Prospective Construction Systems for Mass Housing

No.
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TECHNOLOGY PROFILE

Expanded Polystyrene Core Panel System

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation
Government of India
New Delhi

SYSTEM IN BRIEF

Polystyrene Core Panel System is based on factory made panels, consisting of self extinguishing expanded polystyrene sheet (generally corrugated) with minimum density of 15Kg/m^3 and thickness not less than 60 mm, sandwitched between two engineered sheet of welded wire fabric mesh, made of high strength galvanized wire of 2.5 mm to 3 mm dia. A 3 mm – 4 mm dia galvanized steel truss wire is pierced completely through the polystyrene core at the offset angle for superior strength and welded to each of the outer layer sheet of steel welded wire fabric mesh. The panels are finished on the site using coat of minimum 30 mm thick shortcrete (1:4) applied under pressure.
(See Fig. 1)

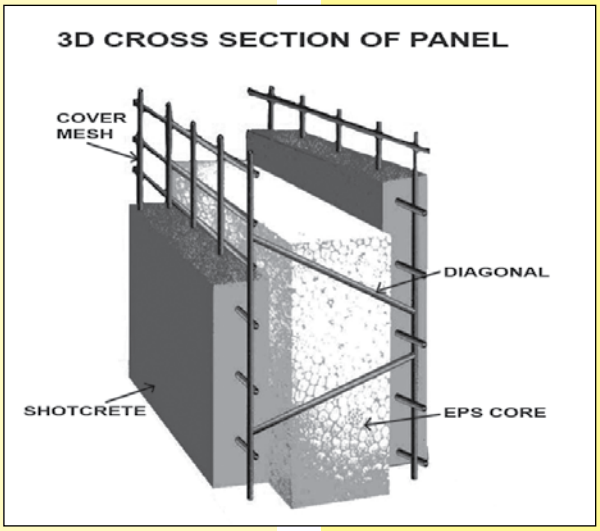
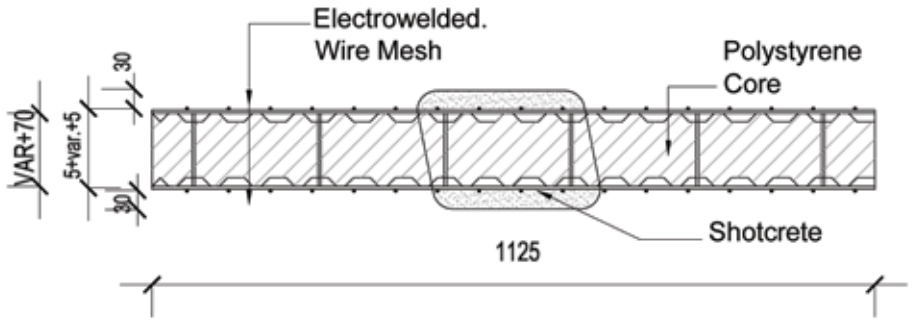
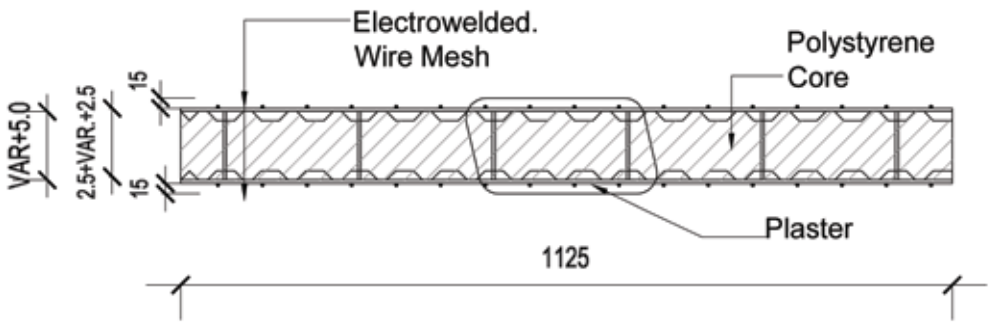


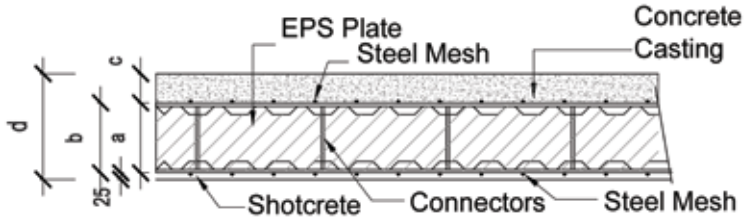
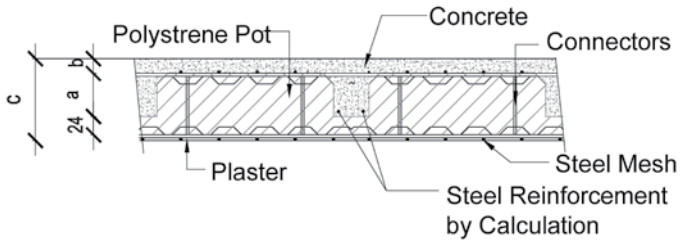
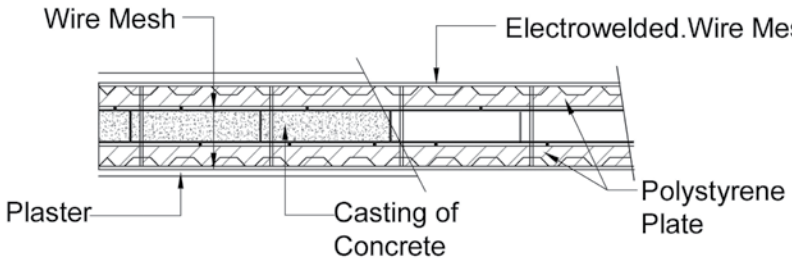
Fig. 1

The technology (developed about 30 years back) is now in use successfully in many other countries like Morocco, Algeria, South Africa, Kenya, Austria, Malasiya, Ireland, Romania & Australia with involvement of different agencies and brand names.

PANEL TYPES

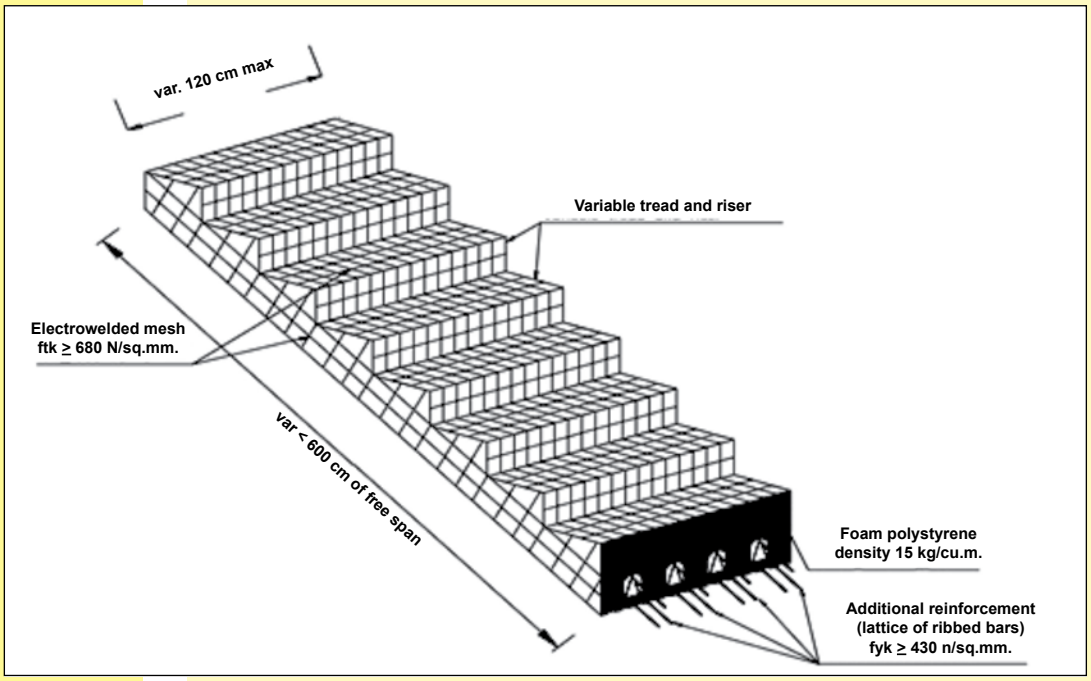
The Panels manufactured are of different types depending upon the application. The details of the different types of typical panels are given below:

Types of Panel	Longitudinal wire	Transverse Wire	Cross Steel Wire	Polystyrene Core	Finished Masonry
Single Panel for structural uses	2.5 mm / 3.5 mm ø spaced @ 65 mm	2.5 mm ø spaced @ 65 mm	3.0 mm ø approx 68 nos. / m^2	Density >15 Kg/ m^3 Thickness not less than 60 mm	Not less than 130 mm
					
Single Panel for Internal partition, external walls and insulation	2.5 mm ø spaced @ 70 mm	2.5 mm ø spaced @ 70 mm	3.0 mm ø approx 68 nos. / m^2	Density > 15 Kg/m^3 Thickness 40 mm to 320 mm	90 mm to 370 mm
					

Types of Panel	Longitudinal wire	Transverse Wire	Cross Steel Wire	Polystyrene Core	Finished Masonry
Single Panel for horizontal structure for floor/ roof	3.5 mm / 4.5 mm spaced @ 65 mm	2.5 mm ø spaced @ 65 mm	3.0 mm ø approx 68 nos. / m^2	Density 15 - 25 Kg/m^3 Thickness 80 mm to 160 mm	155 mm to 235 mm
					
	a = EPS Nominal Thickness (variable between 80 mm to 160 mm); b = Distance between thickness steel meshes (a + 10 mm); c = Concrete thickness (average ≥ 25 mm); d = Total thickness (2xc+a) Generally used for buildings of not more than 4 storeys for floor and covering slabs with maximum span of 4 m.				
Floor Panel with reinforcement at joist	2.5 mm ø spaced @ 70 mm	2.5 mm spaced @ 70 mm	3.0 mm ø approx. 68nos. /m^2	Density > 15 kg/ m^3	
					
	a = thickness of core; b = thickness of concrete; c = overall thickness Panels are used for the floor and the roof system and 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. Suitable upto 8m span with the live load of up to 4 kN/m^2.				
Double Panel					
External mesh	2.5 mm ø spaced @ 65 m	2.5 m ø spaced @ 65 mm	3.0 mm ø approx 68nos. /m^2	Density 25 Kg/m^3 thickness 50 mm to 80 mm	Finished inter-plate thickness 120 mm to 200 mm
					
Internal Mesh	5 mm ø spaced @ 100 mm	5 mm ø spaced @ 260 mm		Density 25kg/m^3 thickness 50 mm to 80 mm	
	Externally the panels are sprayed with traditional pre-mixed cement based plaster. The space between the panels are filled with concrete. It functions as insulating elements as well as formwork.				

CONNECTIONS	
Connecting the wall panel to the concrete substrata	By dowels embedded in concrete
Coplanar panels	By overlapping one row of electro welded mesh and tying using 16 gauge wire.
Walls panels and ceiling panels of intermediate floors	By protruding the inner vertical dowels that connect the upper and lower wall panels through. Then putting corner mesh, tied with 16 gauge wire to the mesh of the lower wall panels as well as to the base mesh of the ceiling panel. Openings for doors & windows etc. are braced using flat mesh at 45° above and below corners of the opening.
Consecutive Floors	Using the same dowels utilized to connect the wall of the first floor to the foundation. Additional reinforcement of electro–welded mesh is provided on edges and diagonal fringe by tying on the inner and outer face of the panels by suitable wire.

Staircase Panel

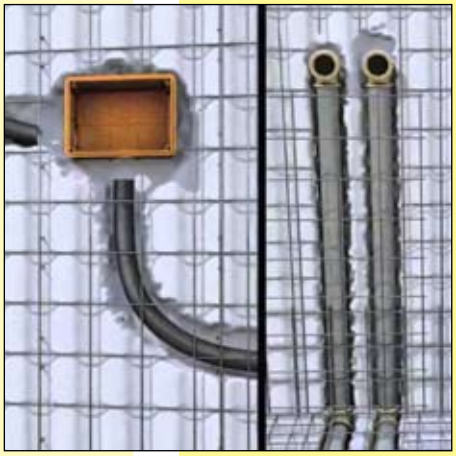


Galvanized steel wire mesh:

Longitudinal wires:	2.5 mm dia
Transversal wires:	2.5 mm dia
Cross steel wire:	3.0 mm dia
Polystyrene slab density:	> 15 kg/m^3

FEATURES OF PANEL SYSTEM	
Load carrying capacity	Numerous lab tests, performed in different parts of the world, have highlighted the high load resistance of the panels which after compression testing with centred load performed on a single finished panel, 2700mm high, have shown that they withstand a maximum load of up to 1530 kN/m ≈ 153 ton/m. The Monolithic joints of the building system provide a high level of structural strength to buildings.
Seismic Performance	The prototype houses tested using both artificial and natural accelerograms with peak values over 1.0g, came through unscathed. Buildings made using panels are particularly lightweight, so have a low seismic mass, but are at the same time rigid due to two sheets of reinforced plaster that interact to create an enveloping 'shell' of the whole structure.
Thermal behaviour	The thickness and density of the panel can be customised to deliver specific thermal insulation requirements. Furthermore, the EPS core extends throughout the surface which makes up the building envelope eliminating thermal bridging. For example, a wall with a 80 mm core and finished thickness of about 15cm provides the same thermal insulation as an insulated solid masonry wall of about 40cm, with obvious advantages in terms of additional space.
Acoustic behaviour	The panel has got good acoustic behaviour, coupling with sound-absorbing materials (such as plasterboard, cork, coconut fibre, rock wool, etc.), further optimizes the acoustic insulation of those walls.
Sustainability and Energy Efficiency	The insulating envelope provided by polystyrene core eliminates thermal bridges and ducts within the panel. This brings high level of energy efficiency. The system provides significant improvements in indoor thermal comfort by greatly reducing energy consumption and promoting strategies aimed at sustainable development.

Fire resistivity	The quality of the expanded foam polystyrene used for panels is self-extinguishing and is perfectly encased by layers of reinforced concrete as external coat to sides of the panel and inhibit combustion. Fire resistance has also been verified in tests performed in various laboratories. For instance, a wall erected using a 80 mm core single panel with 150 mm thickness provides REI* 150 fire resistance, which means that for 150 minutes, the panel can resist fire for 150 minutes with respect to load bearing capacity, integrity and insulation. * *R=Load bearing capacity; E=Integrity; I=Insulation*
Cost effectiveness	Compared to traditional products, panels achieve far better results, at considerably reduced cost. The speedy construction represent additional savings.
Rapid installation	The system has been used in many countries worldwide. The construction experiences using the system show a marked reduction in construction time compared to traditional building methods. Panels are industrialized, and for this reason, assembly processes are optimised, labour is significantly reduced, and construction time decreased by roughly 40%.
Lightness, ease of transport and handling	Being light weight and rigid, panels are both easy to handle and transport even in the most adverse conditions. Prior to an application of shortcrete, a panel weighs between 3.5kg/m^3 to 5 kg/m^3 which means that a single worker can easily handle a 3 m^2 wall, that is, a panel as high as the storey height.
Versatility	The building system gives full design flexibility as it offers a complete range of building elements such as load-bearing walls, curtain walls, floors and stairs. The panels are easy to use in the construction of any type of structure, and can be shaped to any geometric requirement i.e. flat or curved by simple cutting the panels at site.
Compatibility with other existing system	It is an extremely versatile building system which is completely compatible with all other existing construction systems; in fact, panels are even suitable for completing reinforced concrete or steel structures. In addition, panels can be easily anchored to other construction elements, such as steel, wood, and pre-stressed concrete.



Blast resistance	A series of tests has been carried out on a variety of panels finished with different types of high strength concrete. The tests were conducted using a powerful explosive, in a test chamber optimized to produce uniform shock waves on the face of the panels. The panels performed excellently withstanding explosions of 29.5 tons/m^2.
Wide choice of Finishes	Buildings constructed using panels can be completed in a variety of finishes, or can be painted traditionally on smoothed plaster. The surface of the walls has the appearance of a thin sheet of reinforced plaster that can easily accommodate all types of wall coverings including stone tiles and rain screen cladding.
Cyclone resistant	Laboratory tests conducted on buildings, to determine the resistance of cyclone impact and damage caused by wind- borne debris confirm the strength of the building system against such loads. Building constructed in cyclone prone area have shown very high resistance to cyclonic wind.
REQUIREMENTS FOR SETTING UP OF PLANTS	
	The viability depends upon the quantum of work. Generally requirements of 1.5 lakh sqm of panel per year for minimum period of three years makes the plant viable.
PAC ISSUED	
	BMTPC under Performance Appraisal Certification Scheme has evaluated the System by EMMEDUE SPA, Italy and issued Performance Appraisal Certificate No 1010-S/2014 (may be downloaded from website www.bmtpc.org). The systems by any other agency may be required to be verified.

References:

- PAC No. 1010-5/2014 : Performance Appraisal Certificate issued by BMTPC, New Delhi
- Manual on M2 System by EMMEDUE, S.P.A. Italy.
- Manual on Schnell Home, Schnell Wire, Italy.
- Certificate No. 06/0241, Irish Agreement Board, Ireland.
- Technical Report on Experimental Evaluation of Building System M2 by Structure Lab. Department of Engineering, Ponitificia Universidad Catolica Del Peru.
- Review of EVG-3D Technology for residential buildings in India, IIT Mumbai.
- Report on Performance Tests conducted on EMMEDUE Panel System at Hesarghalta, Bangalore Civil Aid Techno Clinic Pvt. Ltd., Bangalore.

About BMTPC

Set up in 1990, Building Materials & Technology Promotion Council (BMTPC) an autonomous organisation under the Ministry of Housing & Urban Poverty Alleviation strives to bridge the gap between laboratory research and field level application in the area of building materials & construction technologies.

Vision
"BMTPC to be world class knowledge and demonstration hub for providing solutions to all with special focus on common man in the area of sustainable building materials, appropriate construction technologies & systems including disaster resistant construction."

Mission
"To work towards a comprehensive and integrated approach for promotion and transfer of potential, cost-effective, environment-friendly, disaster resistant building materials and technologies including locally available materials from lab to land for sustainable development of housing."

For more information, kindly contact:

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