

Emerging Construction Systems



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**Building Materials & Technology
Promotion Council**

Ministry of Housing & Urban Affairs
Government of India
New Delhi





Conventional Construction Systems

The ubiquitous construction systems around the globe are:

Load bearing Structure

In this system, walls are constructed using bricks/stone/block masonry and floor/roof slabs are of RCC/stone/composite or truss. It is cast in-place system commonly known as load bearing system as load of structure is transferred to foundation and then to ground through load bearing walls.

RCC Framed Structure

In this cast in-situ system, the skeleton of a structure is of RCC column and beam with RCC slab. The infill walls can be of bricks/blocks/stone /panels. The load of the structure is transferred through beam and column to the foundation.

Steel framed Structure

Here RCC beam and columns are replaced by hot rolled steel sections.



Emerging Construction Systems

The conventional construction systems are primarily cast in-situ slow pace construction systems and can not meet the present requirement of housing shortage. Therefore, it is judicious to adopt new construction systems which are fast track and deliver quality construction without compromising functional and structural requirements.

These new systems are precast concrete construction, hot and cold form steel construction, large formwork systems, sandwich panel construction, factory made prefabricated systems etc. These systems are being practiced world over and some of the developing countries have successfully met the huge housing demand using them.

It is time that construction fraternity in India take a paradigm shift from slow track system to these fast track emerging systems which are being explained in this handbook in a simple form.

The technical details about these systems can be obtained from BMTPC website.



Formwork Systems

(Engineered Formwork Systems)



Formwork for Monolithic Concrete Construction

- ❖ The conventional mode of construction is cast-in-place RCC framed structure with infill masonry walls using formwork for beam, column & slabs separately, whereas in this system, all walls, floors/slabs, stairs together with door & window openings are cast in-situ monolithically using specifically custom designed modular formwork made up of aluminium/plastics/steel/ composite, for the entire modular unit.
- ❖ The appropriate grade of concrete and reinforcement is used as per design and the entire casting of a modular unit is done in a single pour.
- ❖ Being modular predesigned formwork system, it acts as a assembly line production and enables rapid construction of multiple/mass scale units of repetitive type.



Modular Tunnel form

- ❖ Tunnel formwork is a mechanized system for cellular structures. It is based on two half shells which are placed together to form a room or cell. Several cells make an apartment. With tunnel forms, walls and slab are cast together.
- ❖ The formwork is set up for the day's pour in the morning. The reinforcement and services are positioned and concrete is poured in the afternoon. Once reinforcement is placed, concrete for walls and Slabs shall be poured in one single operation. The formwork is stripped the early morning and positioned for the subsequent phase.
- ❖ Here the walls and slabs are cast in a form of a tunnel leaving two sides open whereas in monolithic concrete construction the entire room is cast in a single pour.



Formwork Systems

(Stay-in-Place Formwork Systems)



Sismo Building Technology

- ❖ Sismo (patented) Building Technology is an insulating shuttering kit for whole building unit based on a three-dimensional lattice made of galvanized steel wire. The lattice is filled with materials of different nature to serve as formwork.
- ❖ The basic structure of the Sismo building module is steel wire lattice. At the exterior sides of the lattice, infill panels are inserted, which transform the lattice into a closed structure that can be filled with concrete.
- ❖ The steel wire also acts as armature and anchoring for the finished material and it holds reinforcement bars in place during concrete filling.
- ❖ The various components of the system are 3D lattice, infill panels, structural filler and finishing.



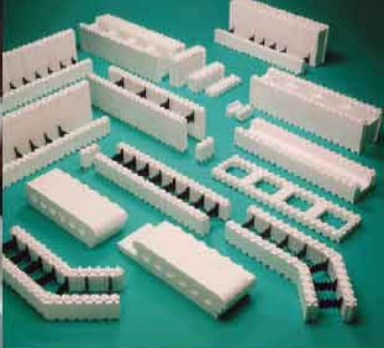
Structural Stay-in-Place Formwork System (Coffor)

- ❖ It is a patented structural stay in place formwork system to build load bearing monolithic concrete wall structures based on shear wall concept.
- ❖ The formwork is composed of two filtering grids comprising of rib meshes which are made up of galvanized plain steel (GP) sheets with a herringbone mesh pattern (rib lath) reinforced by C profile GP sheet vertical stiffeners. These grids are further connected by articulated horizontal MS rebar loops in one direction and Cold Rolled Close Annealed (CRCA) plate/GP horizontal connectors in other direction.
- ❖ After the erection of formwork panels in alignment, corners, edges of door and window frames are closed with rebar positioning & concrete of required Grade is poured in the panels. The concreting may be done with a pump, bucket or with a shovel loader. The inside and outside walls are finished with cement plaster of suitable grade.



Insulating Concrete Forms (ICF)

- ❖ These are formwork systems which are left in the structure after concreting and act as insulation.
- ❖ Insulating concrete Forms (ICF) System is a patented system of M/S Reliable Insupacks (P) Ltd and comprises of a panel of two walls of Expandable Polystyrene (EPS) separated by a nominal distance of 150mm by hard plastic ties. These are assembled on site to hold reinforced concrete.
- ❖ The forms are open ended hollow polystyrene blocks which are fit tightly together through tongue-and-groove to form a shuttering system when joined together. Concrete is poured into the hollow space to form a continuous wall. When cured, this wall supports the structural loads from floors/roofs, and the shuttering provides thermal insulation. Reinforcing steel shall be provided as required from design.



Monolithic Insulated Concrete System (MICS)

- ❖ Monolithic Insulated Concrete System (MICS) is a patented system of M/s Maiwir Ecotech Pvt. Ltd.. It is a formwork system for reinforced concrete made with a rigid thermal insulation that stays in place as a permanent interior and exterior substrate for walls, floors and roofs.
- ❖ This system consists of two layers of modules i.e. Expandable Polystyrene (EPS) separated by hard plastic ties. The modules are interlocking modular units that are dry stacked (without mortar) and filled with cast-in-place concrete. The units lock together and create a form for the structural walls or floors of a building. When cured, the wall supports the structural loads from floors and roofs, and the shuttering provides thermal insulation. Reinforcing steel shall be as required from design.



Lost-in-Place Formwork System

– Plaswall Panel System

- ❖ Plaswall Panel System is a lost in place formwork (patented system of M/s FTS Buildtech Pvt. Ltd), where two fiber cement boards (FCB) of 6mm thickness each are bonded through HIMI (High Impact Molded Inserts) spacers.
- ❖ These panels are erected in situ to produce straight-to-finish panels. A monolithic structure is then created by filling the entire structure with suitable grade of concrete to produce panels for structural applications.
- ❖ Reinforcing steel shall be as required from design. Presently, the fibre cement board (FCB) are imported from Malaysia for use in the construction of structures.



Lost-in-Place Formwork system

– Plasmolite Wall Panels

- ❖ Plasmolite Panels are lost in place formwork system (patented system of M/s FTS Buildtech Pvt. Ltd), where two fibre cement boards (FCB) of 6 mm thickness are bonded together through High Impact Molded Inserts (HIMI) spacers. These panels are erected in situ to produce straight to finish panels which are filled with light weight foam concrete.
- ❖ The thus finished walls may be used as partition walls for external and internal applications and can be integrated with conventional RCC/Steel framed structure.
- ❖ Reinforcing steel shall be as required from design. Presently, the fibre cement board (FCB) are imported from Malaysia for use in the construction of structures.



Precast Sandwich Panel Systems

(EPS based Systems)



Advanced Building System – EMMEDUE

- ❖ EMMEDUE Advanced Building System (patented) is based on factory made panels consisting of self-extinguishing expanded polystyrene core (generally corrugated) sandwiched between two welded wire fabric mesh made of high strength galvanized wire. A galvanized steel truss wire is pierced completely through the core at an offset angle for superior strength and welded to each of outer layer welded wire fabric mesh.
- ❖ The panels are finished at site using shotcrete of mix of cement and coarse aggregate of required thickness on both sides.
- ❖ The panels are used for load bearing walls and floors and suitable upto 3 to 4 storey buildings.



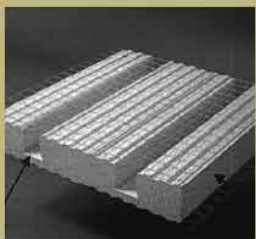
Rapid Panels

- ❖ Rapid Panel is Worldhaus Construction Pvt. Ltd. patented EPS Core Panel System.
- ❖ It is a prefabricated assembly of high-Strength steel wire forming a panel with core of expanded polystyrene (EPS).
- ❖ The basic unit of the Rapid Panel is the zig-zag truss. Steel wire is bent into a zigzag shape to form a continuous chain of web members. This bent wire is then welded to continuous chord wires at every node to form the complete truss.
- ❖ During construction, Rapid Panels are installed as walls and/or slabs. Specified mixtures of mortar or concrete are applied to the surfaces of the panels to complete the structure.



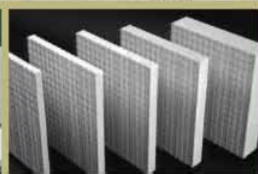
Reinforced EPS Core Panel System

- ❖ Reinforced Expanded Polystyrene Core Panel System is a factory produced sandwich panel system for the construction of low rise buildings up to G+3 and as filler walls in high rise RCC and steel frame buildings. These panels are being produced by Jindal Steel & Power Ltd.
- ❖ A core of undulated polystyrene is covered with interconnected zinc coated welded wire mesh on both sided reinforcement and shotcrete.
- ❖ The panels are finished on site by spraying concrete to realise the different structural elements i.e. Vertical Structural Walls, Horizontal Structural elements (slabs, floors) and non structural cladding elements.



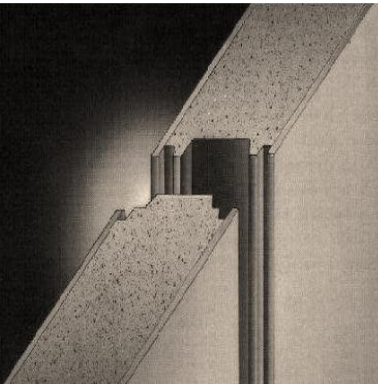
QuickBuild 3D Panels

- ❖ QuikBuild panel system (Patented) of Beardsell Ltd. consists of a welded wire space frame integrated with expanded polystyrene insulation core.
- ❖ The wall panel is placed in position and a wythe of concrete of required thickness is applied to both sides. The wall panel receives its strength and rigidity from the diagonal cross wires welded to the welded-wire fabric on each side.
- ❖ The shell of the structure is built manually by erecting the panels directly onto the slab with protruding reinforcement rods and then finished by plastering with cement using the traditional method or by shotcreting to create a monolithic structure.



Concrewall Panel System

- ❖ The Concrewall is patented system of Schnell Wire System. It comprises of panels of expanded polystyrene (EPS) insulation and steel reinforcement which are site applied with concrete.
- ❖ The Concrewall panel comprises of a layer of welded wire mesh on either side of EPS core welded together by steel orthogonal trusses which penetrates through EPS core. The panels are joined together in a desired configuration on site and sprayed on both sides with shotcrete to form a sandwich type construction.
- ❖ The exterior of the panels may be finished with weather proof coating such as plaster while interior surfaces (walls) and ceilings can either be plastered or lined with conventional lining material.



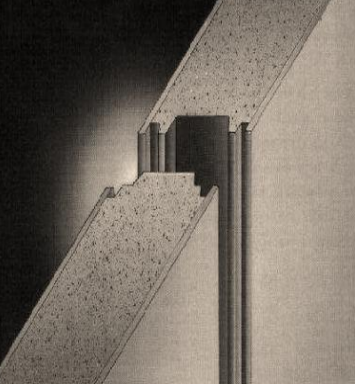
Precast Sandwich Panel Systems

(Other Systems)



Glass Fibre Reinforced Gypsum (GFRG) Panel System

- ❖ GFRG is an integrated composite building system using factory made prefab load bearing cage panels and monolithic cast in-situ RC infilled for walling and floor/roof slabs, suitable for single storey to ten storey building.
- ❖ It is made of calcined gypsum plaster, reinforced with glass fibres and panels manufactured to a thickness of 124mm under carefully controlled conditions to a length of 12m and height of 3m, containing cavities.
- ❖ The panel are being produced at FRBL Kochi and RCF Mumbai and being promoted by IIT Madras.



Prefabricated Fibre Reinforced Sandwich Panels

- ❖ The Prefabricated Fibre Reinforced Sandwich Panels known as Aerocon Panels are patented panels of M/s HIL Ltd. These are sandwich panels, made of two fibre reinforced cement facing sheets, on either sides of a lightweight concrete core.
- ❖ These panels have a unique tongue and groove jointing system that facilitates rapid construction and are fully cured at the factory itself. These panels are manufactured by using Flexo Board (FOB)/ Fibre Cement Board (NT).
- ❖ These panels can be used for variety of applications such as for partitions, cladding, mezzanine floors, boundary walls, etc.



Rising EPS (Beads) Cement Panels

- ❖ Rising EPS (Beads) Cement Panels are patented panels from M/s Rising Japan Infra Pvt. Ltd. These are lightweight composite wall, floor and roof sandwich panels made of thin fiber cement/calcium silicate board as outer and inner faces with a core of EPS granule balls, adhesive, cement, sand, fly ash and other bonding materials in mortar form.
- ❖ The core material in slurry state is pushed under pressure into preset molds. Once set, it shall be moved for curing and ready for use with RCC or steel framed structure.
- ❖ These panels are presently manufactured by the firm in China and shortly a plant will be installed in India.





Light Gauge Steel Structural Systems



Light Gauge Steel Framed Structure (LGSFS)

- ❖ Light Gauge Steel is cold form steel which has an advantage over hot rolled steel as it is lighter in weight and on thin sections of any form can be manufactured.
- ❖ Normally, LGSFS is factory made galvanized light gauge steel components assembled as panels at site and suitable for 3 to 4 storey structures.
- ❖ The infill walls can be of any material ranging from precast boards, blocks, EPS panels or an external layer of insulation material and outer leaf of Cement Particle Board or dry mix shotcrete.
- ❖ The floor/roof can be RCC/Steel truss/Steel deck on joists as per the requirement.



Light Gauge Steel Framed Structure with Infill Concrete Panels (LGSFS-ICP)

- ❖ LGSFS-ICP Technology is a patented technology using factory made Light Gauge Steel Framed Structure (LGSFS). The infill wall comprises of factory made pre-cast panels filled with light weight concrete at site.
- ❖ The LGS frame is a “C” cross-section with built in notch, dimpling, slots, service holes etc. produced by computerized roll forming machine.
- ❖ The frames are assembled using metal screws at site to form wall on a prebuilt concrete floor. The provisions for doors, windows, ventilators and other cut-outs as required are incorporated in the frame. The roof structure is conventional RCC slab.



Steel Structural Systems



Factory Made Fast Track Building System

- ❖ Factory Made Fast Track Modular Building construction system (Patented) is hot rolled steel frame structure with different walling components, manufactured and fabricated in a controlled factory environment.
- ❖ The steel-modules pre-fitted with flooring, ceiling tiles, electrical and plumbing fittings are transported to the site for installation.
- ❖ Once all the components are assembled and erected at site, shotcreting is done on the factory made 3-D Expanded Polystyrene (EPS) panel walls making it a monolithic structure.
- ❖ The floor is composite steel floor deck slab.



Joists

Speed Floor System

- ❖ The Speedfloor (patented) system is a suspended concrete flooring system using a hot rolled steel joist as an integral part of the final concrete and steel composite floor.
- ❖ It is a hybrid concrete/steel tee-beam in one direction and an integrated continuous one-way slab in other direction.
- ❖ The joists of different depths are manufactured from pre-galvanized high tensile steel. These joists are roll formed, punched, pressed and slotted in a fully computerized machine.
- ❖ The joist depth and the concrete thickness are varied depending on the span, imposed loads and other functional considerations and custom manufactured.





Precast Concrete Construction Systems



Waffle-Crete Building System

- ❖ Waffle-Crete Building system consists of large structural ribbed panels of reinforced precast concrete, bolted together and the joints between the panels are caulked to form the walls, floor and pitched or flat roofs of buildings.
- ❖ The surface of each panel consists of 51 mm thick slab or skin, stiffened with the ribs around the perimeter and across the panel, giving an overall panel thickness of 152 mm or 203 mm.
- ❖ The floors are constructed using precast reinforced concrete floor panels supported on precast concrete grade beams.
- ❖ The window & door frames are incorporated into the wall panels during casting or fitted after erection into openings that are formed in the panels during casting.



Precast Large Concrete Panel System

- ❖ Precast Large Construction Panel (PLCP) system is a structural system comprising of various precast elements such as walls, beams, slabs, columns, staircase, landing and customized elements.
- ❖ There are two types of precast concrete elements, namely precast reinforced concrete elements and precast pre-stressed concrete elements, prefabricated in a precast yard or site.
- ❖ The precast elements are installed on site and supported by temporary jacks. Shims are used to carefully align the elements and grouted after the final adjustments.
- ❖ A typical construction involves design, strategic yard planning, lifting, handling, transportation and assembly of precast elements.



Industrialized 3-S system using RCC precast with or without shear walls, columns, beams, Cellular Light Weight Concrete Slabs/Semi-Precast Solid Slab

- ❖ The industrialized total open prefab construction technology is based on factory mass manufactured structural prefab components conforming to norms of IS standards and BIS Certification mark.
- ❖ In this Patented system, precast dense concrete hollow column shell of appropriate size are used in combination with precast dense concrete rectangular T Shape/L shape beams and lightweight reinforced cellular concrete slabs for floors and roofs/semi-precast solid slab with or without shear wall. The hollow columns are grouted with appropriate grade of in-situ concrete.
- ❖ All the connections and jointing of various structures are accomplished through in situ concreting along with secured embedded reinforcement of appropriate size, length and configuration to ensure monolithic continuous resilient ductile behavior.



Walltec Hollowcore Concrete Wall Panels

- ❖ Walltec Hollowcore Concrete Wall Panels of M/s B N Precast Pvt. Ltd. are extruded non-load bearing concrete hollowcore wall panels.
- ❖ These panels are factory produced using light weight concrete made of river sand, crushed stone aggregate, light weight aggregate and Ordinary Portland cement.
- ❖ The concrete are extruded and cut while still wet to the requisite length. Walls have cylindrical hollow cores which helps to reduce weight, facilitate mechanical, electrical and plumbing services through hollows and provide better sound and thermal insulative properties.
- ❖ The sides of all panels are tongued and grooved to facilitate jointing.



Performance Appraisal Certification Scheme -

A Tool to Propagate Innovative and New
Building Materials & Technologies

Performance Appraisal Certificates Issued on Emerging Technologies/Systems

S. No.	Product	Name of Firm	PAC No.
1	Continuous Sandwich Panel	Sintex Industries Ltd, Kalol Gujarat	1002-S/2011
2	Formwork for Monolithic Concrete Construction	Sintex Industries Ltd, Kalol Gujarat	1006-A/2011
3	Glass Fibre Reinforced Gypsum Panel System	Rashtriya Chemicals & Fertilizers Ltd, Mumbai	1008-S/2011
4	Glass Fibre Reinforced Gypsum Panel System	FACT-RCF Building Products Ltd, Kochi	1009-S/2012
5	Factory Made Fast Track Modular Building System	Synergy Thrislington, Mohali	1011-S/2013
6	Advanced Building System Emmedue	BK Chemtech (I) Pvt Ltd, Italy/Bangalore	1010-S/2014
7	Fluorogypsum Based Anhydrite Binder	Navin Fluorine Intl. Ltd., Mumbai	1012M/2014
8	Speedfloor System	Jindal Steel & Power Ltd., New Delhi	1013-S/2014
9	Light Gauge Framed Steel Structure	JB Fabinfra Pvt. Ltd., Gurgaon	1014-S/2014
10	Polystyrene Based Insulation Tile - Kooltile	Reliable Insupacks Pvt. Ltd., Greater Noida	1015-P/2014
11	Insulla Tiles	Japewa Engg. Pvt. Ltd., Chennai	1016-P/2015
12	Bamboowood Flooring	Mutha Industries Pvt. Ltd., Mumbai	1017-P/2015
13	Quick Build Panels	Beardsell Ltd., Chennai	1019-S/2015
14	Modular Tunnelform	Outinord Formworks Pvt. Ltd., Pune	1018-S/2015

S. No.	Product	Name of Firm	PAC No.
15	Reinforced EPS Core Panel System	Jindal Steel & Power Ltd., Gurgaon	1020-S/2015
16	SRPL Building System (Waffle-Crete)	Shaival Reality Pvt. Ltd., Ahmedabad	1021-S/2015
17	Walltec Hollowcore Panel System	B N Precast Pvt. Ltd., Gandhinagar	1022-P/2015
18	Plastic Honeycomb Toilet Structure	Anjani Technoplast, Greater Noida	1023-P/2015
19	Sound Proof Piping System	Huliot Pipes & Fittings Pvt. Ltd., Vadodra	1024-P/2015
20	Sismo Building Technology	M K S Infosolutions Pvt. Ltd., Manesar	1025-S/2016
21	Rapid panels	Worldhaus Construction Pvt. Ltd., Bangaluru	1026-S/2016
22	Precast Large Concrete panel System	Larsen & Toubro Ltd., Mumbai	1027-S/2016
23	LGSFS-ICP Technology	Society for Development of Composites, Bangaluru	1028-S/2016
24	Insulating Concrete Forms	Reliable Insupacks (P) Ltd, Greater Noida	1029-S/2017
25	Prefabricated Fibre Reinforced Sandwich Panels	HIL Ltd., Hyderabad	1030-S/2017
26	Concrewall System	Schnell Home, Italy	1031-S/2017
27	Rising EPS (Beads) Cement Panels	Rising Japan Infra Pvt.Ltd., New Delhi	1032-S/2017
28	Lost-in-Place Formwork system – Plasmolite Wall Panels (For Partition Walls)	M/s FTS Buildtech Pvt. Ltd., Mumbai	1033- S/2018
29	Lost-in-Place Formwork system –Plaswall Panel System (For Structural Applications)	M/s FTS Buildtech Pvt. Ltd., Mumbai	1034-S/2018
30	Structural Stay-in-Place Formwork System	M/s Coffor Construction Technology Pvt. Ltd., Vadodara	1035-S/ 2018
31	Monolithic Insulated Concrete System (MICS)	M/s Maiwir Ecotech Pvt. Ltd., Khammam	1036-S/2018

OBJECTIVES OF BMTPC

- ***Building Materials & Construction Technologies :***
To promote development, standardization, mechanization and large scale field application of proven innovative and emerging building materials and technologies in the construction sector.
- ***Disaster Mitigation & Management :***
Mainstreaming disaster risk reduction in housing, existing and developmental projects.
- ***Capacity Building and Skill Development :***
To work as a Training Resource Centre for capacity building and promotion of good construction practices to professionals, construction agencies, artisans and marketing of building technologies from lab to land.
- ***Project Management & Consultancy :***
To undertake project management and consultancy services encompassing DPR preparation, innovative design consultancy and vetting, appraisal, monitoring, quality assurance and third party inspection of housing projects under the various Central/State Schemes.



ABOUT BMTPC

Setup in 1990, Building Materials & Technology Promotion Council (BMTPC) under the Ministry of Housing & Urban Affairs strives to bridge the gap between laboratory research and field level application in the area of building materials and 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.”





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