BMTPC
PACS
PERFORMANCE APPRAISAL CERTIFICATION

Concrewall 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 Schnell Home, s.r.l. Unipersonale** Via Borghetto, 2B-zona Ind. San Liberio - 61030 Montemagglore al Metauro (PU) – Italia Tel 39 0721 878711
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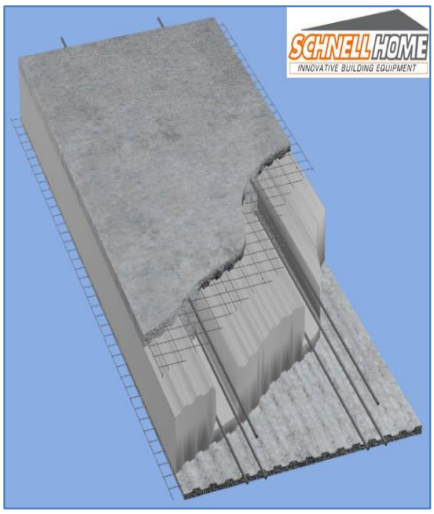
Performance Appraisal Certificate

PAC No.**1031-S/2017**
Issue No. **01**
Date of Issue: **13.01.2017**



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PERFORMANCE APPRAISAL CERTIFICATE

FOR

CONCREWALL SYSTEM

M/s Schnell Home, Italy

STATUS OF PAC No. 1031-S/2017

S. No.	Issue No.	Date of Issue	Date of renewal	Amendment		Valid up to (Date)	Remarks	Signature of authorized signatory
				No.	Date			
1.	2.	3.	4.	5.	6.	7.	8.	9.
1	01	13-01-2017	13-01-2019	--	--	12-01-2019	--	

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PART 1 CERTIFICATION

1.1 Certificate Holder: M/s Schnell Home, s.r.l. Unipersonale
Via Borghetto, 2B-zona Ind. San Liberio
61030 Montemagglore al Metauro (PU) -Italia
Tel 39 0721 878711
Email: schnellhome@schnell.it

1.2 Description of System

1.2.1 *Name of the System*– Concrewall System

1.2.2 *Brand Name* – Concrewall

1.2.3 *Brief Description* – The Concrewall System is an industrial system for the construction of structural walls of reinforced concrete for building in single panel up to G+3.

The system is composed of a factory produced panel of undulated (wave shape) polystyrene covered on both sides by an electro-welded zinc coated square mesh of galvanized steel and linked by 40 connectors per sq m made of high-elastic-limit 3mm dia wires realizing a 3 dimensional hyper-static reinforced steel. (Figs 1 & 2)

The panels are assembled on site and in-situ concrete (double panels, floors, stairs) and shotcreted concrete poured (single panel) to realize the following different elements of the system:

- Vertical structural walls
- Horizontal structural elements
- Cladding element
- Internal walls.

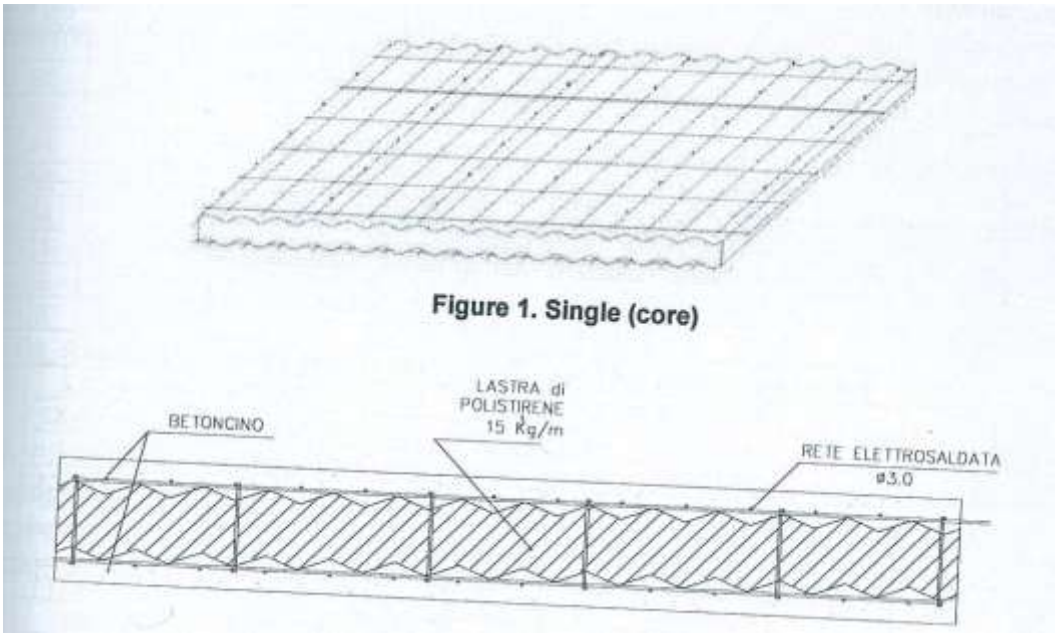

Figure 1. Single (core)

Figure 2. Cross-section

1.3 Panel Types

1.3.1 *Single Bearing Panel*

Used as Load Bearing Wall

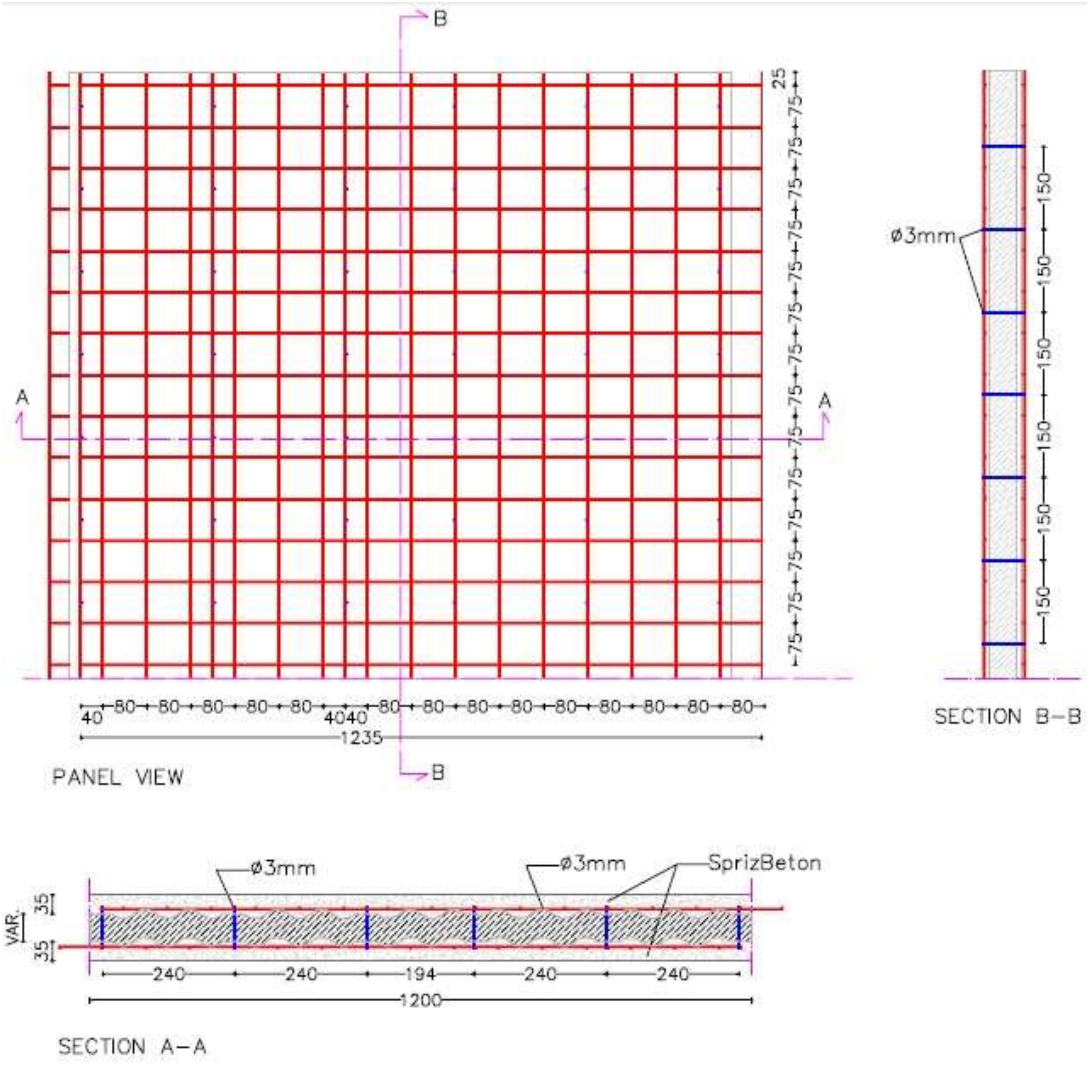

Fig. 3

Mesh

Width	: 1235 mm
Longitudinal wires	: ø 2.5/3.0 mm @ 80 mm c/c (max)
Transverse wires	: ø 2.5/3.0 mm @ 75 mm c/c (max)
Connectors & cross wire	: ø 3.0 mm @ 150 mm c/c

EPS

Density	: ≥ 15 kg/m^3
Thickness	: 40 mm to 240 mm
Wave Depth	: 15 mm

1.3.2 *Single Non Load Bearing Panel*

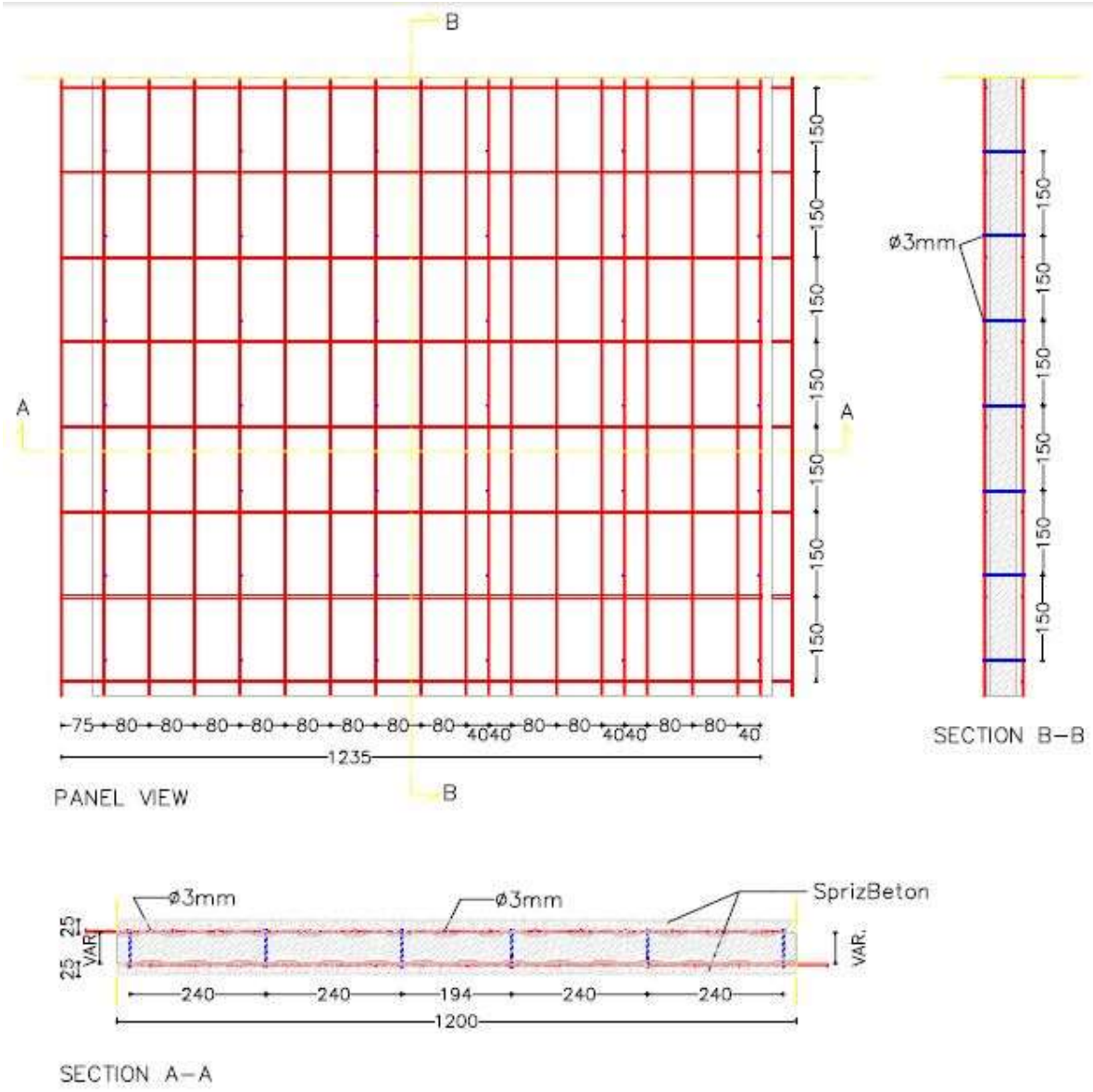

Fig. 4

Mesh

Width		: 1235 mm
Longitudinal wires		: ø 2.5/3.0 mm @ 80 mm c/c (max)
Transverse wires		: ø 2.5/3.0 mm @ 75 /150 mm c/c (max)
Connectors & cross wire	-	: ø 3.0 mm @150 mm c/c

EPS

Density	-	: ≥ 15 kg/m^3
Thickness	-	: 40 mm to 280 mm
Wave Depth	-	: 5 /15 mm

1.3.3 *Single Floor Panel*

Used as floors or roofs span upto 5 m x 5m and supported by the walls in all the sides. The panels are finished on site by 50 mm of casted concrete in upper side and 30 mm of projected plaster in the lower side.

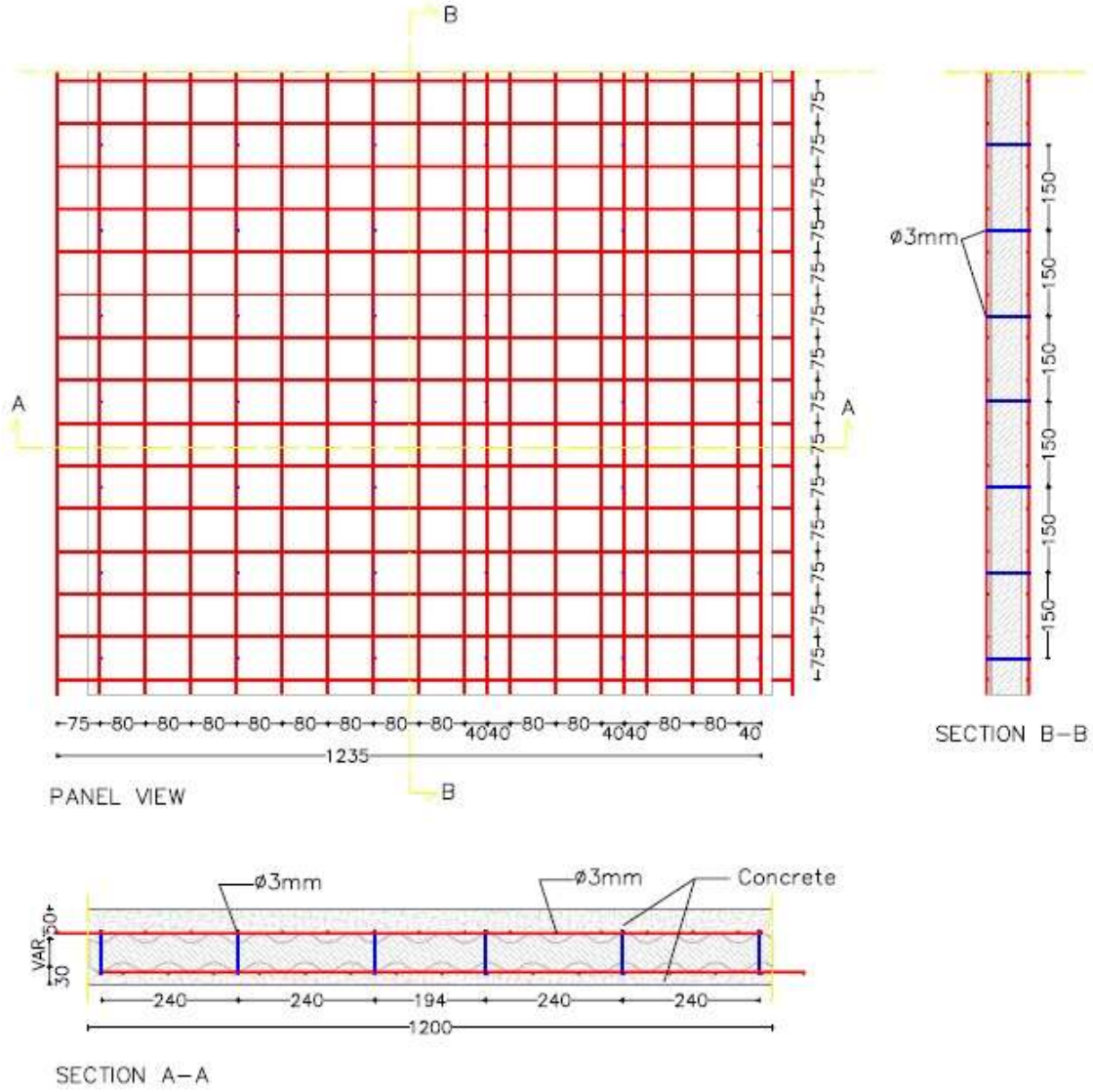

Fig. 5

EPS

Width	: 1200 mm
Thickness	: 80 to 200 mm
Density	: ≥ 15Kg/m^3

Mesh

Width	: 1235 mm
Longitudinal wires	: 2.5 / 3.0 mm ø @ 80 mm c/c
Transverse wires	: 2.5 / 3.0 mm ø @ 75 mm c/c
Connectors & cross wire	: ø 3.0 mm @ 150 mm c/c

1.3.4 *Floor Panel with Joists*

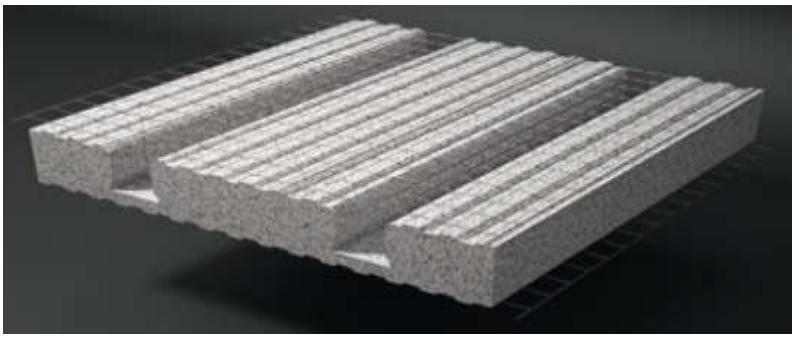

Fig. 6

Galvanized steel wire mesh

Longitudinal wires:	*2.5 mm dia. every 70 mm*
Transversal wires:	*2.5 mm dia. every 70 mm*
Cross steel wire:	*3.0 mm dia.(approx. 68 per m^2)*

Polystyrene slab density: *≥ 15 kg/m^3*

This panel is used for the floor and the roof system and it is reinforced in the joists with concrete casting on the site.
The reinforcement of the panel is integrated during the panel assembly by additional reinforcing bars inside the joists as per the design.
These are suitable for slabs having spans up to 8 m and with live loads up to 4 kN/m^2.

1.4 Assessment

1.4.1 *Scope of Assessment*

1. 4.1.1 Scope of assessment included suitability of manufactured panel to the specified requirements for use in building construction as:

- Load bearing wall panel
- Non-load bearing wall panel
- Shear Wall
- Floor/ roof slab

The structural and water tightness design for each specific structure is the responsibility of the building designer.

1.4.2 *Basis of Assessment*

The system is assessed for use with framed door and window joinery installed with vertical jambs. Assessment of the suitability of panels manufactured as load bearing wall, shear wall, floor/ roof slab etc. is based on:

- Tests on construction materials including individual roof panel, tensile test of galvanized wire, expanded polystyrene and cement mortar vis-à-vis requirements contained in the specifications;
- Determination of Compressive, Flexural and Axial Strength of Expanded Polystyrene Core Panel by IIT Roorkee
- Evaluation Report of the Characterization Tests carried out

by Department of Architecture, Buildings & Structures, University Polytechnic of Marche

- Fire Performance of a Load Bearing Assembly and Fire Resistance Testing of Floor/Ceiling Assembly by Western Fire Center, INC, Washington, USA
- Finite Element Modelling and Analysis of a G+3 EPS Building by IIT Roorkee
- Durability and Serviceability Assessment of Concrete Sandwich Expanded Polystyrene Core Panels
- Structural Stability Assessment and Development of Design Guidelines for Expanded Polystyrene Core Panel System towards Safe & Affordable Housing.
- Quality Assurance Scheme followed by the Certificate holder for process control as per the Quality Assurance Plan attached at Annex A.

1.5 Use of the Concrewall Panel System

1.5.1 The panel may be used generally in the following ways:

1) As load bearing walling in buildings
2) As high capacity vertical and shear load bearing structural walling in multi-storey construction.
3) Non Load bearing wall panels
4) As partition infill wall in multi-storey framed building:
5) As floor/ roof slabs
6) As cladding for industrial building

1.5.2 Special Aspects of use:

- The building to be constructed using Concrewall panel shall be manufactured in accordance with the specifications prescribed in Technical Manual of Schnell Home 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,
- Concrewall 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 Concrewall panel construction should be thoroughly familiar with the various structural aspects. It is also recommended that architects and construction Engineers who undertake Concrewall building design and construction gain familiarity with the properties of material, characteristics of Concrewall panels, and its application and construction system.

1.6 Conditions of Certification

1.6.1 *Technical Conditions*

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

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

3. Schnell Home shall also provide necessary training to the technical persons of the agency engaged for production, design and construction.

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

1.6.2 *Quality Assurance*

The Certificate holder shall implement and maintain a quality assurance system in accordance with Scheme of Quality Assurance (SQA) given in Annex A attached with this Certificate

1.6.3 *Handling of User Complaints*

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

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

1.7 Certification

1.7.1 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 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 various materials used in the manufacture of these panels given in PAC.

2.2 Specifications of The System

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 Steel for both wire mesh and connectors

1.1 Zinc Coating– The zinc covering is variable with the diameter of the wire mesh. Standard wire mesh shall be of 2.5/3.0 mm dia and zinc coating galvanizing shall be of 60/90 gm/m^2 with a tolerance of ± 5 gm/m^2

1.2 Mechanical characteristics

Tensile strength (2.5mm dia):	750 N/mm^2
Yield strength (2.5mm dia):	680 N/mm^2
Tensile strength (3.0mm dia):	700 N/mm^2
Yield strength (3.0mm dia):	600 N/mm^2
Elongation:	> 8%

1.3 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 13163:2013) having density not less than 15 kg/m^3.

2.3 Design Consideration

2.3.1 *General*

(i) The *Concrewall panels* may be designed using the appropriate design software. The buildings constructed with these panels shall be studied and designed reinforced concrete structure since the parameters required for their design are the same as needed for traditional reinforced concrete. In the calculation model, the building shall be designed as a structure composed of load bearing walls with a box- like structure.

(ii) The system is intended for use where Architectural drawings are available and satisfy the various requirements. The Architect and Engineer designer team of the concerned developer (client) is responsible for the drawings and overall building design to comply with

the various regulatory requirements applicable to the area.

(iii)The design engineer shall liase with the engineer of the developer and provide the necessary loading information for the design of the foundation.

(iv)The system shall be designed to provide the required performance against the loads to be taken into account in accordance with IS 875 (Parts 1-5):1987 and the data given by manufacturer for various panels. It shall also provide the required bearing resistance for earthquake and wind forces as per IS 875 (Part 3):1987 and IS 1893 (Part 1):2002, wherever applicable.

(v)Foundation shall be specifically designed in accordance with provision given in IS 1904:1986. Both single and double panels should have starter bars from either foundation or ground floor slab. All foundations should be designed by experienced engineer with appropriate reference.

(vi)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.

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

2.3.2 *Structure*

The *Concrewall* System receives its outer plane strength by its own geometrical configuration. Every longitudinal wire is in correspondence of the wave, so once the plaster is applied, the wire is well covered and the panel acts as a series of micro-column.

2.3.3 *Wind Uplift*

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

2.3.4 *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.

2.4 Machinery Involved

(i) Electronic Polystyrene cutting machine
(ii) Wire straightening machine
(iii) Automatic welding mesh machine
(iv) Automatic welding and Panel assembling machine
(v) Automatic mesh cutting machine
(vi) Automatic mesh binding machine

2.5 Production Process

Concrewall Panels of different dimensions shall be produced with two raw materials namely steel wire in coils and polystyrene blocks.

2.5.1 *Galvanized wire*: It shall include the following phases:

- Perfect straightening and cutting of the required wires
- Assembly by electrical welding of the wires of different dia to make mesh of pre-established lengths

2.5.2 *Polystyrene blocks EPS*: The most complete hypothesis shall include the following phases:
Shape the dried blocks and cut sheets of a specific form and dimension according to the final type of product. The possible scraps shall be grounded and recycled, within certain limits, in the production of EPS blocks on the condition that these are first cleaned and are without any foreign substance, with particular attention to the presence of dust.

2.5.3 *Assembly:*

Assembly of the Concrewall panel shall be made by electro welding no.6 wires (in transversal and perpendicular position with respect to the panel surface) with two meshes, forming a sandwich including the EPS sheet between these, which has been previously inserted.

2.5.4 *Operations 'out of line':*
The production line is complete after cutting and bending of the external overlapping meshes.

2.6 Installation Procedure

2.6.1 *Foundations*

Where Foundations for the Concrewall System are used, they should be levelled and stepped as this makes panel positioning easier.
For concrewall panels, parallel sided timber or metal template of the width of panel shall be required to mark the position of the wall panels on the foundation and the spacing of the starter bar holes.

2.6.2 *Wall start up*

- Line wall positions shall be marked and profiled.
- A timber or metal template of the exact width of panel (from wire to wire) shall be used to mark the position of the panels with chalk or pencil lines.
- On the panel lines positions shall be marked to drill the starter bar holes. These should be in a zig zag pattern at 600 mm centres on each side of the panels. Starter bars should be at all panel joints and on the opposite side in mid panel plus at all wall corner joints.
- Starter bars should be either 6mm or 8 mm dia, 500 mm long

with 100 mm drilled into the foundations and 400 mm above.
- Drill bits shall be used to give a tight fit with the starter bars.
- Once starter bars are in position, place the Concrewall panels between the starter bars starting from a corner. Starter bars shall be wire-tied to the panel mesh and the panels to each other on the overlapping mesh.

2.6.3 W*all construction*

- All corners and wall joints should be reinforced with right angled wire mesh to the full height of the walls.
- To cut panels to fit for door & window openings, wire should be cut with a wire cutter or angle grinder. Measure and mark the cut lines before starting to cut.
- After the wire mesh has been cut, EPS shall be cut with a hacksaw blade or stiff blade hand saw.
- Added steel mesh reinforcement shall be required around door and window openings to ensure that no plaster cracks form in these areas. Mesh reinforcement strips shall be tied diagonally at every corner of openings before plastering.
- Once wall panels are in place and tied together, bracing shall be required to hold them vertical before plastering. This shall be done only on one side of the panels.
- Once the panels are plastered on one side, the wall bracing shall be removed after 24 hours. The panels are now sufficiently stiff so that plastering on other side can be done without bracing.

2.6.4 *Door and Window fittings*

- Before plastering metal ‘cliscoe’ type window and door frames (which should be sized to the width of the panels) may be fitted into the pre-cut panels.
- Metal ‘cliscoe’ type window frame fitted into future house panel before plastering.
- Metal lugs from the back of metal frames shall be wire tied to the panel mesh to keep the frames in position.

For any other kind of frames, suitable method in accordance with the manufacturer’s specifications may be used.

2.6.5 *Plastering*

- Plastering shall be done by machine or hand. The indicative quantity of each material per cum. should be as follows:
- Cement: 350 kg
- Sand with mixed granulometry: 1600kg. Sand should be without clay or any organic substance and totally washed.
- Water – 160 litres. The quantity of water may be different according to the natural sand humidity. The parameters that should be constant are: W/C = 0.52 and I/C = 4.50.
- Any problem of workability should be solved without adding water. The retraction cracks formation may be avoided by

adding Polypropylene fibers in the mix (1kg/m^3).

- In order to control the final plaster thickness, some guides should be used. These shall be removed as soon as the plaster 'sets up' and the spaces are filled and are smoother before the plaster gets dry.
- Spray application should be done in two steps with a first layer covering the mesh applied on both the sides of the wall and the finishing layer as soon as the first layer gets dry.

2.6.6 *Roof/floor panel*

- After the vertical panels are assembled, verticality of the walls should be checked and the bending meshes positioned on all the corners. Thereafter, horizontal bending meshes shall be placed to connect the floor/roof to the vertical panels. The bending meshes should be fixed throughout the perimeter of the floor/roof, at the level of intrados.
- When the horizontal bending meshes are fixed and checked, floor / roof panel shall be placed on these. The lower mesh of the panel shall be fixed by steel wire to the bending meshes.
- Between the edges of floor/roof panel and vertical panel, gap of 3.5 cm should be left to ensure structural continuity. The plaster applied on the walls shall be continued from one level to another level.

Placing of the Concrewall elements for the floor and/or roof should be done before the application of the external layer of plaster on the walls. Casting of concrete on the floor/roof panels (after placing the additional reinforcing bars, if required) should be done after the walls are plastered and a number of props shall be put to limit the deformation of the panel.

2.6.7 *Plumbing and electrical fittings*

- Plumbing and electrical conduits shall be behind the panel wire mesh before plastering.
- The space behind the wire mesh shall be opened up by using a blow torch to partially melt the EPS along the lines of the conduits.
- As the EPS used in the panels is fire retardant, it will melt under the flame but not burn.
- The wire mesh shall be cut with wire clippers to make space for DB boards, switches and plug boxes.

Figures 7 to 15 showing typical details of single panel including door & window details are given at Annex B for guidance.

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 Handling , Storage, Marking & Identification

(i) The panels should be stored on a clean, flat hard surface area on the site. The panels should not be laid down directly on the ground to prevent them from getting dirty, which could lead to problems of plaster adhesion. Preferably, panels should be stored on timber battens approx. 2 m apart.

(ii) The panels should not be exposed to sunlight for not more than 1 month either in storage or during construction in order to prevent changing the polystyrene appearance. The panels should be bound carefully to make sure these are not accidentally blown by the wind.

(iii) Long term storage of the panels shall be done in a covered, protected, dry environment so that corrosion of the reinforcement does not occur and the panels do not get damaged.

(iv) Panels shall be stored and transported to site in a manner that prevents damage, buckling or sprawling of the polystyrene or bending of the mesh reinforcement. Operatives should place the panels in position and tie them down to starter bars of adjoining panels and slabs in the manner described in the Operational Manual.

(v) Panels should be properly braced to provide rigid temporary support to the walls during erection and concrete spraying and placing of concrete in slabs. Propping of walls and slabs should be in accordance with Schnell Operational Manual.

(vi) The panels shall be delivered to the site with an identification issued by the manufacturer that reports the element height.

(vii) The panel layout shall provide instructions for laying the components correctly.

2.9 Good Practices for Installation & Maintenance

Good practices as per requirement of working with Concrewall System of the manufacturer shall be followed for installation and maintenance of the system.

2.10 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**.**

2.11 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.

2.12 Guarantees/Warranties Provided by the PAC Holder

PAC holder shall provide necessary guarantees/ warranties. A brochure giving relevant details of the Schnell Home shall be made available to the client.

2.13 Services Provided by the PAC Holder to the Customer

In-house testing of panels at regular intervals as per the Quality Control Assurance requirement shall be ensured by PAC Holder.

2.14 Manuals

A site Erection Manual and a Manual for Health & Safety shall be provided for each project incorporating the Concrewall System.

2.15 Responsibility

- Specific design using Concrewall System is the responsibility of the designer with the instructions, supervision and guidance of Schnell Home.
- 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.

3.2 Laboratory tests performed for assessment

3.2.1 *Testing of samples by Foreign Laboratories/ Institutes*

The following tests have been performed by various foreign institutes as per the specifications given by the manufacturer:

3.2.1.2 By Western Fire Center, INC, Washington, USA

1. Fire Performance Evaluation of a Symmetric, Load-Bearing Wall Assembly

The Symmetric, load-bearing wall assembly consisting of panels of 80 mm undulated EPS foam core with wire mesh on each side of the foam with 6 mm standoff and concrete layers totaling a nominal 45 mm thickness on each side of the foam core, passed all requirements of the 1-hr fire endurance test according to ASTM E119. The fire resistance wall had a finish rating of 61 min. The wall assembly did not allow flames to pass through the wall assembly for the 1-hr test, nor did the average unexposed temperature supersede 139ºC + ambient or a single-point temperature supersede 181ºC + ambient.

2. *Fire Resistance Testing of Floor/Ceiling assembly*

Panels consisted of 160 mm thick undulated undulated EPS foam core with wire mesh on each side of the foam with 6 mm standoff and concrete layers totaling a nominal 50 mm thickness were applied to top of the foam core and 45 mm thickness to bottom of the foam core as well as around perimeter to complete the 450 mm x 350 mm assembly. The floor/ceiling assembly passed all the requirements of the 1-hr fire endurance test according to ASTM E119. The wall assembly did not allow flames to pass through the assembly for 60 min based on when the test was terminated. There was no unexposed temperature failure for average or single-point thresholds (139ºC + ambient, 181ºC + ambient) during the 60 min. test. Therefore, this assembly can be certified for a 60 min resistance line.

3.2.1.3 *By Giordano Institute, Italy -- Thermal Insulation Tests:*

- Single Panel Concrewall (PCS) 80 mm thick – Thermal transmittance Up = 0.557 W/m^{2}K

3.2.1.4 *By CSI (MI), Italy – Acoustic Tests*

- Single Panel Concrewall (PCS) 80 mm thick -- Traditional plaster Rw= 37 dB

- Single Panel Concrewall (PCS) 80 mm thick – Acoustic plaster Rw= 37 dB

3.2.1.5 *By CSI (MI), Italy – Fire Resistance Test:*

- Single Panel Concrewall (PCS) 80 mm thick

3.2.1.6 *By LAPI (PO), Italy – Resistance to Impact with soft body*

- Single Panel Concrewall (PCS) 80 mm thick – 50kg with impacts of 900 &1200J – No cracks were observed

3.2.1.7 *By LAPI (PO) – Water Penetration Test*

- Single Panel Concrewall (PCS) 80 mm thick – No Penetration was observed after three hours

3.2.2 *By Wind Science & Engineering Research Center, Texas Tech University*

Missile Test was conducted by Wind Science & Engineering Research Center, Texas Tech University on 130 mm and 150 mm thick panels: Missile test according to Florida Building Code, International Code Council Texas Deptt. of Insurance windstorm Resistance Construction Guide. The following results were obtained:

- Single Panel Bearing Wall (PCSP) 80 mm thick– are resistant to the Florida Building Code & Dade County Hurricane Envelope resistance = 55 km/h missile & 225 km/h hurricane.
- Single Panel Bearing Wall (PCSP) 80 mm thick – threshold of perforation = 142 km/h missile & 354 km/h hurricane impact resistance. Since two of the panels were tested to the highest standard for hurricanes 177 km/h & 355 km/h hurricane and were reasonably resistant, the 150 mm panel can be rated to 146 km/h & 362 km/h hurricane impact resistance, which is the highest rating per ICC-5r00 Standard.

3.2.3 *Evaluation Report of the Characterization Tests carried out by Department of Architecture, Buildings & Structures, University Polytechnic of Marche*

The following tests were carried out forming part of this report:

1. *Characterization tests on materials*

- *Tests on sprayed structure plaster:* Two types of tests were carried out—the first on 40x40x160 mm samples made during the panel completion phase and the second on cores taken from the panel side edging after the tests. The results of the tests are shown in Table 1 & 2 of Annex C. Table 1 gives the average break load, bending tensile strength & average and Table 2 shows the compression & puling strength results.

- *Tests on the electro-welded mesh:* The electro-welded mesh was put through pulling tests. Two of the six tested samples had a fragile behavior by the joint welding before yielding while the other four reached the yield point but showed very low ductility 9 (Lower than 2). The pulling strength results and the percentage of extension obtained besides the break modality observed is shown in Table 3 of Annex C.

- *Tests on the core layer:* In order to know the mechanical features of the panel core layer, creep tests were performed on samples made of three layers of sprayed structural plaster and two connecting layers. The tests were repeated on identical samples but without the polystyrene inner layers. The results are shown in Table 4 of Annex C.

2. *Bending test on floor panels* -- Six tests were carried out on the following panels:

- Two tests on Single Panel Floor (PCSS) 80 mm thick (total thickness 160 mm) with a 3.3 m clear span;
- Two tests on Single Panel Floor (PCSS) 120 mm thick (total thickness 200 mm) with a 4.3 m clear span;
- Two tests on Single Panel Floor (PCSS) 160 mm thick 16 panels (total thickness 240 mm) with a 5.3 m clear span

The difference in length of the panels is due to the different length of the inner core while the sprayed structural plaster layers have all the same thickness. The ultimate loads, corresponding greatest moment by the centre line and the equivalent uniformly loads resulting in the same greatest moment by the centre line for each panel category is shown in Table 5, Table 6 shows the Reduced elastic modulus, Table 7 shows the Crack moments by the centre line and Table 8 of Annex C shows the Break moments by the centre line for each category of panel.

3. Compression tests on wall panels -- A total of 16 tests were carried out as detailed brlow:

- Two centred compression tests on Single Panel Bearing Wall (PCSP) 80 mm thick
- Two centred compression tests on Single Panel Bearing Wall (PCSP) 120 mm thick
- Two eccentric compression test on Single Panel Bearing Wall (PCSP) 160 mm thick
- One centred compression test on Single Panel Evolution Wall (PCSE) 80 mm thick
- One centred compression test on Single Panel Partition Wall (PCST) 80 mm thick
- Two eccentric compression tests on Single Panel Bearing Wall (PCSP) 80 mm thick
- Two eccentric compression tests on Single Panel Bearing Wall (PCSP) 120 mm thick
- Two eccentric compression tests on Single Panel Bearing Wall (PCSP) 160 mm thick
- One eccentric compression test on Single Panel Evolution Wall (PCSE) 80 mm thick
- One eccentric compression test on Single Panel Evolution Wall (PCSE) 120 mm thick

PCSP panels are single bearing panels made of a core layer of variable thickness 80 mm, 120 mm or 160 mm as indicated by the acronym of each panel) and two outer layers of 35 mm thickness.

PCSE panels are an evolution of the previous ones and are different from standard panels as the core layer of polystyrene is

not waved and the electro-welded mesh is separated by suitable spacers.

PCST partition panels are similar to single bearing panels but they have half the number of spacers connecting the two electro-welded meshes.

All the panels have a reinforced sprayed structural plaster edging. The data used for analysis of the panels is shown in Table 9 and the ultimate load values for each type of panel is shown in Table 10 of Annex C.

4. *Diagonal Compression tests on wall panels* -- The following tests were carried out:

   - Two diagonal compression tests on PCSP08 single panels (panels 5.1 & 5.2)
   - Two diagonal compression tests on PCSP08 transversely pre-stressed single panels
   - Two diagonal compression tests on PCSP08 single panels stiffened along their perimeter

   The test results are shown in Table 11 of Annex C.

5. *Tests on wall-floor joints* – Each sample is formed by PSCP08 wall panels and PCSS08 floor panels. The following tests were carried out:

   - One test on a joint where the floor panel upper face was tied to the wall panel outer face (joint 1)
   - One test on a joint where the floor panel faces were tied to the wall panel inner face (joint 2)

   The test results are shown in Table 12 of Annex C.

6. *Static test on a floor built with wall panels* -- The floor under testing was made of single floor panel PCSS12 and the prototype vertical walls made of single bearing panels PCSP08.
   The static test was carried out progressively until the floor collapsed with a nominal load uniformly distributed acting on the loaded floor portion of 2000 kgf/m^2 as shown in Table 13 of Annex C.

3.2.4 *Testing of samples by IIT Roorkee*

IIT Roorkee has conducted various tests on the sandwich panels.

3.3 Usage of the System

The manufacturer has constructed various housing projects from one storey to six stories and factories in India and several countries listed below:

3.3.1 *Projects carried out in India (As reported)*

I. *Buildings*

- Mass Housing G+3 buildings at Vasai, Maharashtra
- Industrial Township at Angul, Orissa
- Hostel and Hospital Buildings in Punjab and Himachal Pradesh
- Angadwadi Buildings across India by Vedanta group
- In-fill Wall use in Multi storey buildings across India

II. *Plants*

- Maad Constructions Co. Ltd., Pune, Maharashtra
- Jindal Steel & Power Ltd., Angul, Orissa
- Synergy Thrislington, Mohali, Punjab

III. *Use with other Systems*

- In-fill walls for Steel-frame and Floor buildings
- Aluminium/Plastic formwork

3.3.2 *Projects carried out in Other Countries* (As reported)

I. *Housing Projects*

- Several housing projects from one storey to six stories at various places in Italy
  Several housing projects from one storey to six stories at various places in Spain with the Concrewall Panel system assembled in Italy
- Several housing projects from one storey to six stories in Hungary, Russia, Saudi Arabia, Oman, Libya, Mexico, France, Venezuela, Brazil and Argentina 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: .....

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

for and on behalf of
Member Secretary, BMBA

PART 5 LIST OF STANDARDS & CODES USED IN ASSESSMENT

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

5.1.1 IS 456:2000 -- Code of practice for plain and reinforced concrete

5.1.2 IS 875:1987 -- Code of practice for design loads for buildings and Structures

5.1.3 IS 1893 (Part 1):2002 – Criteria for Earthquake Resistant Design of Structures

5.1.4 IS 4671:1984 – Specifications for expanded polystyrene for thermal insulation purposes

5.1.5 IS 4326:1993 – Code of Practice for Earthquake Resistant Design and Construction of Buildings

5.1.6 BS 476(Part 22):1987 – Fire resistance

5.1.7 ASTM E 1886-04 – Standard Test Method for Performance of Curtain walls, Doors, Windows and Impact protection systems impacted by Missiles exposed to cyclic pressure differentials

5.1.8 ASTM E90-90 – Sound Proofing

5.1.9 UNI EN ISO 10211(Part 1& 2):1996 – Thermal insulation

5.1.10 UNI EN ISO 140(Part 3):2006 – Acoustic Insulation

5.1.11 MIP 058:2008 – Test method for Impact with a soft body Impermeability to water jet

5.1.12 FEMA 320/361/The ICC 500 – Standard for the Design & construction of Storm shelters (Debris impact)

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.

CERTIFICATION

In the opinion of Building Materials & Technology Promotion Council's Board of Agreement (BMBA), **Concrewall System** bearing the mark manufactured by M/s Schnell Home s.r.l. Unipersonale, Italy is satisfactory if used as set out above in the text of the Certificate. This Certificate **PAC No. 1031-S/2017** is awarded to **M/s Schnell Home s.r.l. Unipersonale, Italy.**

The period of validity of this Certificate is for a period of two years i.e. from **13-01-2017 to 12-01-2019**.

This Certificate consists of cover page and pages 1 to 43.

Embossing Seal of BMBA

Dr. Shailesh Kr. Agarwal
Chairman, TAC
& Member Secretary, BMBA
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, (Govt. of India)
Core-6A, 1st Floor, India Habitat 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 Poverty Alleviation, Government of India

Place: New Delhi, India

Date:.....

PART 6 ABBREVIATIONS

Abbreviations

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

Performance Appraisal Certification Scheme - A Brief

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

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

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

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

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

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

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

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

ANNEX A

(Clause 1.4.2)

QUALITY ASSURANCE PLAN FOR CONCREWALL SYSTEM

S. No.	Parameters to be inspected	Requirement specified	Test Method	Frequency of Testing
A.	**Raw Materials**			
1.	Zinc Coated Drawn Steel Wire Mesh	Steel mesh 2.5/3.0 mm @ 65/70 mm/cc	As per Company Standards	Every Lot
2.	Expanded Polystyrene (ESP)	Density shall not be less than 15 kg/mm^3,	As per Company Standards	Every Lot
3.	Cement – PPC, OPC 43 & 53 Grade i) Compressive strength ii) Setting time	As specified	IS 8112:1989 IS12269:1987	Every Batch
4.	Fly Ash Grade I – Fineness, Lime reactivity, Compressive strength, Drying shrinkage and Soundness	As specified	IS 3812 (Part 1):2003	Every Batch
5.	Coarse Aggregate (Metal) – Grading, Fineness Modulus, Specific gravity, Water absorption, Moisture content, Flakiness index, Elongation, Deleterious substance, Soundness, Aggregate impact & crushing value and Abrasion value	As specified	IS 383:1970	Every Batch
6.	Fine Aggregate (Sand) -- Grading, Specific gravity, Water absorption, Moisture content, Deleterious substance, Soundness	As specified	IS 383:1970	Every Batch
7.	Water	As specified	IS 456:2000	Every Batch
8.	Concrete	As specified	IS 456:2000	Every Batch
9.	Reinforcement -- Mild steel Grade I, Fe 415 & Fe 500 Grade	As specified	IS 1786: 2008	Every Batch
B. Welded Mesh / Concrewall System				
1.	**Acceptance of the raw materials i) Steel Mesh ii) Polystyrene (EPS)** Amount of material,	Quantity, Appearance & completeness/ Brand, Compliance of material and Dimensions as per	Visual, Vernier Caliper and Tape	Every Lot

	Visual inspection, Specifications verification and Dimensional controls	manufacturer Specifications	measure	
2.	**Straightening and cutting wire** Coil steel wire straightening and cutting in the right size of the longitudinal and transversal wires	Dimensions and Condition of material as per manufacturer Specifications	Visual and Tape measure	Every Length
3.	**Electro welding** Steel wires welding to obtain a mesh	Dimensions and Orthogonally as per manufacturer Specifications	Tape measure	Every dimension of the panels
4.	**Shaping polystyrene** Cutting the polystyrene panels from the blocks in right dimensions	Dimensions as per manufacturer Specifications	Tape measure and Vernier caliper	Every dimension of the panels
5.	**Welding/Assembling panels** Assembling electro welded mesh and polystyrene panels	Dimensions and Orthogonally as per manufacturer Specifications	Tape measure and Vernier caliper	Every dimension of the panels

ANNEX B
(Clause 2.6.7)

DRAWINGS

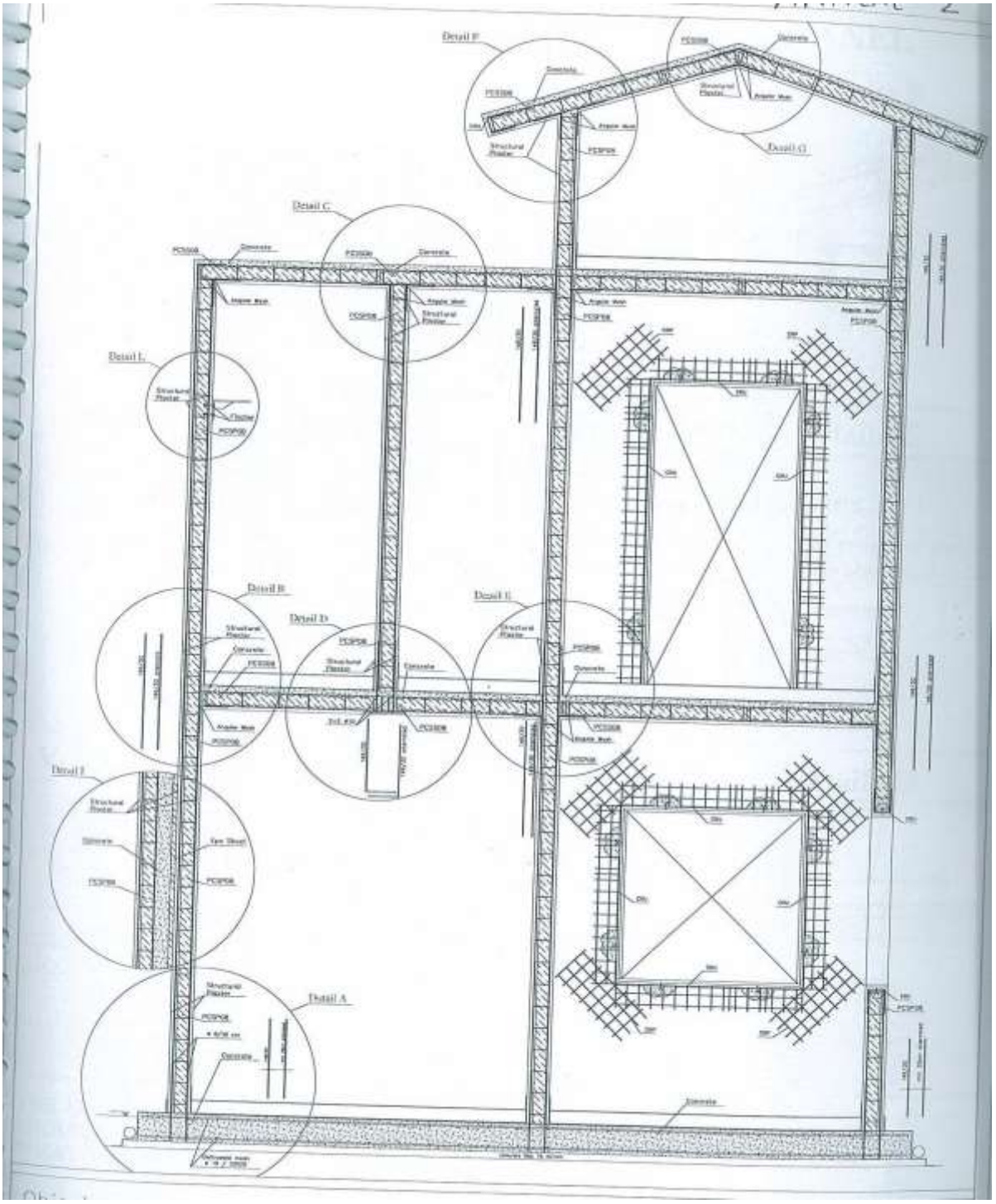

Figure 7. Building Details for Single Panel -- Elevation

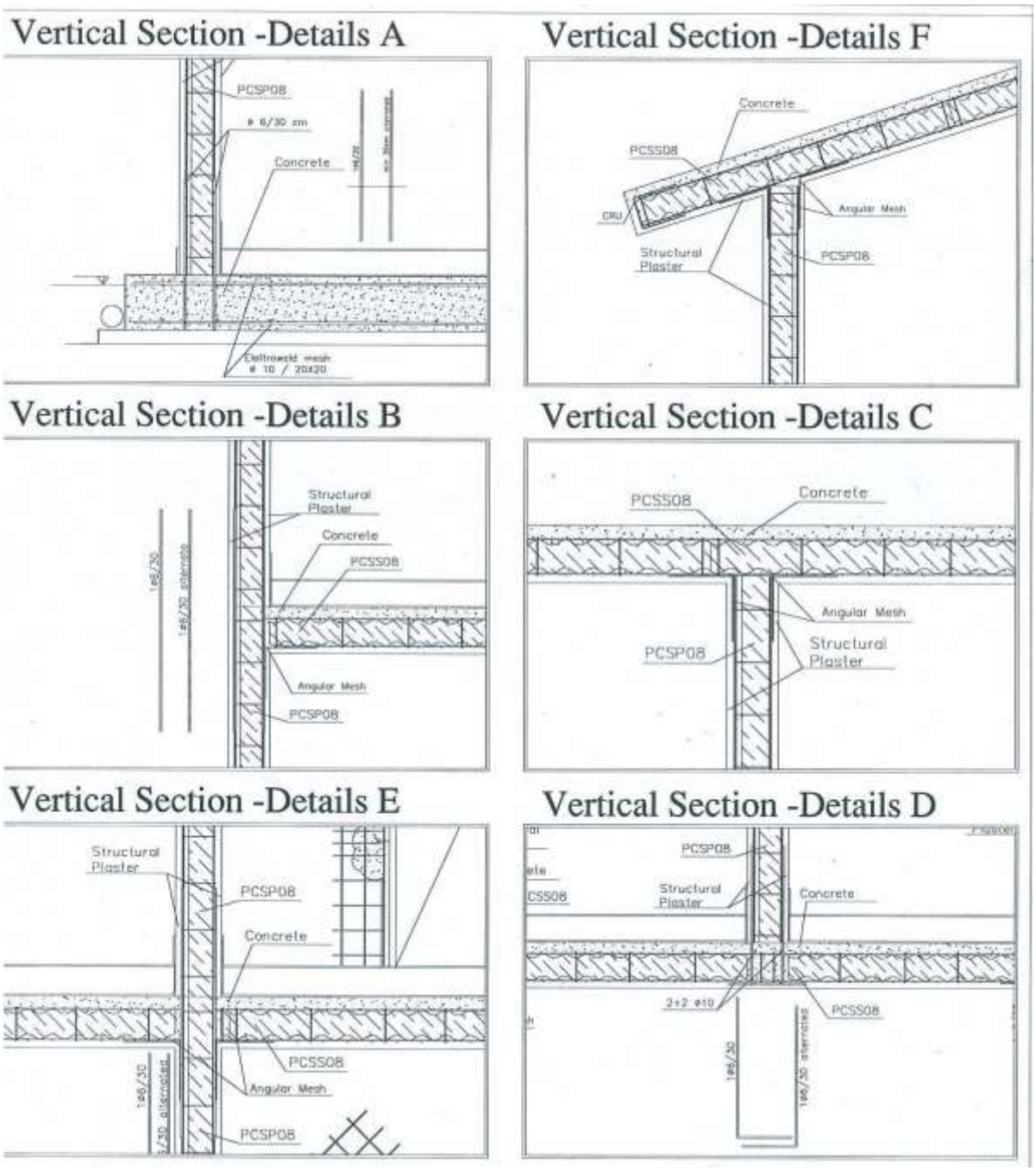

Figure 8. Building Details for Single Panel -- Sections

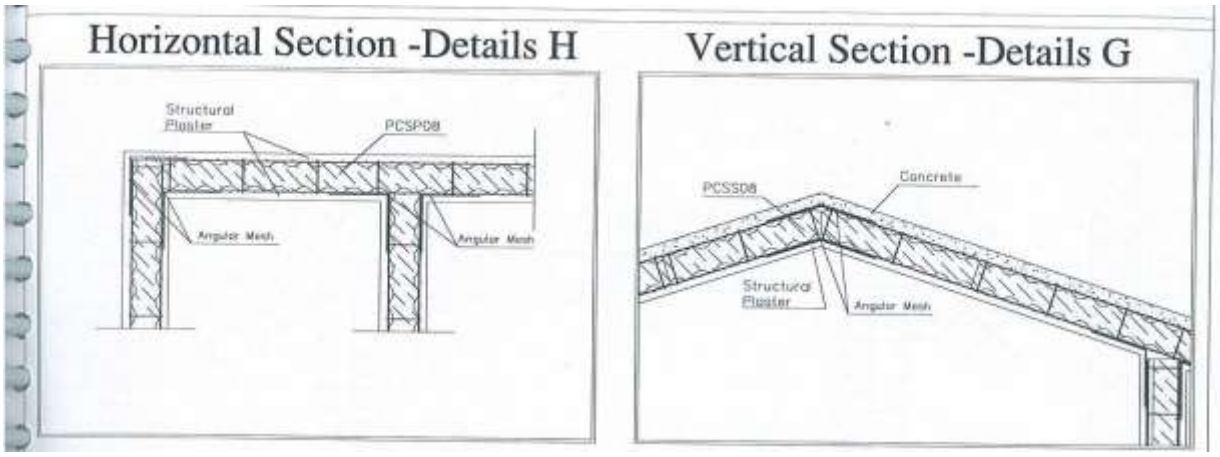

Figure 9. Building Details for Single Panel -- Sections

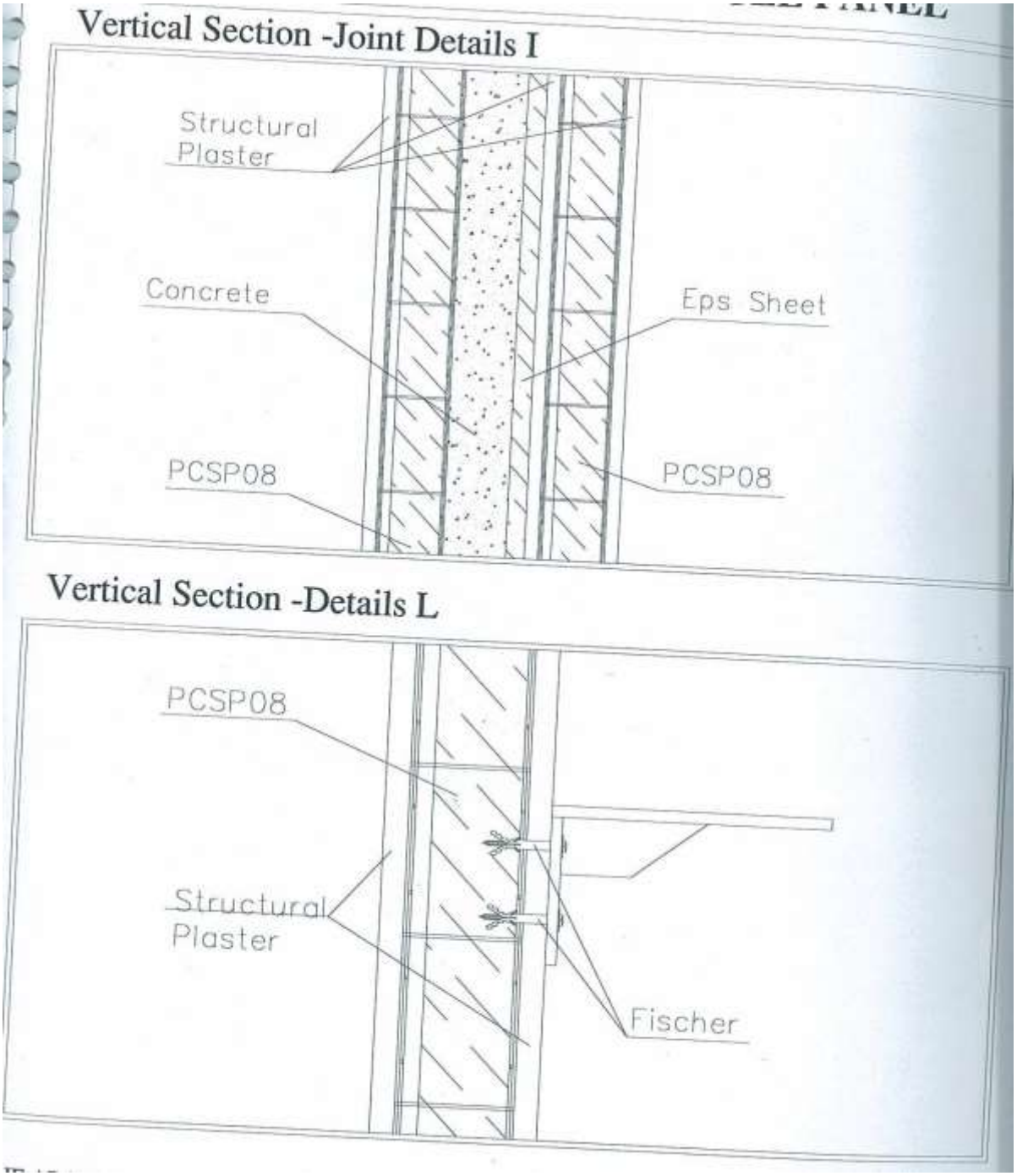

Figure 10. Building Details for Single Panel -- Sections

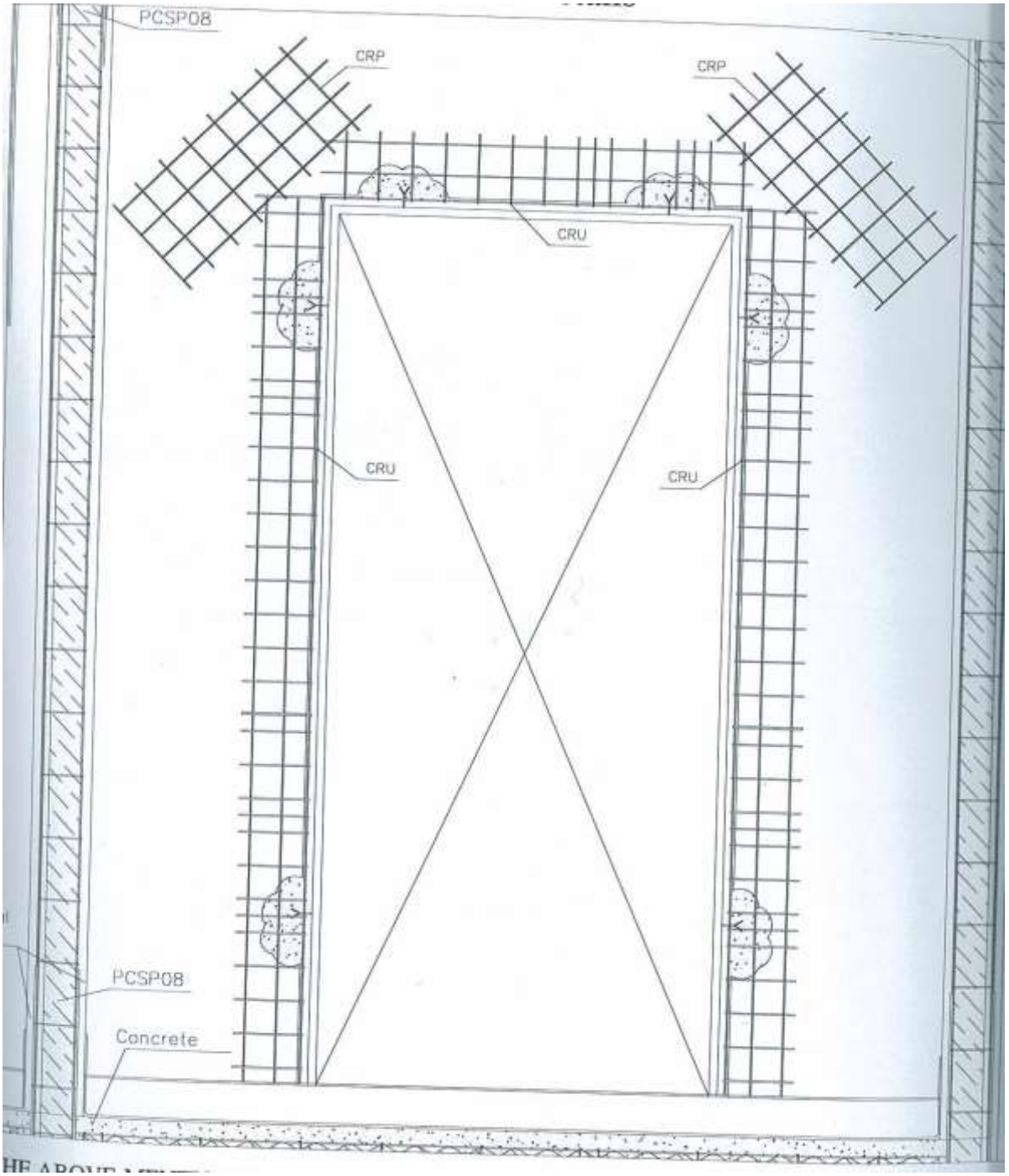

Figure 11. Building Details for Single Panel – Door Detail

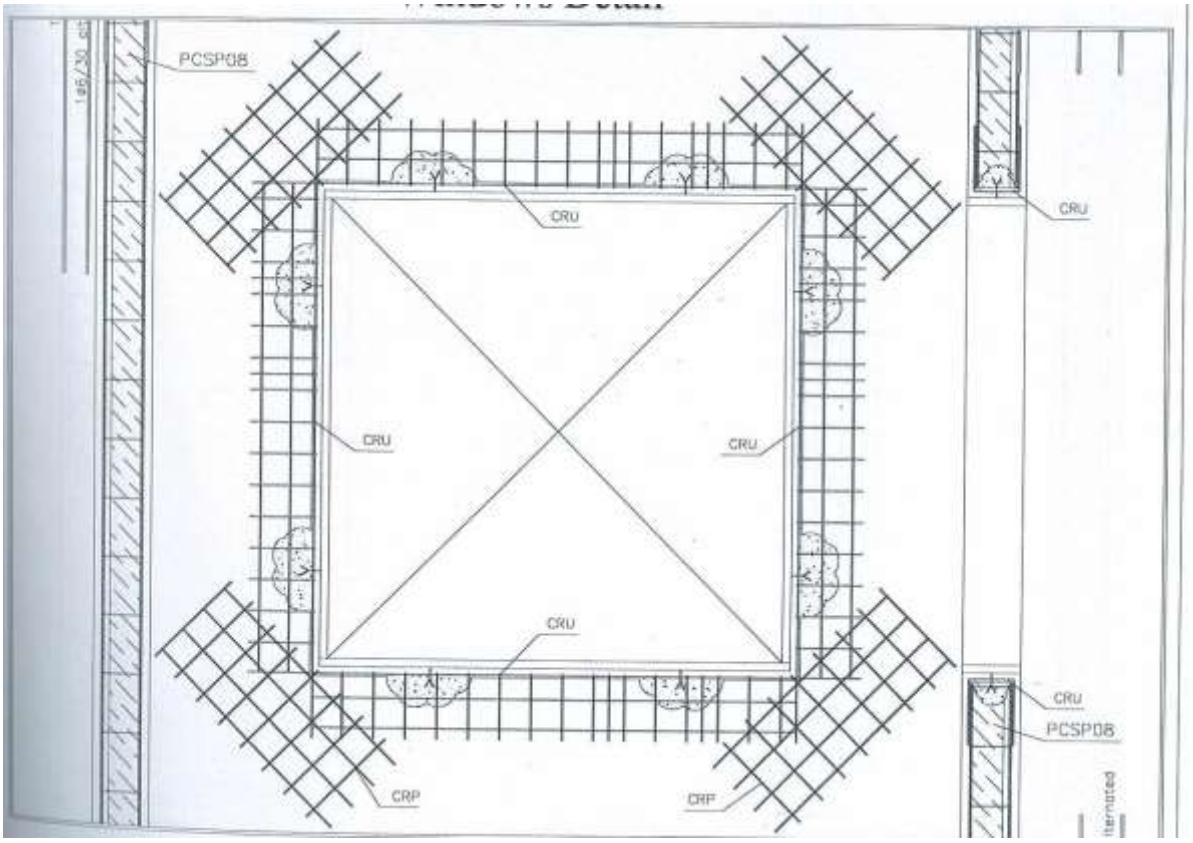

Figure 12. Building Details for Single Panel – Window Detail

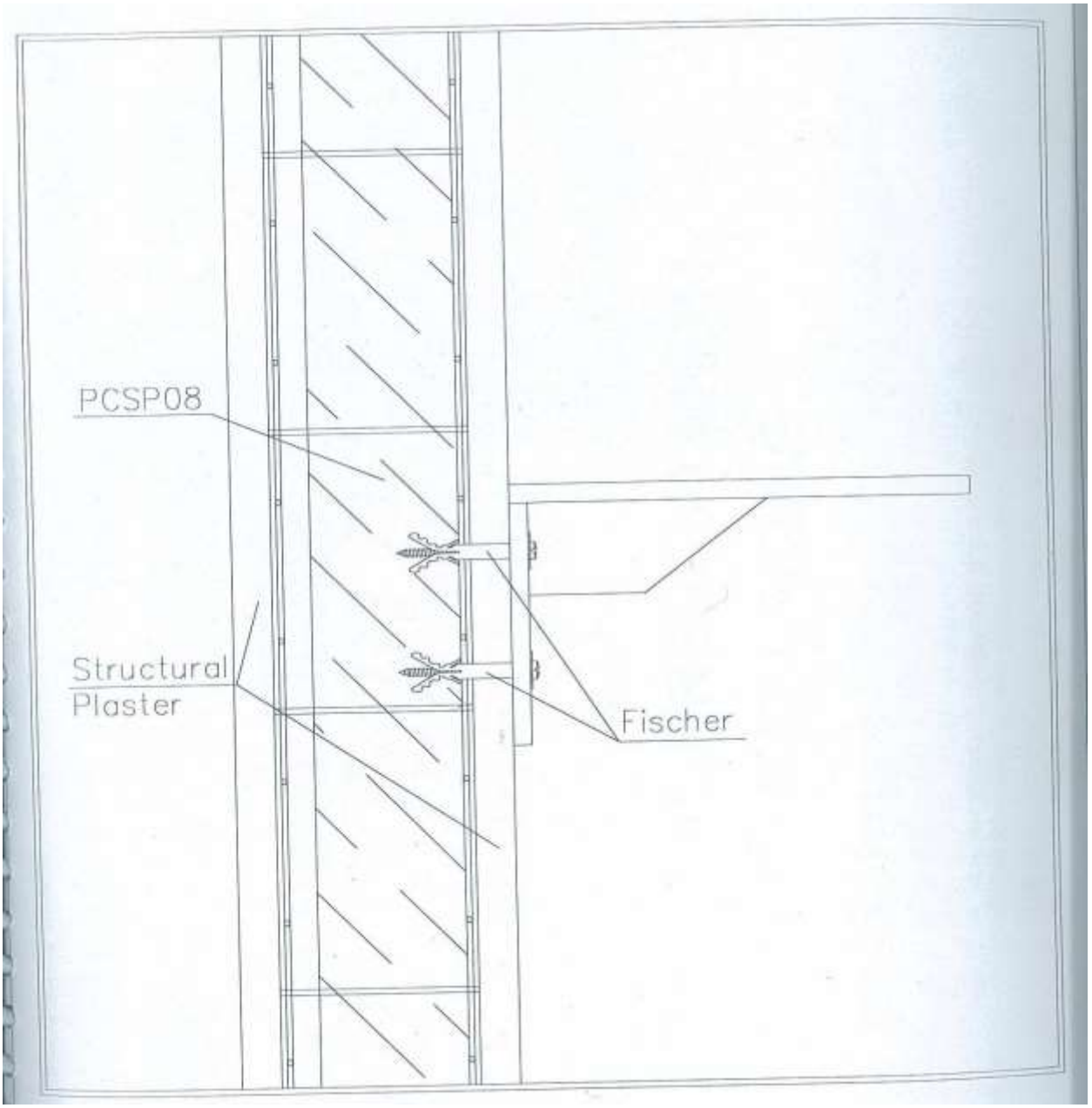

Figure 13. Building Details for Single Panel – Fisher & Plaster Detail

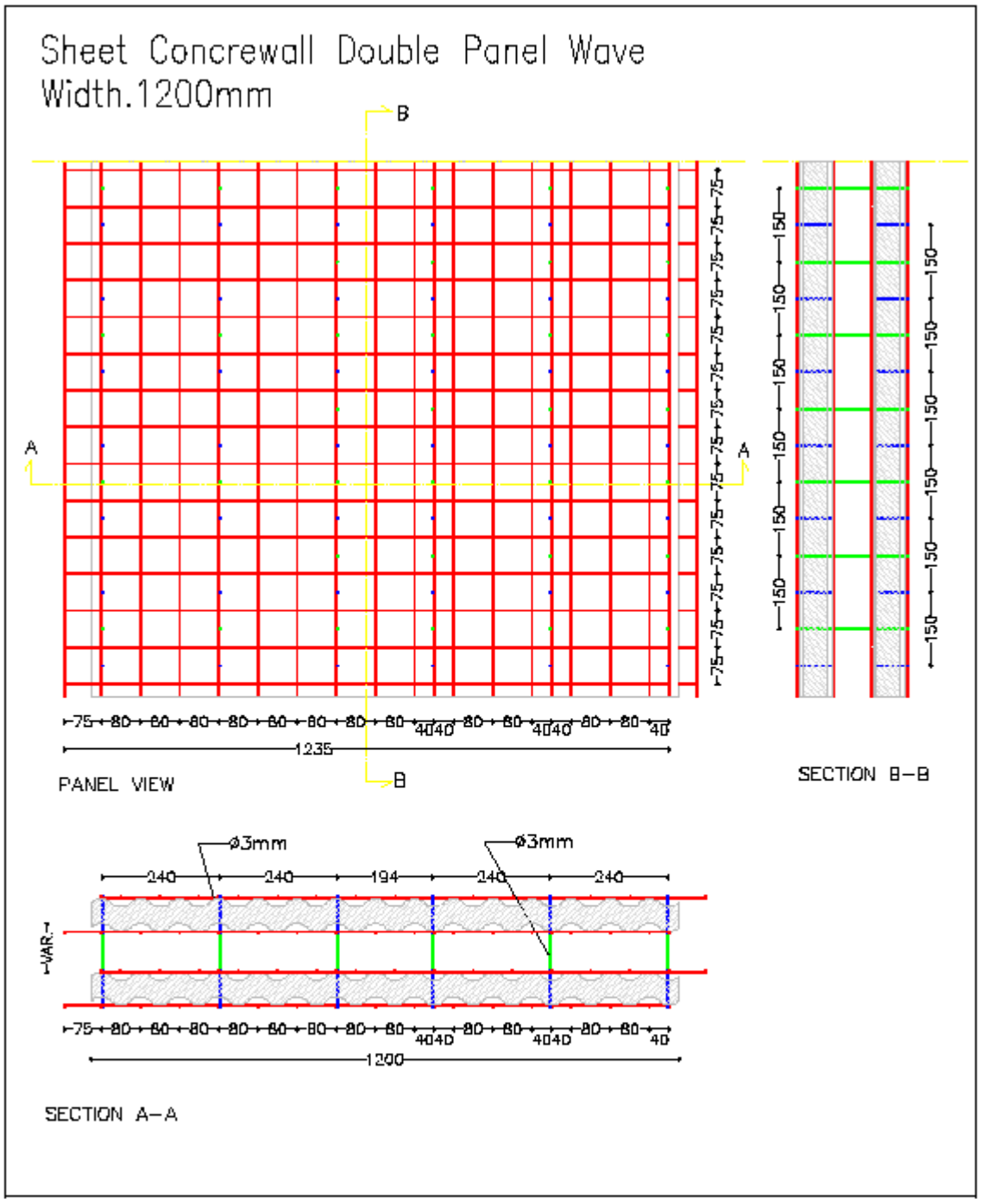

Figure 14. Sheet Concrewall Double Panel

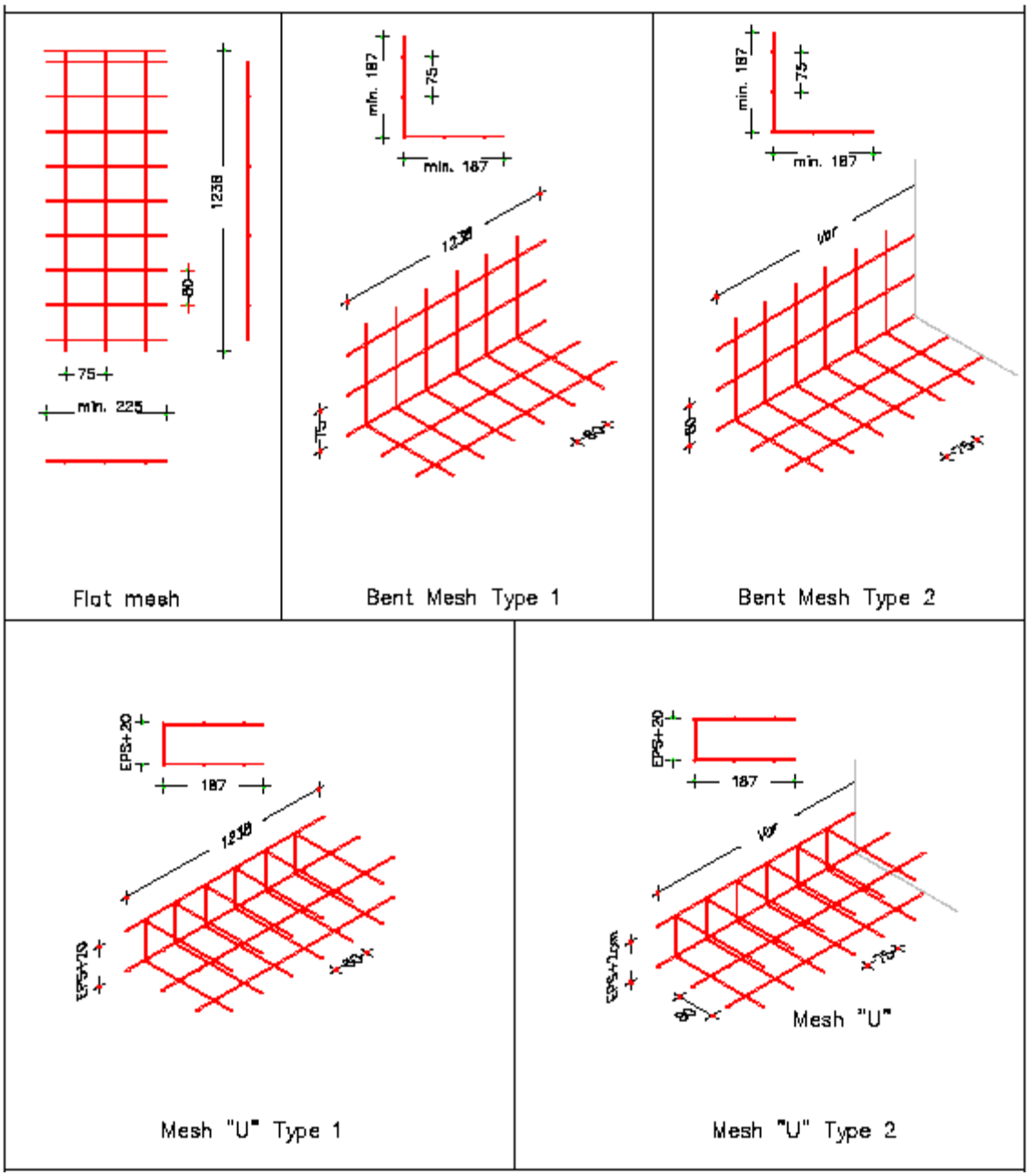

Figure 15. Sheet Reinforcement Mesh

ANNEX C

(Clause 3.2.3)

*TEST RESULTS**

Table 1. Test of 40x40x160mm Samples

Sample	Break load (Bending) (kN)	Average Break Load (Compression) (kN)	Bending tensile Strength (N/mm^2)	Average Compression Strength (N/mm^2)
P.1.1	3.48	35.10	6.80	21.14
P.1.2	--	36.54	--	22.01
P.1.3	2.85	35.10	5.64	20.90
P.2.1	2.86	32.13	5.65	19.13
P.2.2	2.23	35.18	4.52	21.45
P.2.3	2.61	32.02	5.10	19.29
B1	2.40	40.38	5.16	24.93
B2	2.34	32.60	4.97	20.97
B3	2.57	36.64	5.27	22.07
A1	2.98	36.71	6.41	22.66
A2	2.52	35.90	5.35	21.89
A3	2.48	36.55	5.53	22.84
C1	3.11	38.48	6.45	22.37
C2	2.83	38.94	5.80	23.46
C3	2.46	38.87	5.23	23.70
C4	2.39	37.72	4.96	23.00
Average	2.67	36.18	5.52	21.95

Table 2. Tests on cores

Sample	Test type	Diameter Ø (cm)	Thickness h (cm)	Strength Max(kN)	C (h/d)	Fc (N/mm^2)	Fct (N/mm^2)
1c	Compression	9.4	9.4	214.90	1.00	30.9	--
1t	Indirect pulling	9.4	6.8	22.30	--	--	2.22
2c	Compression	9.4	9.2	160.20	0.99	25.0	--
2t	Indirect pulling	9.4	7.2	25.80	--	--	2.43
3c	Compression	9.4	9.4	142.70	1.00	20.5	--
3t	Indirect pulling	9.4	6.9	23.70	--	--	2.33
4c	Compression	9.4	9.3	163.40	1.00	24.0	--
4t	Indirect pulling	9.4	7.2	27.80	--	--	2.62
Average						25.1	2.40

Table 3. Tests on the Electro-welded mesh

Sample	Test	Dia (mm)	Max. S (kN)	Max. tensile strength (N/mm^2)	Length (mm/3cm)	A_{10} (%)	Break
1.1	Pulling	3	5.60	792.64	32.40	8.00	On the wire
1.2	Pulling	3	4.60	651.10	31.14	3.80	On the link
2.1	Pulling	3	4.75	814.42	32.50	8.33	On the wire
2.2	Pulling	3	5.80	820.95	31.96	6.53	On the link
3.1	Pulling	3	4.66	659.81	31.01	3.37	On the wire
3.2	Pulling	3	6.17	673.21	--	--	On the link

Table 4. Tests on links

Sample	Test	Diameter (mm)	Max.Strength (kN)	Break
1.1	Detachment	3	2.17	Joint detachment
1.2	Detachment	3	3.03	Joint detachment
2.1	Detachment	3	2.86	Joint detachment
2.2	Detachment	3	2.90	Joint detachment
3.1	Detachment	3	1.92	Wire yield
3.2	Detachment	3	2.88	Joint detachment

Table 5. Bending Test

Panel	Ultimate load (kN)	Greatest moment (kN/m)	Eq.uniformly dist. load (kN/m^2)	Crack load (kN)	Crack moment (kNm)	Crack qeq (kN/m^2)
6.1	18.3	10.52	6.90	--	--	--
6.2	18.5	10.64	6.98	3.0	1.73	1.13
7.1	14.9	8.57	5.62	2.6	2.15	0.83
7.2	14.4	8.28	5.43	3.0	2.48	0.96
8.1	13.7	7.88	5.17	1.0	1.08	0.27
8.2	13.0	7.48	4.90	1.2	1.29	0.33

Table 6. Reduced elastic module

Panel	B* (m)	H* (m)	€*	$€_{fess*}$
6.2	1.12	0.16	0.30	0.06
7.1	1.12	0.21	0.24	0.05
8.2	1.12	0.25	0.21	0.05

where
B = breadth of panel
H = thickness of panel
€ = reduction factor of the section
$€_{fess}$ = reduction factor in the cracking phase

Table 7. Crack moments by the centre line

Panel	P_{fess} * (kN)	M_{fess} * (kN/m)	p.p * (kN)	$M_{p.p}$* (kNm)	$M_{fess.tot}$ * (kNm)	ß*
6.2	3.0	1.73	1.84	2.5	4.23	0.34
7.1	2.6	2.15	2.07	4.8	6.95	0.36
8.2	1.2	1.29	2.02	7.1	8.39	0.45

where
P_{fess} = panel cracking weight
M_{fess} = moment due to panel cracking weight
p.p = panel own weight
$M_{p.p}$ = moment due to Panel cracking weight
$M_{fess.tot}$ = total cracking moment
ß = reduction factor of tensile strength

Table 8. Break moments by the centre line

Panel	P_u * (kN)	M_u * (kN/m)	p.p * (kN)	$M_{p.p}$* (kNm)	$M_{u.tot}$ * (kNm)	M_{res}* (kNm)
6.2	18.4	10.6	1.84	2.5	13.1	12.2
7.1	14.6	12.1	2.07	4.8	16.9	16.6
8.2	13.3	14.4	2.02	7.1	21.5	21.1

Where:
P_u = ultimate load,
M_u = related moment by the centre line
p.p = panel own weight,
$M_{p.p}$ = moment due to panel own weight
$M_{u.tot}$ = total ultimate moment
M_{res} = plastic moment

Table 9. Compression Test Results

Panel	Ultimate Load (kN)	Average ultimate load (kN)	Distributed ultimate load (kN/m)
2a.1	701	742	662.5
2a.2	783		
3a.1	806	825	736.6
3a.2	844		
4a.1	855	881	786.6
4a.2	907		
X.2	736	---	657.1
Y.2	765	---	683.0
2b.1	375	388	346.4
2b.2	401		
3b.1	460	503	448.7

3b.2	545		
4b.1	524	577	515.2
4b.2	630		
X.1	461	---	411.6
Y.1	591	---	527.7

Table 10. Ultimate loads (centred compression)

Panel	Average ultimate load (kN)	P_{cr1}* (kN)	P_{cr2}* (kN)	P_{cr3*} (kN)	€*
PCSS08	742	82.8	3653.0	931	0.25
PCSS12	825	92.8	7424.0	1082	0.15
PCSS16	881	92.8	13169.2	1221	0.10

Where:
P_{cr1} = ultimate load for the first case
P_{cr2} = ultimate load for the second case
P_{cr3} = actual ultimate load
€ = ratio between P_{cr3} & P_{cr2}

Table 11. Diagonal compression test results

Panel	Test type	1st crack load (kN)	Break load (kN)	Break modality
5.1	Diagonal compression without pre-compression	144	302	Break due to local crushing preceded by diagonal cracking
5.2	Diagonal compression without pre-compression	129	342	Break due to local crushing preceded by diagonal cracking
5.3	Diagonal compression with 30 kN pre-compression	118	332	Break due to local crushing preceded by diagonal cracking
5.4	Diagonal compression with 90 kN pre-compression	168	306	Break due to local crushing preceded by diagonal cracking
C.1	Diagonal compression without pre-compression	103	341	Break due to diagonal stress
C.2	Diagonal compression without pre-compression	137	225	Break due to diagonal stress

Table 12. Results of the tests on joints

Joint	Crack load (kN)	Crack moment (kNm)	Ultimate load (kN)	Ultimate moment (kNm)	Break modality
1.	1.54	-1.06	4.89	3.37	Break of the vertical panel outer face
	-1.90	-1.31	-5.80	-4.00	
2.	1.60	1.01	3.02	2.08	Break by the connecting point between floor panel and vertical panel
	-1.23	-0.86	-3.40	-2.34	

Table 13. Static test on floor

Increase No.	Nominal load uniformly distributed on the loaded floor (kgf/m^2)	Increase No.	Nominal load uniformly distributed on the loaded floor (kgf/m^2)
0.	80	11.	1120
1.	160	12.	1220
2.	240	13.	1320
3.	320	14.	1420
4.	420	15.	1520
5.	520	16.	1620
6.	620	17.	1720
7.	720	18.	1820
8.	820	19.	1920
9.	920	20.	2000
10.	1020		

**The above tables should be read in conjunction with the Test reports available with the PAC Holder/BMTPC*