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

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

आज़ादी का अमृत महोत्सव

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TRAINING-C (VOCATIONAL) TRAINING PROGRAM ON INNOVATIVE CONSTRUCTION TECHNOLOGIES AND CONSTRUCTION PROCESS

INTRODUCTION

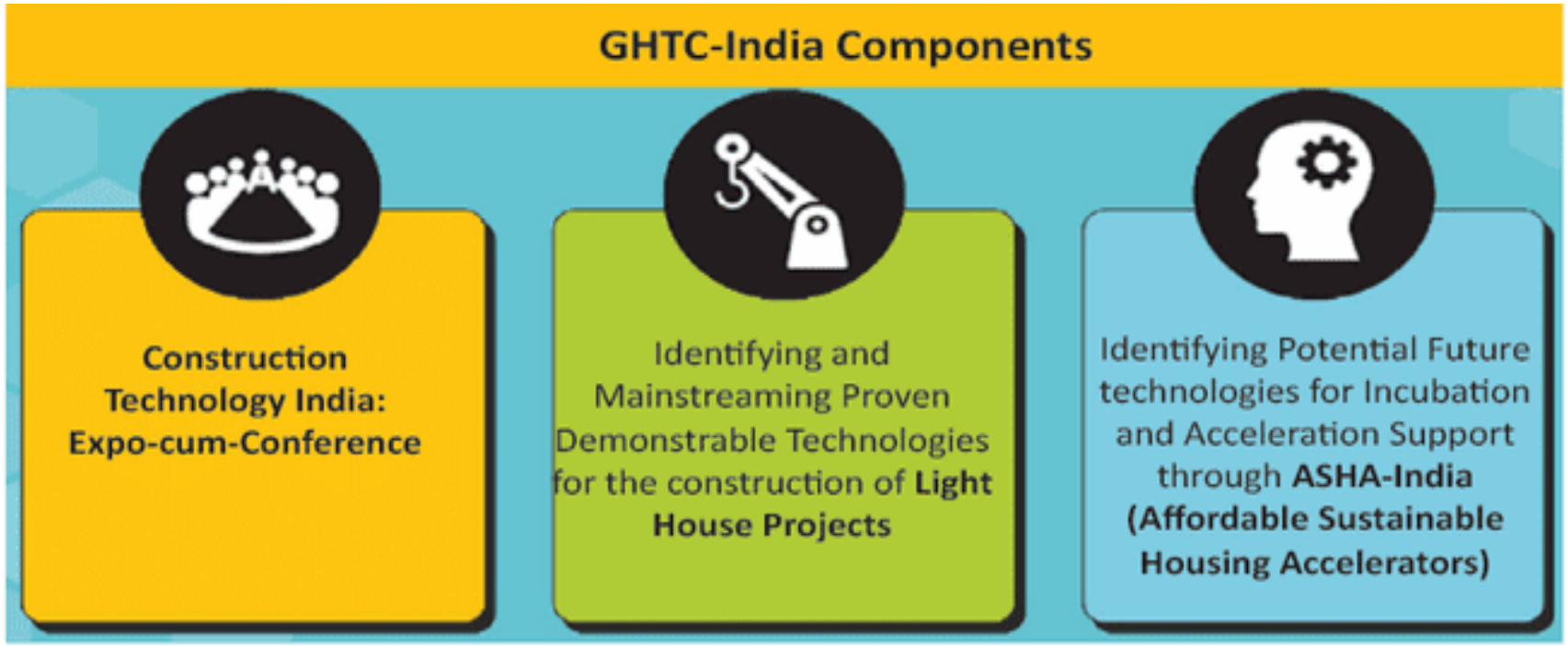
1. Introduction of Ministry of Housing and Urban Affairs
2. Introduction of Global Housing Technology Challenge
3. Introduction of GIZ
4. Introduction of Climate Smart Building Cell

INTRODUCTION - MoHUA

- **Ministry of Housing and Urban Affairs (MoHUA)** is the supreme authority of the Government of India to formulate and monitor all the programmes concerning the housing and urban affairs of the country.
- Under MoHUA's flagship mission **Pradhan Mantri Awas Yojna-Urban (PMAY-U)** it ensures a pucca house to all eligible urban households by the year 2022.

INTRODUCTION- GHTC (INDIA)

- **MoHUA,** due to the need for sustainable technological solutions for faster and cost-effective constructions suited to geo-climatic and hazard conditions of the country, initiated the **Global Housing Technology Challenge (GHTC)-India to identify and mainstream a basket of innovative housing technologies across the globe.**
- 54 proven technologies were shortlisted suiting different climatic zone conditions in the CTI conference in 2019.



INTRODUCTION – GIZ AND IGEN (INDO GERMAN ENERGY PROGRAM)

- The Government of the Republic of India and the Federal Republic of Germany under the Indo-German Technical Cooperation, agreed to jointly promote the "Indo-German Energy Programme" **(IGEN)** with the aim to foster sustainability in the built environment.
- Deutsche Gesellschaft für Internationale Zusammenarbeit **(GIZ)** GmbH has been working jointly with the Government of India for over 60 years, for sustainable economic, ecological, and social development.
- GIZ is an international cooperation enterprise for sustainable development which operates worldwide, on a public benefit basis.

INTRODUCTION – CLIMATE SMART BUILDINGS (CSB CELL)

- Ministry of Housing and Urban Affairs (MoHUA) aims to enhance climate resilience and thermal comfort in the affordable housing segment through IGEN's programme, **Climate Smart Buildings (CSB)**.
- It will be achieved by adopting sustainable and low-impact design, materials, and the best available construction technologies.
- The intent is to demonstrate the use of innovative technologies to provide desired thermal comfort for mass replication.

SESSION-1

1. Light House Projects in India
2. Construction Technologies of six LHPs

AIM FOR THE INCEPTION OF LIGHT HOUSE PROJECTS

- **Light House Projects** have been conceptualized as part of **Global Housing Technology Challenge – India (GHTC-India)**
- Ministry of Housing and Urban Affairs Under **PMAY(U)**, set up a **Technology Sub-Mission (TSM)** to provide:
    - Alternative sustainable technological solutions.
    - Better, Faster & cost-effective construction methodologies.
    - Houses suiting to geo-climatic and hazard conditions of the country.
- Construction of six **LHPs** with allied infrastructure and six categories of globally proven innovative technologies were envisaged in six different states.

CONCEPT OF LHP PROJECTS

The fundamental concept of the Light-House Projects is to encourage large-scale participation of the people of India for mainstreaming the proven technologies.

- Serve as **live laboratories** for the transfer of technology to the field by, planning, design, production of components, construction practices, and testing.

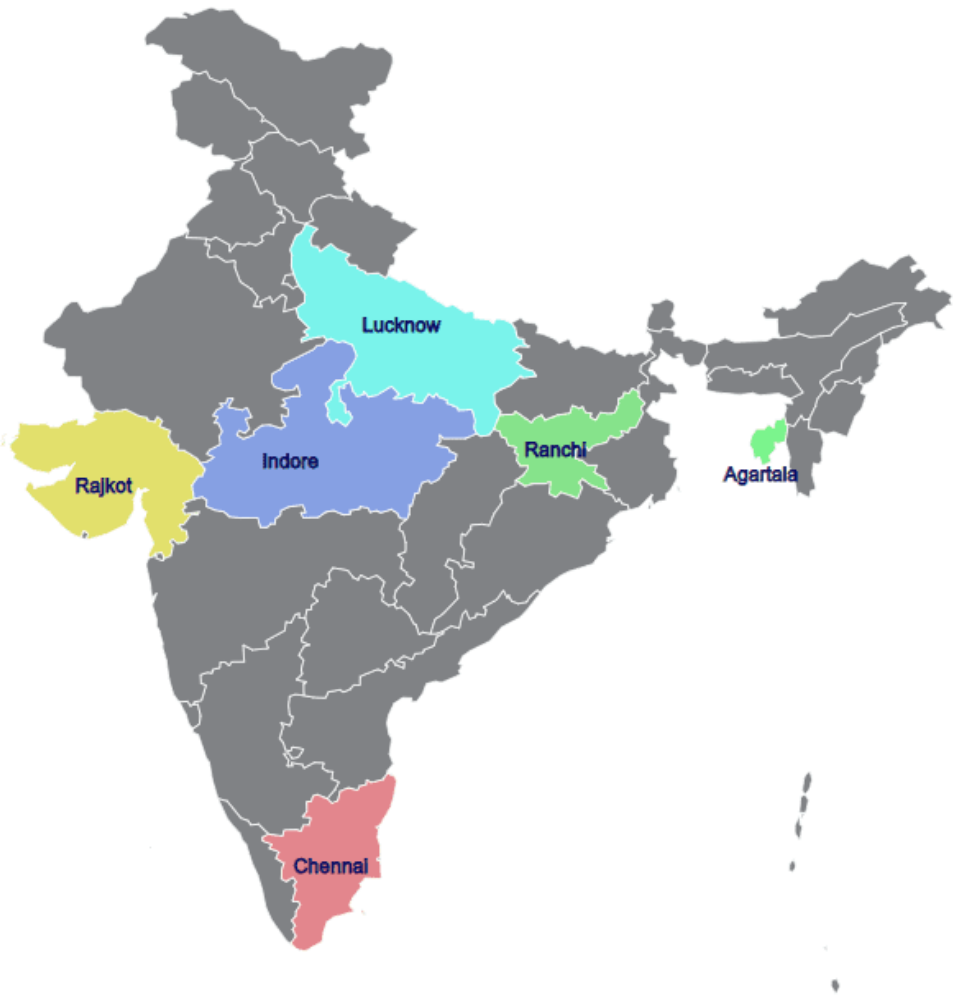
Live Lab for :

- ✓ ***Students,***
- ✓ ***Faculties,***
- ✓ ***Builder,***
- ✓ ***Professionals of Public and Private sectors, and other stakeholders, to create technical awareness for on-site learning.***

THE LIGHT-HOUSE PROJECTS- INDIA

Hon'ble Prime Minister Shri Narendra Modi laid the foundation stone of six Light House Projects (LHPs) each consisting of approx. 1000 houses on January 1, 2021, in six cities :

- **Indore** (Prefab Sandwich panel),
- **Rajkot** (Monolithic concrete construction using tunnel formwork)
- **Chennai** (Precast concrete construction system assembled at the site)
- **Ranchi** (Precast concrete construction system-3d volumetric)
- **Agartala** (Light gauge steel and PEB)
- **Lucknow** (Stay in place formwork and PEB)

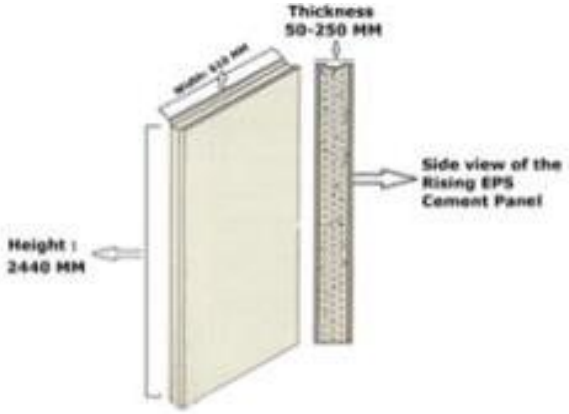


THE LIGHT-HOUSE PROJECTS: SUMMARY

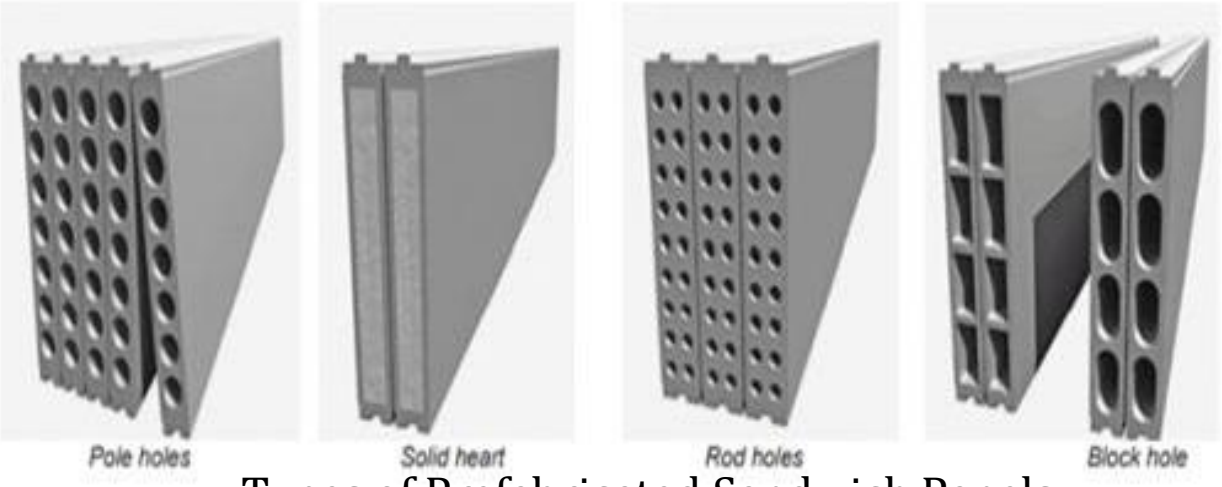
LHP Location			Chennai (Tamil Nadu)	Rajkot (Gujarat)	Indore (Madhya Pradesh)	Ranchi (Jharkhand)	Agartala (Tripura)	Lucknow (Uttar Pradesh)
Sl. No.	Particulars	Units						
1	Name of Technology	Name	Precast Concrete Construction System-Precast Components	Monolithic Concrete Construction using Tunnel Formwork	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	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	34.50
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

LHP Indore-Prefabricated Sandwich Panel System

- Lightweight composite wall, floor and roof sandwich panels made of thin fibre cement or calcium silicate board as face covered boards.
- Core material is 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 steel support structure beams and columns.



Prefabricated EPS Sandwich Panel



Types of Prefabricated Sandwich Panels

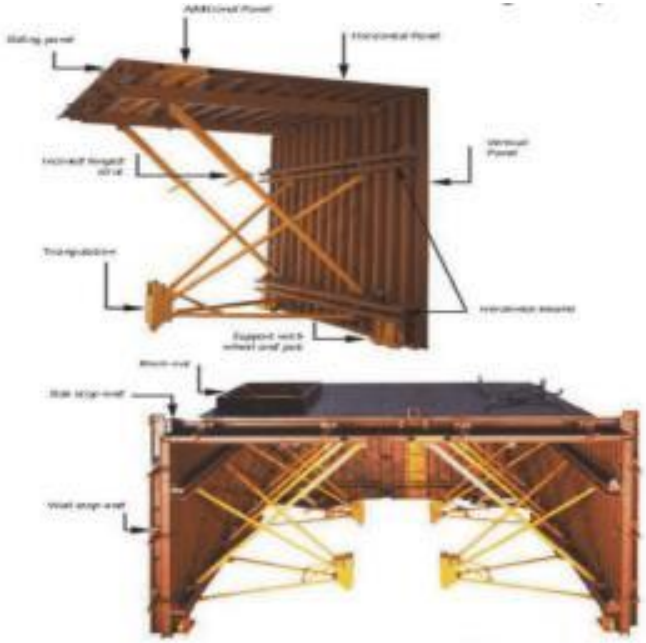
Steel Structure Prefabricated EPS Panel

LHP Indore-Prefabricated Sandwich Panel System

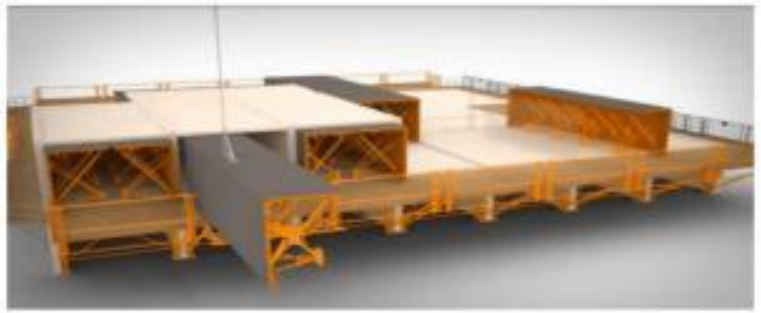
LHP Indore Explained by Video

LHP Rajkot- Monolithic Concrete Construction using Tunnel Formwork

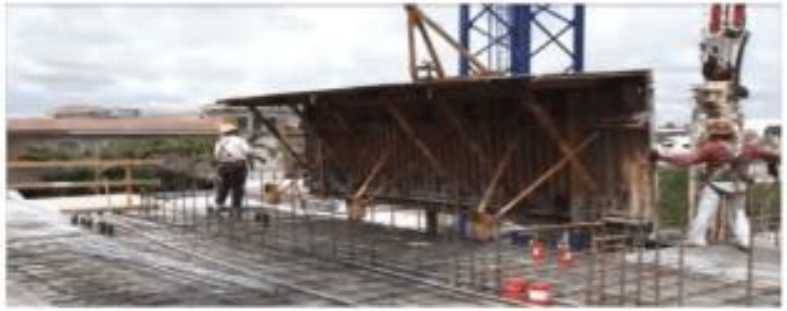
- Customized engineering formwork replacing conventional steel or plywood shuttering systems.
- Mechanized system for cellular structures.
- Two half shells which are placed together to form a room or cell.
- Walls and slab are cast in a single day.
- The formwork is stripped the next day for subsequent phase.



Tunnel Formwork



Box out of door and windows



Kicker form of tunnel formwork panel

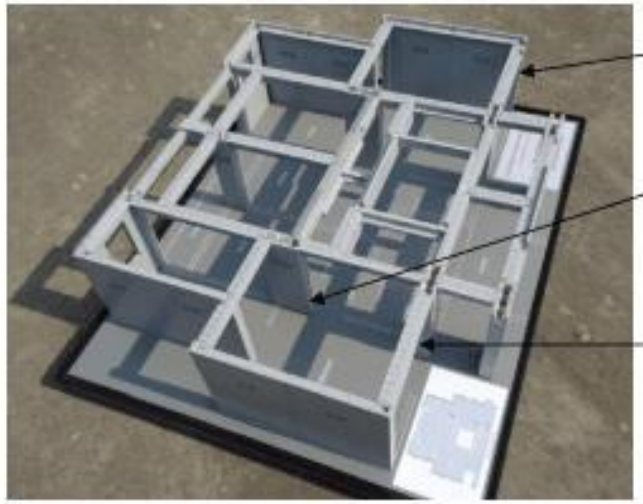
Monolithic Tunnel Formwork Panel

LHP Rajkot- Monolithic Concrete Construction using Tunnel Formwork

LHP Rajkot Explained by Video

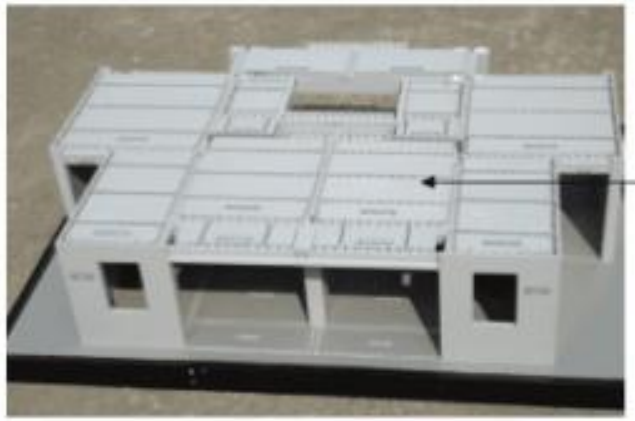
LHP Chennai-Precast Concrete Construction System Assembled at Site

- Precast dense reinforced cement concrete hollow core columns and RCC shear walls is being used as structure .
- AAC blocks in partition walls are being used.
- Dowel bars, continuity reinforcement placed at connections.
- Self-compacting concrete is being used in hollow cores of columns.



Installation of panels

Precast concrete wall (Panels)



LHP Chennai-Precast Concrete Construction System Assembled at Site

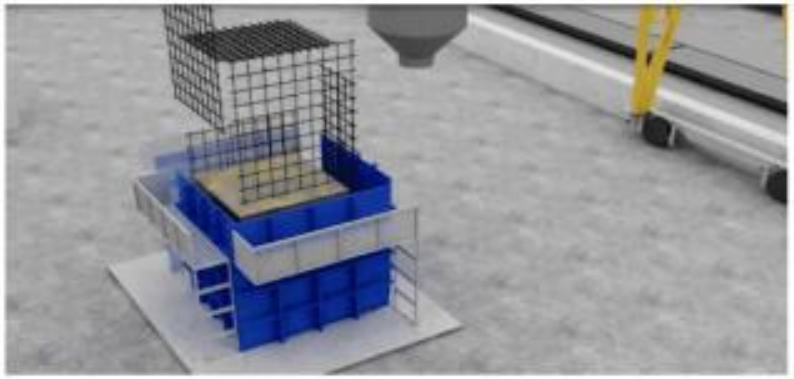
LHP Chennai Explained by Video

LHP Ranchi- Precast Concrete Construction System – 3D Volumetric

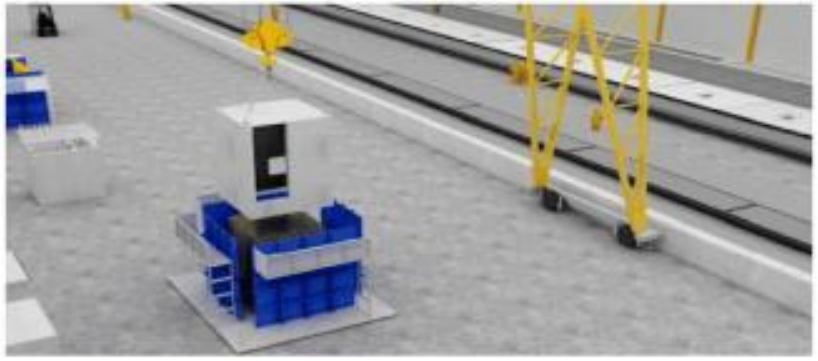
- Components like room, Bathroom, Kitchen etc are cast monolithically in Plant or Casting yard in a controlled condition.
- Magic Pods (Precast Components) are transported, erected & installed using cranes .
- Prestressed slabs are installed as flooring elements.
- Consecutive floors are built in similar manner to complete the structure.

Transportation of Magic Pods

Construction and installation



Pre Casting of building modules



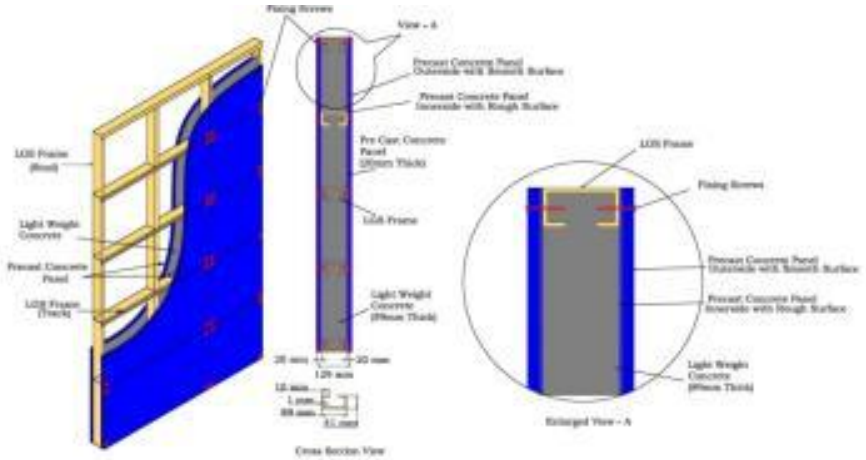
Pre Casting of building modules

LHP Ranchi- Precast Concrete Construction System – 3D Volumetric

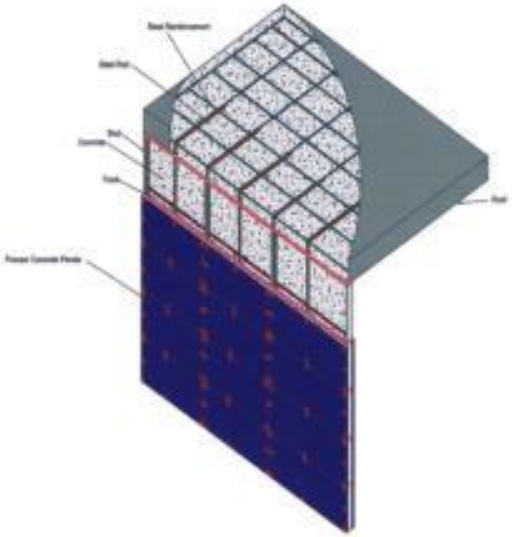
LHP Ranchi Explained by Video

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

- Light Gauge Steel Framed Structure with Infill Concrete Panels (LGSFS-ICP) Technology.
- Factory made Light Gauge Steel Framed Structure (LGSFS), light weight concrete and precast panels are being used.



Structural Details of LGSFS-Infill Concrete Wall



Precast concrete panels

Light Gauge Steel Frame Structure

Assembly of LGS Frames and Construction of Wall

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

LHP Agartala Explained by Video

LHP LUCKNOW- PROJECT OVERVIEW

Project Brief	
Location of Project	Avadh Vihar, Lucknow, U.P.
No. of DUs	1,040 (S+13)
Plot area	20,036 sq.mt.
Carpet area of each DU	34.51 sq.mt.
Total built up area	48,702 sq.mt.
Technology being used	Stay In Place Formwork System with pre-engineered steel structural system
Other provisions	Community Centre, Shops
Broad Specifications Broad Specifications	
Foundation	RCC raft foundation
Structural Frame	Pre-engineered steel structural frame
Walling	Stay In Place PVC Formwork System
Floor Slabs/Roofing	Cast in-situ deck slab

LHP LUCKNOW- PROJECT PLAN

Project Details:

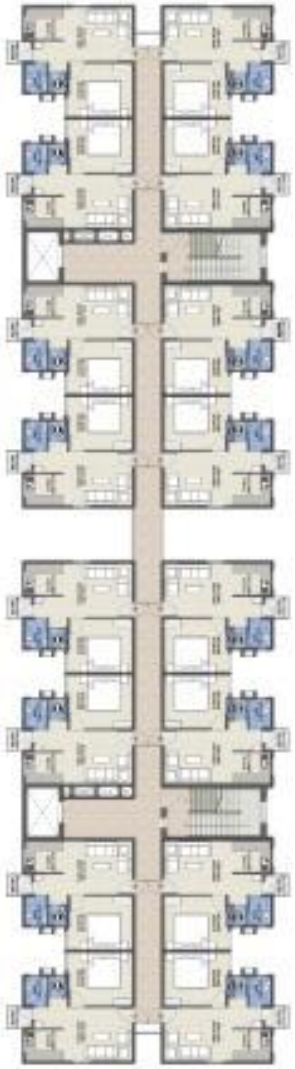
Technology Used: Stay In Place PVC Formwork with PEB Steel Structure
Plot area : 20,036 sq.mt.
Carpet area of each DU : 34.51 sq.mt.
No. of Floors: S+13
No. of DUs: 1024
No. of Blocks: 4
Community Hall
Commercial Block

Amenities:

Rooftop Solar PV/Solar Street lights
Sewage Treatment Plant
Under Ground water reservoir
Rainwater Harvesting
Solid Waste Management
Elevator
Emergency Power Backup
Fire Fighting System

LHP LUCKNOW- PROJECT PLAN

SITE PLAN



TYPICAL FLOOR PLAN

Unit Plan

LHP Lucknow- Technology

- SIP formwork is an advanced hybrid construction technology consisting of rigid polyvinyl chloride-based polymer panel infilled with self-compacting concrete in a building envelope.
- In this wall system PVC panel is used as a permanent stay-in-place finished formwork instead of concrete walls.
- Hot rolled Pre-Engineered building steel sections act as a structural framework of the building.
- SIP formwork works as a partition of building walls.

LHP Lucknow- Construction Methodology

Foundation

RCC Raft Foundation by conventional method

PEB Structure

Hot rolled Steel Section

Deck Slab

0.09 mm thick GI sheet. Reinforcement and deck slab casting

Panel Placement

Individually placed by sliding and interlock

Panel Reinforcement

8 mm steel bar used in 250x250 mm mesh

Electric & Plumbing Ducts

Ducts must be places before the concreting

Concrete Pouring

Self-compacting concrete is used as infilled material in PVC SIP panel

Finishing

Door
Window
False Ceiling
Electrical & Plumbing Services

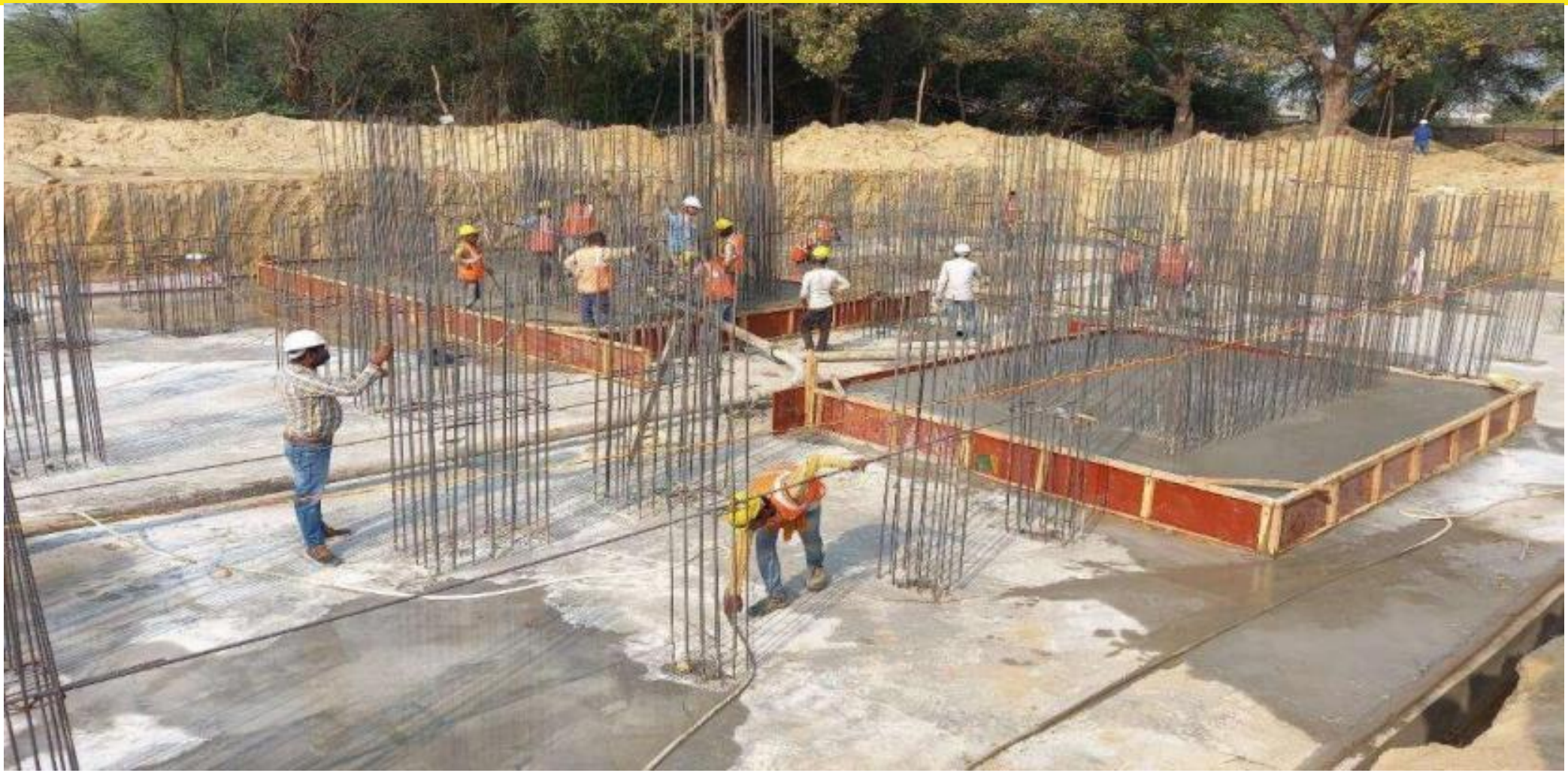
LHP Lucknow- Foundation

- Conventional as per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Raft foundation with RCC column up to plinth height.
- RCC plinth beam and grade slab at plinth level.

LHP Lucknow- Foundation

- Reinforcement and shuttering for raft foundation

LHP Lucknow- Foundation



- All building blocks have Raft foundation with 500 mm thick M-25 Concrete.
- **An additional thickness of 400 mm has been constructed around staircase and lift well.**

LHP Lucknow- Foundation

- Columns of M25 Grade Concrete are being cast upto plinth height over already laid cured raft.

LHP Lucknow- Foundation

- Back filling with soil and water in layers of 200 mm with proper compaction.

LHP Lucknow- Foundation

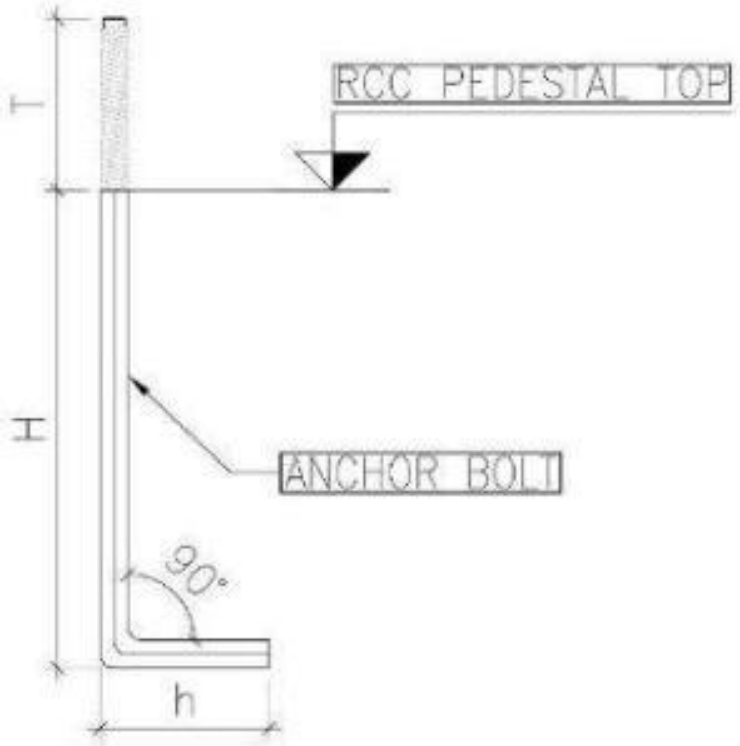
- Anchor bolts have been cast with concrete at plinth level over which factory made built up columns with base plate will be erected.
- The reinforcement laying & shuttering work is in progress for shear wall construction of lift & staircase portion.

LHP Lucknow- Structural System

- Pre-Engineered Building system comprising of built-up fabricated I sections for beams and columns

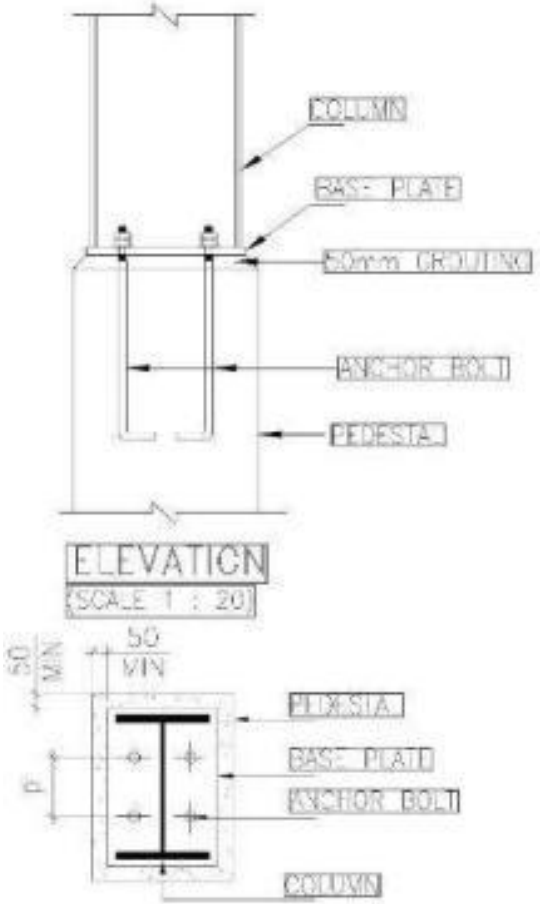
LHP Lucknow- Structure

- Connection details of built up steel column at plinth level (Stilt) with foundation (plinth beam)



Typical anchor bolt detail

Anchor bolt is inserted below plinth level upto height H and projected above plinth up to height "T".



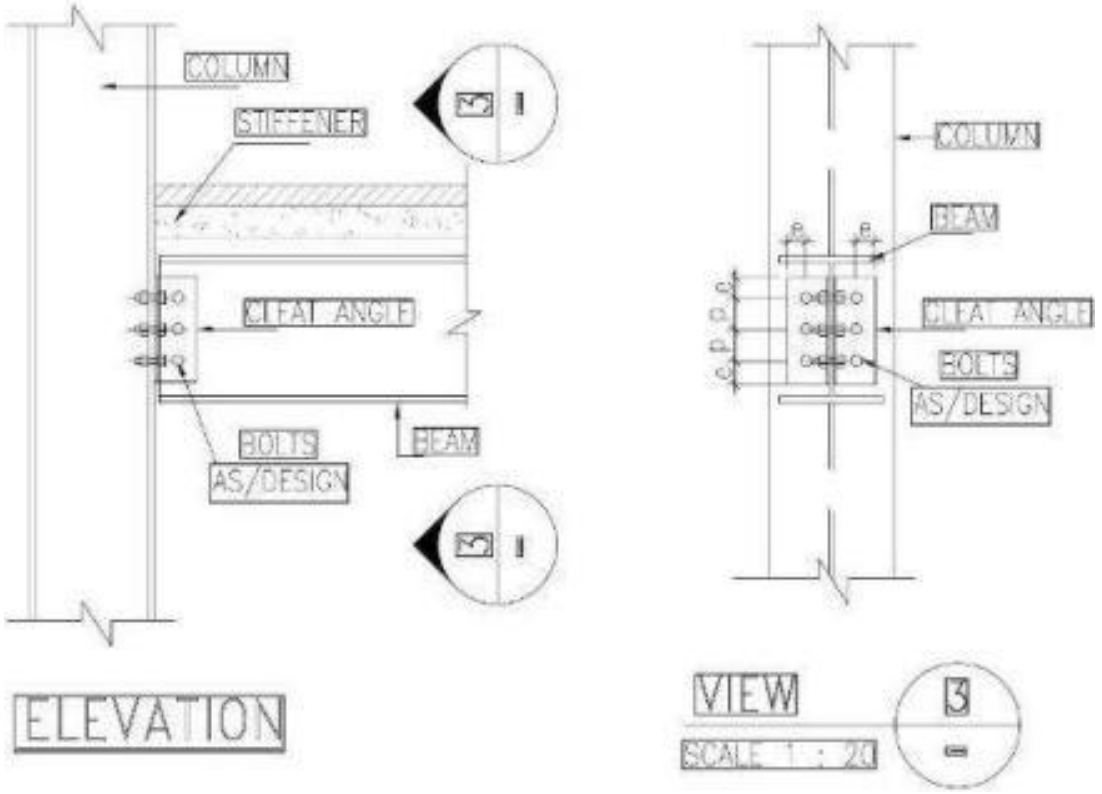
Typical base plate detail

The built up steel I column is being fixed with anchor bolts and base plate

Dia (mm)	H (mm)	h (mm)	T (mm)
16	400	100	100
20	500	100	100
24	600	100	150
27	700	100	150
30	800	100	150

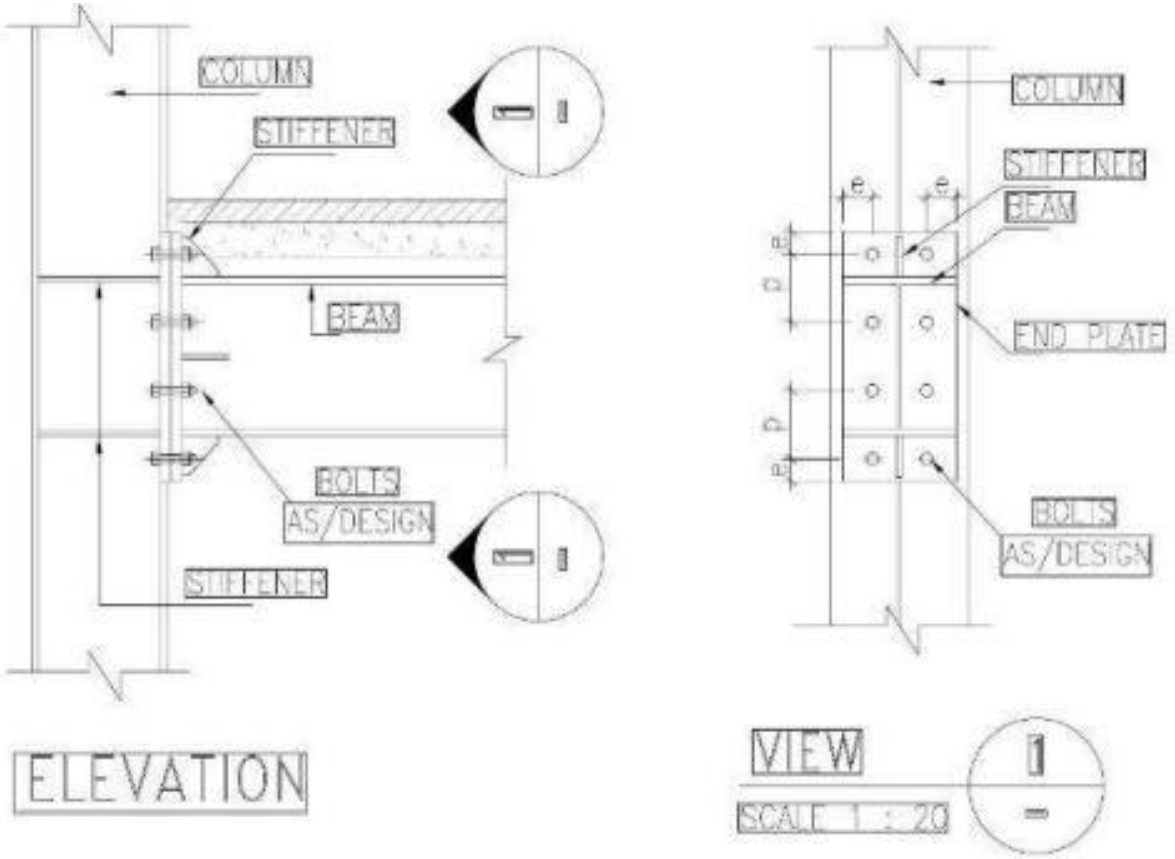
Anchor bolts schedule

LHP Lucknow- Structure



Typical beam to column flange shear connection

Steel beam is being connected to the column through cleat angle connected to the web portion of beam



Typical beam to column flange moment connection

The steel beam is being connected to column through plates on flange & web portion

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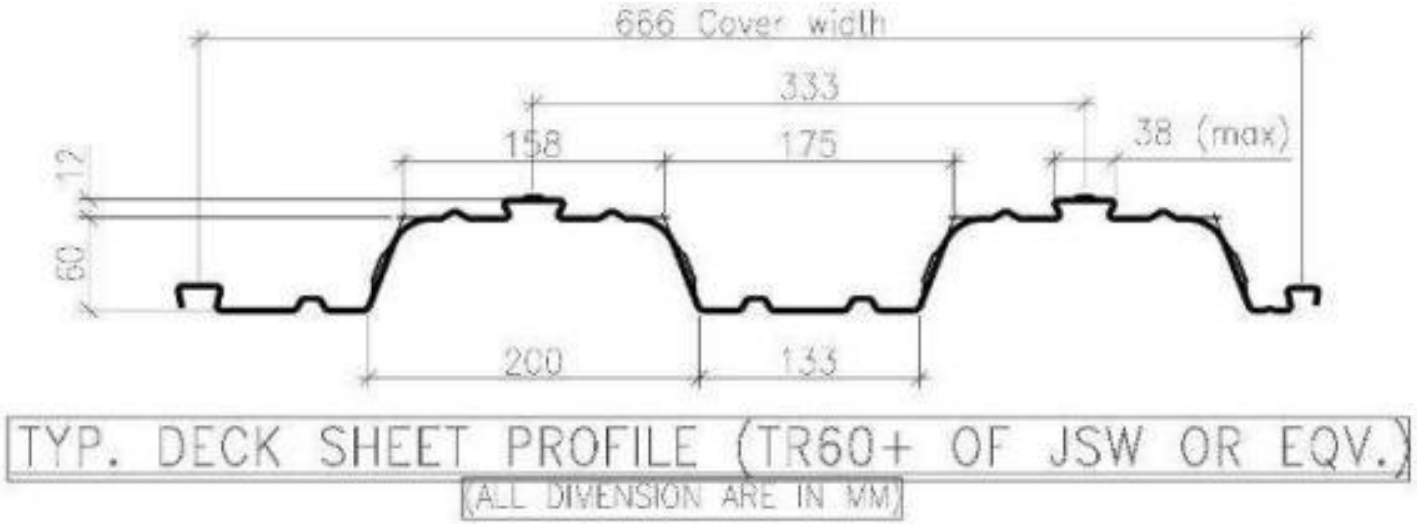
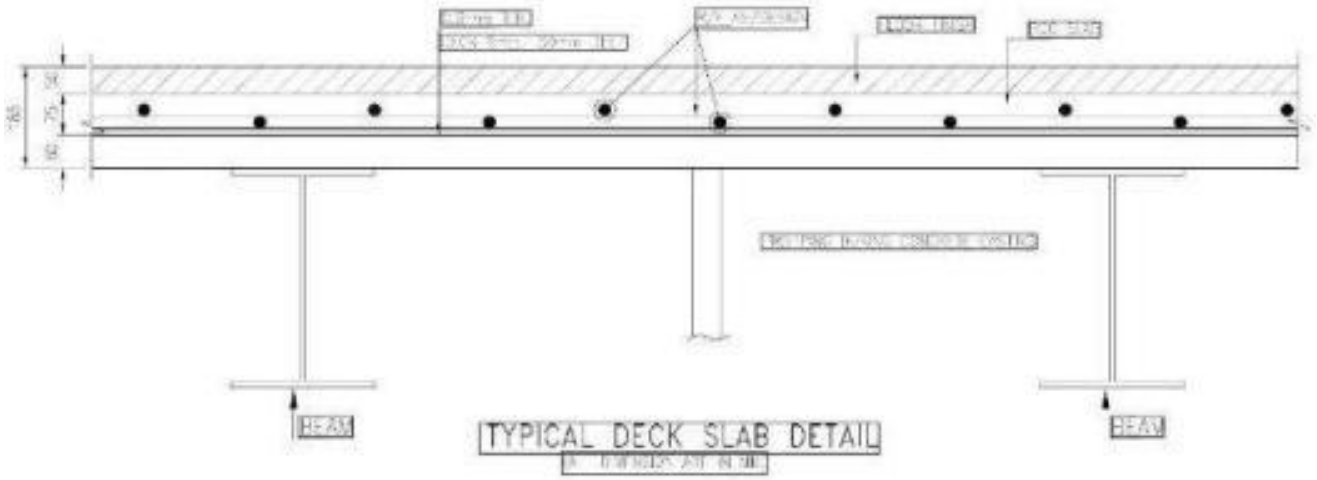
LHP Lucknow- Erection of Steel Structure

LHP Lucknow- Deck Slab

- After erection of steel beams and column (PEB Structure), steel deck sheet of thickness 0.9 mm are placed with required bearing on the beams.
- Concrete screed of 75 mm is poured on the deck sheet in M25 with reinforcement as per structural design.
- Structural design for reinforcement is as per IS 456-2000.
- G enerally, nominal reinforcement is provided in concrete screed of deck slab to take care of shrinkage & cracking.



Typical deck sheet profile



Typical deck slab detail

LHP Lucknow- Deck Slab

LHP Lucknow- Deck Slab

LHP Lucknow- Wall Erection

LHP Lucknow- Wall Erection Process

LHP Lucknow- Wall Erection Process

LHP Lucknow- Reinforcement in Walls

LHP Lucknow- Electrical & Plumbing Conduiting

LHP Lucknow- Wall Concreting

LHP Lucknow- Complete Structure of a Block

LHP Lucknow- Other Services

Electrical Switch Board

False Ceiling

Structure Cover with Cement Fiber Board

False Ceiling with Gypsum Board

False Ceiling with Gypsum Board

LHP Lucknow- Sample Finished House

LHP Lucknow- Quick Reference Table

1	**Timing**	SIP should be installed within 24 hours of pouring the slab or footing.
2	**Speed of installation**	150 sqm installed by four people per day on average.
3	**Storage and handling**	• Stack up to two packs high with spacers on a level surface. Spacers should be at four points for even distribution of dead weight, particularly to prevent distortion in extreme heat. • Panels are lightweight (maximum 23 kgs per sqm) and can be handled by two people.
4	**Placing and pouring height**	• Place panels carefully to accommodate starter bars and other details. Panels clip and slide into place and lock together with ease. Use a rubber mallet or similar for adjustment and persuasion to height and line. • Panels will withstand the dynamic bursting pressure of fresh concrete in single pours up to three meters high. Use horizontal bracing for pours greater than three meters.

LHP Lucknow- Quick Reference Table

5	Reinforcement	• Place from the top, aligning as close as possible to starter bars if applicable. The internal ribs will assist in achieving desired centres. Can be designed and placed at a vertical spacing of 150mm or 200mm increments. • If necessary, thread from the open end of the wall as the wall progresses. When a run ends at an existing wall and horizontal bars are required, place a length of a horizontal bar with an attached draw wire in the voids, then ease the bar forward. Spacing is to relate to voids in vertical diaphragms at 150mm increments.
6	Propping and aligning	• Use raking props at 1500mm centers to maintain plumb. For walls up to three meters in height, affix prop to a panel at the top third of the height. • The base should be plumb from the previous set. Use a laser to check horizontal and vertical alignment/plumb of panels.
7	Concrete mix and pouring	• Advisable mix should be minimum 25MPa for load bearing and 7.5mpa for non-load bearing, 10mm aggregate at 180mm slump. • Fill SIP panels carefully in layers of concrete not exceeding three meters high at a time. To reduce pressure and segregation at the base of the panels, discharge the concrete so that it impacts on as many internal ribs as possible.

LHP Lucknow- Quick Reference Table

8	Vibrating and contraction control	• Only certain cases vibrate poured concrete at a low frequency. The slick fine PVC surface will allow the concrete to slide easily into any air pockets or voids of SIP. • No contraction control is required
9	Services and door window openings	• Services and all other in situ requirements are the same as conventional formwork systems. • Windows, doors, and other openings are easily placed and cut in with standard pre-pour procedures.
10	Finishing	• SIP panels have a clean, straight, semi-gloss substrate perfect for a range of internal and external render and paint systems. • For concealing PEB we can use gypsum board and cement fibreboard and other wooden compatible materials also.

LHP Lucknow- Limitations

- Stay in Place PVC Form walls need pre-planned installation of MEP services for concealed networks.
- Doors and windows position shall not be changed after pouring of concrete.
- Erection of panels shall be under the supervision of trained staff.
- High-intensity UV rays harm the outer envelope, so it is not advisable in the tropical region.
- Skilled worker needed for PEB Erection and SIP Installation.

LHP Lucknow- Advantages

- Gives very aesthetic finished surface in different color options without plastering.
- No curing is required. About 50% less use of water.
- Faster as compared to conventional buildings.
- About 40% Less usage of manpower as compared to conventional construction. As all panels are prefabricated in the factory.
- Light in weight as compared to other conventional materials.
- SIP does not corrode, chip, or stain & is resistant to UV, bacteria, fungi, etc.,
- The polymer content used in the manufacturing of formwork is up to 55% recycled content and is further recyclable, making it an eco-friendly material.
- The PVC system provides insulation from the surroundings and gives better thermal comfort to occupants. Overall, this system is energy efficient as less water and operation energy requirements are less as compared to conventional buildings.

THANK YOU!