नवरीतिः (NAVARITIH)

(New, Affordable, Validated, Research Innovation Technologies for Indian Housing)

Certificate Course on Innovative Construction Technologies

THIRD BATCH

APRIL 30 to MAY 7, 2021

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NAVARITIH : Certificate Course on Innovative Construction Technologies was launched by Hon'ble Prime Minister Shri Narendra Modi during the Foundation Stone Laying of Light House Projects at six locations through video conferencing on January 1, 2021.

Objectives

- *Familiarise* the professionals with the latest materials and technologies being used worldwide for housing.
- Provide an *awareness* of the state of art of materials and technologies in terms of properties, specifications, performance, design and construction methodologies so that professionals can successfully employ these in their day to day practice.
- Provide *exposure* to executed projects where such materials and technologies have been implemented.

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First Batch of NAVARITIH Inaugurated by Shri Durga Shanker Mishra, Secretary, Ministry of Housing & Urban Affairs on 11.2.2021 and conducted from February 12 to 18, 2021 wherein 125 participants participated.

The Second Batch was conducted from March 19 to 26, 2021 wherein 115 participants participated.

Recording of the Inaugural Session available at BMTPC's YouTube Channel.

NAVARITIH: CERTIFICATE COURSE ON INNOVATIVE CONSTRUCTION TECHNOLOGIES

THIRD BATCH – April 30 to May 7, 2021

Time Table for Online Classes

30.4.2021 - DAY 1: Friday		**Session 01**
1730 to 1900 hrs.	Emerging Construction Systems – Introduction, opportunities, challenges	Prof. P.S.N.Rao, Director, SPA
1900 to 2030 hrs.	Emerging construction technologies promoted through PACS/BMTPC/ CPWD/ GHTC-India /MoHUA	Dr.Shailesh Kr. Agrawal, ED, BMTPC
1.5.2021 - DAY 2: Saturday		**Session 02**
1400 to 1530 hrs.	Formwork Systems – Introduction, Concepts and its features, design philosophy	Dr. K. M. Soni, ADG (Retd), CPWD
1530 to 1700 hrs.	GFRG Panel Systems – Introduction, Concepts, construction methodology, implementation and case studies	Prof. A. Meher Prasad, IIT Madras
2.5.2021 - DAY 3: Sunday		**Session 03**
1400 to 1530 hrs.	Stay-In-Place Formwork Systems– Introduction, Concepts and its features	Dr. N. Gopalakrishnan, Director, CBRI
1530 to 1700 hrs.	Stay-In-Place Formwork Systems– Construction methodology, implementation and case studies	Shri Amit Pal, Mahindra Happinest Developers Ltd.
3.5.2021 - DAY 4: Monday		**Session 04**
1730 to 1900 hrs.	Precast Sandwich Panel Systems – Introduction, Concepts, construction methodology, implementation and case studies	Shri S.K. Singh, CBRI Roorkee
4.5.2021 - DAY 5: Tuesday		**Session 05**
1730 to 1900 hrs.	Steel Structural Systems– Introduction, Concepts and its features	Prof. Subrata Chattopadhyay, IIT Kharagpur
1900 to 2030 hrs.	Steel Structural Systems– Construction methodology, implementation and case studies	Prof. Haimanti Banerji, IIT Kharagpur

5.5.2021 - DAY 6: Wednesday		**Session 06**
1730 to 1900 hrs.	Light Gauge Steel Frame Systems– Introduction, Concepts and its features	Prof. M. Madhavan, IIT Hyderabad
1900 to 2030 hrs.	Light Gauge Steel Frame Systems– Construction methodology, implementation and case studies	Prof. M. Madhavan, IIT Hyderabad
6.5.2021 - DAY 7: Thursday		**Session 07**
1730 to 1900 hrs.	Precast Concrete Buildings – Introduction, Concepts and its features	Prof. Amlan K Sengupta, IIT Madras
1900 to 2030 hrs.	Precast Concrete Buildings – Construction methodology, implementation and case studies	Prof. Amlan K Sengupta, IIT Madras
7.5.2021 - DAY 8: Friday		**Session 08**
1730 to 1900 hrs.	3D Precast Volumetric System – Introduction, Concepts and its features	Shri S J Vijay Chairman Salmon Leap and Director hoMMission India
1900 to 2030 hrs.	3D Precast Volumetric System – Construction methodology, implementation and case studies	Shri Siddharth Sharma, M/s SGC Magicrete LLP Ltd.

Note: There will be 15 minutes Q&A Session after every lecture and 10 minutes break between the lectures.

Final Examination: At the end of the course, there will be online examination based on Multiple Choice Questions (MCQ). This may be taken at any time at any day within 45 days after conclusion of the Course i.e. Day 8.

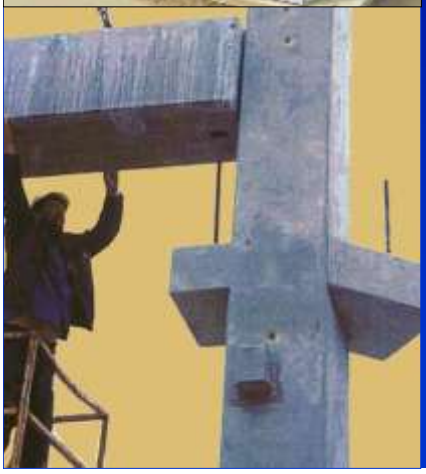
Login with your e-mail id and password

Your DASHBOARD has following sections:

- Notice Board
- Download Course eBook
- Weblink for joining classes
- Reference material
- Reference websites
- Circulars by Government on innovative technologies
- Films on innovative technologies
- Download Presentations and View Recordings of Classes

Final Examination:

At the end of the course, there will be online examination based on Multiple Choice Questions (MCQ). This may be taken at any time at any day within 45 days after conclusion of the Course i.e. Day 7.



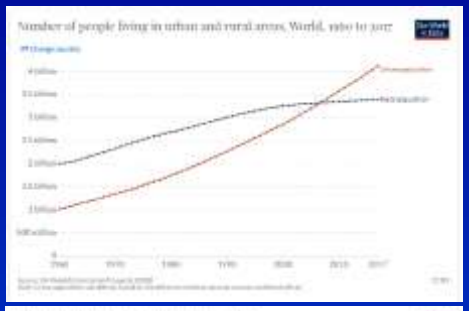
Emerging Construction Systems for Mass Housing

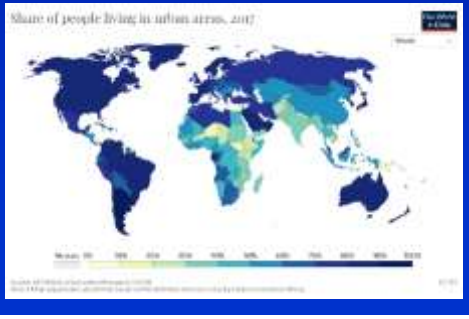
by

Dr. Shailesh Kr. Agrawal
Executive Director

Building Materials & Technology Promotion Council
Ministry of Housing & Urban Affairs
Government of India

How Urban is World?





- More than half (54%) of the world's population now live in urban areas — increasingly in highly-dense cities.
- More than 1 million people per week move into urban areas and more than 4 billion people live in urban areas globally.
- By 2050 it's projected that more than two-thirds of the world population will live in urban areas, i.e. close to 7 billion people.
- For most of human history, populations lived in very low-density rural settings. Urbanization is a trend unique to the past few centuries.
- Asia is going through historic demographic transformation from rural society to urban society. By 2025 majority of Asian population will be urban.
- Just under 1-in-3 people in urban areas globally live in a slum household.

Growing Opportunities with Rapid Urbanization

Source: *UN report on World Urbanisation Prospects (2014 revision)*

To cater to this growing population, India has to build 600-800 million m² urban space every year till 2030 i.e. a new Chicago every year.

- With US $3 trillion GDP, India is one of the largest and fastest growing economies in the world. It is witnessing massive public investment, robust private consumption, and structural reforms leading to rapid growth (> 7%).
- India is poised to become $5 trillion economy by 2022 & aspiring to become a $10 trillion economy by 2030.
- Construction in India is emerging as the third largest sector globally; it may reach US $750 billion in value by 2022.
- Cities, which will contribute over 80% to GDP by 2050, need to be Receptive, Innovative and Productive to foster sustainable growth and ensure better quality of living.
- Hence, a comprehensive strategy of **3-S Mantra** has been adopted: **Skill, Scale and Speed.**

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Present Aim of the Government of India through

PMAY(U) Achievement
11.252 million

BLC	68.69 Lakh
AHP	23.31 Lakh
ISSR	4.54 Lakh
CLSS	15.96 Lakh

प्रधान मंत्री आवास योजना–शहरी
Pradhan Mantri Awas Yojana-Urban

Pradhan Mantri Awas Yojana
Housing for All (Urban)
by 2022

Physical Progress

Grounded 80.2 Lakh
Completed 48.02 Lakh
Occupied 43 Lakh

It is envisaged to construct 11.2 million houses by 2022 in urban area and about 10 million houses in next 3 years in rural areas

(Urban : 2.1 million houses a year, ~6000 houses per day)

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Conventional Construction Systems

business as usual approach

The prevalent construction systems in India 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-situ system and called load bearing system as load of structure is transferred to foundation and then to ground through walls.

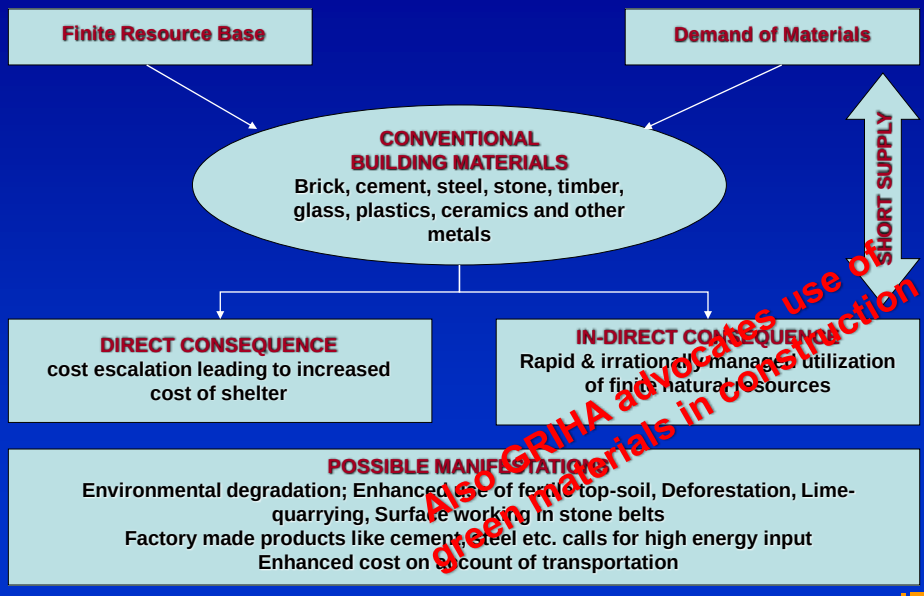
RCC Framed Structure

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.

Conventional Building Materials



Also GRIHA advocates use of green materials in construction

CONVENTIONAL CONSTRCTION SYSTEMS

business as usual approach

- There is too much of dependency on cement, aggregates and water in these traditional constructions. In particular, the fine aggregate (sand) and water to-day are quite scarce.
- It is also seen that, on account of shortage of skilled labour, these constructions today, in general, are not upto the mark in terms of quality.
- In addition, traditional construction cannot be green buildings normally. But green buildings are the order of the day, in view of energy scarcity and, fast depletion of precious natural materials.

SLOW TRACK CONSTRUCTION

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Green Aspects Ignored?

- Resource Efficiency
- Energy Efficiency

- Eco-friendliness
- Health

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business as usual approach

- **Buildings consume**
  - **40% of energy**
  - **25% of water**
  - **40% of resource**

As per UNEP, GHG emissions will double by 2050 as compared to 30% as of today on a business as usual scenario

- **Buildings activities contribute**
  - **50% of air pollution**
  - **42% of GHG emission**
  - **50% of water pollution**
  - **48% of solid wastes**

SOURCE : TERI-GRIHA

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Addressing Challenges of Construction Industry in India

- *How do we stay competitive with volatile raw material prices?*
- *How can we minimize environmental impact and reach sustainable operation?*
- *How can we ensure safety is maintained at the highest standards?*
- *How can we better utilize assets within the value chain and share best practices?*
- *How can we improve site productivity and drive operational efficiency throughout the value chain?*
- *How do we eliminate waste of materials, poor communication, duplication of efforts and errors?*

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Need of the Hour

- Use of renewable resources for building materials
- Use of raw materials resources based on waste products
- Efficient use of existing conventional materials by producing factory made (pre-cast) building components
- Affordability and sustainability
- Industrialization of housing sector

Why New Technologies for Mass Housing?

Speed ?
Quality ?
Safety ?
Sustainability ?
Life Cycle Cost ?
Thermal, Acoustics, Fire?

Sustainable Buildings

- ❖ 30%-50% reduction in energy use
- ❖ 40% reduction in water use
- ❖ 35% reduction in GHG emission
- ❖ 75% reduction in waste

As a professional community of engineers, designers & planners, how many of us at present using

- Building materials which have less dependence on natural resources
- Building materials which are based on agricultural & industrial waste
- Construction systems which optimizes the use of cement, sand & steel i.e. prefab systems, factory made building components
- Less dependence on water, sand, aggregates during construction
- Technologies which are not dependent on fossil fuels
- Zero construction & demolition waste
- Dust free technologies
- Materials & systems based on renewable resources
- Wood substitutes based on plantation timber

Are you aware of

buying a house in a factory & assemble at site
3D printing of house
Prefab, pre-finish Volumetric construction
Water and Cement free Concrete
Reinforced concrete without steel as reinforcement
Bio mimic building materials & components
Zero energy buildings
Building Information Modelling

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Looking Back / Rear view

Levels of Construction Technology

Level 0	Level 1	Level 2	Level 3	Level 4
				
MATERIAL	COMPONENTS	ELEMENTAL OR PLANAR SYSTEMS	VOLUMETRIC SYSTEM	COMPLETE BUILDING SYSTEMS
Basic materials for site-intensive construction ✓ Involves more Labour ✓ Time consuming	Manufactured components ✓ Fabricated in Factory ✓ Can't be build On-site ✓ Assist in construction speed & quality	Linear or 2D components ✓ Series of Pre fabricated elements assembled to form the shell ✓ Requires on-site work	3D components in the form of modules ✓ Volumetric, forms a completed part of the building ✓ Involves more than one trade in the factory	Modular components - fully finished and delivered to site ✓ Finished interior & exterior surfaces ✓ Less on-site work

Source: Gibb., A.G.F., *Off-site Fabrication—Pre-Assembly, Pre-Fabrication, and Modularization*

Courtesy : hou Mission

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D F M A

Design for Manufacture & Assembly

Design for Manufacture
Design for Assembly

Manufacturing of Buildings

Prefabricated Prefinished Volumetric Construction

BUILDING INFORMATION MODELLING

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3D Printed House at Kanchipurum by L & T

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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 call of the day to adopt new construction systems which are fast track and at the same time meet 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 fast track emerging systems.

Emerging Trends in Housing construction

- **Engineered Formwork Systems**
- **Stay-in-Place Formwork Systems**
  - ✓ *Insulating Concrete Formwork Systems*
  - ✓ *Structural stay-in-place Formwork Systems*
- **Precast Sandwich Panel Systems**
  - ✓ *EPS Panel Systems*
  - ✓ *GFRG panel Systems, Cement Panel Systems*
- **Light Gauge Steel Structural Systems**
- **Steel Structural Systems**
- **Precast Concrete Construction Systems**
  - ✓ *3D volumetric construction*
  - ✓ *2D large panel systems*
  - ✓ *Beam, column, components based systems*

Requirements for mass housing

- Quality of construction
- Time required for construction,
- Cost of construction

Quality in any construction

- **Safety of the structure**
  - against anticipated live loads.
  - safety and stability with respect to the prevailing wind loads and with respect to the possible earthquake loads and other loads such as snow, cyclone etc.
- **Performance of the structure during its life span**
  - Thermal efficiency of the construction during summer and winter
  - Acoustics efficiency, Damp proof-ness/water tightness of the construction during rains
  - Efficiency of the joinery systems, Fire resistance characteristics of the structure
- **Durability of the structure**
  - Deterioration of components with age
  - Deterioration of components due to atmospheric pollutions
  - Deterioration of foundation system due to polluted/chemically adverse soil media
  - Life expectancy (*Our normal housing constructions are designed for a life of 60 years and above*)

Speed of Construction

- In the present day context, it has become essential to go in for faster constructions in order to meet the heavy demand and in order to cut down wastage and overhead charges.
- The traditional constructions being adopted around us is basically ‘slow track construction’ and not amenable for mass housing projects.
- On account of the undue time taken, the overheads and wastages are quite high leading to time & cost overruns.

Cost of Construction

Economies of scale also plays an important role while deciding the cost/m^2

BMTPC's Initiative - Emerging Technologies

- BMTPC took an initiative to study/select emerging technologies suitable to Indian geo-climatic conditions.
- Through Global Expression of Interest (EOI)
  - Constituted Technology Advisory Group for identification, evaluation and selection of the suitable technologies/ systems, comprising of eminent experts from Government, CSIR, academic and private agencies.
- Through awarding Performance Appraisal Certification Scheme (PACS- a voluntary scheme of BMTPC)

Broad Parameters for evaluation of technologies

- Suitability to Indian climatic and hazard conditions
- Structural stability including fire safety
- Material specification and its durability
- Thermal and acoustic behaviour
- Green concept
- Joints and connections specially for prefabricated system
- Cost effectiveness of the emerging technologies vis-à-vis conventional construction system (RCC and masonry construction)
- Speed of construction and quality
- Fixing of plumbing & electric services
- Scale of minimum number of houses
- Users' feedback and certification, wherever possible.
- Compatibility and adherence of the system to established standards
- Any shortcoming of the system

Mechanism for Evaluation

- **Collection and review of available data, test reports vis-à-vis requirements as per Indian conditions**
- **Testing from NABL recognized laboratories wherever required**
- **Study of demo construction using emerging technology**
- **Wider consultation through workshops/seminars/exhibitions**
- **Details deliberation by Technical Committee for approval**
- **Recommendation of emerging technology including issue of PACs**

End User Benefits through Technology Intervention

- *Safer and disaster resilient house*
- *Better quality of construction*
- *Low maintenance*
- *Speedy construction resulting in early occupancy*
- *Cost effective and environment friendly*
- *Better fire resistance & thermal efficiency*

Formwork Systems

Formwork is temporary or permanent moulds into which concrete is poured.

- ✓ Traditional timber Formwork
- ✓ Steel Formwork
- ✓ Engineered formwork systems
- ✓ Insulated formwork systems
- ✓ Stay-in-place structural formwork systems

Integral in-situ construction (Mass Housing)

Monolithic Concrete Construction Technology

Fast Track Construction Technology

- **Replacing cast-in-situ Formwork with factory made customized formwork systems**
- **Formwork material is Aluminium / composites / steel having 100 to 500 repetitions**
- **Assembly line construction i.e. placing the formwork, pouring the concrete, moving the formwork to upper level**

Monolithic Concrete Construction Technology

- The conventional mode of construction is RCC framed structure with infill masonry walls 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.
- 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 of units of repetitive type.

Monolithic Concrete Construction

- In the Monolithic concrete construction with aluminium/plastic/stell/composite forms system, Concrete walls and slabs are cast monolithically at one pour.
- The system allows reduction in thickness of concrete members below the minimum value than the conventional construction, thus reducing the consumption of natural resources.
- Single floor with built up area of about 300 sqm. can be completed in two days using the aluminium formwork system.
- The technology reduces the cost of repair and maintenance compared to conventional system.

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Monolithic Concrete Construction

- Walls and slabs are cast in one operation in specially designed light weight form/ moulds in concrete.
- Concrete is poured in the forms & forms are removed after the setting of concrete takes place, resulting in box like cubical structure of required architectural design.
- The pre-designed formwork also acts some sort of assembly line production and enables rapid construction of multiple units of repetitive type.

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A typical plan of one of the mass housing projects

Monolithic Concrete Construction

Monolithic Concrete Construction Technology

Finished 'mass houses' – integral 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 in a single day.
- 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..

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Insulated Concrete Form Work (Reliable Insupack)

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- **Replacing cast-in-situ Formwork with factory made formwork systems**
- **It is sacrificial formwork or lost formwork means formwork is left in the structural system to later act as insulation layer**

Insulated Concrete Form Work

- Insulating concrete Forms (ICF) System 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 fit tightly together to form a shuttering system. Concrete poured into the hollow space to form a continuous wall. When cured, this wall supports the structural loads from floors and roofs, and the shuttering provides thermal insulation. Reinforcing steel is not normally required other than for lintels.

Insulated Concrete Form Work

- Upper and lower surfaces of the polystyrene panels are castellated and the vertical mating surfaces are tongue-and-groove to form a tight fit when joined together.
- The rigid formwork does not require supporting falsework. The inner surfaces have tapered grooves running vertically and have offset on opposite faces to ensure uniform concrete thickness. They also form locks for end stops.
- The outer surfaces are grooved vertically at 50mm centres to aid cutting and trimming

Structural Stay-in-Place Formwork System (Coffor)

- Replacing cast-in-situ Formwork with factory made formwork systems
- It is sacrificial formwork or lost formwork means formwork is left in the structural system to later act as reinforcement (shear/flexure)

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, closing of corners, edges of door and window frames, 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.

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Structural Stay-in-Place Formwork System (Coffor)

- COFFOR is a patented structural stay in place formwork system to build load bearing concrete wall structures, Shear wall concept
- Coffor advantage to pour concrete of wall and slab in one pass allows to create monolithic earthquake resistance structure.
- Coffor Replace Column and Beam structure plus Brick masonry work.
- Coffor Cost = Cost of Frame structure +Cost of Brick masonry.

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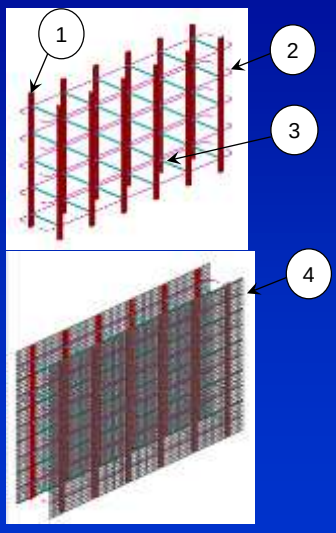
Structural Stay-in-Place Formwork System (Coffor)

COFFOR Materials' specifications



- ***Part – 1: C-Profile***
  - This are vertical stiffeners,
  - They are made up of 0.6 mm thick GP sheet. Galvanization done 140 or 180 GSM
  - Area of profile is 60.6 mm^2 (i.e > 8 mm ϕ tor bar)
- ***Part – 2: Rebar***
  - Rebar's are horizontal stiffeners at every 200 cc
  - They are 5 mm ϕ MS bars of Fe 250 and its work as distribution bar.
- ***Part – 3: Connector***
  - They connects C profile & Rebar.
  - They are made up of 1.6 thick CRCA plate or GP with 120 GSM Galvanization
- ***Part – 4: Rib Mesh***
  - Rib meshes are filtering grids.
  - They are made up of 0.42 mm thick GP sheets, Galvanization 275 GSM or 180 GSM
  - Its prevent crack generated in plaster

Precast Sandwich Panel Systems

- EPS Core Panel Systems
- Other Sandwich Panel Systems
  - Fibre cement board
  - MgO Board
  - AAC panels

- **Replacing brick and mortar walls with dry customized walls made in factory**

Panel Building System using Steel Mesh, Polystyrene Core and Chipping Concrete

- Panel Building system is a load bearing wall construction which is seismic resistant and thermally insulated.
- Buildings of any typology or architectural structure, ranging from most simple to the most complex one, could be constructed.
- The base element of the building system is a modular panel composed of two electro-welded galvanized steel meshes, reciprocally joined by connectors , in the middle of which is a suitably shaped foam polystyrene plate.
- High resistance steel meshes composed of bars having dia. 2.5 to 5 mm. are made in factory. Panels could be supplied with meshes having different dia. and different geometrical characteristics.


AIRMATIC

Concreting of floor

Construction of roof in progress

Application of micro concrete to polystyrene wall panels under progress

Finished construction

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 for 3 to 4 strorey 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 pouring concrete (double panel, floors and stairs) and 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 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.

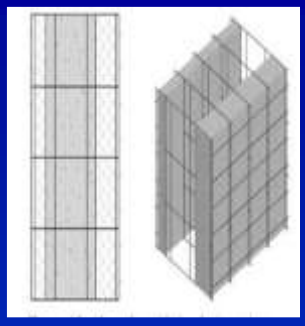
Concrewall Panel System

- 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.

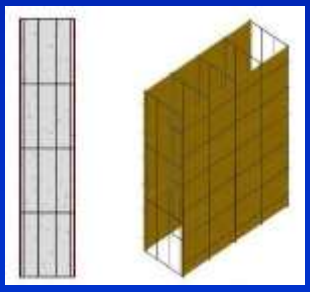
Sismo Building Technology

- Sismo (patented) Building Technology is an insulating shuttering kit for whole building 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.

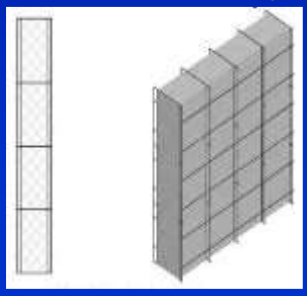
Typical detail of a wall



Inside board & outside insulation strips



Inside & outside board strips



Module with insulation as core

Type of Modules

Depending on the internal and external material, the walls may be divided into following types:

(i) Inside & outside insulation (EPS) strips symmetrical and asymmetrical

(ii) Inside board and outside insulation (EPS) strips

(iii) Inside & outside board strips

(iv) Inside & outside insulation strips

(v) 2 Sismo walls decoupled and insulated for an optimized acoustic performance. This type is typically used as separating wall between apartment and houses.

(vi) Module with insulation strips as core material

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, contains cavities.
- The panel are being produced at FRBL Kochi and RCF Mumbai and being promoted by IIT Madras.

Glass Fibre Reinforced Gypsum (GFRG)/ Rapidwall Building System Technology (evaluated through PACS)

- Glass Fibre Reinforced Gypsum (GFRG)/ Rapidwall is a building panel product, made essentially of gypsum plaster, reinforced with glass fibres.
- Used since 1990 in Australia. Although its main application is in the construction of walls, it can also be used in floor and roof slabs in combination with reinforced concrete.
- The panels may be unfilled, partially filled or fully filled with reinforced concrete as per the structural requirement.

bmtpc

Glass Fibre Reinforced Gypsum (GFRG)/ Rapidwall Building System Technology (evaluated through PACS)..contd.

bmtpc

Steel Structural Systems

- **Light Gauge Steel Structural Systems**
- **Hot Rolled Steel Structural Systems**

- **Replacing cast in situ RCC structural frame with factory made steel (hot rolled) structural system**

Typical Prefab housing

Concept

Design Process

↓

Factory Fabrication of steel Modular Components & EPS Panels

↓

Provisioning of Utilities in between Modular Frames

↓

Transportation to Site

↓

On Site Erection of steel Structure & Infill Panels

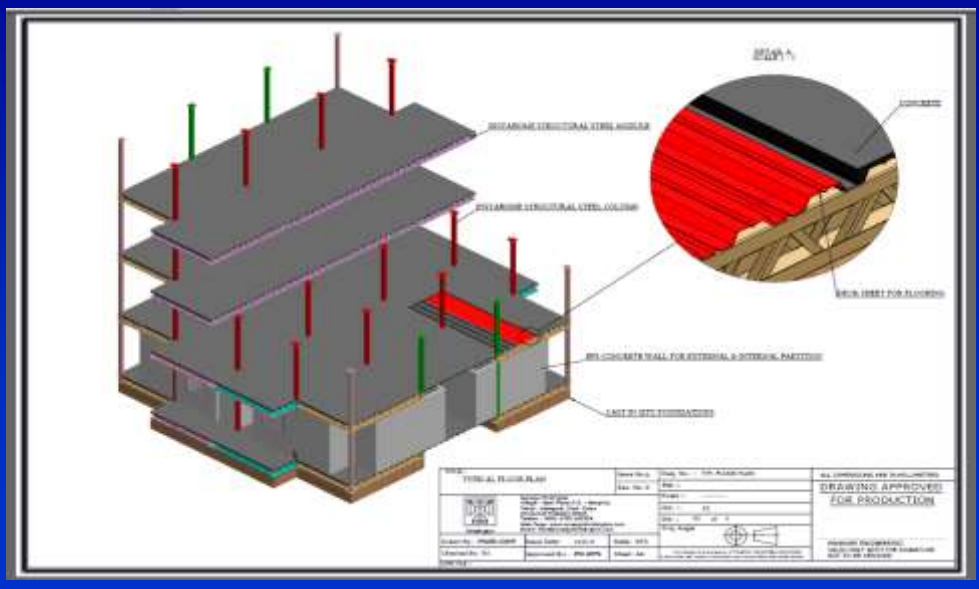
↓

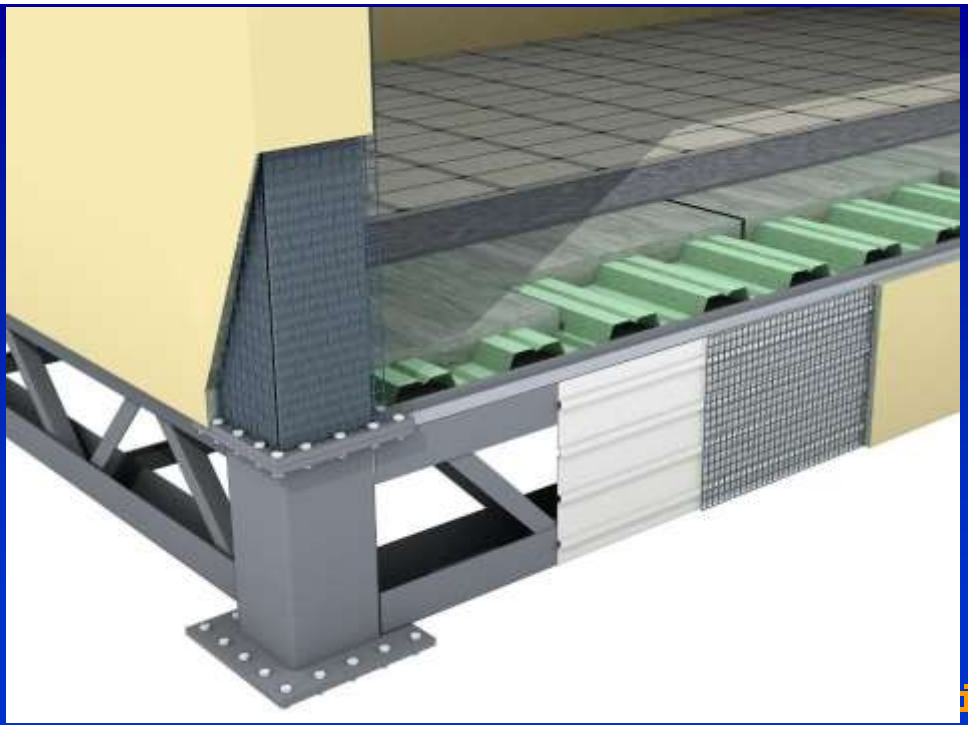
In Situ Concreting

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, shortcreting 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.

INSTAHOME SYSTEM





Steel skeleton with Aerocon panel infills

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.

bmipc

Speed Floor System

- The heart of the system is a roll-formed, galvanised high tensile steel joist 3mm thick.
- The joist is manufactured by roll-former in a single integrated operation.
- The joists are Punched, pressed, pre-cambered and cut to length at a fast production rate.
- Slab is made of concrete.
- By using the steel structures as main frame, there are so many advantages e.g. Cost savings, Faster in completion, Quality, Sustainable construction, Early occupancy, Easy recyclable

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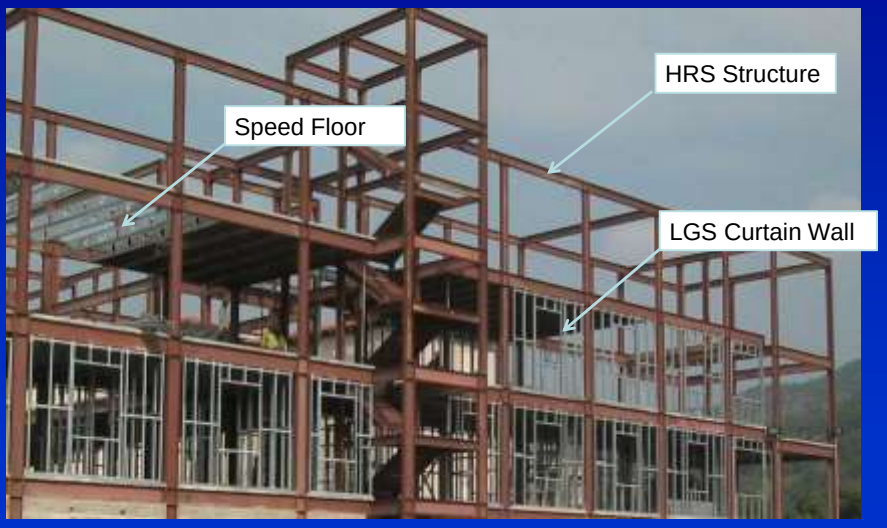
COMBINATION OF HRS ,LGS AND SPEED FLOOR ,FOR DORMITORY BUILDING



Light Gauge Steel Structural Systems

- **Replacing cast in situ RCC structural frame with factory made light gauge steel (cold rolled) structural system**

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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 manufacture.
- 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 CP Board or dry mix shotcrete.
- The floor/roof can be RCC/Steel truss/Steel deck on joists as per the requirement.

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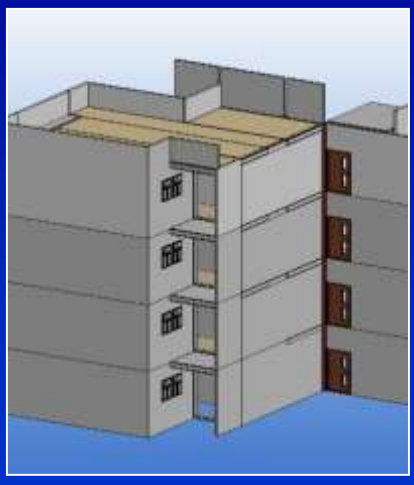
Light Gauge Structure System

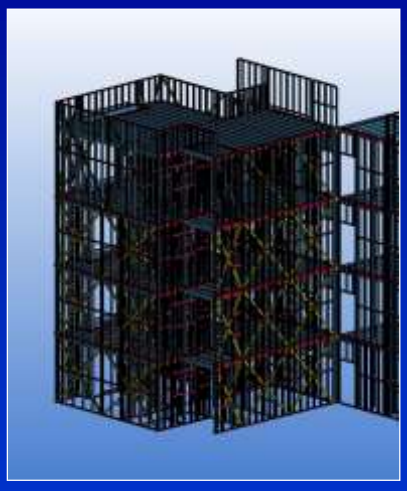
- Frame is made of cold rolled high strength steel sections and EPS panels for walling.
- Internal walls covered with gypsum and cementitious board. Exterior wall Sprayed with cementitious material directly onto the studs.
- Faster construction by prefabricated panels. All structural components are precisely pre-manufactured and simply assembled on site.
- Enhanced Thermal & Acoustic insulation with Boarding/Expanded Polystyrene (EPS) /Rockwool/Vapour Barrier.
- Eco friendly structure. Superior and sustainable performance. Minimum Impact on natural resources.

Composite construction – Light gauge steel skeleton

G+3 – Residential Building



Perspective View



Framing View of the model

Erection

- Tapcon Screw

ERECTION –DIFFERENT STAGES

Composite construction -
In-situ concrete floor and roof

Completed Building

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 precast 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 cutouts as required are incorporated in the frame. The roof structure is conventional RCC slab.

View from top - Composite construction

Precast Concrete Construction Systems

- **Replacing cast in situ RCC structural frame with factory made structural components – 2D / 3D**
- **Customized Factory made beams, columns, wall panels, slab/floors, staircases etc.**
- **Customized factory made volumetric construction i.e. the entire module (room)**

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.

Waffle crete System

- Precast wall-floor panels made from concrete and steel. Anchor bolts, connection bolts, grouts etc. are used in construction.

Casting

- Rebar
  - Fe 415
  - Standard Sizes of Rebar – 12 mm, 16 mm & 20 mm
- Mesh
  - 6 mm mesh at 200 mm c/c
- Concrete
  - M30 grade concrete without flyash
  - Concrete design as per IS 456, SP16
  - No coarse aggregates more than 20 mm size
  - Water-cement ratio : 0.4
  - Mix design with additives to get 10 N/mm2 strength in 18-24 hrs
- Swift Lift Anchor
  - Two anchors in each wall panel
  - Four anchors in each floor panel
  - Spacing of anchor according to cutouts provision in respective panel


Casting Bed Where panels are casted
CONSTRUCTION OF DWELLING UNITS UNDER I.H.S.D.P. FOR
SLUMS FOR Anand Nagarpalika
FP-479,285,287


Bld-1, Survey No-285
Bld-2, Survey No-285
Bld-3, Survey No-285
CONSTRUCTION OF DWELLING UNITS UNDER I.H.S.D.P. FOR
SLUMS FOR Anand Nagarpalika
T.P. 479,285,287


Survey No-287
CONSTRUCTION OF DWELLING UNITS UNDER I.H.S.D.P. FOR
SLUMS FOR Anand Nagarpalika
TP-479,285,287

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.

Concrete components prefabricated in precast yard or site and installed in the building during construction

Assembly of precast concrete elements and in-situ floors and roofs

Assembly of precast concrete elements and in-situ floors and roofs

In-situ floors and roofs

A completed multistorey structure

Industrialized 3-S system using using RCC precast columns, beams & slabs with/without precast RCC shear walls

- 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 autoclaved cellular concrete slabs for floors and roofs. 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.

Industrialized 3-S system using using RCC precast columns, beams & slabs with/without precast RCC shear walls

- 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 system Dense Concrete hollow column shell of appropriate size are used in combination with pre -cast dense concrete rectangular T Shape/L shape beams and lightweight reinforced autoclaved cellular concrete slabs for floors and roofs.
- 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.

Factory set-up at Delhi






OMIPC

Precast yard and factory set-up at Delhi







OMIPC

Industrialized 3-S system using using RCC precast columns, beams & slabs with/without precast RCC shear walls…contd.

Pre-stressed Precast Prefab Technology Using Hollow Core Slab, Beams, Columns, Solid Walls, Stairs, etc.

- Pre-stressed precast RCC technology using hollow core slabs, beams, columns, solid walls, stairs etc. are designed and manufactured in factory, shipped and erected at site.
- Multi-storey precast concrete frames are constructed with columns and beams of different shapes and sizes, stair and elevator shafts and floor slabs.
- The joints between the floors elements are executed in such a way that concentrated loads are distributed over the whole floor. This system is widely used for multi storey buildings.
- The structural frame is commonly composed of rectangular columns of one or more storeys height. The beams are normally rectangular, L-shaped or inverted T-beams. They are single span or cantilever beams, simply supported and pin-connected to the columns. Hollow core floor slabs are by far the most common type of floor slabs in this type of structure.

Pre-stressed Precast Prefab Technology Using Hollow Core Slab, Beams, Columns, Solid Walls, Stairs, etc…contd.



PMAY Project at Naya Raipur, Chhattisgarh

Technology: Hollow Core Slabs and Precast Large RCC Panels




Moducast® System

- The Moducast® System (Mooreliving India Building Solutions LLP) combines a series of modules to create the overall building, this provides complete flexibility in the layout.
- The structure is designed in splitable transportable modules. These panels are assembled on specially designed steel beds and floor concrete is done linking the panels to the floor reinforcement forming a monolithic structure.
- This module is moved to various stages to complete the secondary operations and finishing works just like in a car assembly line. Finished module is then transported to site and erected together to form the final structure. It is suited for low to medium rise mass housing projects.

3D MONOLITHIC VOLUMETRIC Construction

Courtesy :

Typical Offsite construction facility

Robotics & Automation for Prefabricating Precision Components for Buildings

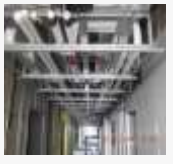
Precast Hollow Core Slabs, Double Walls, Retaining Walls Lift Cores and Mesh Welding

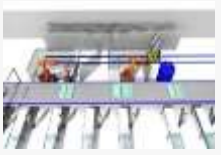
Prefabricated Bathrooms + Modular MEP

Sealant Injection for Aluminum Glazing

Marble and granite cutting and polishing

In-house Design & Engineering Team with Global Expertise





Spraying Machine for Wood Products

Integration and turnkey solution including MEP and finishes
Manufacturing instead of construction
Reduced labor on site
Complete coordination and execution of full scope

Courtesy : KEF Infra

BMTPC under Performance Appraisal Certification Scheme (PACS) Identified, Evaluated, Certified and Promoted New Emerging Technologies

(Gazette Notification No. I-16011/5/99 H-II in the Gazette of India No. 49 dated December 4, 1999)

ENGINEERED FORMWORK SYSTEM

Monolithic Concrete Construction System

Modular Tunnel Form

Identification, Evaluation & Certification of Emerging Technologies

STAY-IN-PLACE FORMWORK SYSTEM


Insulating Concrete Forms


Monolithic Insulated Concrete System


Structural Stay-in-place formwork system (Coffor)


Lost-in-place formwork system- Plaswall Panel system


Lost-in-place formwork system- Plasmolite Wall Panels


Sismo Building Technology


Glass Fibre Reinforced Gypsum Panel System


Stay-In-Place PVC Wall Forms


Permanent Wall Form (PVC)

Identification, Evaluation & Certification of Emerging Technologies

PREFABRICATED SANDWICH PANEL SYSTEM


Advanced Building System – Emmedue


Rapid Panels


Rising EPS (Beads) Cement Panels


Flyash EPS (Beads) Cement Sandwich Panels


Reinforced EPS Core Panel System


QuickBuild 3D Panels


PIR Dry Wall Pre-Fab Panel System


Baupanel System


Concrewall Panel System


Prefabricated Fibre Reinforced Sandwich Panels


V-Infill Wall (Light Weight EPS Wall)


Nano Living System Technology

Identification, Evaluation & Certification of Emerging Technologies

LIGHT GAUGE STEEL STRUCTURAL SYSTEM

Light Gauge Steel Framed Structure (LGSF)

Light Gauge Steel Framed Structure with Infill Concrete Panel Technology

Identification, Evaluation & Certification of Emerging Technologies

PREFABRICATED STEEL STRUCTURAL SYSTEM

Factory Made Fast Track Modular Building System

Speed Floor System

Continuous Sandwich (PUF) Panels With Steel Structure

Identification, Evaluation & Certification of Emerging Technologies

PRECAST CONCRETE CONSTRUCTION SYSTEM


SRPL Building System (Waffle-Crete)


Precast Large Concrete Panel System


Industrialized 3-S system


Walltec Hollowcore Concrete Panel


K-Wall Panels


Robomatic Hollowcore Concrete Wall Panels


Urbanaac Precast Construction Technology


Integrated Hybrid Solution - One

Global Housing Technology Challenge - India (GHTC-I)

https://ghtc-india.gov.in/

Technology	Applicants
Precast Concrete Construction System - 3D Precast volumetric	4
Precast Concrete Construction System – Precast components assembled at site	8
Light Gauge Steel Structural System & Pre-engineered Steel Structural System	16
Prefabricated Sandwich Panel System	9
Monolithic Concrete Construction	9
Stay In Place Formwork System	8
Total	54

Global Housing Technology Challenge - India (GHTC-I)

1 **Precast Concrete Construction System – 3D Volumetric**

1	Pre-cast concrete system with columns, beams, walls, slabs, hollow core slabs & also 3D Volumetric components	Katerra
2	Vertical structural modules cast in Plant/Casting yard are assembled together through casting of floor panel. The unit is transported & installed at site.	Moducast Pvt. Ltd
3	3D Modular casting using steel mould and high performance concrete of building modules in factory. These pods are transported to the construction site & assembled	Magicrete Building Solutions,
4	Modules with 3D Volumetric Precast concrete unit, various units make on house	Ultratech Cement Ltd,

Global Housing Technology Challenge - India (GHTC-I)

2 **Precast Concrete Construction System – Precast components assembled at site**

1	Precast Large Concrete Panel (PLCP) System with structural members (wall, slab etc.) cast in a factory/ casting yard and brought to the building site for erection & assembling	Larsen & Toubro
2	Pre-cast Concrete Structural system comprising of pre-cast column, beam, precast concrete / light weight slab, AAC blocks/ infill concrete walls.	B.G. Shirke Construction Technology Pvt. Ltd
3	Optimal Pre-cast concrete System through structural Analysis, design & equipment support	Elematic India,
4	Precast concrete construction system using precast walls with precast plank floor	PG Setty Construction Technology Pvt Ltd,
5	Precast components comprising of beams, coloumns, staircase, slab, hollow core slab etc. manufactured in plant & erected on site	Teemage
6	Pre-cast sandwich panel system & Light weight Pre cast Light Weight concrete slab	Nordicflex
7	Prefabricated Interlocking Technology (without mortar) with Roofing as Mechnized Precast R.C. Plank & Joist system	Adalakha Associates Pvt. Ltd
8	Large Hollow wall prefab concrete Panel (lightweight, interlocking, concrete panel) using factory produced large standard hollow interlocking concrete block	William Ling,

Global Housing Technology Challenge - India (GHTC-I)

3

Light Gauge Steel Structural System & Pre-engineered Steel Structural System

1	LGS Framing with various walling & roofing options	Mitsumi Housing Pvt. Ltd,
2	LGS Framing with various walling & roofing options	Everest Industries Ltd,
3	LGS Framing with various walling & roofing options	JSW Steel Ltd.,
4	LGS Framing with various walling & roofing options	Society for Development of Composites
5	LGS Framing with various walling & roofing options	Elemente Designer Homes
6	LGS Framing with various walling & roofing options	MGI Infra Pvt. Ltd.,
7	LGS Framing with various walling & roofing options	RCM Prefab Pvt. Ltd,
8	LGS Framing with various walling & roofing options	Nipani Infra and Industries Pvt. Ltd.,
9	LGS Framing with various walling & roofing options	Strawcture Eco
10	LGS Framing with various walling & roofing actions	Visakha Industries Ltd.
11	Prefabricated steel structural system with Dry wall system as AAC panels, PUF panels etc	RCC Infra Ventures Ltd.
12	Hot rolled steel frame with speed floor	Jindal Steel & Power Ltd.
13	Hot rolled steel section with AAC Panels as floor & slab	HIL Ltd.
14	AAC wall and roof panel system to provide integrated solution. AAC products are reinforced and used in both load and non-load bearing applications	Biltech Building Elements Ltd
15	AAC Panels are Wire mesh/ steel reinforced for use as wall & slab. Appears to be non load bearing panels to be used with structural framing.	SCG International India Pvt Ltd
16	Precast Light Weight Hollow-core wall Panel is a non-structural construction material with framed structures.	Pioneer Precast Solutions Private Limited

Global Housing Technology Challenge - India (GHTC-I)

4

Prefabricated Sandwich Panel System

1	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Worldhaus
2	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Bhargav Infrastructure Pvt.Ltd
3	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Rising Japan Infra Private Limited
4	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Bau Panel Systems India Pvt Ltd,
5	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	BK Chemtech Engineering
6	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	MSN Construction
7	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Beardshell Ltd.
8	Pre-fab PIR (Poly-isocyanurate) based Dry Wall Panel System" as non-load bearing wall	Covestro India Pvt. Ltd.,
9	Sandwich panels as wall & slab	Project Etopia Group

Global Housing Technology Challenge - India (GHTC-I)

5

Monolithic Concrete Construction

1	Aluminium formwork system for Monolithic Concrete construction	Maini Scaffold Systems
2	Aluminium formwork system for Monolithic Concrete construction	KumkangKind India Pvt. Ltd
3	Aluminium formwork system for Monolithic Concrete construction	S-form India Pvt. Ltd.,
4	Aluminium formwork system for Monolithic Concrete construction	ATS Infrastructure Ltd.
5	Aluminium formwork system for Monolithic Concrete construction	Innovative housing & Infrastructure Pvt. Ltd
6	Aluminium formwork system for Monolithic Concrete construction	MFS formwork Systems Pvt. Ltd.
7	Aluminium formwork system for Monolithic Concrete construction	Knest Manufacturers LLP
8	'Tunnel form' construction technology, an cast in situ RCC system, based on the use of high-precision, re- usable, room-sized, steel forms or moulds for monolithic concrete construction	Outinord Formworks Pvt. Ltd.
9	Aluminium formwork system for Monolithic Concrete construction	Brilliant Etoile

Global Housing Technology Challenge - India (GHTC-I)

6

Stay In Place Formwork System

1	Expanded-Steel Panel reinforced with all- galvanised Steel Wire-Struts serving both as the load- bearing steel structure and as the stay-in-place steel formwork filled with EPS-alleviated concrete	JK Structure
2	Factory made prefab Glass fibre reinforced Gypsum cage panels suitable for wall & slab with reinforcement & concrete as infill as per the requirement	FACT-RCF Building Products Limited
3	Structural Stay In Place Galvanized Steel formwork system for walling with the same bottom single layer formwork for slabs/ in-situ slab	Coffor Construction Technology Pvt.Ltd
4	Factory produced PVC Stay in place formwork with concrete & reinforcement in walling units with cast insitu RCC Slab	Joseph Jebastin (Novel Assembler)
5	Fully load bearing walls with 150 mm monolithic concrete core sandwiched inside two layers of EPS as walling The forms are open ended hollow polystyrene interlocking blocks which fits together to form shuttering system	Reliable Insupack
6	Ready to use Stay in place polymer formwork, light weight, with flooring slab (combination of ferro cement and natural stone) placed on RCC precast joists)	Kalzen Realty Pvt. Ltd
7	Fast Bloc, Insulated Concrete Form (ICF), acts as formwork for concrete and rebar, Co1oumn/post and beam construction, creating an strong skeleton in the walls.	Fastbloc Building Systems
8	Formwork system "Plaswall with Two fibre cement boards (FCB) & HIMI (High Impact Molded Inserts) bonded between two sheets of FCB in situ and erected to produce a straight-to finish wall with in-situ concrete	FTS Buildtech Pvt.Ltd

Affordable Sustainable Housing Accelerators - India (ASHA-India)

Under GHTC-India, providing Incubation and Acceleration Support to the Potential Future Domestic Technologies under Affordable Sustainable Housing Accelerator (ASHA) – India under two categories:

- ***Pre-Prototype Technologies for Incubation Support***
- ***Post-Prototype Technologies for Acceleration Support***

Affordable Sustainable Housing Accelerators - India (ASHA-India)

S.No.	Company Name	Technology		Technology Brief
1.	Saltech Design Labs Pvt Ltd C2-603, Highrise Hostel, Pandit Deendayal Petroleum University, Raisan Gandhinagar- 382007	Composite material made from plastic and industrial waste		Saltech Design Labs Pvt. Ltd. has have developed a manufacturing process and machines which can transform mixed plastic and industrial waste into composite materials, which can in turn be molded into usable, more cost-effective, and more sustainable alternatives to conventional cement concrete pre-cast pave blocks, kerb stones, and tiles. The composite manufacturing process works with various types of plastic wastes, does not require segregation, and can be employed even in highly contaminated environments.
2.	Green Forms Private Limited Glorifac International Opp. Petrol Pump, Neemka,Tigaon Road, Faridabad- 121004	Polymeric thermal insulation		Glorifac Green Forms is a proven system of formwork for reinforced concrete made with Green Form Polystyrene Resin – a recycled, technically enhanced, and patented thermal insulation foam made with waste materials that stays in-place as a permanent interor and/or exterior substrate. The material is dry stacked, and does not require mortar or concrete filling. It can be used for various kinds of constructions, meets stringent energy efficiency standards, and can withstand natural disasters.
3.	Gohemp Agroventures Pvt. Ltd., Kandwal gaon, near Rishikesh- 246121	Biocrete		The technology utilizes agricultural waste from the hemp processing industry to make hempcrete, a composite concrete, which can replace walling and insulation materials in framed structures. It also lays a foundation for making composite materials with other plant products such as bamboo, mesta, jute etc.
4.	Gouda-Torgerson Humengi Bldg. Sys. Ind. Pvt Ltd 854 Tower B2, Spaze I Tech Tower, Sector 49, Gurgaon- 122001	Humengi mortarless interlocking blocks		Humengi® technology is a low cost, high quality, highly accurate mass-production mortar-less self-interlocking load bearing or non-load bearing CMU system for cheaper, faster, stronger and safer construction. It allows for considerable time, and in-turn, cost reductions in construction by setting new levels of standardization.
5.	Prashak Techno Enterprises Pvt. Ltd. D-101, 10 Kasturkunj, Ics Colony, Bhosale Nagar, Pune- 411007	Habitech – Nivaratantra (housing and sanitation solutions)		Habitech-NivaraTantra® Technology comprises four innovations: a) Compacted-Intermeshing® blocks made from local soil/ash. Its production is entirely green process using simple-to-use equipment, unlike conventional bricks. Blocks have novel structural voids for intermittent horizontal and vertical reinforcement enabling appropriate structural strength, disaster-resilience and obviates use of beams, columns. Voids also enable natural air curtain against temperature, noise-pollution and water penetration. b) Peggable-Contoured® flat roofing structure comprising Joist and contoured pans leading to roof with higher load-bearing capacity and lesser cement. c) Anaerobic Inclined-multi-baffles® system enables better fecal matter digestion. d) Discharged effluent is treated in uniquely constructed-wetland comprising horizontal and sub-surface flow units with scientific hydraulic profile enabling treated water safely discharge- able for irrigation and non-drinking usage.

Affordable Sustainable Housing Accelerators - India (ASHA-India)

S. No.	Company Name	Technology	Technology Brief
1.	Auroville Earth Institute (Hempcrete Builders)	Hempcrete constructin system	A hempcrete-based construction system including interlocking bricks, panels, and composite reinforced elements.
2.	Anant National University	Prefabricated prefinished volumetric construction using recycled plastic	Prefabricated prefinished volumetric construction (PPVC) using recycled plastic & industrial wastes.
3.	Drishtee Foundation	Bamboo low cost housing	Use of treated bamboo for low-cost housing construction, and skilling of local workforce.
4.	Feynman Innovations Pvt. Ltd.	Robotic mobile construction	Construction with a robotic mobile arm and accompanying software.
5.	Favo Construction Technologies Pvt. Ltd.	Construction 3D printing with custom built swarm robotic system	3D printing technology with custom-built wheeled swarm robotic system
6.	Tvasta Manufacturing Solutions Pvt. Ltd.	3D printing in construction	Indigenously developed 3D printing technology for construction.
7.	MICOB Private Limited	3D concrete printer	High performance and mobile 3D concrete printing.
8	Suresh Chawla	Precast panels	Precast panel solutions
9.	Rahul V Ralegaonkar (VNIT, Nagpur)	Sustainable construction material uising agro-industrial by-products	Sustainable construction materials using agro-industrial by-products.
10.	Perumalla Komal (PIDBOSS)	PPVC (prefabricated prefinished Volumetric construction) technology	Prefabricate prefinished volumetric construction (PPVC) technology.
11.	Slab Engineering Private Ltd.	3D volumetric precast technology - design	3D volumetric precast design and construction.

Light House Projects under GHTC-India

Location	Technology	Houses
Indore	Prefabricated Sandwich Panel System	1,024
Rajkot	Monolithic Concrete Construction System	1,144
Chennai	Precast Concrete Construction System-Precast Components Assembled at Site	1,152
Ranchi	Precast Concrete Construction System-3D Pre-Cast Volumetric	1,008
Agartala	Light Gauge Steel Structural System & Pre-Engineered Steel Structural System	1,000
Lucknow	Stay in-place Formwork System	1,040

- GHTC-India was launched to identify and mainstream innovative proven construction technologies from across the globe which are Cost-effective, Climate & Disaster Resilient, Sustainable and Green.
- Shortlisted Technologies will showcase 6 Light House Projects (LHPs) in 6 States through challenge process as **Live Laboratories.**
- **3S** Mantra of Skill, Scale & Speed for superior quality of construction

Ministry of Housing and Urban Affairs
Government of India

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects

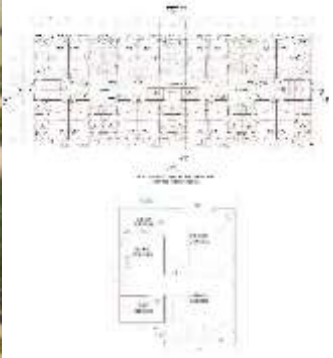
Hon'ble Prime Minister laid the foundation stone of six LHPs on 01.01.2021

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects at INDORE, MADHYA PRADESH

Technology being used:

Prefabricated Sandwich Panel System



No. of Houses	1,024
No. of Floors	S+8
Plot Area	41,920 Sqm.
Per House Carpet Area	29.04 Sqm.
Project Cost	Rs. 128.00 Cr
Per House cost (with infrastructure)	Rs. 12.50 lakhs

Light House Projects at RAJKOT, GUJARAT

Technology being used:

Monolithic Concrete Construction using Tunnel Formwork

No. of Houses	1,144
No. of Floors	S+13
Plot Area	39,599 Sqm.
Per House Carpet Area	39.77 Sqm.
Project Cost	Rs. 118.90 Cr
Per House cost (with infrastructure)	Rs.10.39 lakhs

Light House Projects at LUCKNOW, UTTAR PRADESH

Technology being used:

PVC Stay in Place Formwork System

No. of Houses	1,040
No. of Floors	G+13
Plot Area	20,000 Sqm
Per House Carpet Area	34.5 Sqm
Project Cost	Rs.130.90 Cr
Per House cost (with infrastructure)	Rs.12.58 lakhs

Light House Projects at CHENNAI, TAMIL NADU

Technology being used:

Precast Concrete Construction System

No. of Houses	1,152
No. of Floors	G+5
Plot Area	33,596 Sqm
Per House Carpet Area	26.58 Sqm
Project Cost	Rs. 116.27 Cr
Per House cost (with infrastructure)	Rs.10.09 lakhs

Light House Projects at AGARTALA, TRIPURA

Technology being used:

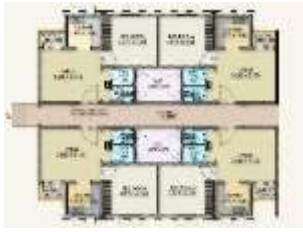
Light Gauge Steel Frame System (LGSF) with Pre-Engineered Steel Structural System

No. of Houses	1,000
No. of Floors	G+6
Plot Area	24,000 Sqm
Per House Carpet Area	30.00 Sqm
Project Cost	Rs.162.50 Cr
Per House cost (with infrastructure)	Rs.16.25 lakhs

Light House Projects at RANCHI, JHARKHAND

Technology being used:

Precast Concrete Construction System – 3D Volumetric



No. of Houses	1,008
No. of Floors	G+8
Plot Area	31,160 Sqm
Per House Carpet Area	29.85 Sqm
Project Cost	Rs.134.00 Cr
Per House cost (with infrastructure)	Rs.13.29 lakhs

Summary of Six Light House Projects (LHPs)

LHP Location			Chennai (Tamil Nadu)	Rajkot (Gujarat)	Indore (Madhya Pradesh)	Ranchi (Jharkhand)	Agartala (Tripura)	Lucknow (Uttar Pradesh)
Sl. No	**Particulars**	**Units**						
1	**Name of Technology**	Name	Precast Concrete Construction System-Precast Components	Monolithic Concrete Construction using Tunnel Formwork	Prefabricated Sandwich Panel System	Precast Concrete Construction System – 3D Volumetric	Light Gauge Steel Frame System (LGSF) with Pre-Engineered Steel Structural System	PVC Stay in Place Formwork System
2	**No. of Houses**	No.	1,152	1,144	1,024	1,008	1,000	1,040
3	**No. of Floors**	No.	G+5	S+13	S+8	G+8	G+6	G+13
4	**Plot Area**	Sqm	33,596	39,599	41,920	31,160	24,000	20,000
5	**Per House Carpet Area**	Sqm	26.58	39.77	29.04	29.85	30.00	34.5
6	**Project Cost**	INR (in Cr)	116.27	118.90	128.00	134.00	162.50	130.90
7	**Per House cost** (with infrastructure)	INR (in Lakh)	10.09	10.39	12.50	13.29	16.25	12.58

Demonstration Housing Projects

Demonstration Housing Project at Gachibowli, Hyderabad, Telangana

Salient Features

1.	Area of Site	1085.00 sq.mts (11674.6 sqfts)
2.	No. of Dwelling units (DUs)	32 Nos. (G+3)
3.	Carpet area each DU	Type A: 38.74 sqmt; Type B: 39.30 sqmt
4.	Built up area of each DU	Type A: 53.18 sqmt.; Type B: 53.10 sqmt.
5.	Total Covered Area	1702.00 sq.mts (18313.52 sqfts)
6.	Technology being used	Structural Stay-in-Place Steel Formwork System (Coffor) (16 Houses) Light Gauge Steel Framed Structure (16 houses)
7.	Dwelling unit comprises of	Two bedrooms, multi-purpose room, kitchen, Two WC & bathroom
8.	Infrastructure components	Internal roads & pavements, Septic Tank, water supply, sewerage, external electrification, Drainage, Landscaping etc.

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Demonstration Housing Project at Gachibowli, Hyderabad, Telangana

Status of Demonstration Housing Project using Coffor and LGSF at Gachibowli, Hyderabad, Telangana

No. of Dwelling Units : 32 (G+3) in two blocks;
Project Cost of Houses including infrastructure: Rs.400.37 lakhs

Carpet Area: Type A: 38.74 sqmt; Type B: 39.50 sqmt

Status of Demonstration Housing Project using Monolithic construction with structural stay in place CR steel specially designed formwork system at Bihar Shariff, Bihar

No. of Dwelling Units : 36 (G+2);
Project Cost of Houses including infrastructure: Rs.393.63 lakhs

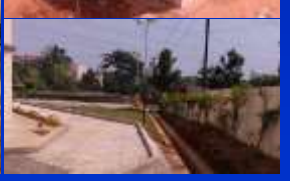
Carpet Area: 29.67 sqm.
Partially funded by NHB & DFID

Demonstration Housing Project at Chandrashekharpur, Bhubaneswar, Odisha

Salient Features

1.	Area of Site	0.43 Acre (1740 sqfts) - allotted by the State Govt.
2.	No. of Dwelling units (DUs)	32 Nos. (G+3)
3.	Carpet area each DU	23.09 sqmt
4.	Built up area of each DU:	34.21 sqmt.
5.	Total Covered Area	1094.76 sq.mts (11779.6 sqfts)
6.	Technology being used	Expanded Polystyrene Core Panel System (EPS) Technology
7.	Dwelling unit comprises of	A bedroom, multi-purpose room, kitchen Alcove, Separate WC & bathroom
8.	Infrastructure components	External water supply, pavers, sewerage system and solar street lights, etc.

Status of Demonstration Housing Project using EPS Core Panel Technology at Chandrashekharpur, Bhubaneswar, Odisha



No. of Dwelling Units : 32 (G+3);
Project Cost of Houses including infrastructure: Rs.235 lakhs

Carpet Area: 23.90 sqm.
Partially funded by NHB & DFID

Demonstration Housing Project at Aurangabad Jagir, Lucknow, Uttar Pradesh

Salient Features

1.	Area of Site	4075.00 sq.mts (43863.3 sqfts)
2.	No. of Dwelling units (DUs)	40 Nos. (G+1)
3.	Carpet area each DU	26.40 sqmt.
4.	Built up area of each DU	40.31 sqmt.
5.	Total Covered Area	1612.4.50 sq.mts (17355.0 sqfts)
6.	Technology being used	Stay in Place EPS based double walled panel System
7.	Dwelling unit comprises of	A bedroom, multi-purpose room, kitchen, Separate WC & bathroom
8.	Infrastructure components	Internal and external roads & pavements, Septic Tank, water supply, sewerage, external electrification, Drainage, Landscaping, Boundary Wall, Bore well, UGT etc.

Status of Demonstration Housing Project using Stay in Place EPS based double walled panel System at Aurangabad Jagir, Lucknow, Uttar Pradesh

No. of Dwelling Units : 40 (G+1);
Project Cost of Houses including infrastructure: Rs.430 lakhs

Carpet Area: 26.40 sqm.
Partially funded by NHB & DFID

Demonstration Housing Project using GFRG Panel System at Saraswathi Nagar, Nellore

No. of Dwelling Units : 36 (G+1); Technology used: GFRG Panel System; Project Cost of Houses and a Community Building : Rs.455 lakhs

Carpet Area: 30.20 sqm.
Cost of construction: Rs.1675 per sqft.

Summary of ongoing Demonstration Housing Projects (DHPs)

S. NO.	Location of the Project	Panchkula (Haryana)	Agartala, (Tripura)	Ahmedabad (Gujarat)	Chimbel (Goa)
1	Usage of the project	Working women hostel (on rental basis)	Rental basis (Shelter for Destitute Women)	To be given to PMAY (U) Beneficiaries	Rental basis (Old Age Home)
2	No. of Dwelling units (DUs)	40 Nos. (G+3)	40 Nos. (G+1)	40 Nos. (G+3)	G+1 - Rooms (single) – 5 nos., Rooms (twin sharing)– 2 nos., Room (triple sharing) – 1 no., Rooms (four sharing) –4 nos., Room (6 sharing) – 1 no., Room (7 sharing) –1 no., Room (10 sharing) - 1 no.
3	Other provisions	Guest Room-1, Medical Room-1, Care Taker Room-1, Daycare Centre-1, Common Room/Dining Room - 1 and Laundry-1	Office -1, Medical Room-1, Care Taker Room-1, Dining Room – 1, Kitchen – 1, Activity Room – 2.	Unit consists of Living room, a Bed room, a Kitchen, a Bath room, a W.C, a Lobby, a Verandah and a Wash area	Activity room (1 no.), Prayer room (1 no.), Dining hall with kitchen (1 no.), Reading room (1 no.), Doctors room (2 nos.), Physio therapy Room (1 no.), Emergency care Room (1 no.), Nurses Room (1 no.), Caretaker Room (1 no.) Rm (1 no.), office (1 no.), Convenience St. (1 no.), lift room (1 no.) and separate toilets for ladies & gents.
4	Plot Area for DHP	1412.36 Sq.mts.	2363.5 Sq.mts.	2372.00 Sq.mts.	2000 Sq.mts
5	Carpet Area of a unit	26.57 Sq.mts.	25.84 Sq.mts.	35.78 Sq.mts	Different Room sizes as per usage
6	Total Built up Area of unit	31.51 Sq.mts.	29.90 Sq.mts.	51.42 Sq.mts (553.28 sqfts)	As per usage
7	Total Covered Area	2015.95 Sq.mts.	1833.74. Sq.mts.	2056.8 Sq.mts.	1954.2 Sq.mts.
8	Technology being Used	Light Gauge Steel Framework System (LGSFS) with Cement Fibre board on both side of walls and infill of rock wool.	Structural Stay In Place Steel Formwork (Coffor)	Integrated Hybrid Solution-One (HIS-ONE)	Light Gauge Steel Framed Structure With Precast Concrete Panels On Both Side Of Wall And Light Weight Concrete As Infill
9	Total Tendered Cost	Rs 520.83 Lakhs	Rs 682.915 Lakhs	Rs 432.87 Lakhs	Rs 518.64 Lakhs
10	Cost per sq.ft (without infra)	Rs 2199.01	Rs 3025.25	Rs 1620.00	Rs 2204.11
	Cost per sq.ft (With infra)	Rs.2401	Rs.3461	Rs.1956	Rs.2467
11	Equivalent Cost (per DU)	Rs.10.80 lakh	Rs.14.80 lakh	Rs.10.80 lakh	Rs.11.52 lakh

DHP at Panchkula : Present Status




Finishing work is on ground floor is under progress. 1st, 2nd and 3rd floors completed. Progress is slowed down due to COVID-19 pandemic.

179

DHP at Agartala : Present Status



Finishing work is in progress. Progress is slowed down due to COVID-19 pandemic.

180

DHP at Ahmedabad : Present Status

Production of components at site

RCC Footing Work in progress

Progress is slowed down due to COVID-19 pandemic.

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DHP at Chimbel, Goa : Present Status

Layout work and cutting of trees under progress. Currently, the premises is being used as vaccination and testing centre for COVID-19. State Govt. has asked contractor to stop the work for time being.

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Details of upcoming Demonstration Housing Projects (DHPs)

S. No.	Location of the Project	Bhopal (Madhya Pradesh)
1	Usage of the project	Rental Basis (Sports Hostel)
2	No. of Dwelling units (DUs)	40 nos. (G+3)
3	Other provisions	Office with Toilet (1 No.), Dining Hall with Kitchen and store (1 No.), Common Room with toilet (1 No.), Medical Room with toilet (1 No.), Care Taker Room (1 No.), Activity Rooms (2 Nos.), Laundry (1 No.)
4	Plot Area for DHP	2709.0 Sqmt.
5	Carpet Area of a unit	29.05 Sq.mts.
6	Total Built up Area of unit	34.15 Sqmt.
7	Total Covered Area	2180 Sq.mts.
8	Technology proposed	One of the technology out of 54 technologies recommended by Ministry of HUA under GHTC-India

Technical Bids are under evaluation and the financial bids will be opened by the end of this week and work will be awarded.

BMTPC Films on Emerging Technologies

Technology Sub-Mission under PMAY-HFA (Urban)

- Ministry of HUPA has set up a Technology Sub-Mission to facilitate adoption of modern, innovative and green technologies and building materials for faster and quality construction of houses.
- Identifying specific solutions and appropriate design considering local conditions and requirements
- Technical training of Planners, Architects and Engineers including artisans
- Identifying and transplanting global best practices with adaptation for local conditions
- Set up mechanisms for testing and accepting materials including new materials in construction

MoUs have been signed with 5 IITs, 13 NITs and 11 Architecture/Planning institutes to support the States in adoption of new Technologies.

Documents published in association with Ministry of HUPA

i. Compendium of Innovative Emerging Technologies shortlisted under GHTC-India
ii. Compendium of Prospective Emerging Technologies for Mass Housing (Third Edition containing 24 New Technologies)
iii. Best Practices : Habitat Planning & Design for the Urban Poor
iv. Compendium of Best Practices in States
v. Model Expression of Interest using Alternate Technology
vi. Multi-Attribute Evaluation Methodology for Selection of Emerging Housing Technologies

Disaster Risk Reduction: A Handbook for Urban Managers:

Objective of this handbook is to help Municipal commissioner and other policy makers understand the concept of risk sensitive planning and ensuring safety against disasters through appropriate implementation of disaster mitigation measures

Adoption of New Technologies by Government Agencies:

- Ministry of Urban Development vide OM No.JS/Works/OM/2016 dt.30.05.2016 has directed CPWD, DDA & NBCC to adopt three new technologies which have been validated by BMTPC at their construction sites initially in Metropolitan cities of India and where the value of works is Rs. 100 crores or more.
- CPWD has also published Schedule of Rates for three technologies namely, Monolithic Concrete Construction, EPS Core Panel System and Light Gauge Steel Framed Structure vide OM No.DG/DSR/010 dt.24.06.2016.
- CPWD has also issued an OM for adoption of three new and emerging technologies in projects/ works of value not less than 100 crores in metropolitan cities on turnkey basis vide OM No.DG/DSR/011 dt.17.08.2016.
- The Ministry of Urban Development vide circular dated December 28, 2016 has notified that these new technologies may be mandatorily adopted for all projects across the country irrespective of location and project cost w.e.f.1.4.2017.
- New technologies have also been included in the recently published National Buildings Code 2016.
- CPWD included in DSR 2016 Prefab Reinforced Concrete Technology as an item No.5.50 to 5.57 vide Correction slip No.6 dated 20.7.2017
- Ministry of Defence has initiated a project for married accommodation with new technologies.
- CPWD included in DSR 2016 various Bamboo based Products under Item No.26.6A to 26.6E.
- Ministry of HUA adopted eight emerging technologies vide OM dated 20.3.2018
- DSR 2018 for New & Innovative Technologies published by CPWD.
- Adoption of New & Emerging Technologies - 54 Technologies shortlisted under GHTC-India, by CPWD vide OM No.17/SE(TAS)/BMTPC/2020/381-H dt.23.9.2020

Adoption of New Technologies by States

AHP houses in Pune, Maharashtra using Precast Construction Technology

- About **15 Lakh houses** are being built using innovative technologies under PMAY(U) & other state schemes.

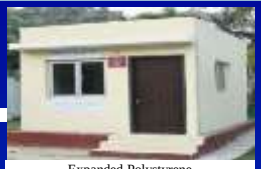
State	Technology
Andhra Pradesh	EPS, Monolithic and Steel Technology
Chhattisgarh	Monolithic and Precast Technology
Gujarat	Monolithic, Precast (Waffle-crete)
Kerala	Glass Fibre Reinforced Gypsum (GFRG)
Maharashtra	Precast (3S) & Monolithic Technology
Odisha	Precast concrete construction
Jharkhand	Global Tender floated
Tamil Nadu	Precast Concrete Technology
States like Assam, Karnataka, Madhya Pradesh, Telangana & Uttarakhand have also expressed interest in Technology neutral bidding process	

54
Alternate technologies Identified

54
technologies approved by CPWD

29
SoRs issued for alternate technologies by CPWD (22+7)

HPL Technology Park propagating New/ Precast Technologies


Expanded Polystyrene


Pre-Engineering Building (PEB)


Transit Shelter using PUF


Prefabricated Timber (Wood) House


Polypropylene Honeycomb Technology


Precast Concrete Technology


Light Gauge Steel


Polyurethane Foam (PUF)


Monolithic Construction


EPS Core Panel
System with Steel Structure


Glass Fibre Reinforced **Gypsum**

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Hon'ble Prime Minister, Shri Narendra Modi, released the Third Edition of Vulnerability Atlas of India on the occasion of Global Housing Technology Challenge - India (GHTC-India), Construction Technology India 2019 Expo-cum-Conference on 2nd March, 2019 at New Delhi.

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Release of Third Edition of Vulnerability Atlas of India by Hon'ble PM

"...कन्स्ट्रक्शन की दुनिया से जुड़े कोई भी हो, सिर्फ बिल्डिंग्स नहीं, कोई भी, ईवन गैस पाइप लाइन डालने वाले भी, इस एटलस को ध्यान में रखते हुए अपनी योजना करें। और मैं सरकार को भी कहूँगा कि अपने टैंडर सिस्टम में भी इसका रैफ्रेन्स लाना चाहिए कि आपने इस एटलस की स्टडी किया है, जहां पर आप काम करने वाले हो, इस एटलस में जिन चीजों को बताया गया है, उसको आप कैसे एड्रेस करने वाले हो..."

– नरेन्द्र मोदी
2 मार्च, 2019

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Ministry of Housing & Urban Affairs, Govt. of India along with School of Planning and Architecture, New Delhi & BMTPC invites you to register for

E-Course on Vulnerability Atlas of India

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E-Course on Vulnerability Atlas of India

This unique e-Course offers…

- Awareness and understanding about natural hazards namely, earthquakes, wind/cyclones, landslides, floods
- Help individuals in evaluation of multi-hazard profile of the region and incorporating them in **DPRs, Design Basis** and **Tenders**
- District-wise damage risk levels to the existing housing stock
- Basic understanding of earthquake, flood & cyclone resistant housing
- Disaster mitigation measures

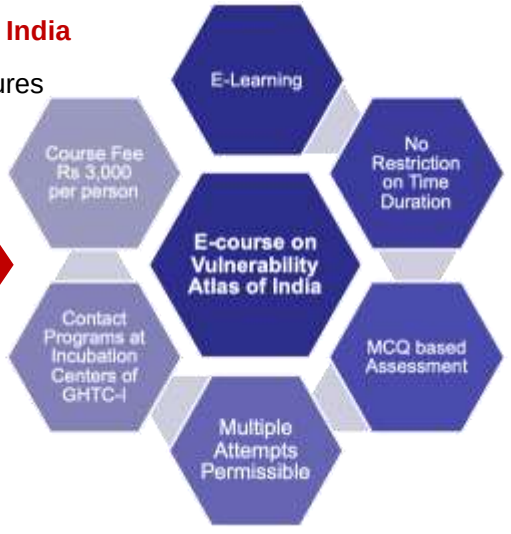
Who can Benefit

- Students/ Faculty/ Practitioners/ Researchers/ Individuals
- Defence/ Central Armed Police Forces
- National/ State Disaster Management Authorities
- Central/ State/ Local Government Officials
- Public/ Private Professionals
- Consulting Organisations, Civil Society Organisations
- Construction Agencies/ Organisations

E-Course on Vulnerability Atlas of India

Salient Features

Fee slashed to Rs.1000/- per person (Rs.500 for students) for limited period upto 30.09.2021
due to global pandemic COVID-19 which has reminded us again the importance of adopting pro-active measures for disaster mitigation & management.



Register for the Course

http://spa.ac.in

https://ecourse.bmtpc.org

Way Forward

- Need to mainstream these technologies into construction industry
- Sensitization, dissemination at Pan India level
- Capacity building, skill development
- Publication of manuals, guidelines, codes, SOR
- Demonstration buildings
- Information, Education and Communication

Let us be part of India's growth story of

Reform, Perform & Transform

bmtpc

www.bmtpc.org

You can reach us at ska@bmtpc.org; info@bmtpc.org;

@bmtpcdelhi

bmtpc.bmtpc

"Creating Enabling Environment for Affordable Housing for All"