



GLOBAL
HOUSING
TECHNOLOGY
CHALLENGE INDIA



Ministry of Housing and Urban Affairs
Government of India



Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

VOCATIONAL TRAINING

Location: Ranchi | Date: 26-27/05/2022

RACHINA



GLOBAL
HOUSING
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CHALLENGE INDIA

RESILIENT, AFFORDABLE AND COMFORTABLE HOUSING THROUGH NATIONAL ACTION

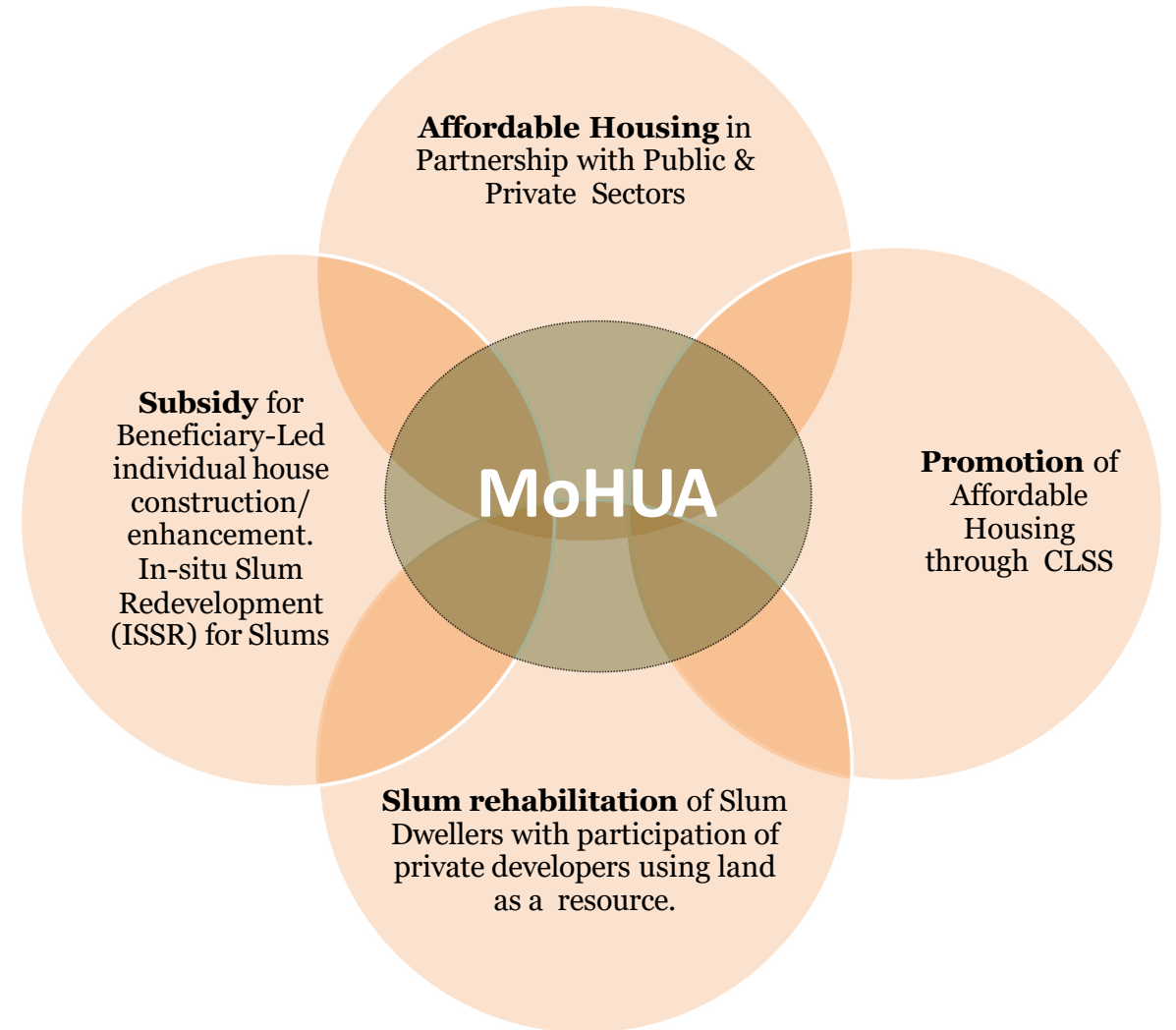
“Innovative Construction Technologies & Thermal Comfort for Affordable Housing”

MoHUA

‘Housing for All’ by 2022.

Under the Mission, Ministry of Housing and Urban Affairs (MoHUA), provides Central Assistance to implementing agencies through States and Union Territories for providing houses to all eligible families/beneficiaries by 2022.

Addressing the affordable housing requirement in urban areas through:



GIZ

- GIZ is an international cooperation enterprise for sustainable development which operates worldwide, on a public benefit basis.
- GIZ is fully owned by the German Federal Government, GIZ implements development programs in partner countries on behalf of the German Government in achieving its development policy objectives.



Session on LHPs

Six Light House Projects (LHPs)

1. Ranchi, Jharkhand

- Precast Concrete Construction System – 3D Volumetric

2. Rajkot, Gujarat

- Monolithic Concrete Construction using Tunnel Formwork

3. Chennai, Tamil Nadu

- Precast Concrete Construction System – Precast Components Assembled at Site

4. Indore, Madhya Pradesh

- Prefabricated Sandwich Panel System

5. Agartala, Tripura

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

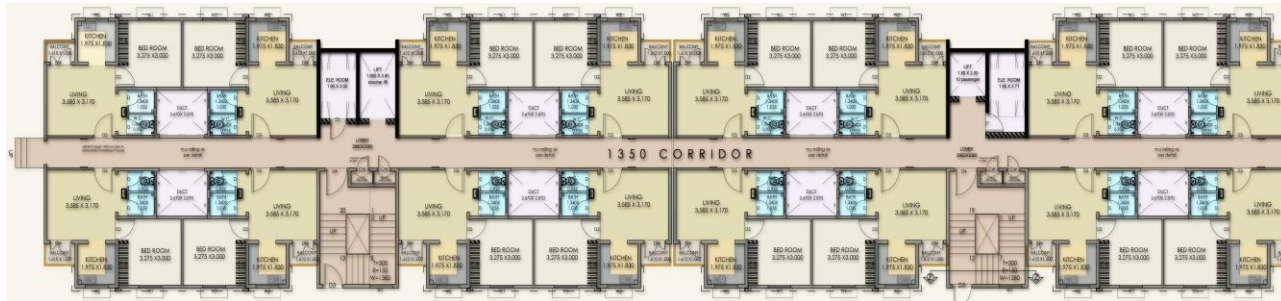
6. Lucknow, Uttar Pradesh

- PVC Stay In Place Formwork System

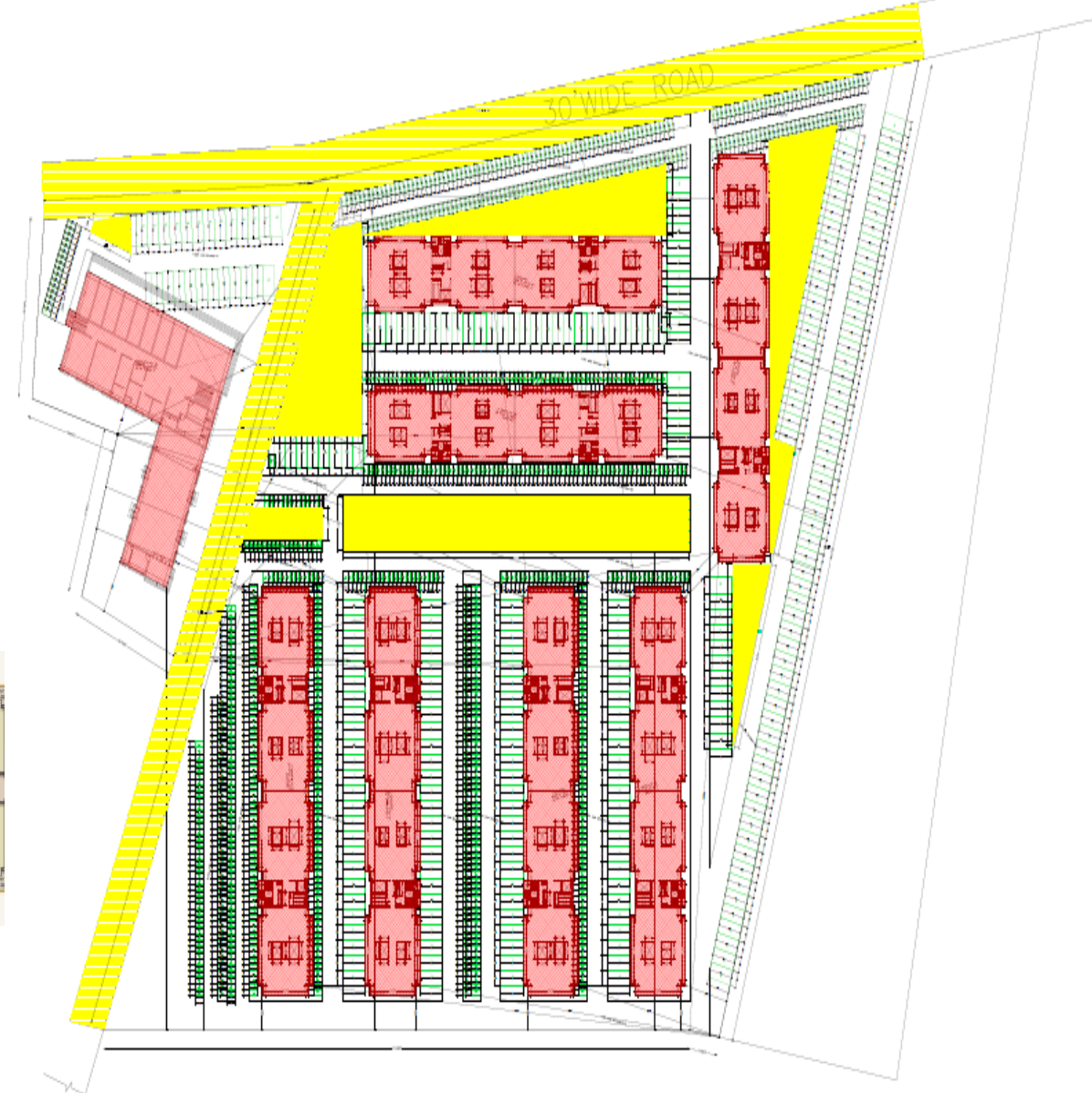
Summary of Six Light House Projects (LHPs)

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	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	S+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	34.50
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

- There are 7 blocks in Ground + 8 configuration with 1008 houses along with basic and social infrastructure.
- Ground coverage of the project is 29.3% and FAR is 2.21.
- Green space is 20%.



Typical floor plan

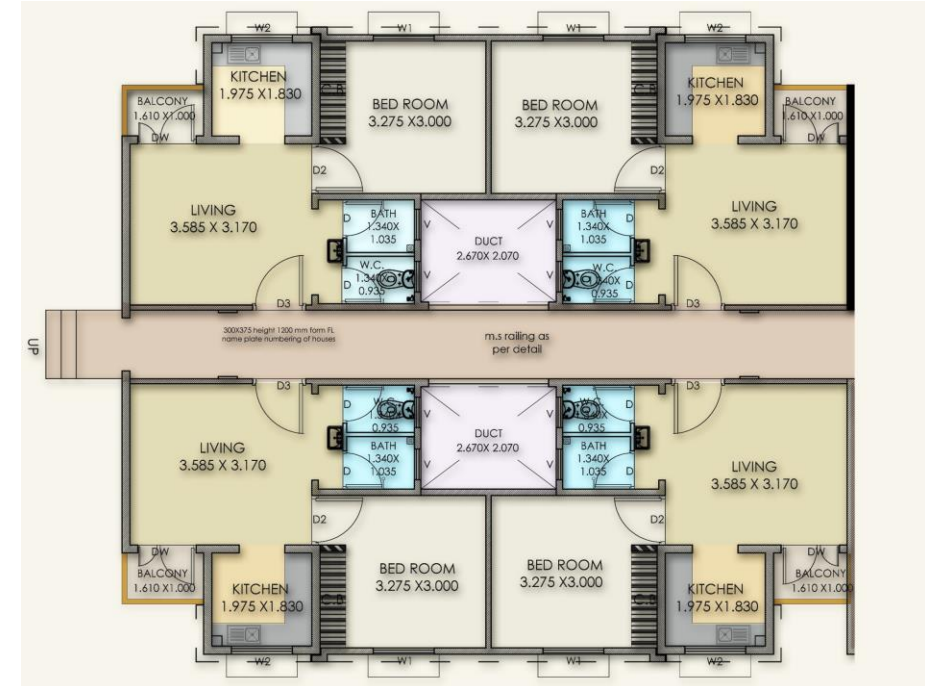


16 dwelling units at each floor of building block with provision of lifts and staircases.

Typical Dwelling Unit plan



Each dwelling unit consists of one hall, one bed room, a kitchen, WC, Bath and a balcony. The carpet area of each unit is 29.85 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 System conforming to NBC

Conventional Construction Systems

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.



Prevalent Construction Systems

Load bearing Structure

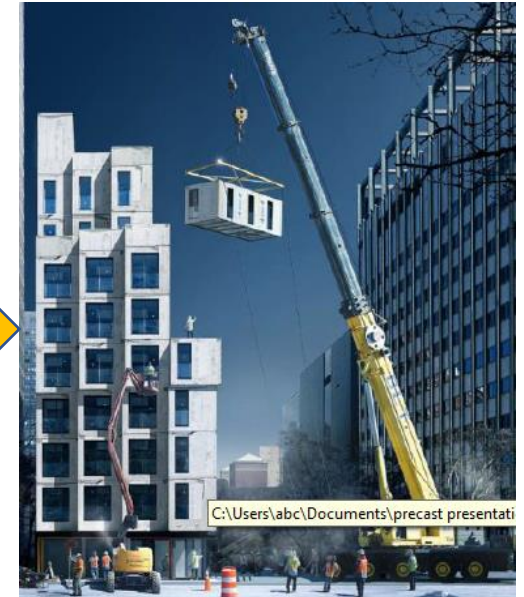


RCC Framed Structure



Technology being Used

Precast Concrete Construction - 3D Volumetric



It is the modern method of building by which precast concrete structural modules like room, toilet, kitchen, bathroom, stairs etc. & any combination of these are cast monolithically in Plant or Casting yard in a controlled condition.

These Modules transported, erected & installed using cranes and are integrated together in the form of complete building unit.

Conventional Construction Systems

Slow

Maximum Use of Natural Resources

Waste Generation

Air/Land/Water Pollution

Labor Intensive

Prescriptive Design

Unhealthy Indoor Quality

Regular Maintenance

Energy Intensive

Cast-in-situ Poor Quality

High GHG Emissions

Unsustainable

Alternate Construction Systems

Fast

Optimum use of Resources

Minimum Waste

Minimum Pollution

Industrialized System

Cost-effective Design

Better health & Productivity

Low Life Cycle Cost

Energy Efficient

Factory Made Quality Products

Low GHG Emissions

Sustainable

MAP SHOWING SIX DIFFERENT LHP LOCATIONS



Establishment of the Cluster Cell in Ranchi, Jharkhand under Global Housing Technology Challenge-India (GHTC-India)”

Jharkhand

Bihar

Odisha

West Bengal

LHPs shall serve as **LIVE Laboratories** for different aspects of **Transfer of technologies**

Sustainable Buildings

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

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)



LHP-RANCHI (Precast Concrete Construction System – 3D Volumetric)

Advantages

- Upto 90% of the building work including finishing is complete in plant/casting yard leading to significant reduction in construction & occupancy time
- The controlled factory environment brings resource optimization, improved quality, precision & finish
- The required concrete can be designed using industrial by-products such as Fly Ash, Ground granulated blast furnace slag (GGBS), Micro silica etc. resulting in improved workability & durability, while also conserving natural resources. In this project Ground granulated blast furnace slag & silica fume is proposed in concrete.
- With smooth surface it eliminates use of plaster
- The monolithic casting of walls & floor of a building module reduces the chances of leakage
- The system has minimal material wastage (saving in material cost), helps in keeping neat & clean construction site and dust free environment
- Use of optimum quantity of water through recycling
- Use of shuttering & scaffolding materials is minimal
- All weather construction & better site organization

Light House Project (LHP) at Chennai, Tamil Nadu

(Technology: Precast Concrete Construction System-Precast Components)

2



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



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



Wall
Panels



Spandrel



Solid Slab Panels



Staircase

LHP-CHENNAI (Precast Concrete Construction System-Precast Components Assembled at Site)

Advantages

- Quality of construction is enhanced significantly due to pre-casting of components by using sophisticated moulds and machineries in factory like environment, assured curing, assured specified cover to reinforcement, proper compaction of concrete results in to dense and impermeable concrete etc. Thus lesser maintenance cost during lifetime of project.
- Inbuilt eco-friendly method of construction in terms of more off-site works in controlled factory like environment results in to significant reduction in wastage of water, natural resources, air pollution and noise pollution.
- Safety of workforce achieved automatically as most of the works are carried out at ground floor in factory like environment, which ultimately enhances the work efficiency and quality.
- Wooden shuttering material is completely avoided and wastage of other construction materials reduced significantly; which results in to conservation of scarce natural resources like soil, sand, aggregate, wood etc.
- Advance procurement of major construction materials, advance pre-casting of structural components and assured completion of work within stipulated completion period will save cost towards escalation & early returns on investments, thus Substantial cost benefit to the client.

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)



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



LHP-AGARTALA (Light Gauge Steel Structural System & Pre-engineered Steel Structural System)

Advantages

- Due to light weight, significant reduction in design earthquake forces is achieved. Making it safer compared to other structures.
- Fully integrated computerised manufacturing of LGSF sections provide very high precision & accuracy.
- Speedier
- Structure being light, does not require heavy foundation
- Structural elements can be transported to any place including hilly areas/ remote places easily
- Structure can be shifted from one location to other with minimum wastage of materials.
- Steel used can be recycled multiple times
- The system is very useful for post disaster rehabilitation work.

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

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

4

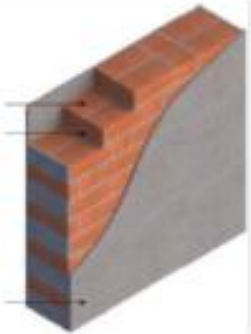


No. of Dwelling Units : 1024 Nos. (S+8)
No. of Block / Tower : 8 Blocks
Units in each Block / Tower : 128 Nos.



PREFABRICATED SANDWICH PANEL SYSTEMS

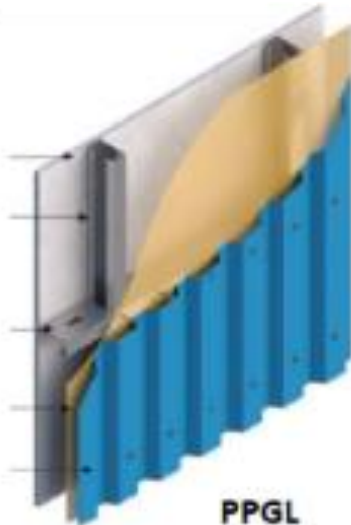
- EPS Core Panel Systems
- Other Sandwich Panel Systems
 - Fibre cement board
 - MgO Board
 - AAC panels



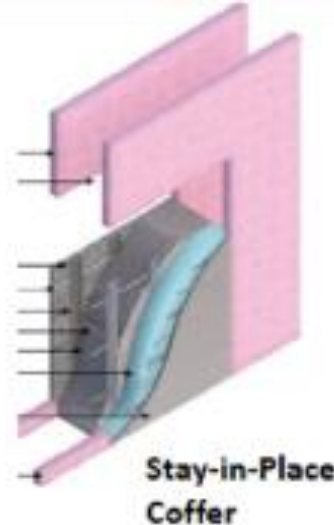
230 MM Clay Brick Wall



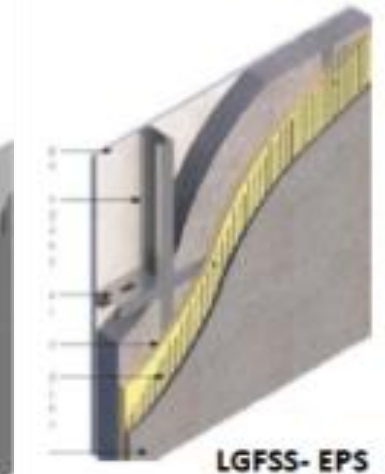
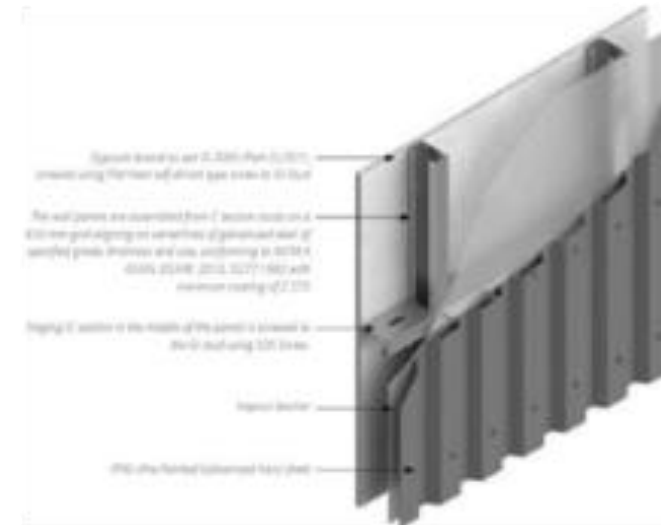
Rat Trap Bond



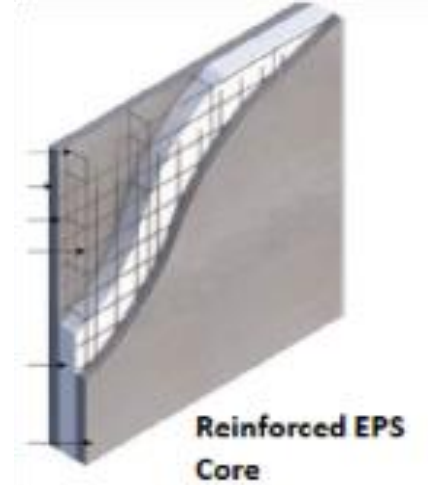
PPGL



Stay-in-Place
Coffer



LGFSS- EPS



Reinforced EPS
Core

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



LHP-INDORE (Prefabricated Sandwich Panel System)

Advantages

- The system is dry walling system, brings speed in construction, water conservation (no use of water for curing of walling components at site).
- The sandwich panels have light weight material as core material, which brings resource efficiency, better thermal insulation, acoustics & energy efficiency
- Being light in weight, results in lower dead load of building & foundation size.

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

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

5

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)



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**



Stay-In-Place PVC Wall Forms

- 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.
- 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.



LHP-LUCKNOW (Stay in Place PVC formwork System)

Advantages

- Having formwork already as part of system, the construction of building is faster as compared to conventional buildings. The formwork needs some support only for alignment purpose.
- The formwork consists of rigid PVC components, which do not corrode, chip or stain & resistant to UV, bacteria, fungi etc., thus ensuring long life of the structure.
- The polymer content used in manufacturing of formwork is up to 55% recycled content and are further recyclable, making it an eco-friendly material.
- The form work system has specific advantage for use in coastal areas as due to polymer encasement it offers higher durability.
- With concrete as filling material, the curing requirement of concrete is significantly reduced, thus saving in precious water resources.
- The formwork system does not have plastering requirement & gives a aesthetic finished surface in different color options.
- The system provides advantages in terms of structural strength, durability enhancement, weather resistance, flexural strength, thermal insulation and ease of construction.

Light House Project (LHP) at Rajkot, Gujarat

(Technology: Monolithic Concrete Construction System)

6



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



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 fibre 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 pre-set moulds. Once set, it shall be moved for curing and ready for use with RCC or steel framed structure.
- These panels are presently manufactured by the firm in China and shortly a plant will be installed in India.

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



LHP-RAJKOT (Monolithic Concrete Construction using Tunnel Formwork)

Advantages

- Facilitates rapid construction of multiple/ mass modular units (similar units)
- Results in durable structure with low maintenance requirement
- The precise finishing can be ensured with no plastering requirement
- The concrete can use industrial by-products such as Fly Ash, Ground granulated blast furnace slag (GGBFS), Micro silica etc. resulting in improved workability & durability, while also conserving natural resource
- Being Box type structure, highly suitable against horizontal forces (earthquake, cyclone etc.)
- The large number of modular units bring economy in construction.



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giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

Thank you



MAGICPOD

Plug & Play Homes

3D MODULAR PRECAST

3rd Generation in
Construction Technology

Content

- 1) About Us
- 2) What is 3D Modular Precast?
- 3) Need for Modular Construction
- 4) Implementation
- 5) Technology Comparison
- 6) Combination with Conventional Construction
- 7) Modular Buildings – History, Case Studies, Adoption
- 8) Implementation in India
- 9) Key Notes

Vision

- Magicrete was founded with the idea of introducing modern methods of construction to help people make their homes better, faster & cheaper.

Journey So Far

- Introduced **MAGICBLOX** 10 years ago as a replacement of clay bricks. Transformed the walling industry with the product which was 10 times larger and made wall construction 5x faster.



Technology Road Map

10% Industrialization

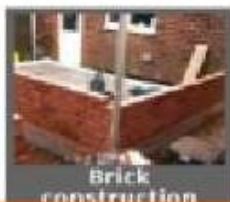
1st Gen Tech

Replacing Red clay
Bricks with AAC blocks.
10x better solution for walling
2008-2015



AAC Block
construction

Pre Magicrete Era



Brick
construction

2nd Gen Tech

Introducing Precast
Building methods.
Man days reduced by
180 days
2016

30% Industrialization



2D Precast



Column-Beam Precast



EPS Wall Panel



Hollow Core Wall Panel



Solid Precast Wall

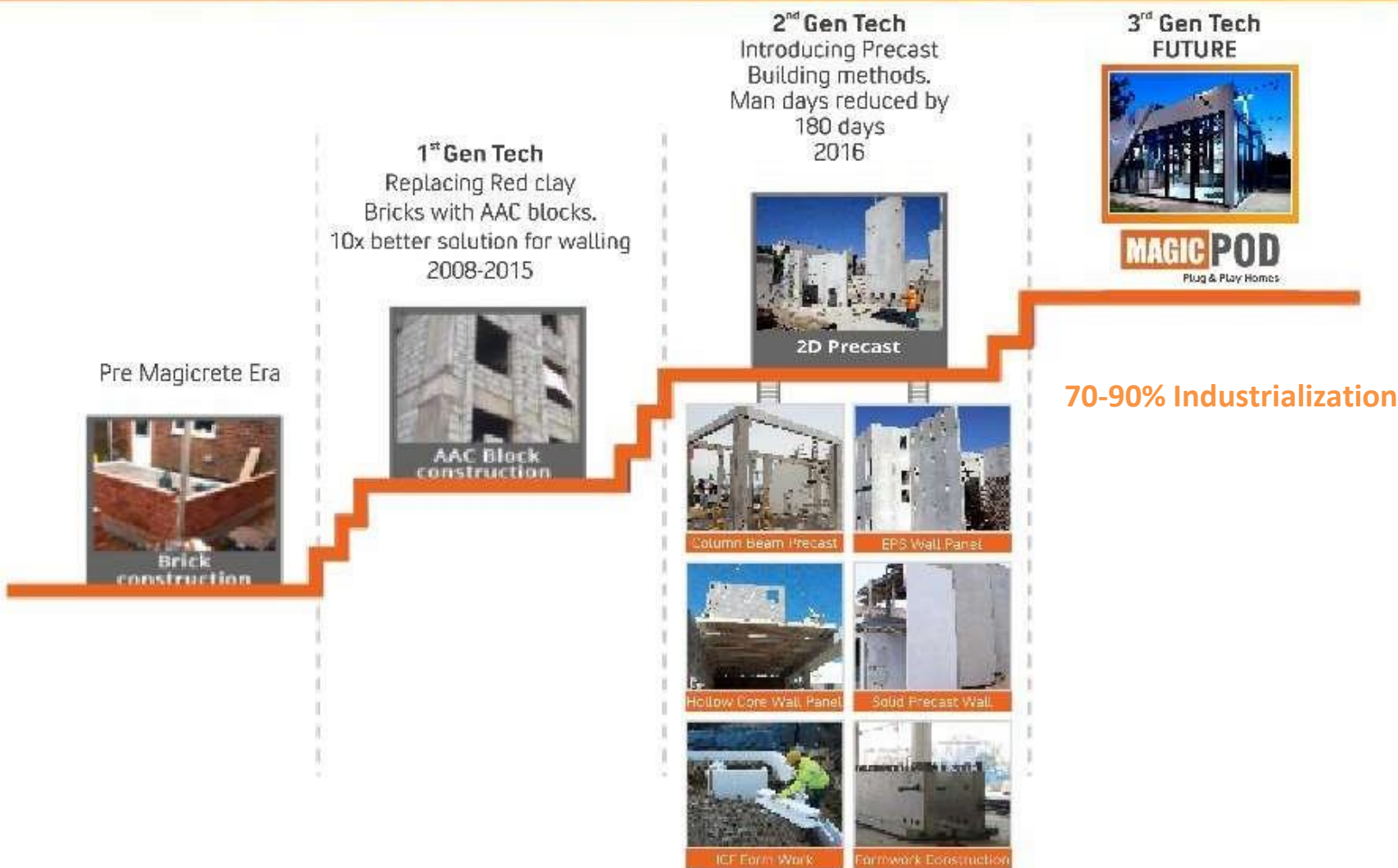


ICF Form Work



Formwork Construction

Future Technology - 2020



Introducing 3rd gen in Construction Technology

MAGIC POD
Plug & Play Homes

3D MODULAR
PRECAST

- Lego like plug and play modules
- Cast and finished in factory
- Assembled on site
- 90% work done in factory

magcrete
the winning experts



MAGICRETE PRECAST
shaping your concrete

MAGIC POD
Plug & Play Homes

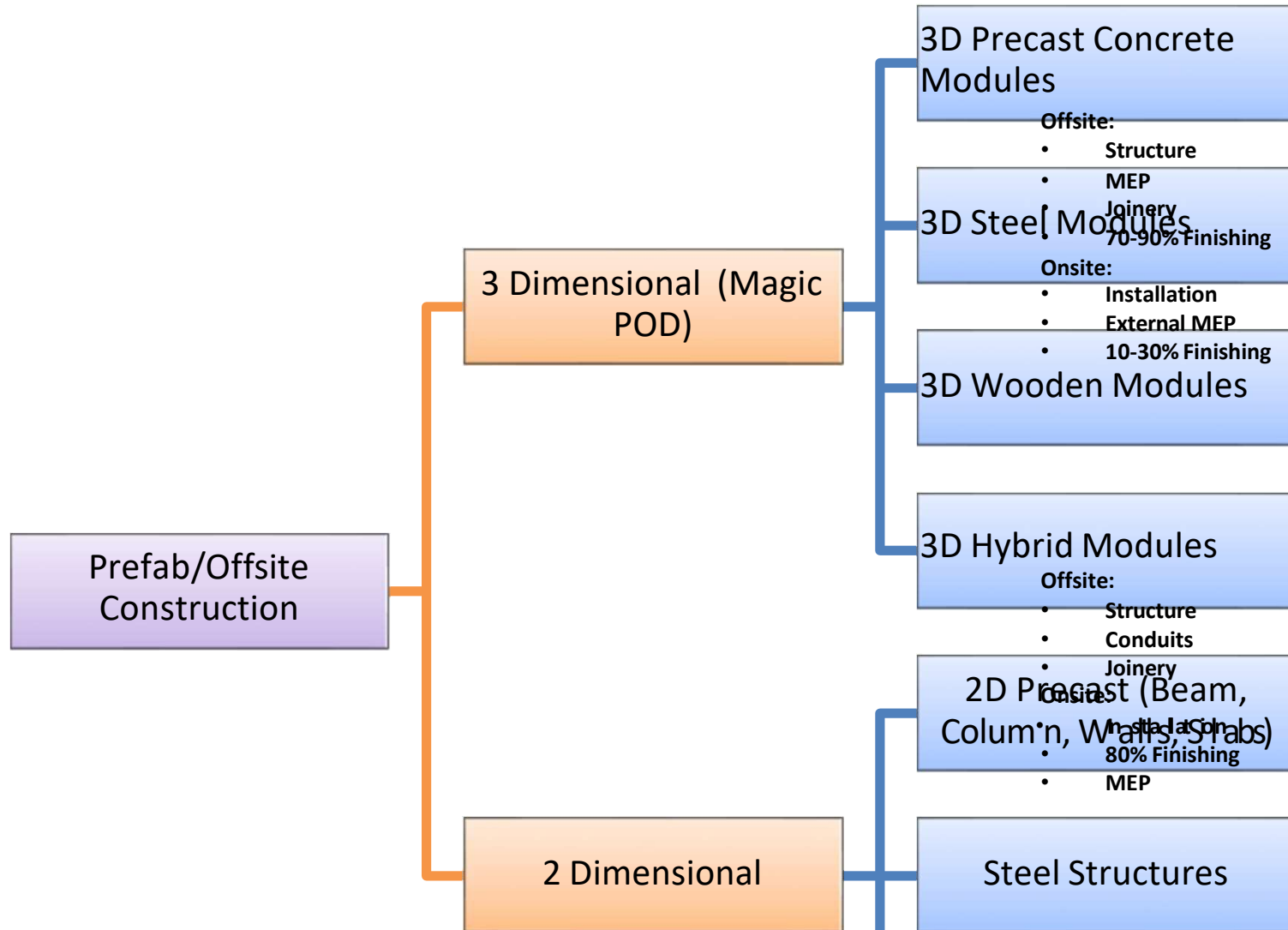
Need for Modular Construction



Figure 1 (Source: Chapman and Butry, "Measuring and Improving the Productivity of the U.S. Construction Industry: Issues, Challenges, and Opportunities." Building and Fire Research Laboratory, National Institute of Standards and Technology: Gaithersburg, MD, 2008.

- Construction industry lags in Labour Productivity
- Need more Industrialization
- Enhanced Factory based approach like automobiles
- Prefab/ Modular Construction is the solution to fill this Gap.

Classification of Industrialized Construction



Steel Processing Area



3D Mould Preparation



Casting of Modules



MEP Works



Logistics



Painting Works



Tiling Works



Joinery Works



Why Magic Pods?

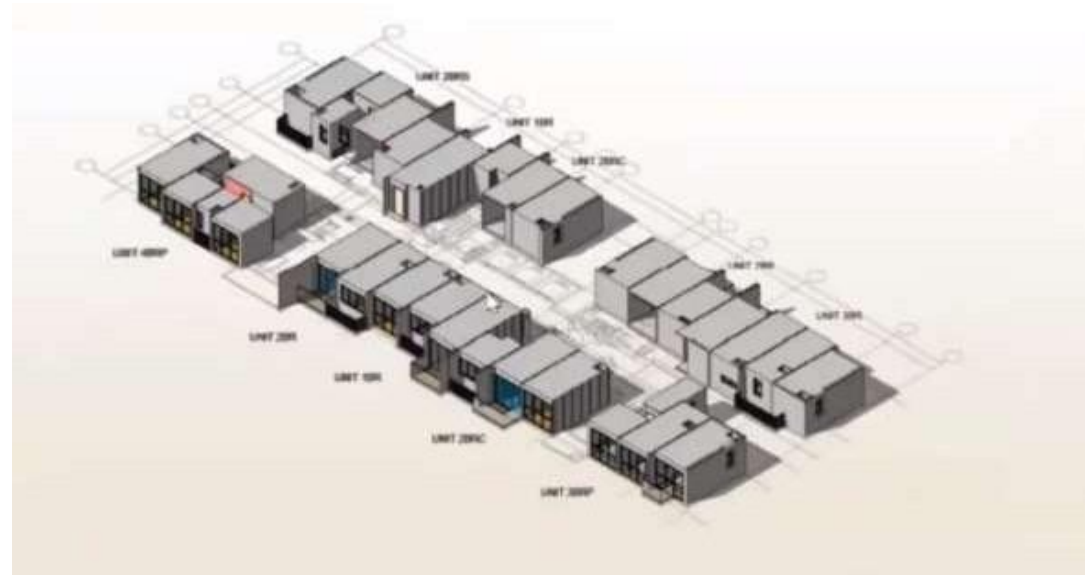
OTHER BENEFITS

- ✓ Reduce labour cost
- ✓ Less material waste
- ✓ Higher quality structures
- ✓ Less site disturbance
- ✓ Flexible & adaptable
- ✓ Movable and permanent buildings options



Modularization of Floor Plan

- Identify the areas to be Modularized
- Make combination of 3D and 2D elements
- Optimize Structural stability, Productivity & Resource Efficiency



Classification of Modules

Walls + Roof + Floor

- **Pros** – Highest Productivity & Resource Efficiency
- **Cons** - Higher weight, 100% Mechanized Mold assembly required

Walls + Roof

- **Pros** – Higher Productivity & Resource Efficiency
- **Cons** - Higher weight, 100% Mechanized Mold assembly required

Walls + Floor

- **Pros** – Higher Productivity & Resource Efficiency
- **Cons** - Higher weight, 100% Mechanized Mold assembly required

Production Line



Finishing Line



Source: Volert

MAGICRETE PRECAST
shaping your concrete

Transport & Installation

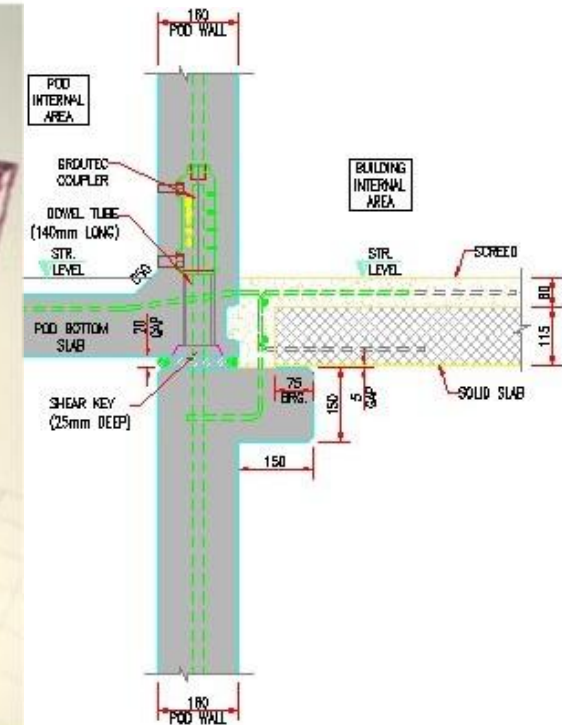
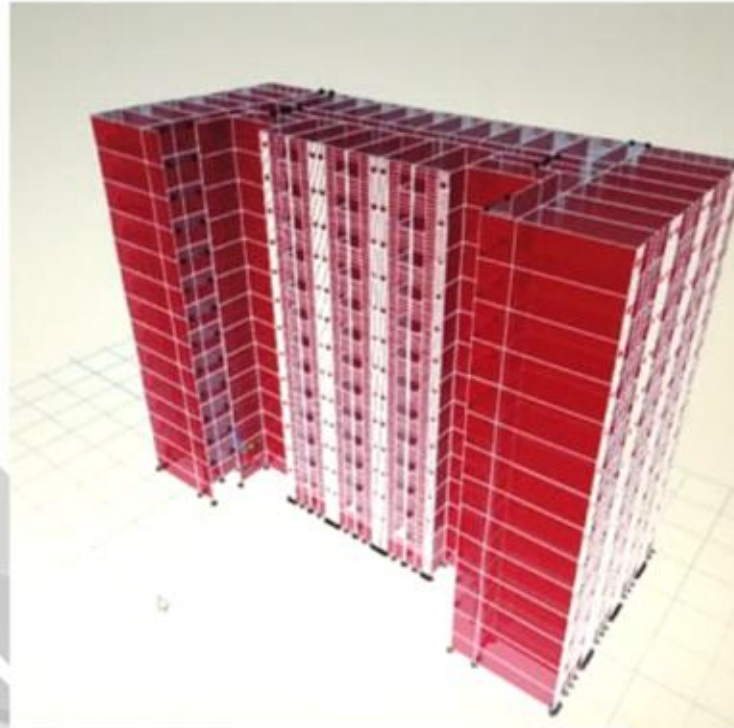


Transport & Installation



Earthquake Resistant Design

- Specially designed inter-pod connections suitable for high seismic zones



Technology Comparison

Parameter	MagicPod (3D Modular Precast)	Conventional Construction
Resource Efficiency	Excellent (up to 60% less manpower)	Poor
Time Reduction	50% lesser	-
Cost Reduction	0.85 x	1.00 x
Safety	Low risk to manpower (only 10% of work on site)	High Risk of injury to manpower
Sustainability	High (uses less & recyclable materials)	Low
Functionality Parameters		
Thermal performance	Provides for use of light weight concrete /polystyrene infill	Normal
Seismic Stability	High (suitable upto zone 4)	Medium
Acoustic	>45dB sound reduction for 100mm wall	>40-45dB average sound reduction
Water Tightness	High due to lesser joints	Depends on workmanship

Technology Comparison

Factors	MagicPod (3D Precast Modular)	Light Gauge Steel Modular	2D Precast	Reinforced EPS Wall Panel	Monolithic Concrete Const.
%age Industrialization	90%	60 - 90%	30%	10%	0%
Durability	High	Medium	High	Medium	High
Life Cycle Cost	Low	High	Medium	Medium	Low
Strength	High	Low	High	Medium	Medium
Automation Possibility	High	Low	Medium	Low	Low
Finishing @ Plant	100%	60 - 80%	0%	0%	0%
Weight of Modules	High	Less	Less	Less	Less
MEP	Concealed	Exposed/Concealed	Concealed	Concealed	Concealed
Scalability	Very high	Low	Medium	Low	Medium
Speed of Exec.	Very high	High	Medium	Low	Medium
Mandays for 300 Sq. Ft. Work	12	22	18	34	31

60% less manpower

How can conventional building benefit from Modular Construction?

By Using Bathroom Pods



Bathroom is a repeatable component – hence can be modularized.



Involves all trades – RCC, Waterproofing, Tiling, Plumbing, Joinery in a cramped place of 50-100 sft, hence a critical job in project completion. Should be done offsite in parallel to building super structure construction.



Fixed Cost – no cost overruns.



Quality – can be easily controlled in a factory environment rather than on site.



Ready to use – fully finished bathrooms ready to use post installation.

Manhour density is highest in bathrooms. Hence ideal for modularization

Types of PBUs



Normal Concrete Pod



Lightweight Concrete Pod



Drywall Pod

Reasons for Adopting Bathroom Pods:

13 trades are done offsite, 40 % manpower reduction, 20% faster construction

Normal Concrete PBUs

MATERIALS AND STRUCTURE

- A monolithic casting
- Floor/wall made of concrete. Weight is about 5T to 6T
- Service pipes are either cast in or installed in recesses provided on walls
- Usually installed by **critical path method** as the POD is too heavy to be pushed in from the side of the building



Light Weight Concrete PBUs

MATERIALS AND STRUCTURE

- Floor/wall made of light weight concrete
- Wall thickness is 50mm, maximum weight including finishes is 3.5 tonnes
- Recess provided on walls to conceal service pipes
- Can be installed by **critical path & non-critical path method**



Dry Wall PBUs

MATERIALS AND STRUCTURE

- Concrete floor pod with drywall, weight is about 3T
- Steel sections as wall frame to secure drywall panels
- Water pipes are concealed in the dry wall
- Backing plates on the wall to mount the fittings and accessories
- **Non-critical path** installation



Installation Methods



Drop in

Critical Path

Slide in

Non Critical Path

Modular Buildings - History



The Hilton Palacio del Rio Hotel, the first Concrete high rise Modular buildings in the world.

Timeline: 202 working days
Location: Texas, 1968

Methodology:

G + 3 floors: Cast in Situ
Elevator Core : Slip form
Rooms: Modular Units
Total Floors: 21
Total Rooms: 496
Installation: 46 Days



Modular Buildings - History



Habitat 67, Built in 1967 in Montreal, Quebec, Canada. Habitat 67 comprises 354 identical, prefabricated concrete Modules arranged in various combinations, reaching up to 12 stories in height.

Modular Buildings - Case Study



The Modules, Philadelphia, US, 2010.
Timeline: 9 Months
Area: 80,000 Sqft.
Total Floors : 5
Rooms: Modular Units
Total Rooms: 89



Victoria Hall, Wembley, UK, 2011.
Timeline: 16 months
Total Floors: 19
Rooms: Modular Units
Total Rooms: 435

Modular Buildings - Case Study

In 2014,
Building 2 at Atlantic Yards, New York



In 2018,
Clement Canopy, Singapore



In 2019...
Condominium at Silat Ave, Singapore



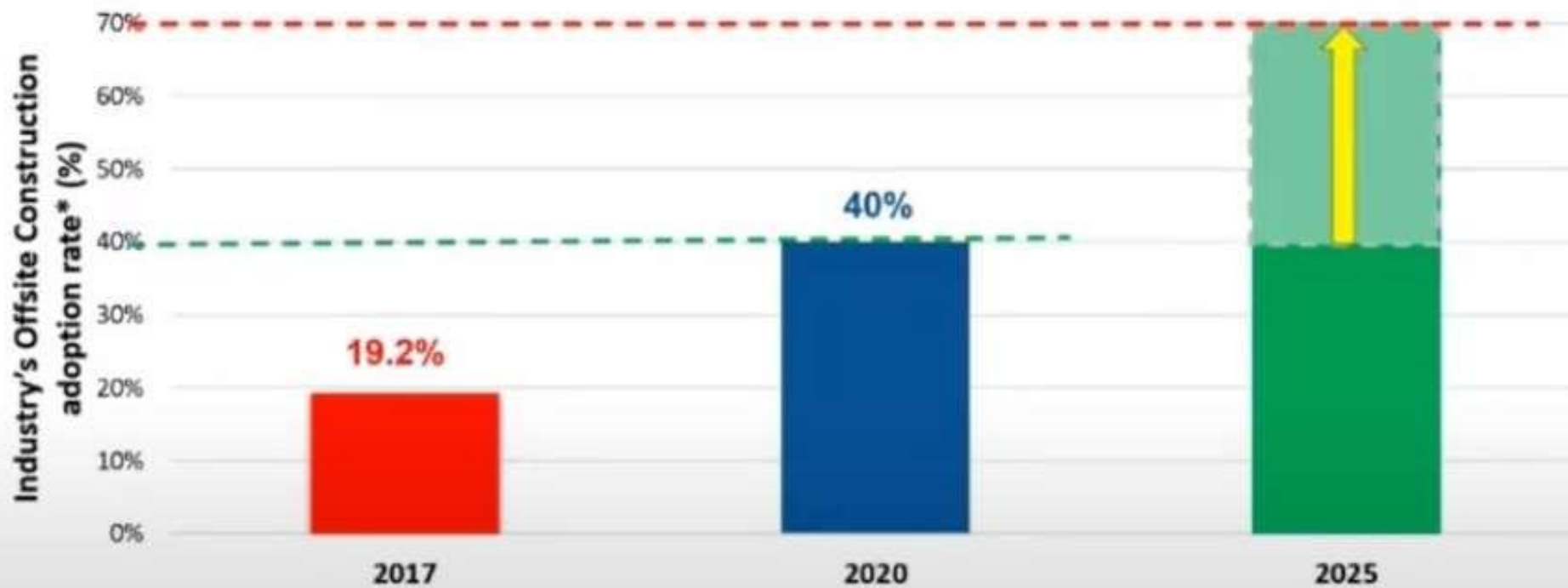
Modular Buildings - Case Study



SOHO Towers, Darwin Australia. 29 story high. The modules were completed & Finished in Ningbo, China & shipped to Darwin, Australia.



Technology Adoption



Implementation in India



Client: MOHUA - GOI

Technology: 3D Modular Precast

Timeline: 15 Months



Total Units: 1008 Apartments

Unit Type: 1 BHK House for EWS

Total Buildings: 7 x G+8

Key Notes

- The Big Change in Construction is coming...
- Onus lies with us...
- We as industry Participants & Drivers have the responsibility to Develop and Inculcate the technology and mainstream it...
- Govt. Institutions will play a very important role in developing Standards and Codes...
- Education Institutes shall also join hands & start courses to help Mainstreaming these technologies...