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

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

Azadi Ka Amrit Mahotsav

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Light House Projects : LIVE LABORATORIES

WEBINAR SERIES: Volume 3 – International Perspective

e-Learning sessions on innovative techniques in new age construction

Aug – Sep 2023

Volume 3 -Session #02 on Light House Project Chennai, Tamilnadu

Theme – International Perspective Innovative Technologies and Practices in LHPs

Date: 28.08.2023, Monday| Time: 15:00 – 17:00

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Light House Projects : Live Laboratories
Webinar Series

Emerging Construction Systems for Mass Housing

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

PMAY (U) Achievement (provisional)

[as on 14th August, 2023]

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आज़ादी का अमृत महोत्सव

G20 INDIA

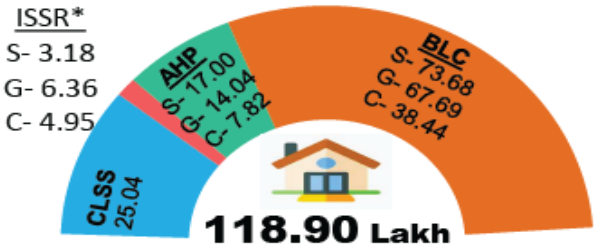
Overall Sanctions for 1.19 crore Houses

Construction of Houses (Nos in lakh)

Demand	Sanctioned	Grounded*	Completed*
112.24	118.90	113.13	76.25

Financial Progress (₹ in Cr)

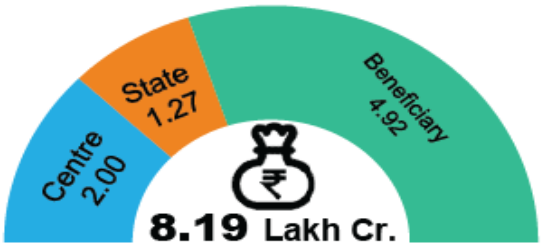
Committed	Released	Expenditure	UC Received
1,99,943	1,48,956	1,42,533	1,42,333



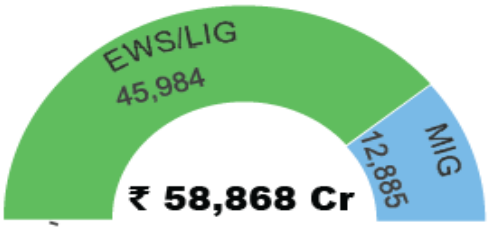
Houses in verticals (Nos in Lakh)

S- Sanctioned G- Grounded C- Completed

Beneficiaries under CLSS (in lakh)



Investment Approved (Rs in Lakh Cr.)



Interest Subsidy under CLSS (Rs in Cr.)

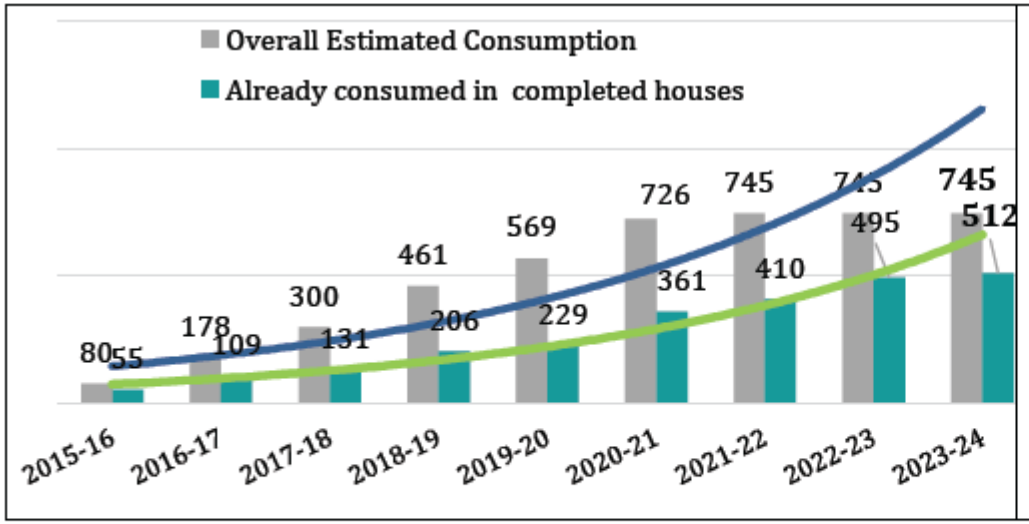
bmtpc

16 lakh houses are being constructed using New Technologies

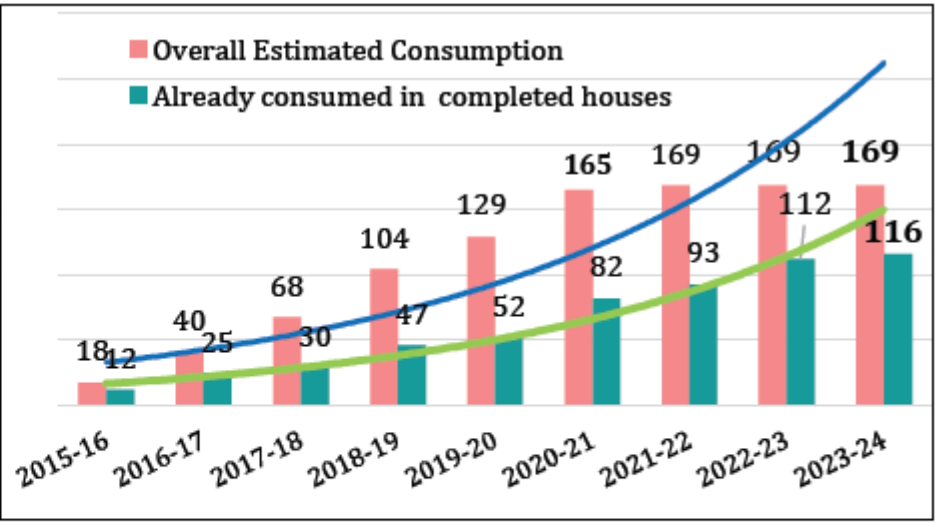
Generation of Employment

Details	Direct	Indirect	Total
Person days (Nos in Cr.)	259	587	**846**
Jobs (in lakh)	93	210	**303**

Cement Consumption (Lakh MT)



Steel Consumption (Lakh MT)

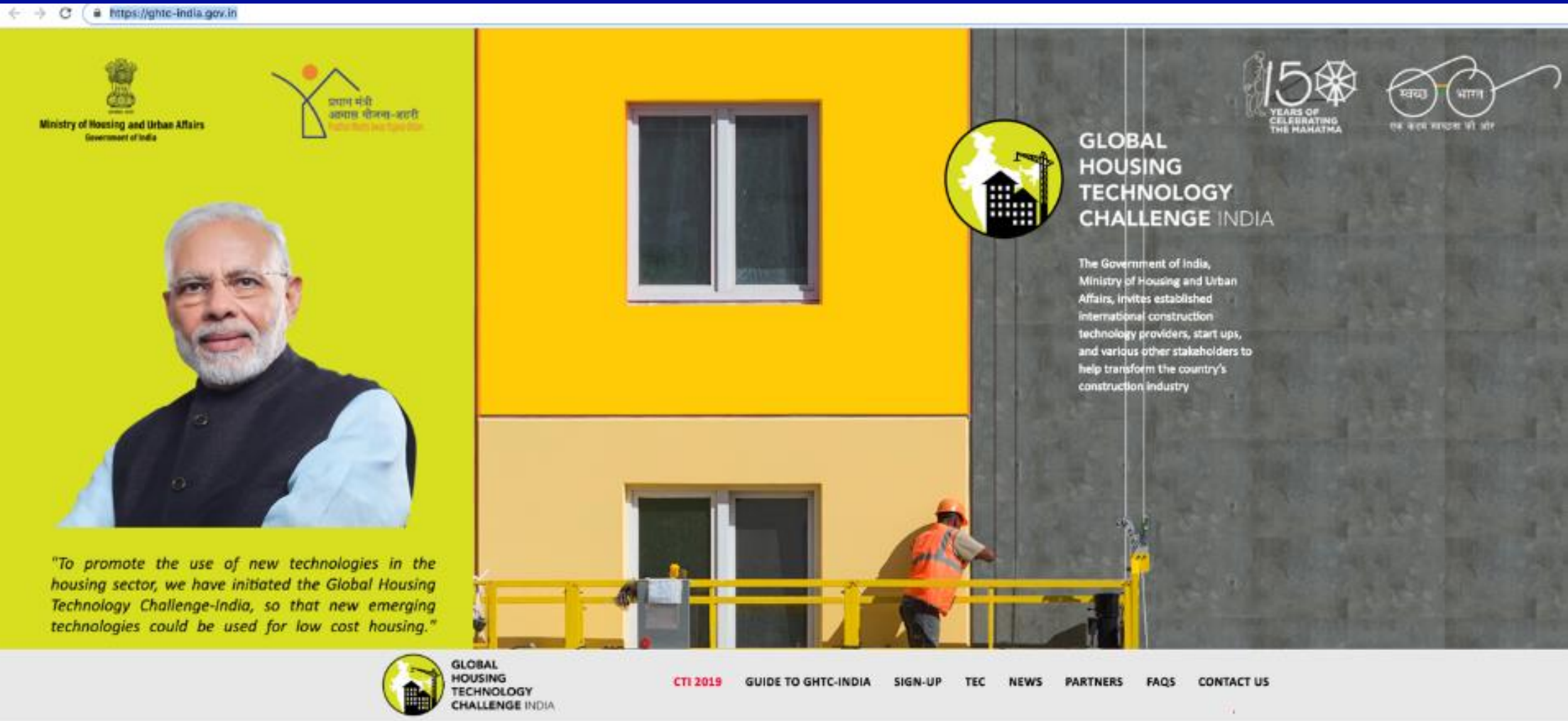


* *includes incomplete works of earlier NURM.*

सबका सपना, घर हो अपना

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Global Housing Technology Challenge - India (GHTC-I)



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

Global Housing Technology Challenge - India (GHTC-I)

Categories	Technology	Tech. Providers
1	***Precast Concrete Construction System - 3D Precast volumetric***	4
2	***Precast Concrete Construction System – Precast components assembled at site***	8
3	***Light Gauge Steel Structural System & Pre-engineered Steel Structural System***	16
4	***Prefabricated Sandwich Panel System***	9
5	***Monolithic Concrete Construction***	9
6	***Stay In Place Formwork System***	8
	Total	**54**

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GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects

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

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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.

Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

3D Precast Volumetric Construction

- Replacing cast in situ RCC structural frame with factory made structural components – 3D
- Customized factory made volumetric construction i.e. the entire module (room)

3D MONOLITHIC VOLUMETRIC Construction

Courtesy :

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

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,

Light House Project (LHP) at Ranchi, Jharkhand

(Technology: Precast Concrete Construction – 3D Volumetric Construction)

No. of Dwelling Units : 1008 Nos. (G+8)
No. of Block / Tower : 7 Blocks
Units in each Block / Tower : 144 Nos.

Light House Project: Ranchi, Jharkhand

Construction Agency	M/s SGC Magicrete LLP
Technology Used	Precast Concrete Construction System – 3D Volumetric
No. of Houses	1,008
No. of Towers	07 (G+8)
Technology brief	• A latest technology where precast concrete **structural modules** like room, toilet, kitchen, bathroom, stairs etc. & any combination of these are cast monolithically in casting yard under controlled condition. • These Modules are **transported and installed** using cranes & push-pull jacks and integrated together at site to form a complete building unit.

Construction Process

1 **Casting of structural modules & slabs in the casting yard**

2 **Placement of modules at site** using cranes

3 **Placement of pre cast floors on already erected structured modules**

4 **Step 2 & 3 are repeated like Lego Blocks to complete a Tower**

2D Precast Concrete Construction

- Replacing cast in situ RCC structural frame with factory made structural components – 2D planar elements
- Customized Factory made beams, columns, wall panels, slab/floors, staircases etc.

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

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,

Light House Project (LHP) at Chennai, Tamil Nadu

(Technology: Precast Concrete Construction System-Precast Components)

No. of Dwelling Units : 1152 Nos. (G+5)
No. of Block / Tower : 12 Blocks
Units in each Block / Tower : 96 Nos.

Light House Project: Chennai, Tamil Nadu

Construction Agency	M/s B.G. Shirke Constriction Private Ltd.
Technology Used	Precast Concrete Construction System - Precast Components Assembled at Site
No. of Houses	1,152
No. of Towers	12 (G+5)
Technology Brief	• Individual **precast building components** (columns & beams, slabs, stairs etc.) are manufactured in the **casting yard** under controlled conditions. • Finished components are then transported to site, erected & assembled through in-situ concreting **(wet jointing).**

Construction Process

1 **Manufacturing** of Pre-cast building components (columns & beams, slabs, stairs etc.) in casting yard

2 **Transportation & Erection** of Pre- cast beams & columns at site

3 **Placement** of pre-cast slabs & **Assembly** through in-situ concreting (wet jointing) with beam and columns

4 **Infill walls** constructed using Autoclaved Aerated Concrete (AAC) Block masonry along with **services** (electricity, plumbing) followed by plastering

PRE-ENGINEERED STEEL STRUCTURAL SYSTEM

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

Steel skeleton with Aerocon panel infills

LIGHT GAUGE STEEL STRUCTURAL SYSTEMS

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

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Global Housing Technology Challenge - India (GHTC-I)

3

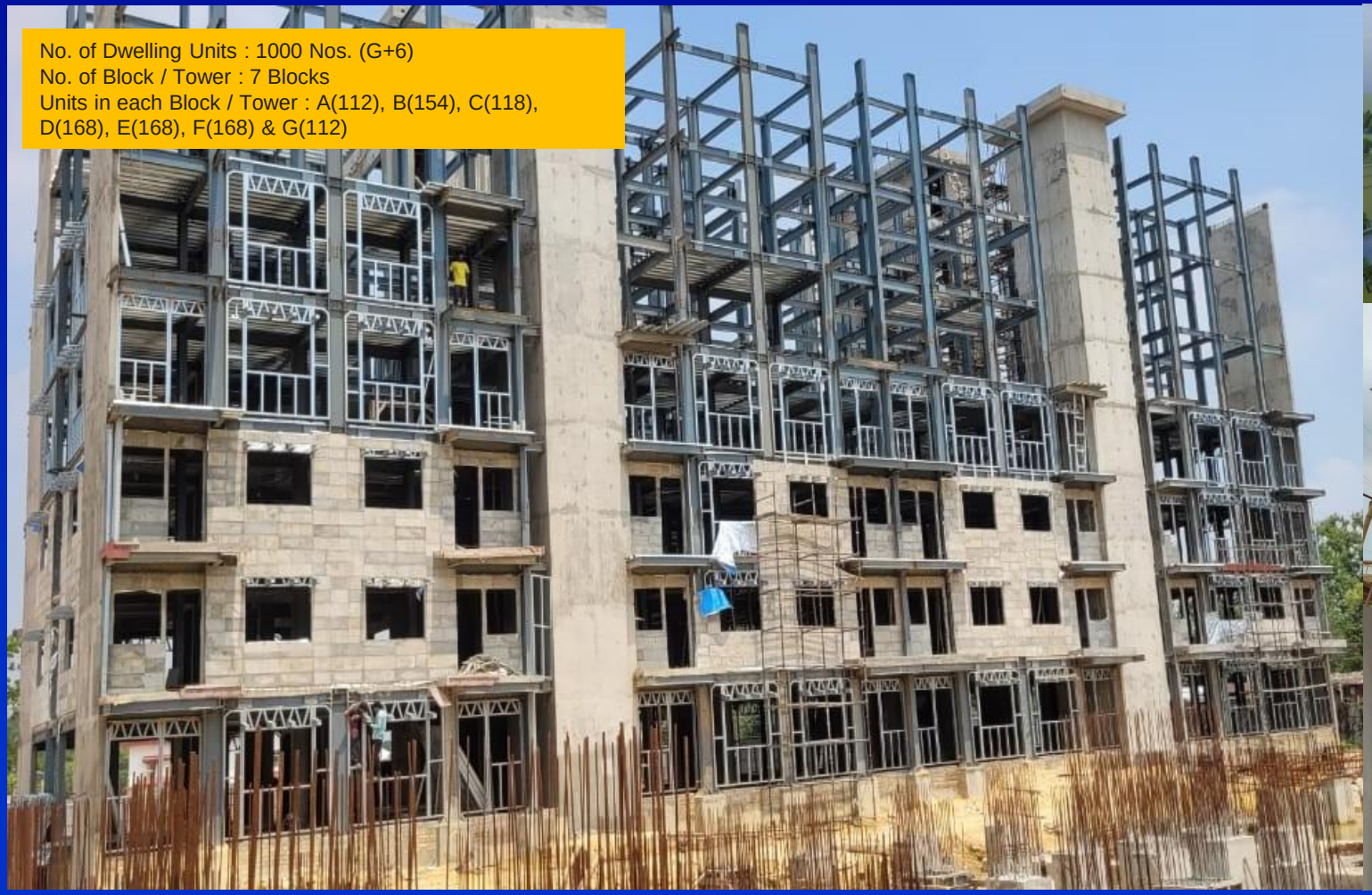
Light Gauge Steel Structural System & Pre-engineered Steel Structural System

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

Light House Project (LHP) at Agartala, Tripura

(Technology: Light Gauge Steel Structural System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1000 Nos. (G+6)
No. of Block / Tower : 7 Blocks
Units in each Block / Tower : A(112), B(154), C(118), D(168), E(168), F(168) & G(112)



Light House Project: Agartala, Tripura

Construction Agency	M/s Mitsumi Housing Pvt. Ltd
Technology Used	Light Gauge Steel Framed (LGSF) System with Pre-engineered Steel Structural System
No. of Houses	1,000
No. of Towers	07 (G+6)
Technology brief	• This system uses factory made galvanized **Light Gauge Steel** wall components in combination with pre-engineered steel structural system for structure • The light gauge steel wall sections are **assembled at site** which are then cladded with concrete panels on both sides and filled with light weight concrete.

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

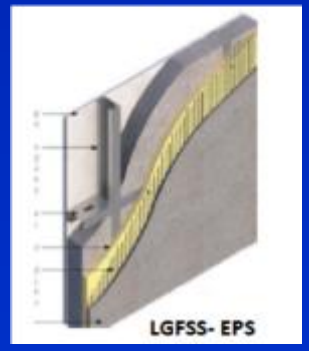
2 **Erection** of factory made **LGSF panels** and **Fixing** of Precast concrete panels for walling

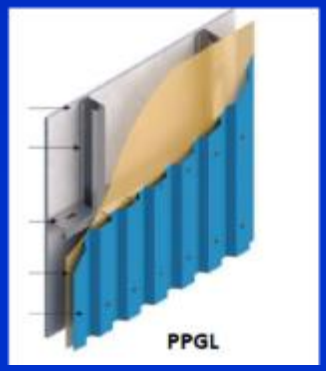
3 **Filling of light weight concrete** between the wall panels

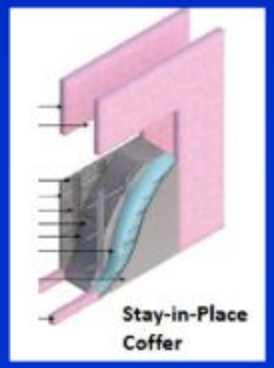
4 **Deck slab installation** in already erected steel structure & **Concreting with services**

PREFABRICATED 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**

SINGLE

DOUBLE

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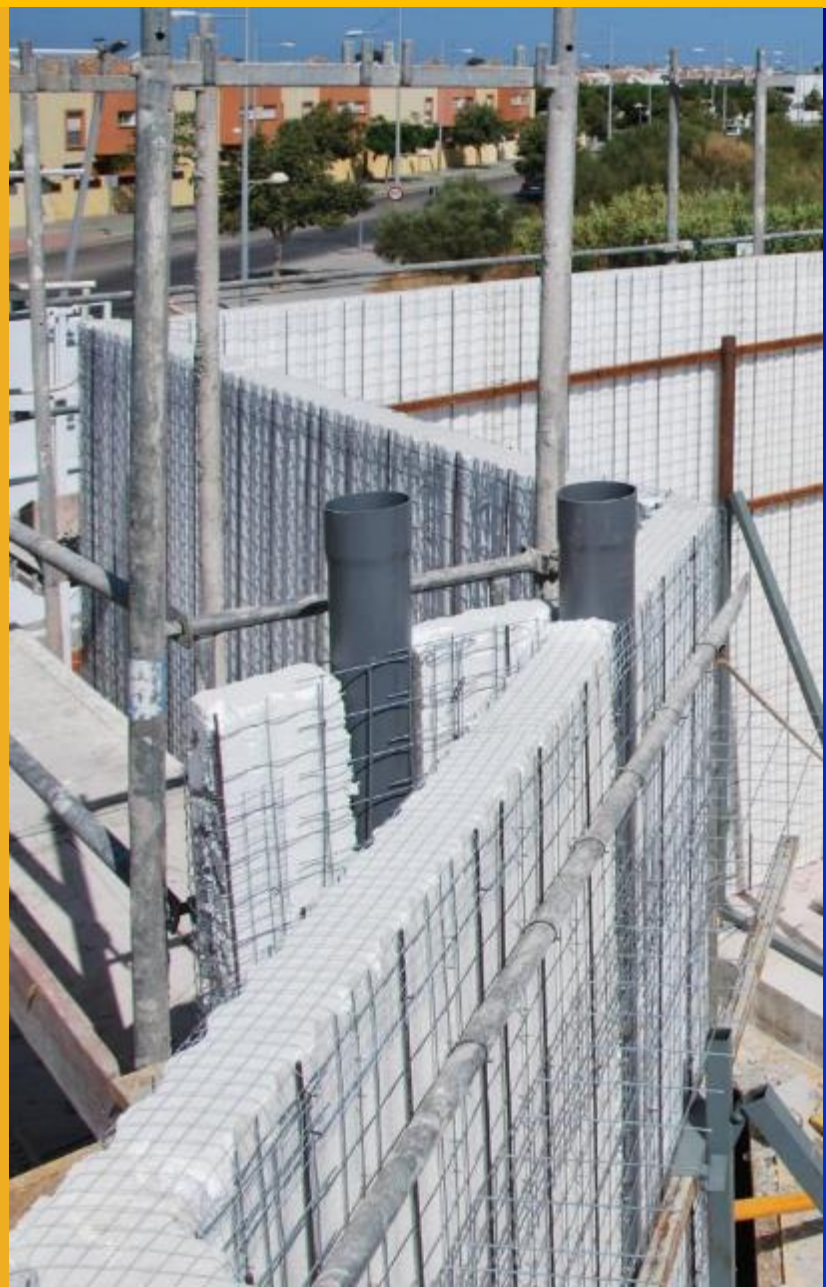
4

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



Light House Project (LHP) at Indore, M.P.

(Technology: Prefabricated Sandwich Panel System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1024 Nos. (S+8)
No. of Block / Tower : 8 Blocks
Units in each Block / Tower : 128 Nos.

Light House Project: Indore, Madhya Pradesh

Construction Agency	M/s KPR Construction Pvt. Ltd
Technology Used	Prefabricated Sandwich Panel System with Pre-Engineered Steel Structural System
No. of Houses	1,024
No of Towers	08 (S+8)
Technology brief	• The **factory-made Prefabricated Sandwich Panel System** comprises of core cement mortar with EPS granules balls sandwiched between calcium silicate boards on both sides. • These panels are being used in combination with **pre-engineered steel structural system as a dry wall construction** in this project.

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

2 **Deck slab installation in already erected steel structure**

3 **Concreting** of deck slabs with reinforcement along with **services**

4 **Factory made Prefabricated sandwich panels** are installed as infilled walls along with services

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 now plants are operational in Pune & Nagpur.

MONOLITHIC CONCRETE CONSTRUCTION

- 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

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

Light House Project (LHP) at Rajkot, Gujarat

(Technology: Monolithic Concrete Construction System)

No. of Dwelling Units : 1144 Nos. (S+13)
No. of Block / Tower : 11 Blocks
Units in each Block / Tower : 104 Nos.

Light House Project: Rajkot, Gujarat

Construction Agency	M/s Malani Construction Co.
Technology Used	Monolithic Concrete Construction using Tunnel Formwork
No. of Houses	1,144
No. of Towers	11 (S+13)
Technology brief	• **Reinforced Concrete walls and slabs** are cast monolithically in single pour (one go) using Tunnel Form work. • It is a customized engineered steel formwork consisting of **two half shells** which are placed together and then **concreting** is done to form a room size module. Several such modules make a house.

Construction Process

1 **Customised Tunnel Formwork** (mould) of steel manufactured in the factory

2 **Placement of Tunnel formwork** in already erected reinforcement cage for walls at site

3 **Placement of slab reinforcement & Concreting** of walls & slabs together in one go along with **services** (electricity,

4 **Infill walls** constructed using Autoclaved Aerated Concrete (AAC) Block followed by plastering

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..

STAY-IN-PLACE FORMWORK SYSTEM

- 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 or reinforcement cage

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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

Light House Project (LHP) at Lucknow, U.P.

(Technology: Stay in-place Formwork System & Pre-Engineered Steel Structural System)

No. of Dwelling Units : 1040 Nos. (S+13)
No. of Block / Tower : 4 Blocks
Units in each Block / Tower : A(494), B(130), C(208) & D(208)

Light House Project: Lucknow, Uttar Pradesh

Construction Agency	M/s Jam Sustainable LLP
Technology Used	Stay in Place PVC Formwork with Pre-Engineered Steel Structural System
No. of Houses	1,040
No. of Towers	04 (S+13)
Technology brief	• Poly-vinyl Chloride (PVC) based permanent stay-in-place form work acting as pre finished walls filled with concrete which requires no plaster and paint • These pre finished walls are used in combination with Pre-Engineered Steel Structural System

Construction Process

1 **Customised steel columns & beams** manufactured in the factory are erected at site

2 **Deck slab installation** in already erected steel structure & **Concreting with services**

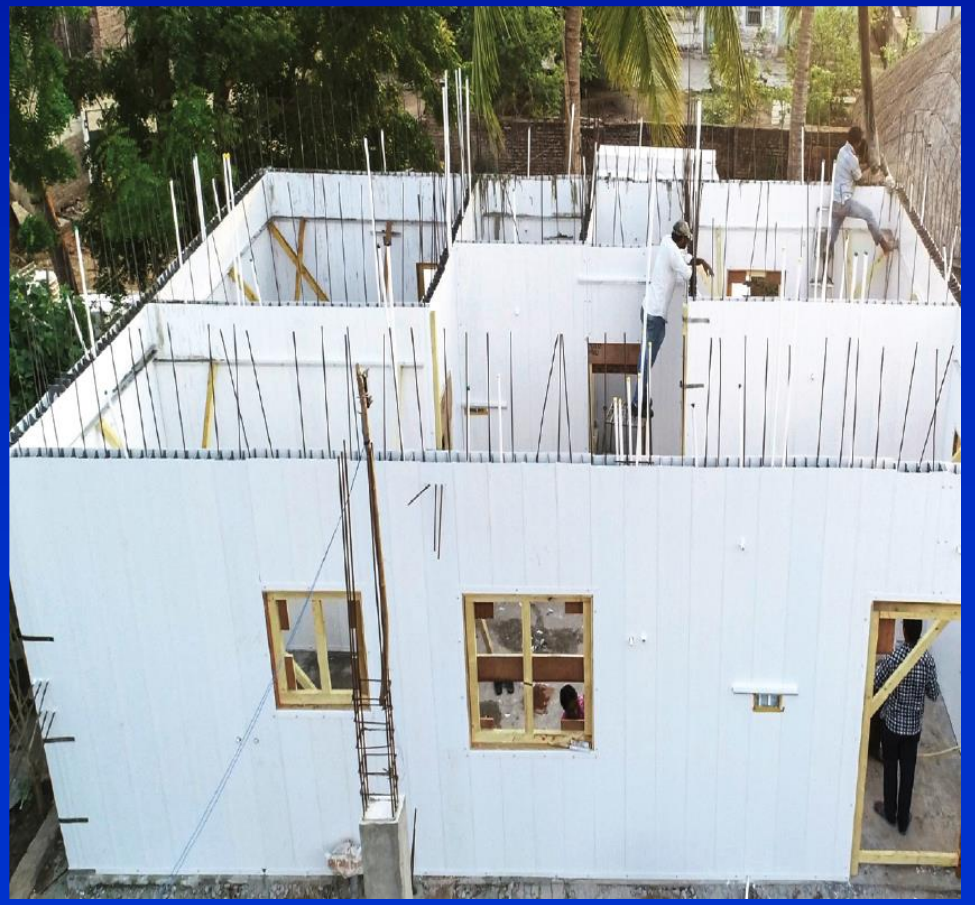
3 **Factory made prefinished PVC Wall forms** are installed as infilled walls along with services

4 **Filling of infill walls with concrete**

Stay-In-Place PVC Wall Forms

- The extruded components slide and interlock together to create continuous formwork with the two faces of the wall connected together by continuous web members forming hollow rectangular components. The web members are punched with oval-shaped cores to allow easy flow of the poured concrete between the components.
- The hollow Novel Wall components are erected and filled with concrete, in situ, to provide a monolithic concrete wall.

- This is a prefinished wall formwork from M/s Novel Assembler Pvt. Ltd. comprising of rigid Poly-Vinyl Chloride (PVC) based polymer components that serve as a permanent stay-in-place durable finished form-work for concrete walls.



Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

Emerging construction systems help to build

SAFER structures

Sustainable Buildings

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

E Economical - low life cycle cost, better quality

R Resilient - disaster-resistant, structurally superior

Adoption of New Technologies by States

AHP houses in Pune, Maharashtra using Precast Construction Technology

- Around **16 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

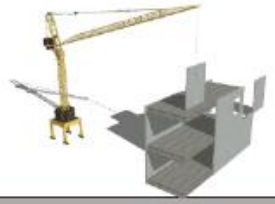
technologies approved by CPWD

34

SoRs issued for alternate technologies by CPWD (27+7)

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 : hoMission Abode All

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"Creating Enabling Environment for Affordable Housing for All"

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Pradhan Mantri Awas Yojana-Urban

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Volume 3 - Session #02 on Light House Project Chennai, Tamil Nadu

Theme – International Perspective Innovative Technologies and Practices in LHPs

Date : 28.08.2023 ,Monday | Time : 15:00 – 17:00

LIGHT HOUSE PROJECT AT CHENNAI

GHTC-India Category:
Precast Concrete Construction System – Precast components assembled at site

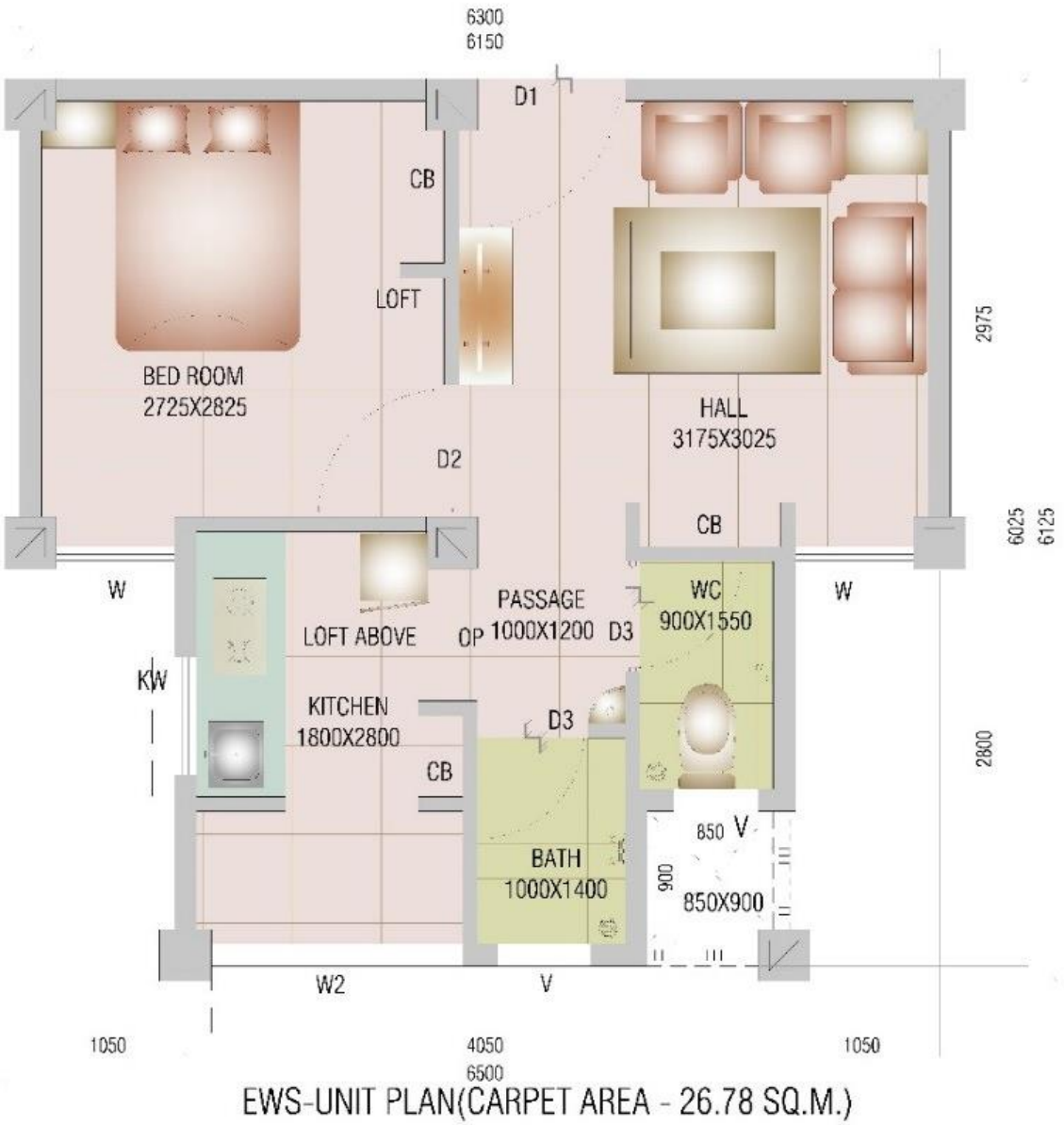
Technology:
Industrialized 3-S system using RCC Precast Columns, Beams, Semi-Precast Solid Slab with AAC Block masonry

- Project brief:
  - 1152 houses constructed in G+5 configuration.
  - The total plot area is around 30,000 Sqm and carpet area of each house is approximately 27 Sqm.
  - There are 12 residential blocks.
  - The project also includes social infrastructure such as Aganwadi, Shops, Milk Booth, Library and Ration Shop.

Typical floor plan

At each floor there are 16 dwelling units

Typical Dwelling Unit Plan



EWS-UNIT PLAN(CARPET AREA - 26.78 SQ.M.)

- Each dwelling unit comprises of one hall, one Bedroom, Kitchen, WC and Bath.
- The carpet area of each unit is 26.78 sq.mt. The sizes of individual rooms & service areas conform to NBC norms.
- **Other special features:**
  - Green rating as per GRIHA
  - Use of renewable resources:
    - Rain water harvesting
    - Solar lighting
  - Solid waste management
  - STP with recycling of waste water
  - Fire fighting services as per NBC norms

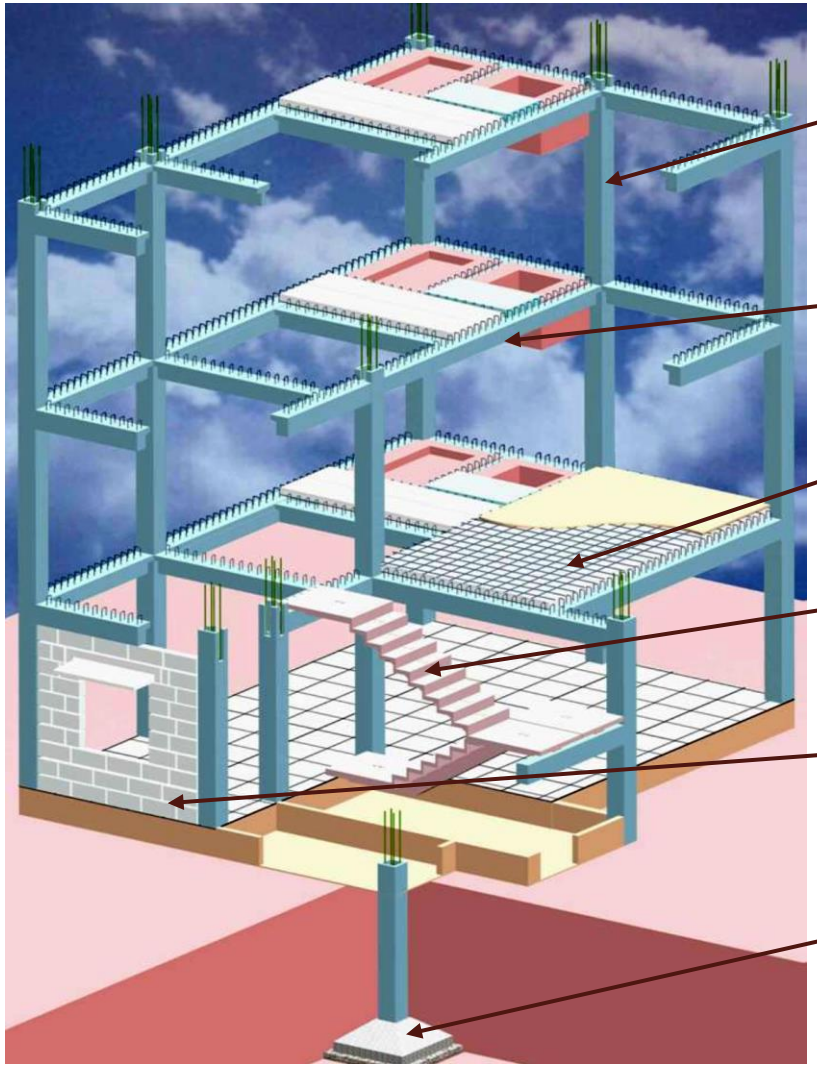
Prevalent Construction Systems

Technology being Used

Load bearing Structure

RCC Framed Structure

Precast Concrete Construction System-Precast Components Assembled at Site



Precast RCC Hollow Columns – core filled in-situ with self-compacting concrete.

Partially Precast RCC Beam – top part being cast with column and slab for monolithicity

Partially Precast slab with reinforced concrete screed

Precast staircase

Autoclaved Aerated Blocks (AAC) masonry for walls. This can also be replaced with precast RCC shear wall

Conventional RCC footing with precast stem column upto plinth level

Technology Details

Building components (beams, columns, slabs, staircases, sunshades) are pre cast in Casting Yard near site

Use of Green Concrete using industrial waste (granulated ground blast furnace slag)

Precast components erected and joined sequentially to construct the entire building

The walls comprise of light weight & environment friendly Autoclaved Aerated Concrete (AAC) Blocks

Internal services are pre-planned in sync with precast components

Technology brings resource optimisation, improved quality, durability & better finish

Neat and dust free construction site due to use of pre-cast components

Minimum use of shuttering and scaffolding materials

Structural Elements

Foundation

- As per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Typical isolated footing along with some combined footings of varying sizes depending on the load.
- Precast RCC Stem columns upto plinth level and connected with precast plinth beam.
- The stem columns have notches in which precast beams are placed.

Structural System

- Industrialized 3-S (Strength, Safety, Speed) prefab method of construction is based on mass produced precast structural components (columns, beams, shear walls, slabs, stairs etc.) onsite or offsite.
- The methodology of construction includes assembly of precast RCC hollow columns, beams and partially precast RCC solid slabs at site. The slabs have in-situ reinforced concrete laid on top after erection thereby making them monolithic.

Floor/ Roof Slab

- The partially precast slab, precast beam and column are assembled together and wet jointed through screed of reinforced concrete laid on top making it monolithic structure.

Autoclaved Aerated Concrete (AAC) Blocks for Wall

- Autoclaved Aerated Concrete (AAC) blocks are lightweight, precast manufactured using foam concrete and suitable as masonry unit. These are non-load bearing infill walls.

Limitations

- Capital intensive since establishment of precast factory is required.
- Minimum number of dwelling units required to achieve cost economy.
- Skilled manpower is required for production and erection of precast components.

Casting of Precast Elements

CASTING OF PRECAST ELEMENTS

- Let's take you to a tour of typical casting yard which is setup at site for production of beam columns and slabs including other components like staircase, sunshades and lintels etc.

CASTING OF PRECAST ELEMENTS

- Casting of partially precast slabs

CASTING OF PRECAST ELEMENTS

Precast Beam

Precast slab

Precast Column

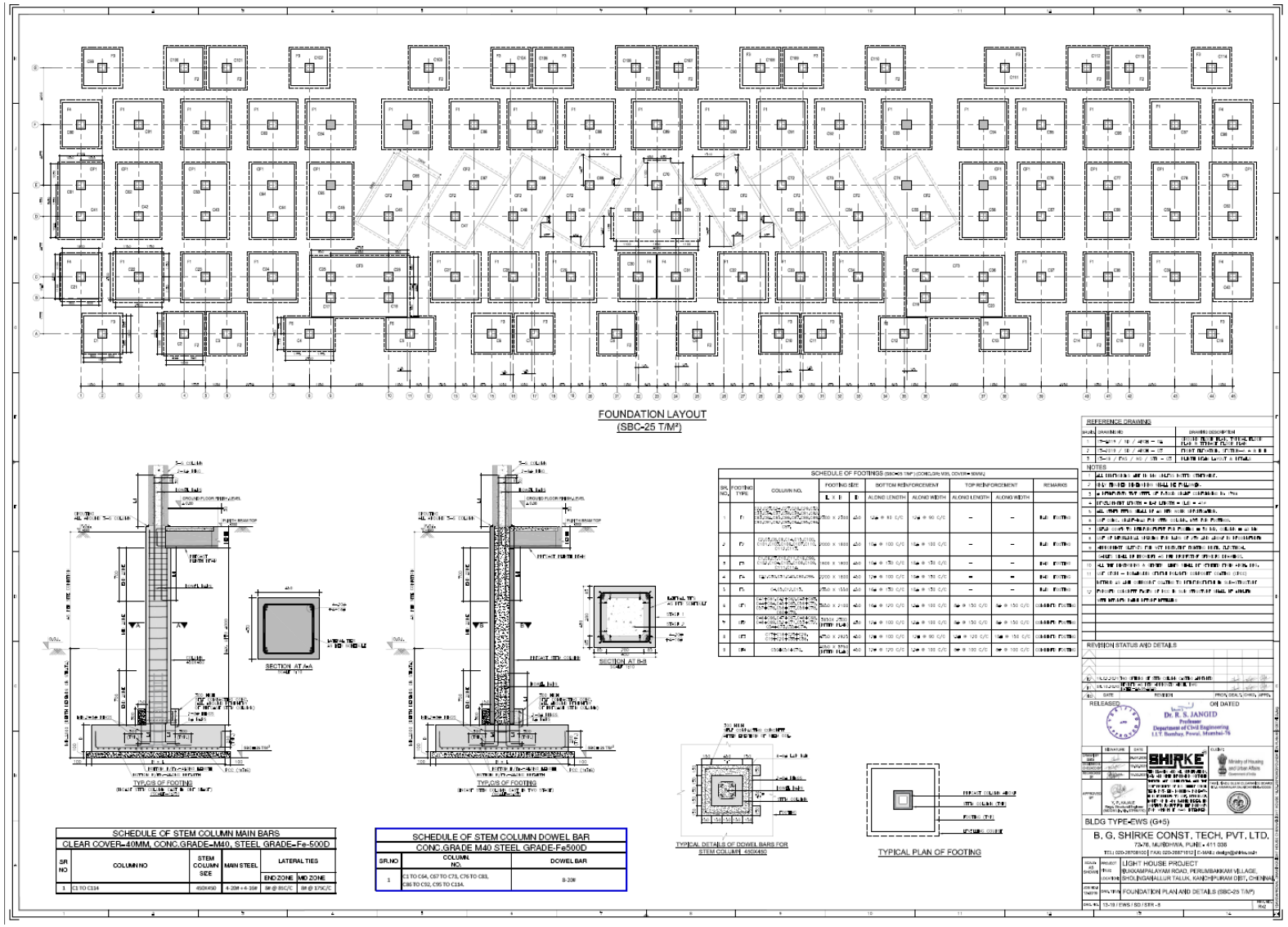
Precast Stairs

Construction Sequence

- Sub-Structure: Foundation
- Super-structure: Structural System
  Floors/ Slab
  AAC Block Masonry for walls
- MEP: Plumbing & Electrical
- Finishing

FOUNDATION

Structural Drawings



FOUNDATION

- The typical project starts with layout and excavation.
- After the layout at site, the excavation of each block is done using mechanical excavators upto the required depth of foundation.

FOUNDATION

- In Chennai project, ground water was encountered during the excavation which was continuously drained during the foundation work.

FOUNDATION

- Before laying the foundation, the plain cement concrete is laid.
- The foundation work started with the PCC of 100 mm thickness.

FOUNDATION

Plate Load Test

- Safe bearing capacity of 25t/m^2 has been considered for design of isolated and combined footing based on the soil investigation done at site by the construction agency.
- The construction agency also conducted plate load test to verify the SBC at representative locations.
- The plate load test was conducted at a depth of 3.0 m from ground level.
- Plate used for test was 0.3mX0.3m having area of 0.09sqm.Capacity of the jack 200KN.
- Least count of settlement gauge was 0.01mm and hydraulic pressure gauge of 10 kg/sq.cm.
- Load increment was done for 24 hrs. Maximum load applied was 576KN. The gross settlement was 4.04mm which was well within the acceptable limit.

FOUNDATION

- After PCC, isolated and combined RCC footings of varying thickness depending upon structural design with M35 concrete are placed.

FOUNDATION

- After PCC, isolated and combined RCC footings of varying thickness depending upon structural design with M35 concrete are placed.

FOOTING REINFORCEMENT

CASTING OF FOOTING

FOOTING COMPLETE

FOUNDATION

Stem Column

- Precast stem column are placed on the RCC footing.
- The size of the typical stem column is 450mmX450mm and its' height is upto the plinth beam. Main bars consist of 4No 20 dia and 4 no. 16 dia.
- The grade of concrete used is M40.
- Column core is formed by using EXPAMESH which acts as a sacrificial formwork to maintain the dimensional accuracy.
- Clear cover to reinforcement is kept at 40mm. OPC cement of grade 53 with C3A content (5% to 8%) has been used below ground level due to high chloride content in the soil as recommended in soil investigation report.
- Exposed surfaces of RCC in sub-structure have been applied with bitumen paint before refilling.

FOUNDATION

- Backfilling of foundation after completion of erection of stem column and plinth beam.

STEM COLUMN ERECTION

STEM COLUMN ERECTION

FOUNDATION

- After erection of these hollow core stem columns, precast plinth beam are integrated in the column notches.

Plinth Beam Erection work in progress

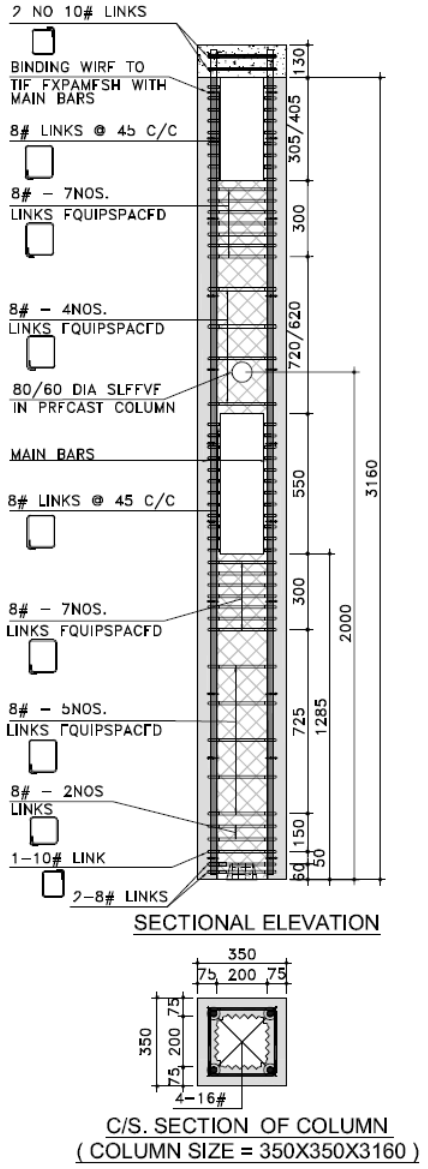
Backfilling work in progress

Backfilling works in progress

STRUCTURAL SYSTEM

Precast Column in Superstructure

- Hollow core precast columns are used which are filled with the self compacting concrete after placement of precast beams for monolithic joint.
- Typical size of the Precast column in ground floor and upper floors is 350mm by 350mm having varying height depending upon the architectural requirement.
- Grade of concrete used is M40 and clear cover to reinforcement is 40mm. Demoulding of side shutter is done after 12 hrs of concreting and 18 hrs for bottom shuttering.



STRUCTURAL SYSTEM

Erected Precast columns with notches and dowels over plinth beam

STRUCTURAL SYSTEM

- Placement of ground floor beam on columns.

STRUCTURAL SYSTEM

Wet jointing of stem column with plinth beam

Grouting of beam – column joint

Beam – column - slab wet jointing

- All the connections and jointing of various structural components are accomplished through in-situ **self-compacting concrete/micro concrete/non shrink grout** as per structural design and codal provisions.

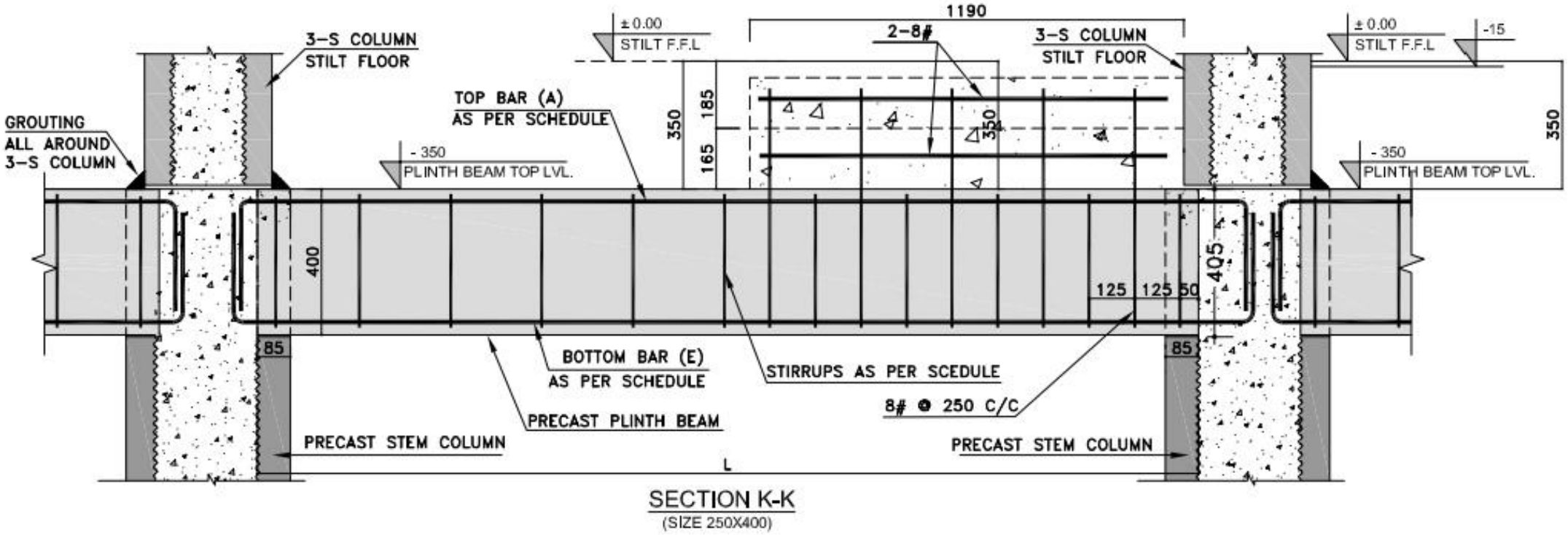
STRUCTURAL SYSTEM

- A typical beam column joint showing monolithic action and continuity thus ensuring better seismic resistance

Before Jointing

After Jointing

STRUCTURAL SYSTEM



Typical Joint between Beam & Column

FLOORS/ SLAB

- After erection of beams and column, partially precast slabs are placed with required bearing on the beams.

FLOORS/ SLAB

- Finally the screed concrete (55mm thickness) is poured over the partially precast slab to ensure monolithic continuous action and ductile behavior of the structure.

FLOORS/ SLAB

- Structural integrity and monolithic behavior is achieved in this technology through wet jointing using dowel bars/ continuity reinforcement placed at connection joints and filled with in-situ self-compacting concrete of higher strength in hollow cores of column.

Partial Precast Slab

PARTIAL PRECAST SLAB WITH REINFORCEMENT

SECOND FLOOR COLUMN, BEAM ERECTION

AAC BLOCK MASONRY

Autoclaved Aerated Concrete (AAC) Blocks for Wall

- Autoclaved Aerated Concrete (AAC) is a lightweight, precast, foam concrete building material suitable for producing concrete masonry unit like blocks. Composed of sand, calcined gypsum, lime, cement, water and aluminum powder, AAC products are cured under heat and pressure in an autoclave.
- After construction of frame with precast beam column and slab, internal walls are constructed using Autoclaved aerated concrete (AAC) blocks having density 451-550 kg/m3 as per IS 2185 (Part-3).

Block size	600x200x150mm for outer walls 600x200x100mm for inner walls

Third Floor Beam, Column, Slab and Second Floor Block Masonry

Fifth Floor Masonry work in Progress

External Plastering work in Progress

Site View

EXTERNAL PAINTING IN PROGRESS

QUALITY CONTROL LAB AT SITE

- Quality control and quality assurance is essential for a project and therefore a quality control lab has been established at site for testing of raw materials and finished products.

The plumbing and electrical services are incorporated as done in conventional method of construction i.e. chasing and filling

FINISHING ITEMS

- The finishing items include pressed steel door frame with flush shutters and PVC doors in toilets.
- uPVC frame with glazed panel and wire mesh shutter are used in windows.
- Vitrified tiles are used in flooring in rooms and kitchen.
- Anti-skid ceramic tiles are used in bath & WC.
- Kota stone flooring is used in common areas & Staircase steps.

INFRASTRUCTURE ITEMS

- The external infrastructure includes
- Laying of Sewerage Pipe Line,
- RCC storm water drain,
- Provisions for Fire Fighting
- Bituminous Internal Road & Paver blocks for Pathway,
- Providing Lifts in building blocks,
- Landscaping of site,
- Street light with LED lights,
- Solar Street Light System,
- Sewerage Treatment Plant (STP),
- External Electrification,
- Water Supply System including underground water reservoir,
- Compound wall with Boundary Gates,
- Horticulture facilities,
- Rain Water Harvesting,
- Solid Waste Management.

Photographs

Photographs

Photographs

Photographs

Living Room

Photographs

Kitchen Unit

Photographs

Bathroom

Photographs

Staircase

Installation of Lift

Photographs


Infrastructure Projects worth over Rs.31,530 Cr
(Railways, National Highways, Petroleum Pipelines and Housing Projec
by
Narendra Modi
Prime Minister
In the august presence of
M. K. Stalin
Nitin Gadkari
Ashwini Vaishnaw
Hardeep Singh Puri
Basavaraj S. Bommai
Y. S. Jagan Mohan Reddy
General (Dr.) V. K. Singh (Retd.)
on Thursday, 26th May 2022 at 5.45 pm at Jawaharlal Nehru
Stadium, Chennai

Photographs

For More Details Please Visit

https://ghtc-india.gov.in

Thank You

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Webinar Series

LIGHT HOUSE PROJECT AT CHENNAI

GHTC - India Category:

Precast Concrete Construction System – Precast Components Assembled at Site

Technology:

Industrialized 3-S system using RCC precast Columns, Beams, Semi-Precast Solid Slab with AAC Block masonry

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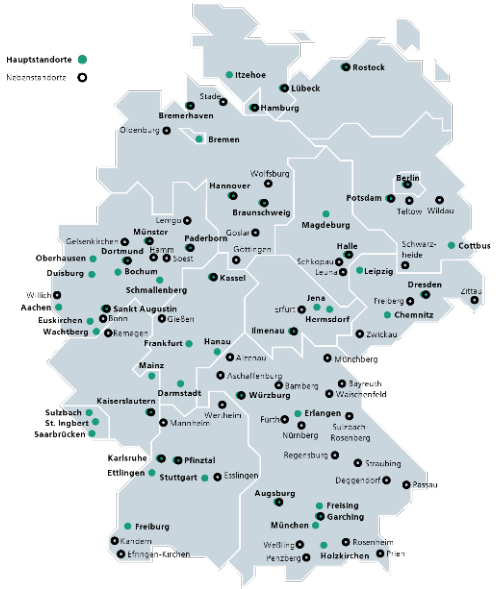
INTRODUCTION

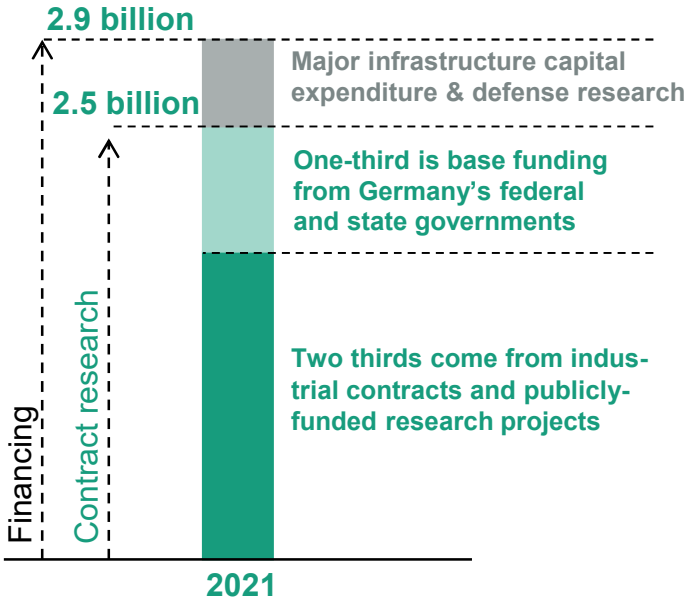
Fraunhofer Society On Applied Science

Applied research with a focus on key future-relevant technologies and the commercialization of findings in business and industry. A trailblazer and trendsetter in innovative developments.

> 30,000 employees



76 institutes and research units



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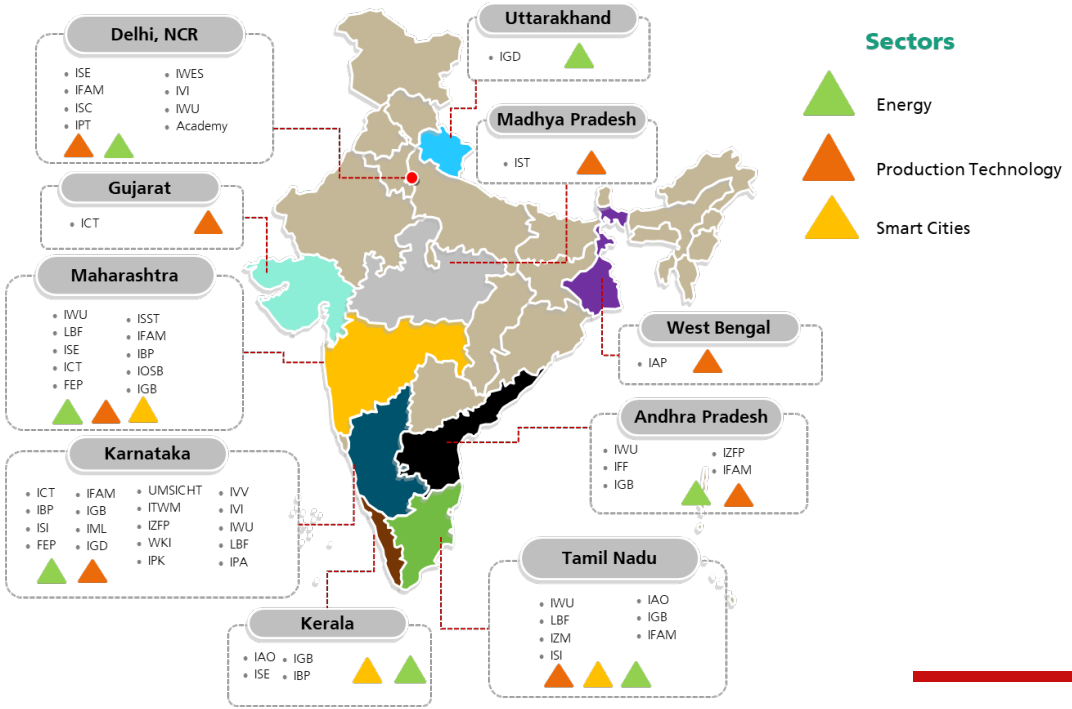
Fraunhofer Society – Presence in India

Present since 15 years

- 56 Institutes
- Revenue € 50 M in last 10 years

Focus areas:

- Production Technology
- Renewable Energy
- Smart Cities
- Artificial Intelligence
- Electromobility
- Clean Tech and Sustainability



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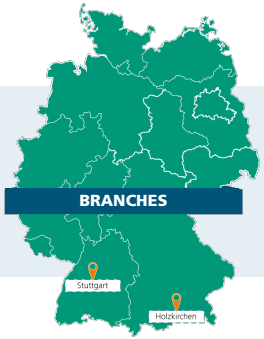
Fraunhofer Institute For Building Physics IBP

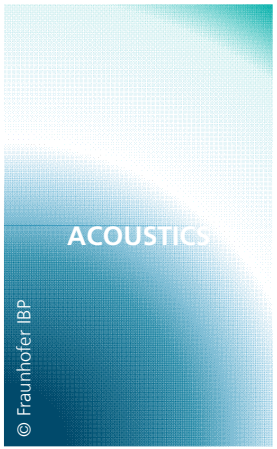
€ 20.5 M
External income

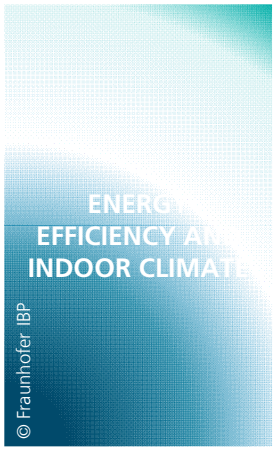
SOURCES OF FUNDS

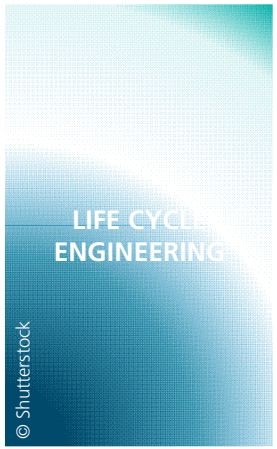
- **45%** Industry / trade associations
- **38%** Federal / state governments
- **17%** EU / Other

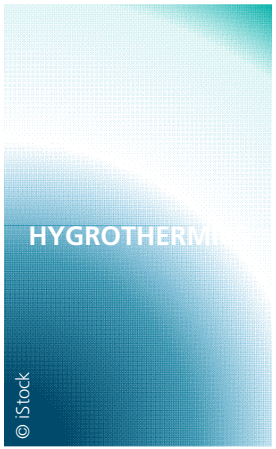


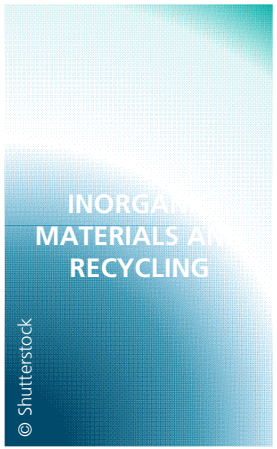
Departments Today

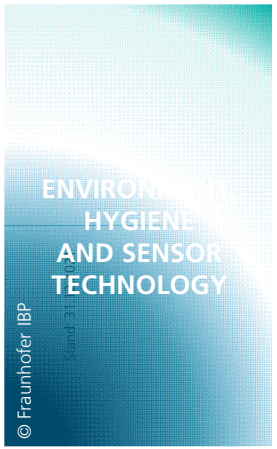












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Light House Projects And Technograhi Programme

Development of short video E-modules on LHP technologies

- field application
- merits and limitations
- thermal comfort
- energy efficiency parameters
- durability

Technograhi Platform
https://bmtpc.org/LatestTopicsDetails.aspx?mid=196

Sharing of International knowledge, experience and best practices on the LHP construction technologies

- Expert Lectures
- Video tutorials
- **Webinars**/in-person conference virtual/real* site visits

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Light House Projects And Technograhi Programme

Chennai

Precast Concrete Construction System – Precast components assembled at site

Rajkot

Tunnel Formwork for Monolithic Construction

Lucknow

Stay in Place Fromwork System

Indore

Prefabricated Sandwich Panel System

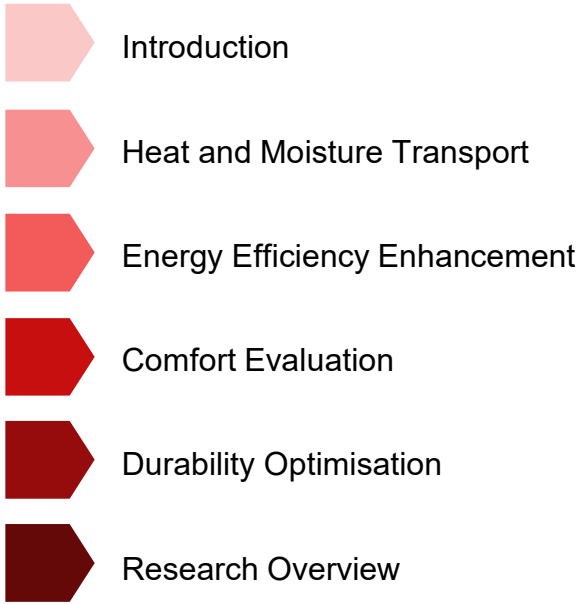
Ranchi

Precast Concrete Construction – 3D Volumetric

Agartala

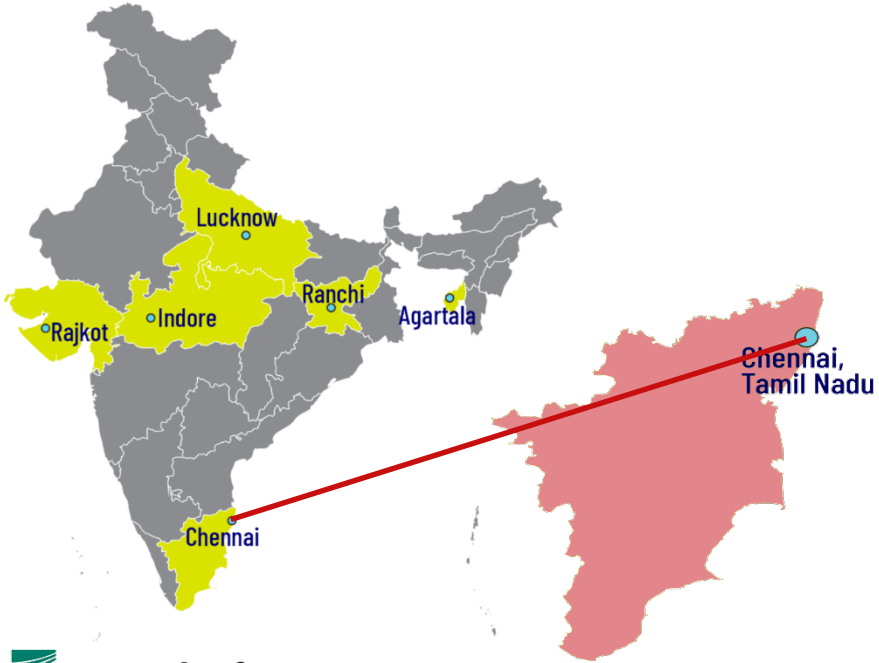
Light Gauge Steel Structural System & Pre-engineered Steel Structural System

Technograhi Platform
https://bmtpc.org/LatestTopicsDetails.aspx?mid=196

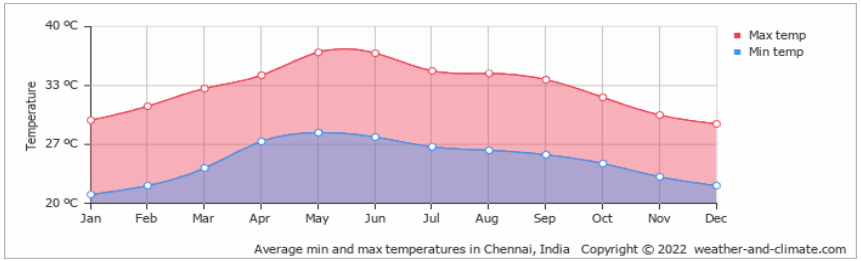


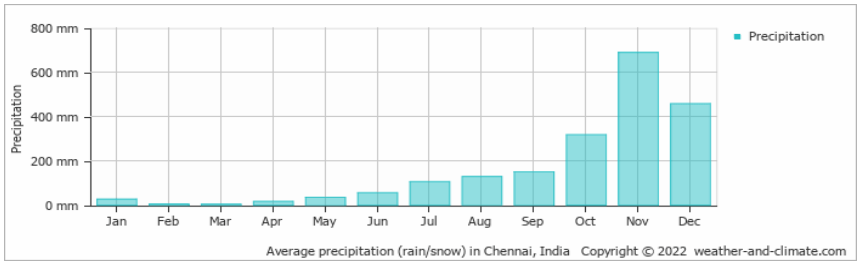
Location And Climate: Chennai

- Altitude: 15 m
- 12,99 ° North 80,18 ° East



- Mean temperature: 28,4 °C
- Normal-rain-sum: 907,2 mm/a





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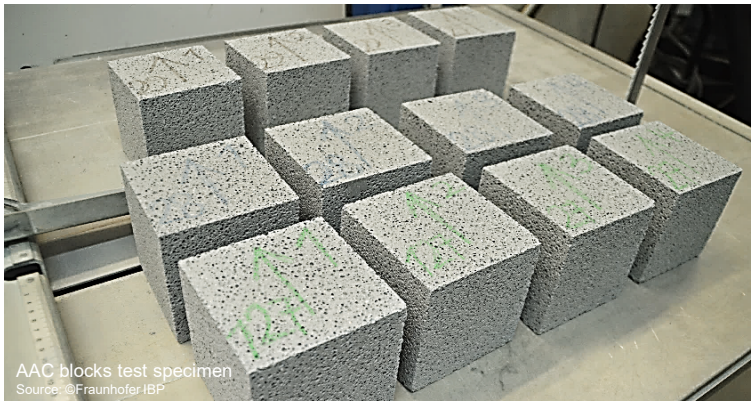
Structural System – Precast Concrete Construction

- Industrialized 3S (Strength, Safety, Speed) prefab method of construction
- Prefabrication techniques include the on-site assembly of precast hollow columns, beams and partially precast RCC (reinforced cement concrete) solid slabs
- In-situ reinforced concrete laid on top of the slabs to ensure monolithicity
- The filler walls are made of AAC blocks

Structural System – Autoclaved Aerated Concrete (AAC) Blocks

- Lightweight, precast building blocks → reducing load on the concrete structure
- High strength and durability
- Larger dimensions than conventional bricks → fewer blocks needed
- **Low thermal conductivity (cellular structure) → good insulation**



AAC blocks test specimen
Source: ©Fraunhofer IBP

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Analysis And Research

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HEAT TRANSFER

Heat Transfer

The parameter which characterizes the heat transfer through the building envelope is the U-value.

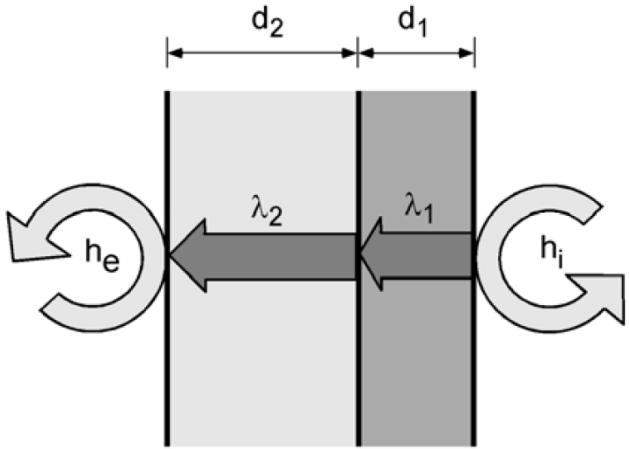
The U-value states the steady-state density of heat transfer rate **per temperature difference** between the environmental temperatures on each side.

Factors affecting the U-value of opaque areas:

- Thickness and heat conductivity
- Air cavities
- Thermal bridges

$$U = \frac{H_T}{A \cdot \Delta\theta} \left[{}^{W}/_{m^2 K} \right]$$

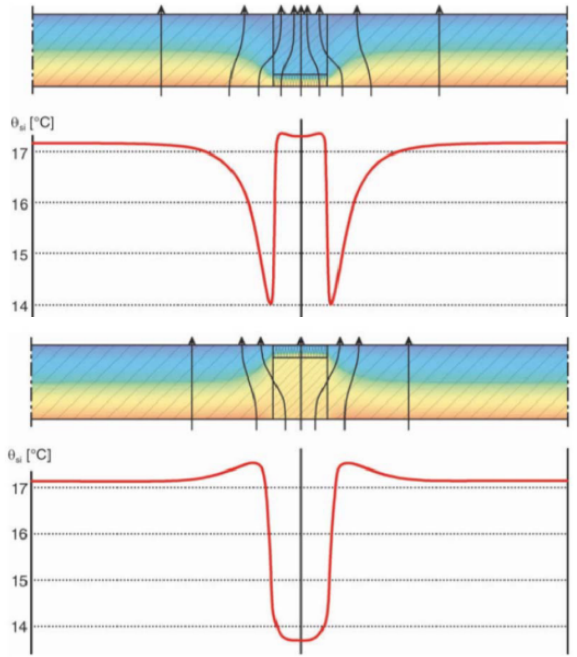
U U-value [W/m²K]
H_T Heat flux $({}^{d_i}/_{\lambda_i})$ [W]
A Area [m²]
$\Delta\theta$ Temperature difference [K]



Material	λ [W/mK]
Reinforced concrete	2,5
Brickwall	0,8
Straw	0,055
Foamglass	0,045
Mineral Wool	0,035

Effects Of Heat Transfer

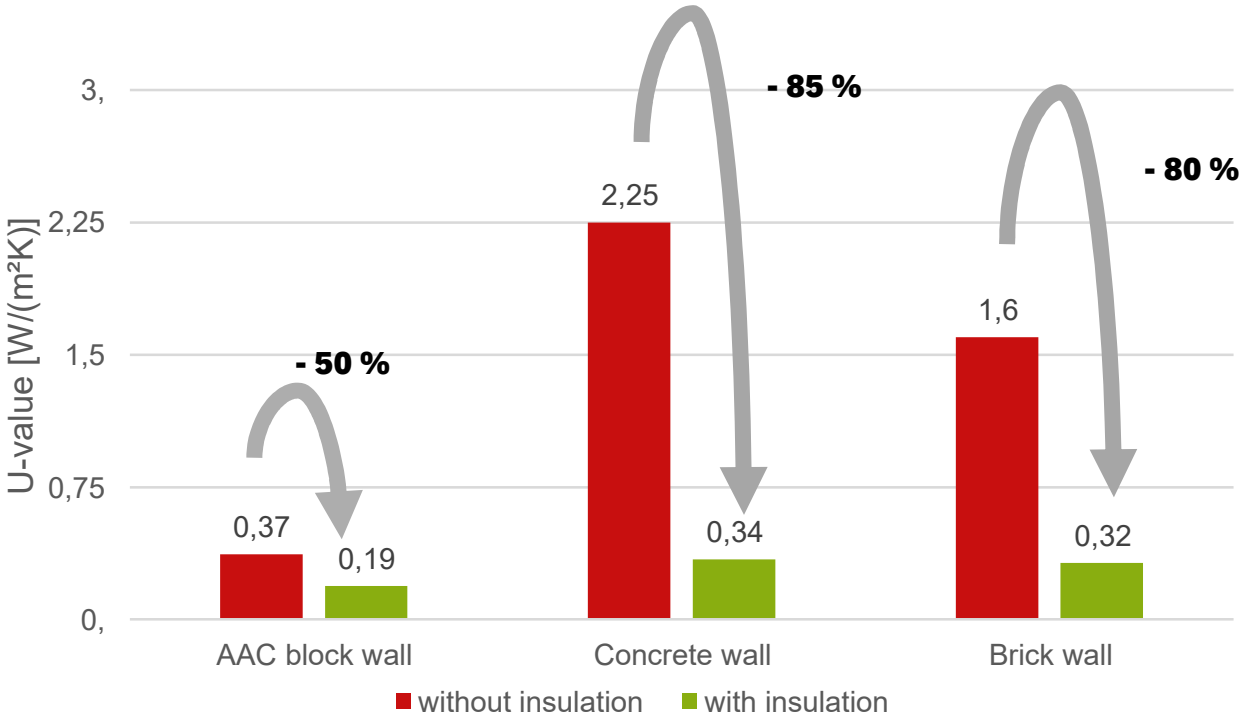
- High surface temperatures on the inside
- Mould growth on the outside
- High energy demand
  - ➢ Wall with U value of 0,4 W/(m²K) gaining 4 W/m²



Reduction Of Thermal Transmission – Actual Design

Using 10 cm of light insulation with heat conductivity of 0.04 [W/(mK)].

Reduction of thermal transmission of up to 85% is possible.



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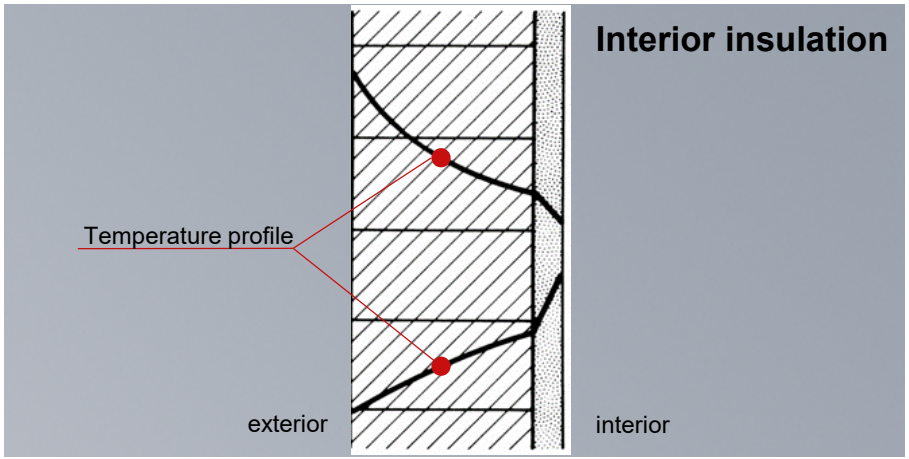
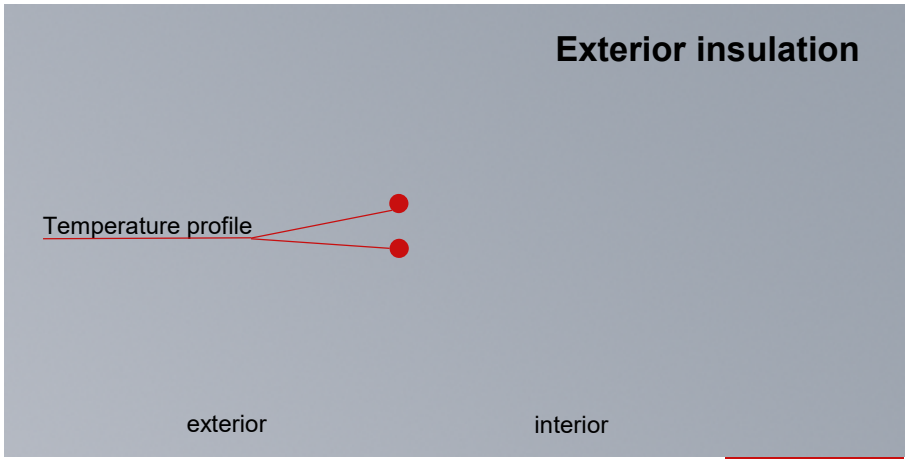
Temperature Distribution – Actual Design

Interior thermal insulation brings the interior surface temperature closer to the indoor temperature. This reduces the risk of mould growth.



External insulation increase the temperature within the construction. This reduces potential for condensation within the construction.



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ENERGY EFFICIENCY IN BUILDINGS

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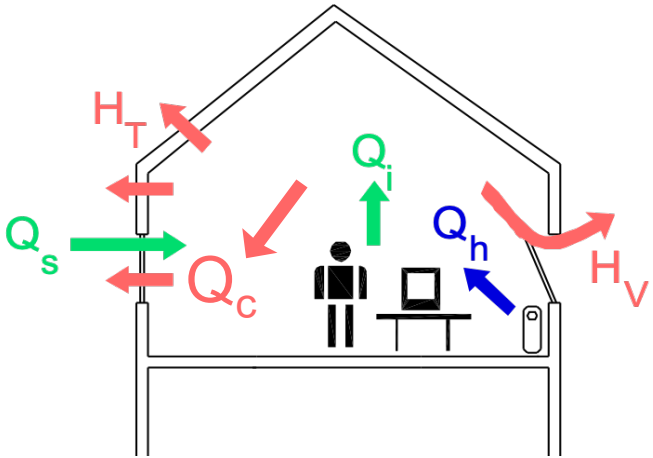
Balancing Basics – Background

$$\dot{Q}_{in} = \dot{Q}_{out}$$

$$Q_S + Q_I = H_T + H_V + Q_C$$

Q_S	Solar gain
Q_I	Internal gain
H_T	Heat transmission
H_V	Ventilation
Q_C	Cooling demand
~~Q_H~~	~~Heating demand~~



ENERGY EFFICIENCY ENHANCEMENT SIMULATION DEMONSTRATION WITH

Video Placeholder

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DURABILITY OPTIMISATION

Internal Resistance – Material Properties

Vapour diffusion	Moisture storage	Water uptake
μ, sd	$w = f(p_K)$	w-value
Passage of moisture through a building component in the form of water vapor.	Function of the ability of a building material to absorb and release moisture.	The property of capillary suction and retention of water.

Durability - Consequences

Mold growth / Algae growth

- High moisture above 80% rel. humidity
- Moderate to high temperatures

Condensation

- Underrun of the dew-point

Corrosion of the construction

- High rel. humidity
- Availability of oxygen

Durability Measurements – System Evaluation

Lab testing of material properties

Free field testing of exterior walls

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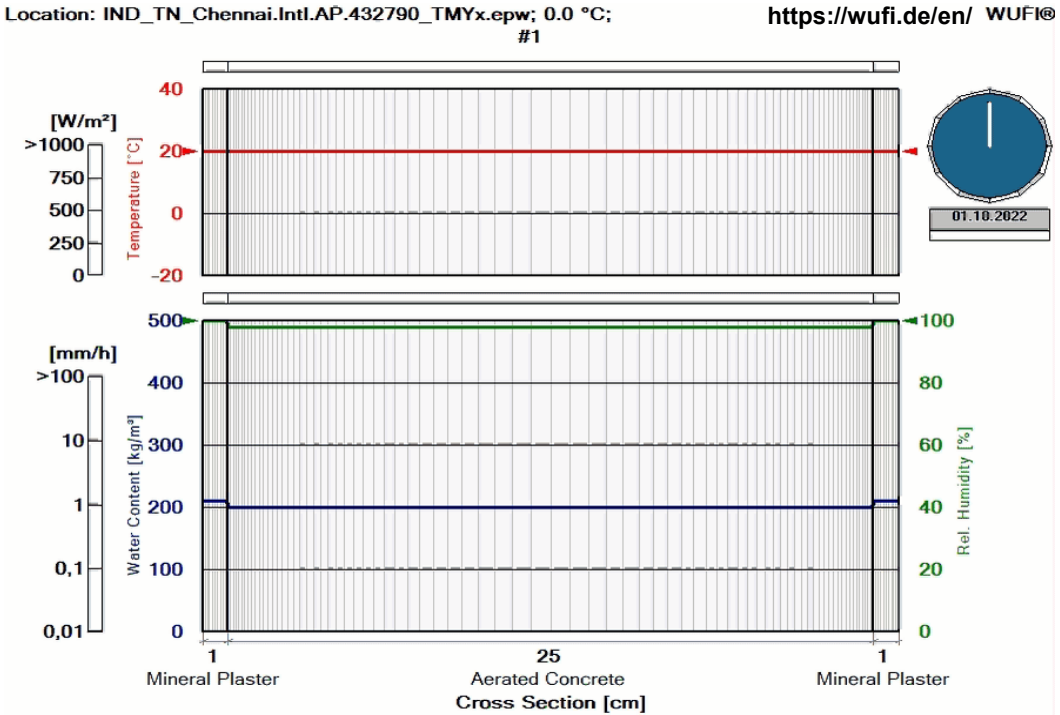
Moisture Control – Using Simulation

Hygrothermal simulation helps to evaluate the construction in an appropriate way in terms of condensation and mould growth.



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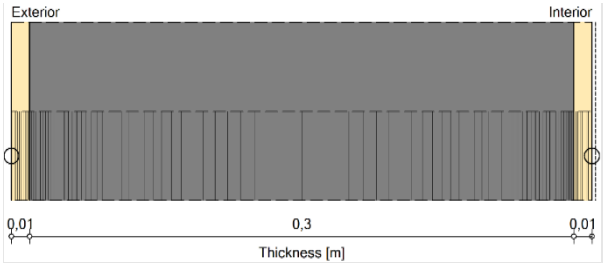
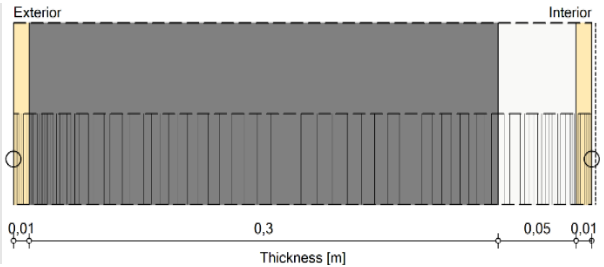
Durability at Chennai – Precast Concrete

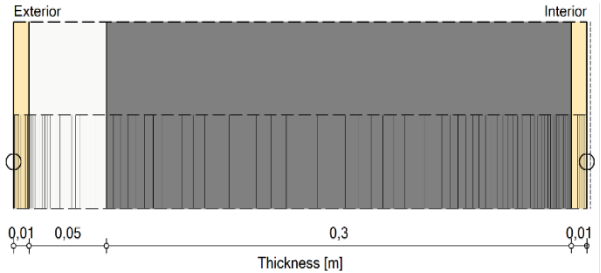
Precast Concrete



Precast Concrete internal insulation

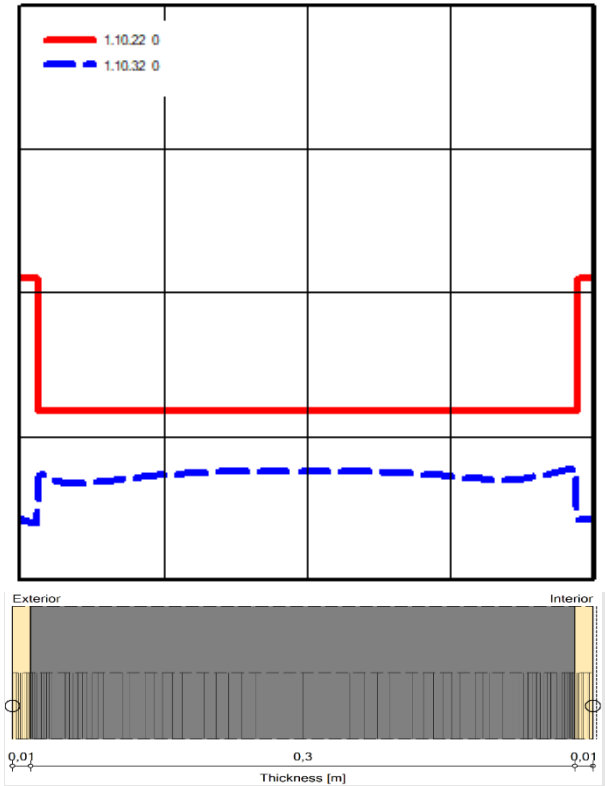


Precast Concrete external insulation

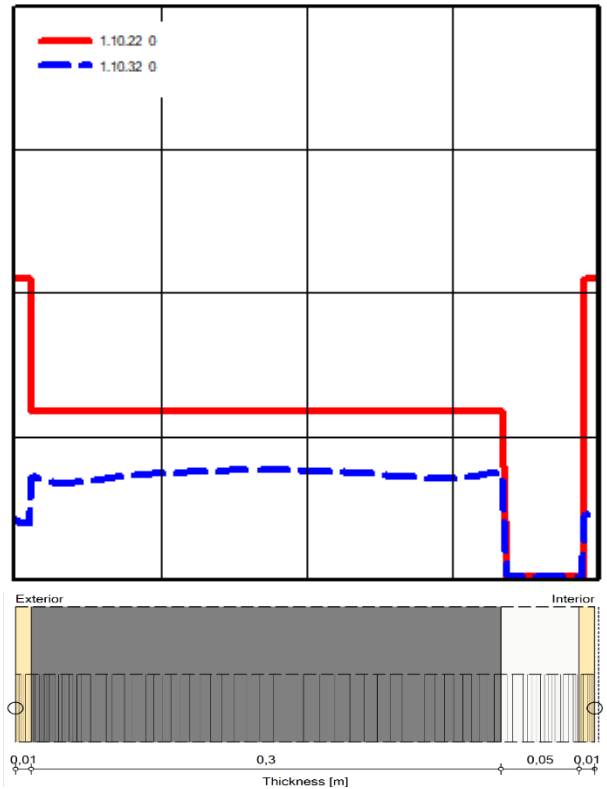


Durability at Chennai – Precast Concrete

Precast Concrete



Precast Concrete internal insulation



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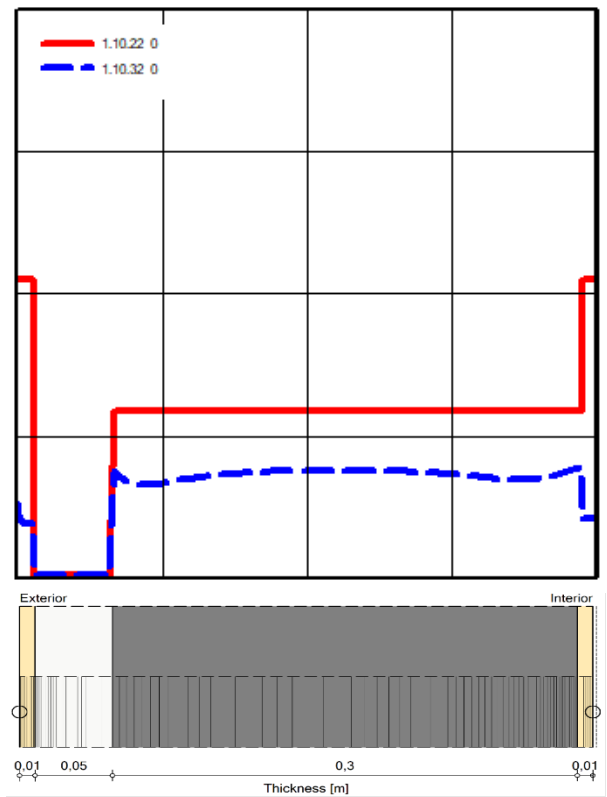

Durability at Chennai – Precast Concrete

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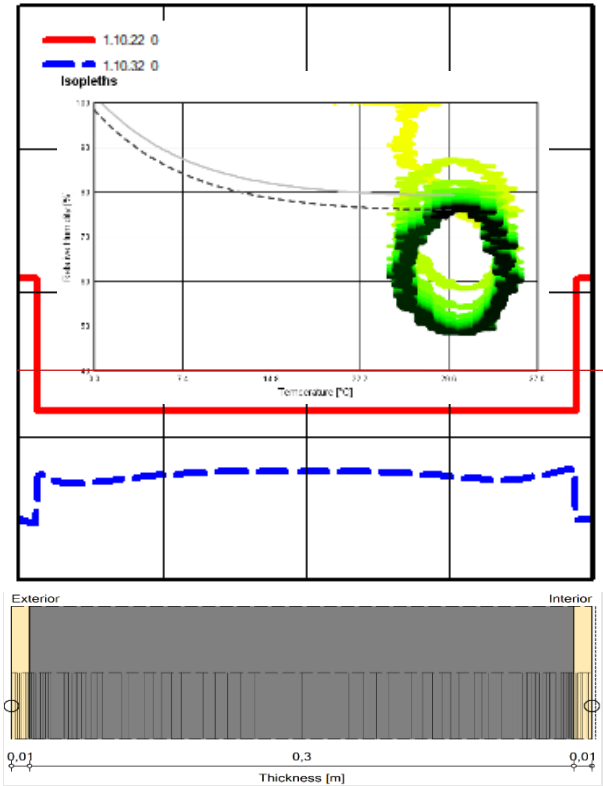

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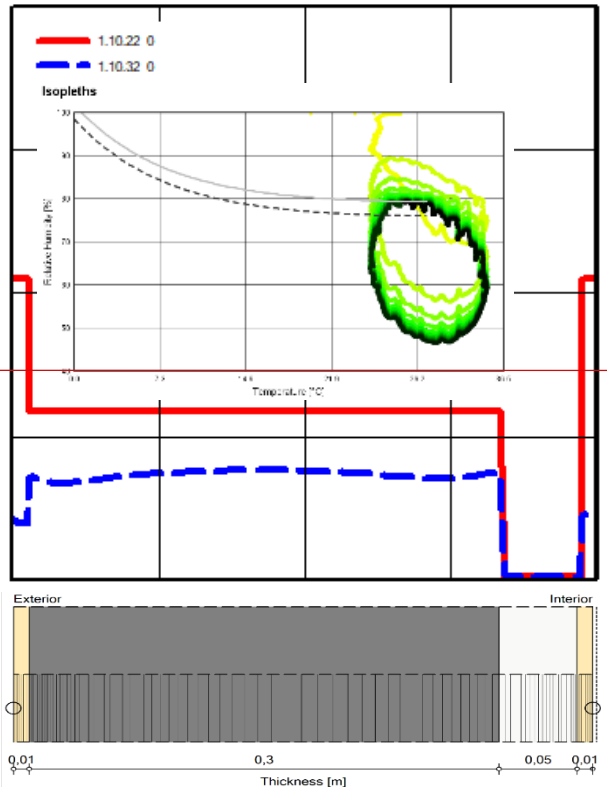
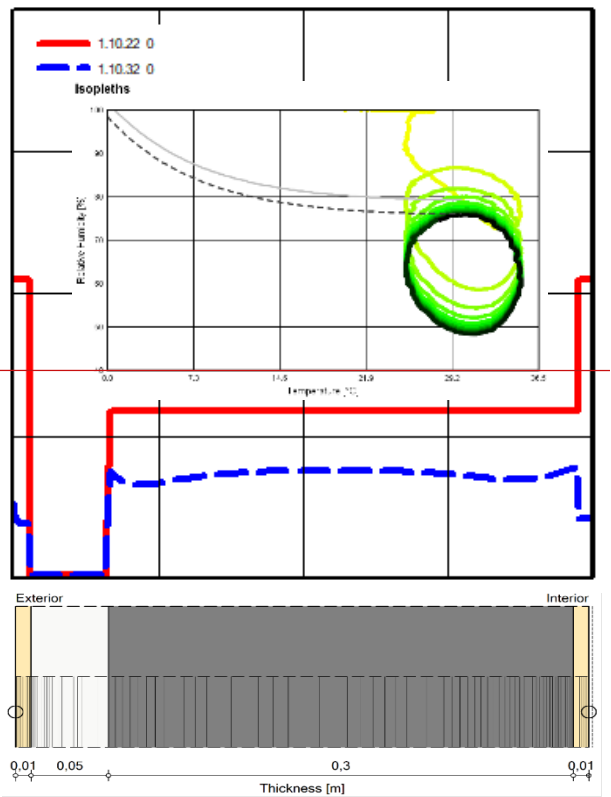


Precast Concrete external insulation



Durability at Chennai – Precast Concrete

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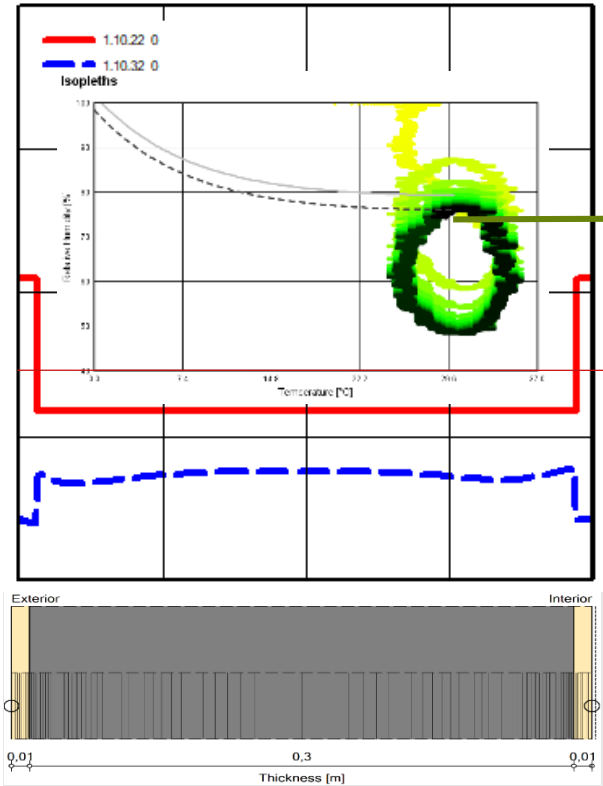

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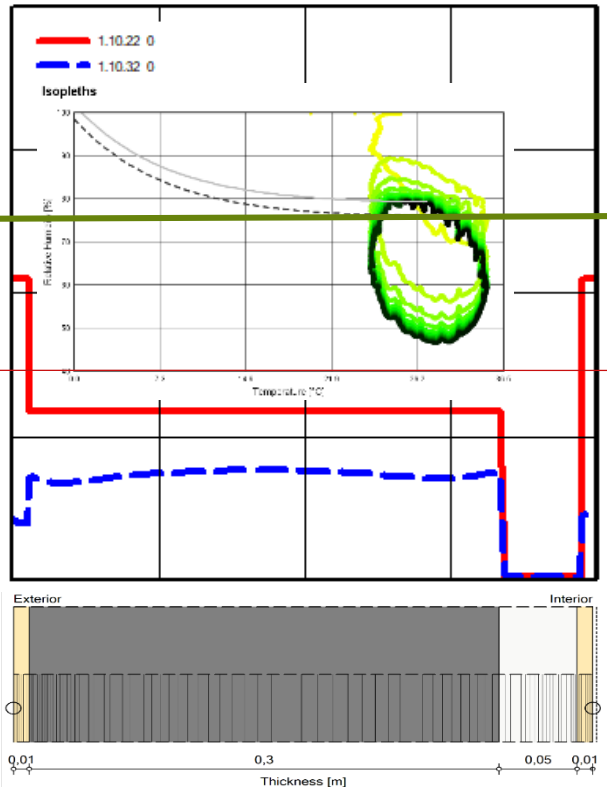

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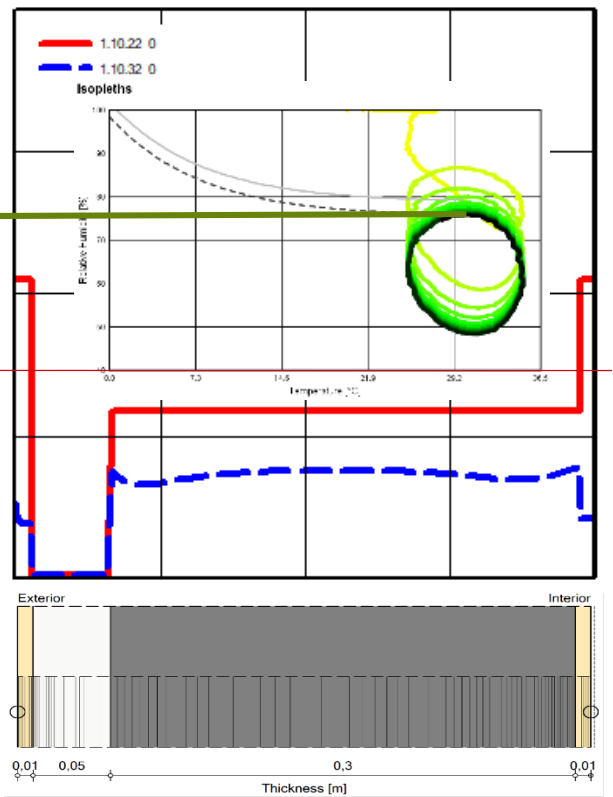

DEVELOPMENT AND POTENTIAL OF AUTOCLAVED AERATED CONCRETE (AAC)

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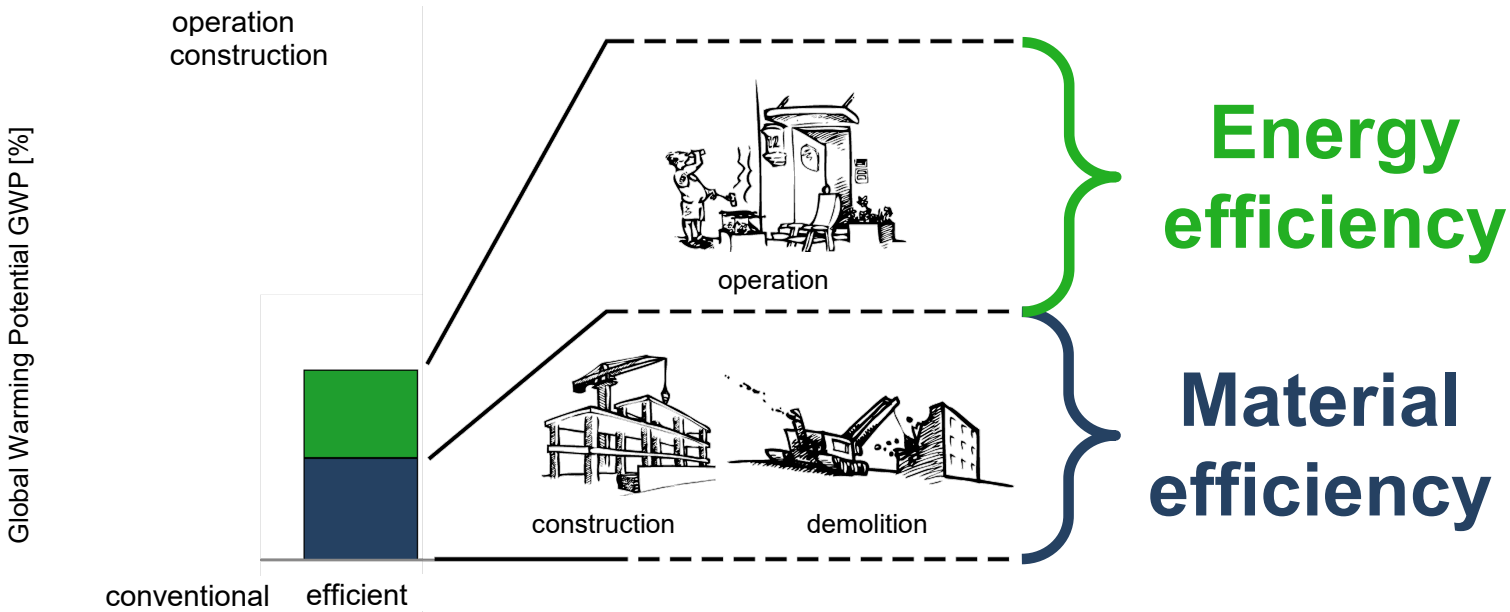
Relevance Of Used Material



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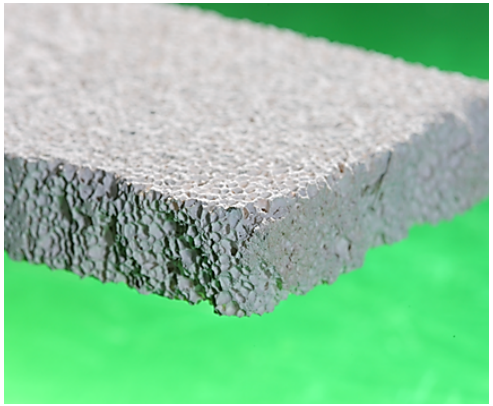
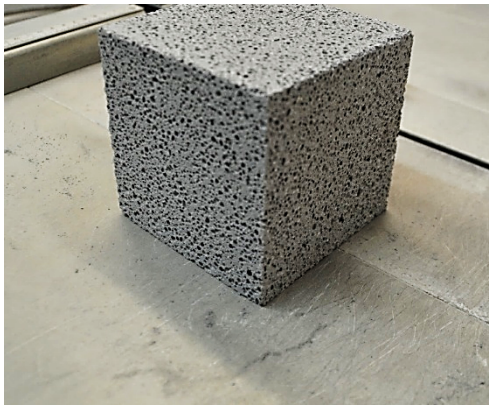
AAC Potential For Using By-Products

Quartz sand



Quartz-based AAC

Rice husk ash



Rice husk ash-based AAC

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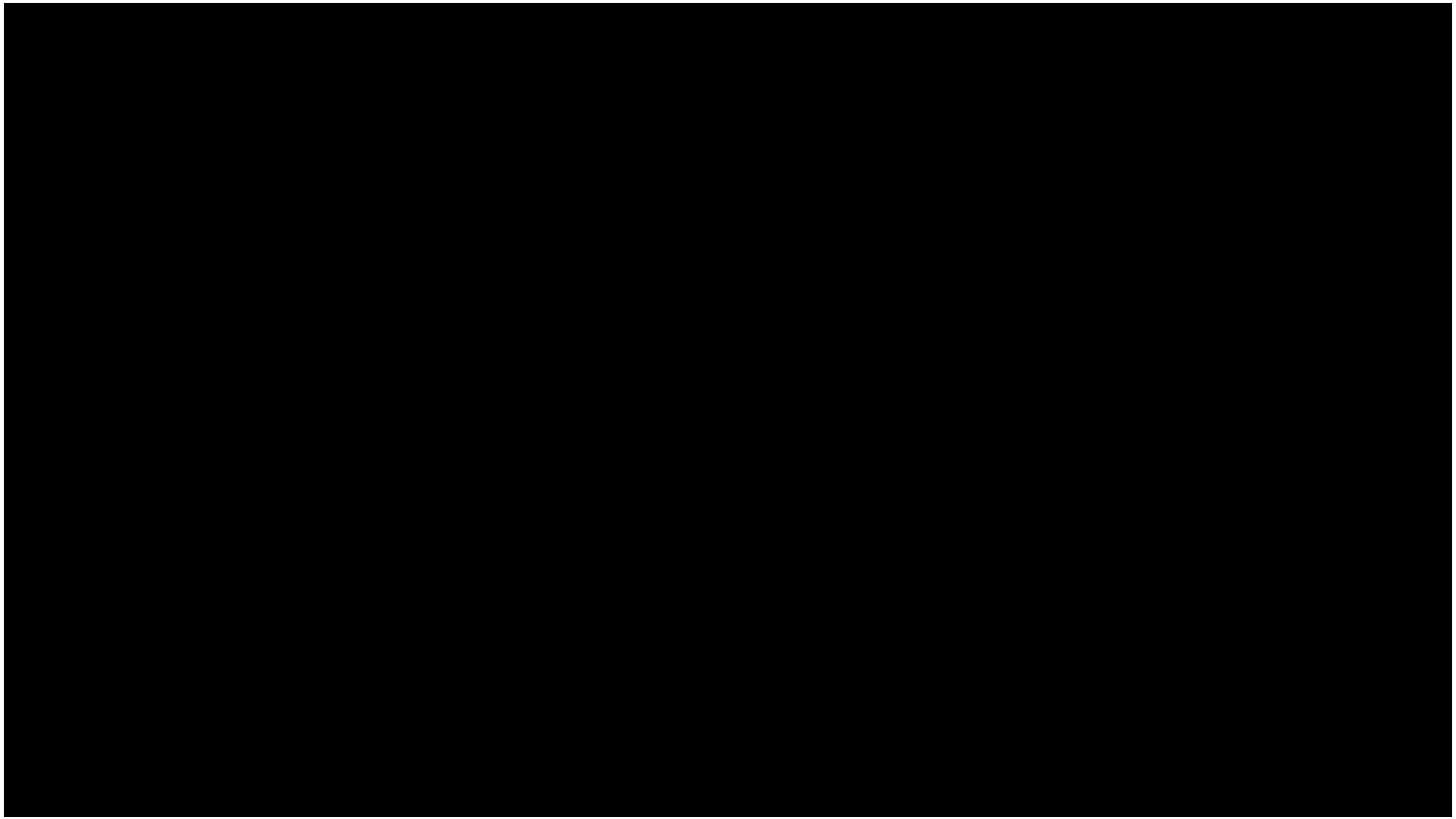
Production Process Of Autoclaved Aerated Concrete



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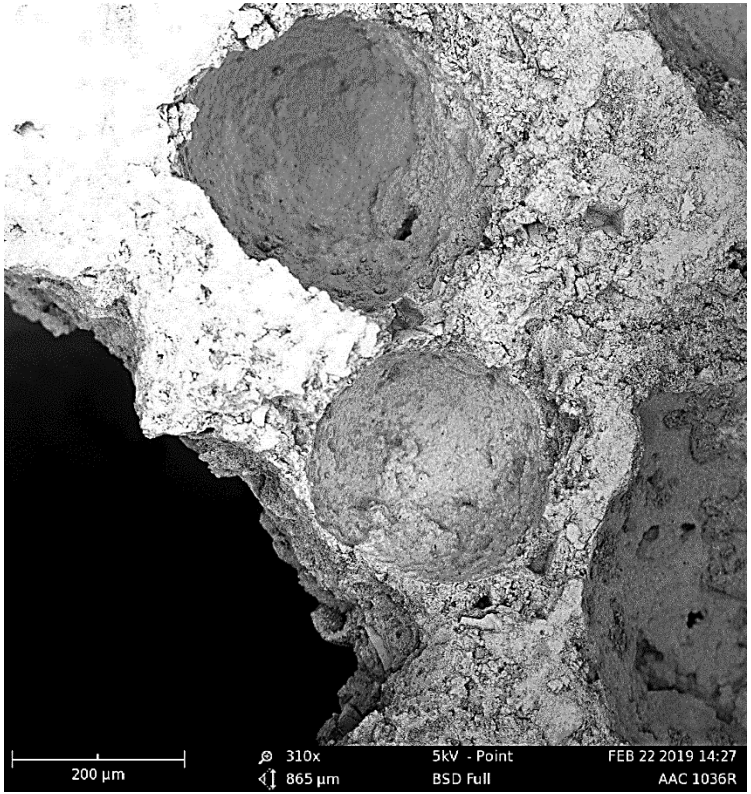
Porosity Of AAC



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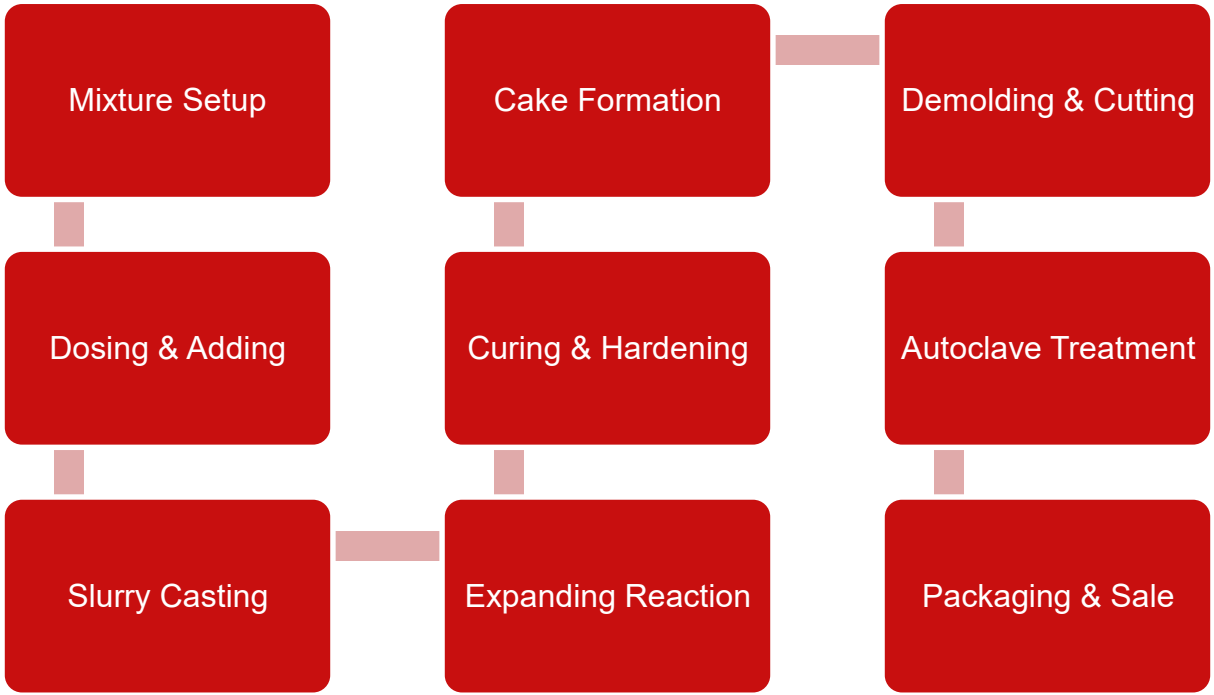
Process Of Industrial Production Of AAC



Further Reads, Links

Technograhi Platform

https://bmtpc.org/LatestTopicsDetails.aspx?mid=196

AAC

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Ministry of Housing and Urban Affairs
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