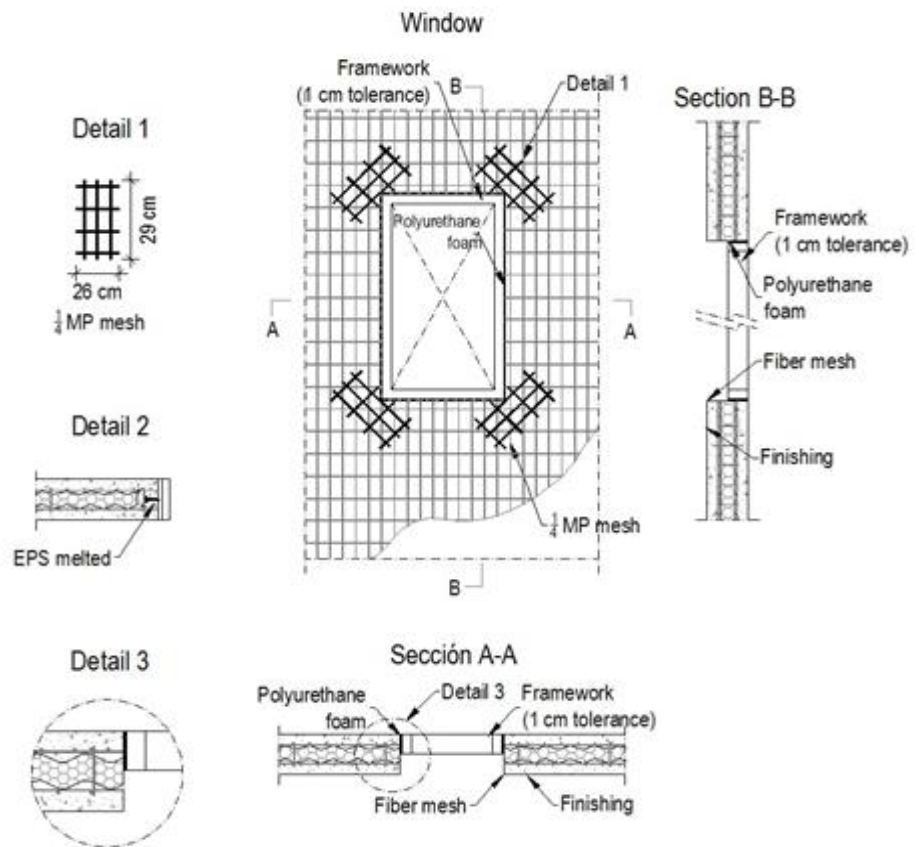
## ANNEX D

(Clause 1.3, 2.6.4)

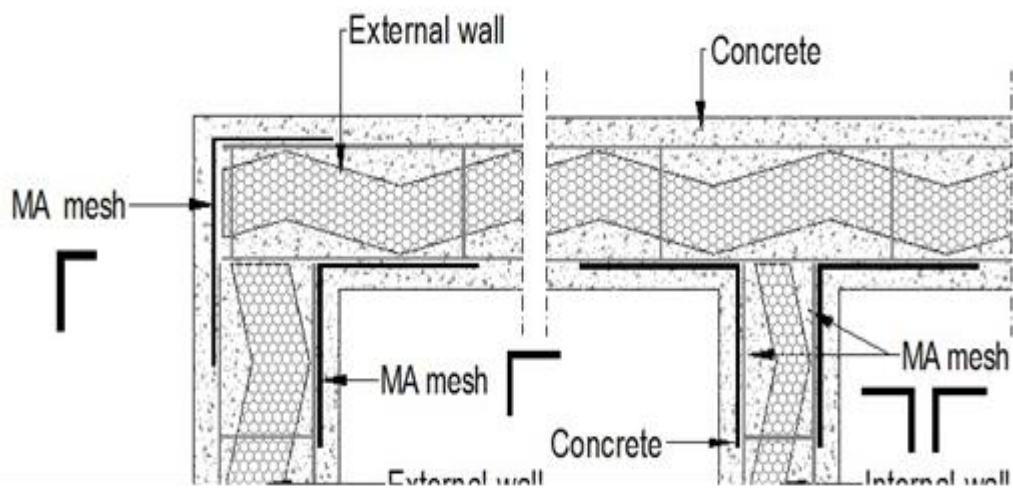
### Jointing and Construction Details



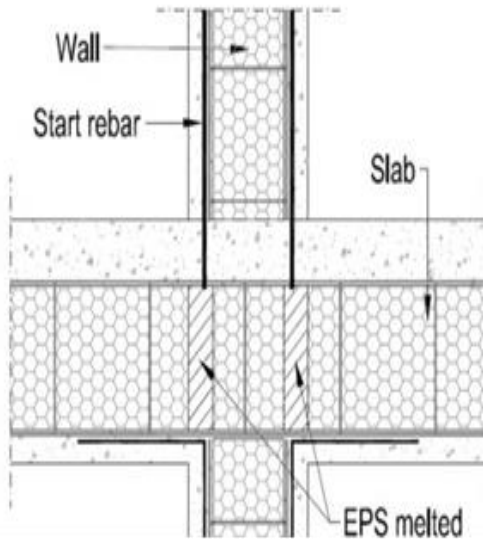
**Door detail**



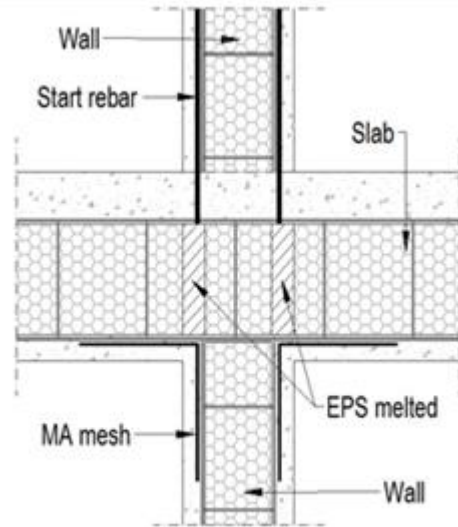
**Window detail**



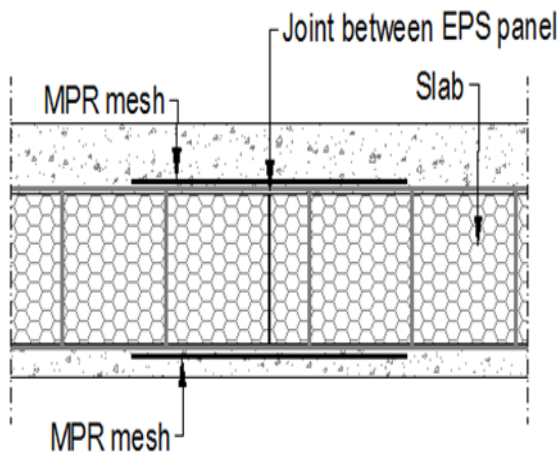
**Joint detail of external wall interface**



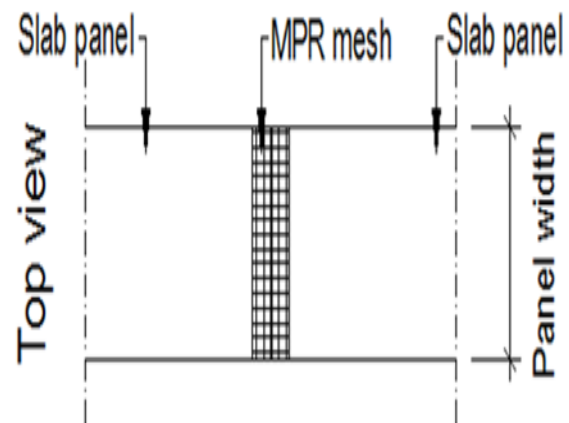
**Joint detail of continuous internal Wall panel with slab panel**



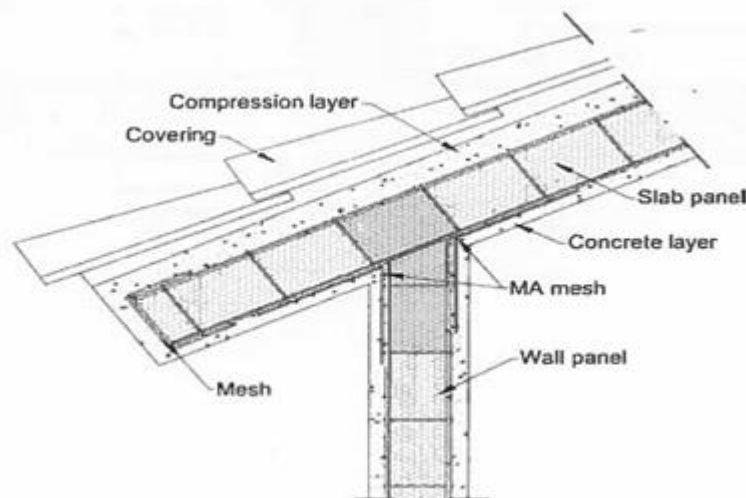
**Joint detail of internal Wall and slab interphase**



**Longitudinal connection between panels**

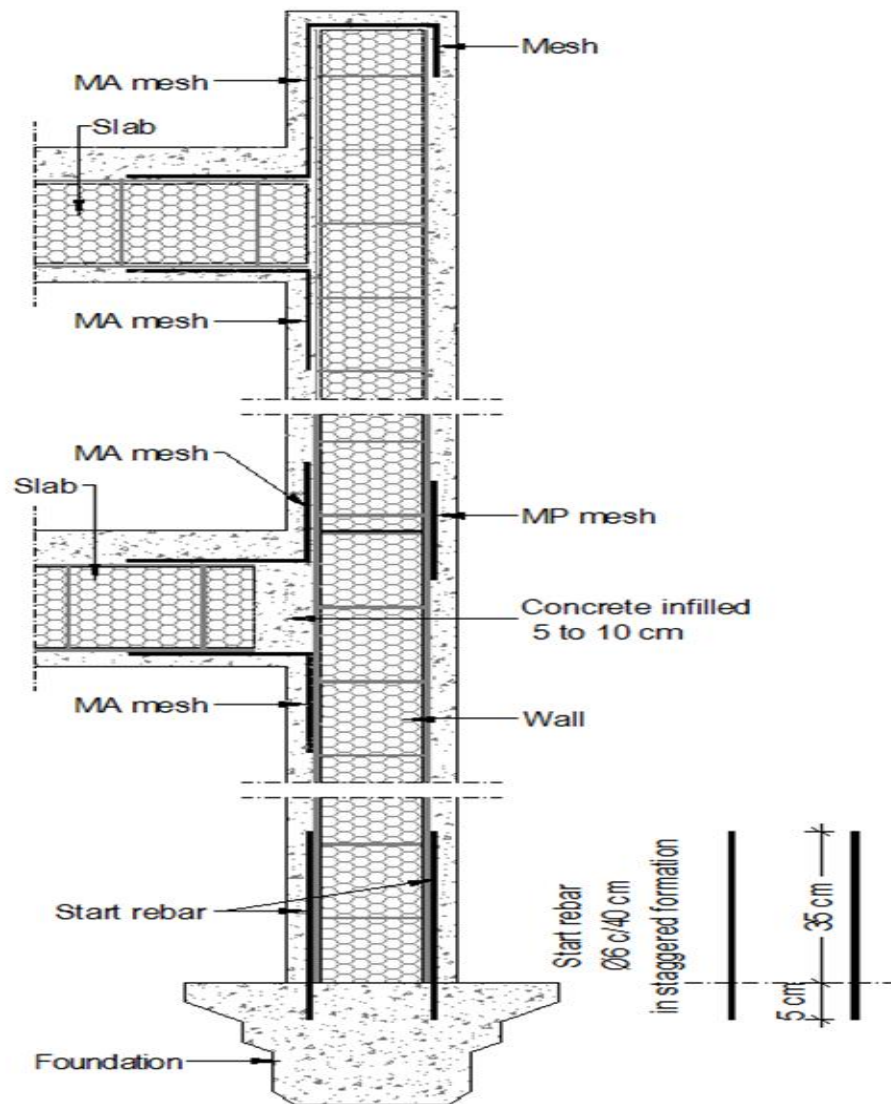


**MPR mesh scheme**



**Joint detail between wall and sloping roof**





**Construction detail**