

VOCATIONAL TRAINING

Monolithic Concrete Construction using Tunnel Formwork

Climate Smart Buildings (CSB)

Cluster cell Rajkot, Gujarat

under Global Housing Technology

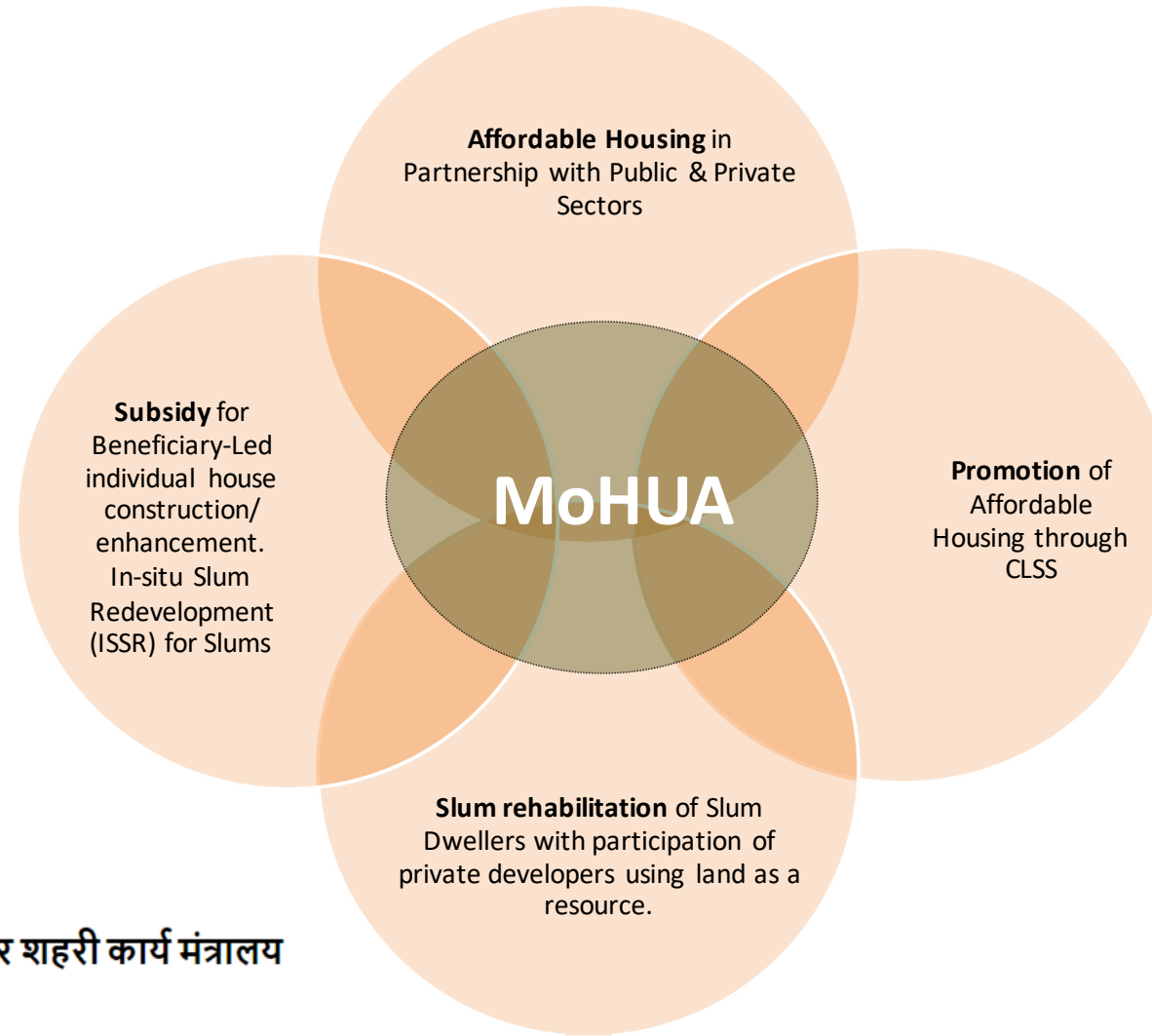
Challenge - India (GHTC-India)

INTRODUCTION - 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:



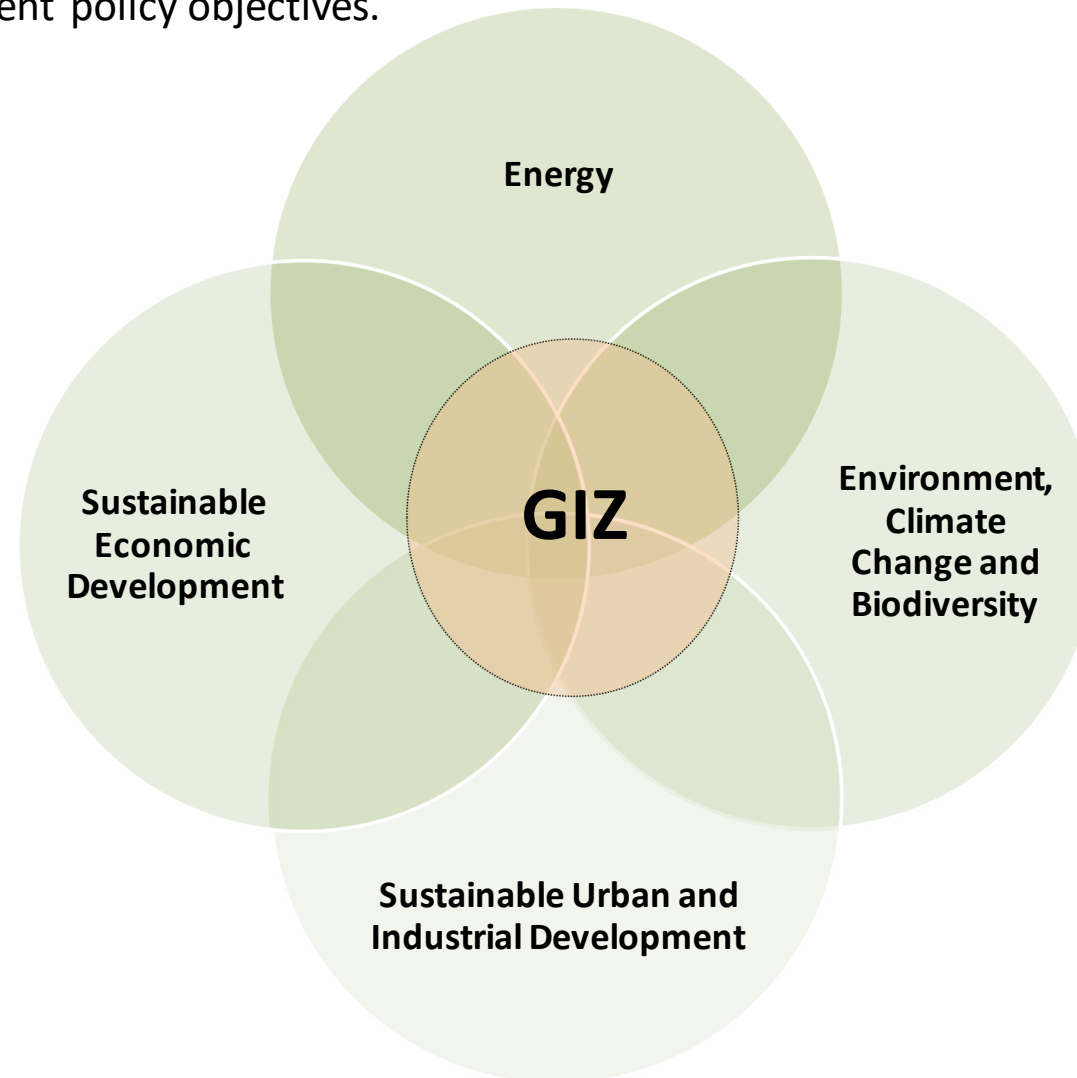
भारत सरकार

आवासन और शहरी कार्य मंत्रालय

सत्यमेव जयते

INTRODUCTION - 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 implement development programs in partner country on behalf of the German Government in achieving its development policy objectives.

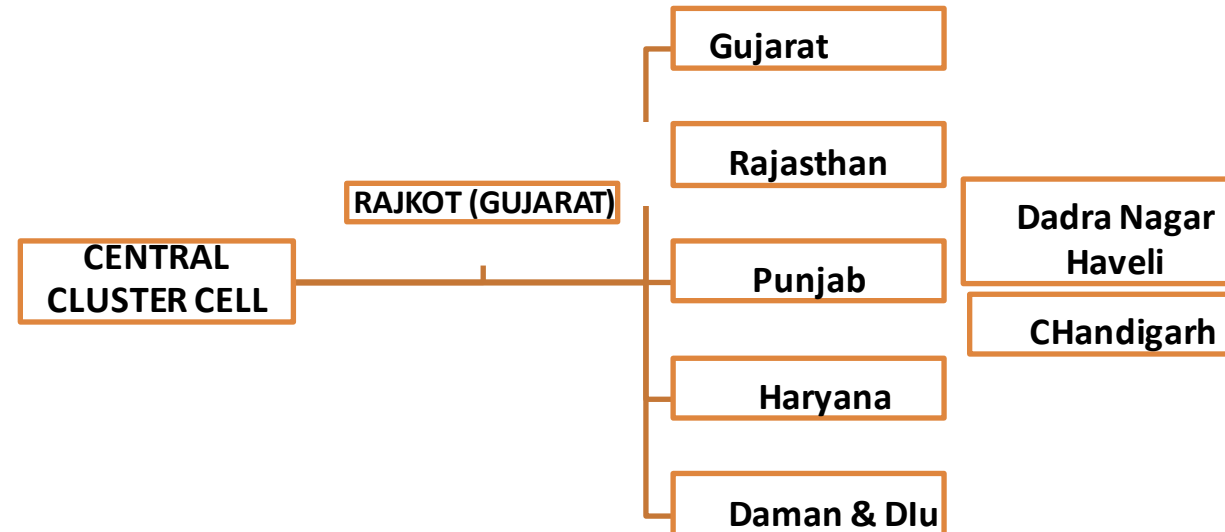


TASKS PLANNED WITH MoHUA

CLIMATE SMART BUILDING

- Technical assistance in developing thermal comfort action plan for climate resilience building for mass scale application in selected states for Affordable Housing
- Technical support in implementation of Global Housing Technology Challenge-India (GHTC-India)

States and UT's under central cluster cell established at Indore



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AIM & CONCEPT

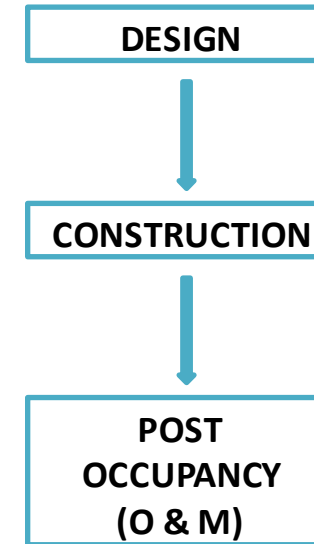
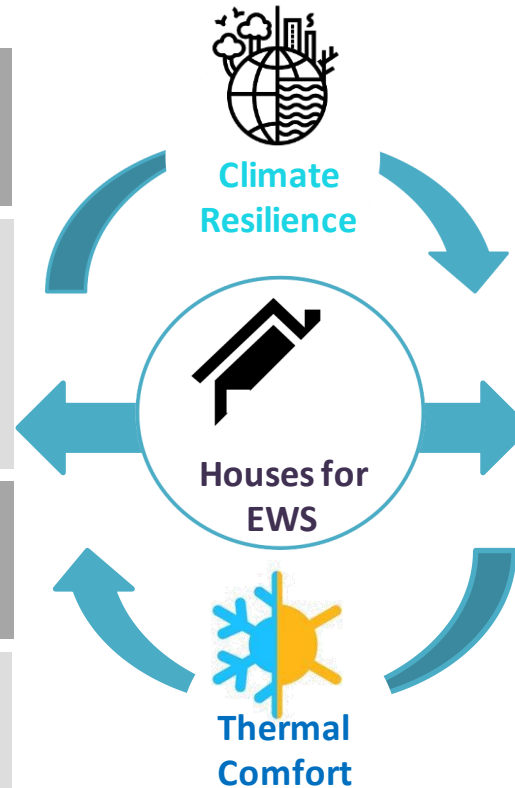


7 AFFORDABLE AND CLEAN ENERGY
Ensure access to affordable, reliable, sustainable, and modern energy for all

9. INDUSTRY, INNOVATION AND INFRASTRUCTURE
Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation

11. SUSTAINABLE CITIES AND COMMUNITIES
Make cities and human settlements inclusive, safe, resilient, and sustainable

13. PROTECT THE PLANET
Take urgent action to combat climate change and its impacts



INTEGRATION IN BY-LAWS

6 LHP ACROSS INDIA



Map showing six different LHP Locations

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

1. Indore, Madhya Pradesh

- Prefabricated Sandwich Panel System

2. Rajkot, Gujarat

- Monolithic Concrete Construction using Tunnel Formwork

3. Chennai, Tamil Nadu

- Precast Concrete Construction System – Precast Components Assembled at Site

4. Ranchi, Jharkhand

- Precast Concrete Construction System – 3D Volumetric

5. Agartala, Tripura

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

6. Lucknow, Uttar Pradesh

- PVC Stay In Place Formwork System

Other 5 LHPs

https://youtu.be/_bl0P9gl0oo

<https://youtu.be/DiGj3BOSfh4?t=14>

<https://youtu.be/ZTrUI--XnEU>

<https://youtu.be/GsmkfQA2rLE>

https://youtu.be/5im2EeF_C1A

Technology of other 5 no. of LHPs explained via video

Summary of Light House Project (LHP)

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

- Have a look at the project brief:
 - 1144 houses will be constructed in Stilt+13 configuration.
 - The total plot area is around 39,600 Sqm and carpet area of each house is approximately 39.77 Sqm.
 - There are 11 residential blocks.
 - The project also includes Community Centre and Health Centre.

Typical floor plan



Block Plan

At each floor there are 08 dwelling units



Typical Dwelling Unit Plan



Unit Plan

- Each dwelling unit comprises of one living room, one Bedroom, one study room, Kitchen and two toilets.
- The carpet area of each unit is 39.77 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



Unit 3D View

LHP RAJKOT

Video on Construction Technology and Construction Process at LHP Rajkot

<https://youtu.be/eGBCorzIf2w>

Design Parameters

General Description: -

- Parking + 13 Above Floor + Stair cabin
- Height of Building from Ground = 43.1 m (FGL to Parapet)
- Height of Typical Floor = 2.950m
- Parking Height = 3.550m
- Plan Area of Building = As per architectural layout

S.No.	DEAD LOAD	
1	Concrete	25 KN/m ³
2	Brick or Block -with plaster	9 KN/m ²
3	Floor finish	1.25 KN/m ²
4	Water proofing	2.25 KN/m ²



Design Parameters

S.No.	Details of Building	
1	Type of Building	Stilt + 13 - high rise building
2	Dimension of the Building	Width of Building -14.960m
3		Length of Building -38.920m
4	Floor Height	Height of Ground Floor -3.550m
		Height of Typical Floor -2.950m
5	Grade of Concrete used	M40 for all Wall, Slabs and Beam elements and M25 for footings.
6	Grade of Steel used	Fe-500
7	Live Load as per IS:875 2015 (Part 2)	For General -2 KN/m ²
		Corridor -3 KN/m ²
8	Wall Load as per IS:875 2015 (Part 1)	Masonry considered as Block wall and Applied load 1.6 KN/m ² on Slab
9	Wall Size and loads Consider	External Wall -200 mm
		Internal Wall -150 mm
		Parapet Wall -100 mm
10	Water Tank Load	15 KN/m ²
11	Additional Liftload	12 KN/m ²

Prevalent Construction Systems

Load bearing Structure



RCC Framed Structure

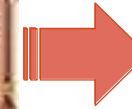


Technology being Used

Monolithic Concrete Construction using Tunnel Formwork



Tunnel formwork
- Customized formwork



Assembly of Formwork



Structure after removal of formwork
- Shear Wall Construction



Concreting after Placing formwork

Structural Elements

- Foundation
- Structural System -
Monolithic Shear Wall
and Slab
- AAC Block Masonry



EXCAVATION



- 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.
- Hard rock was encountered during the excavation which required extra efforts and time to reach the required depth

Foundation

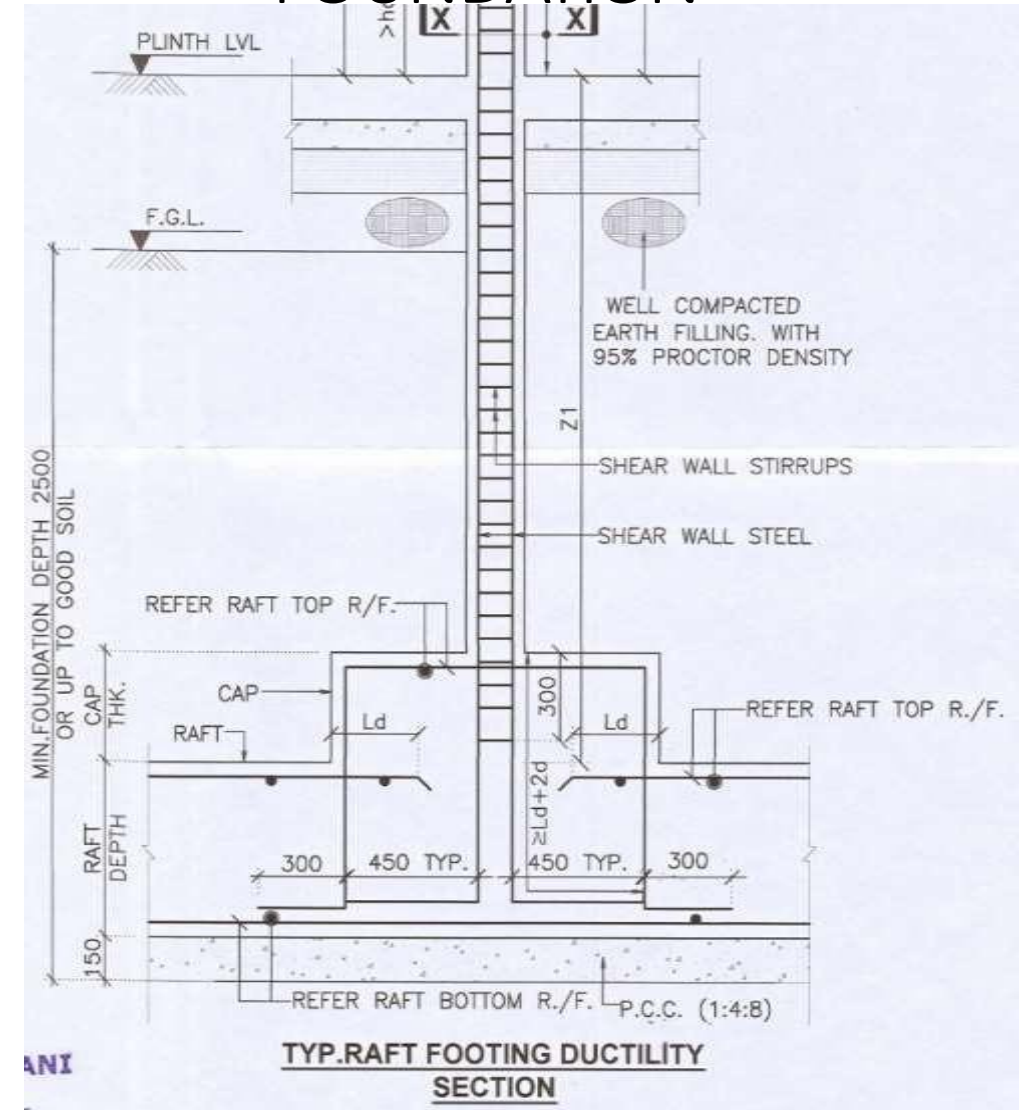
- As per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Typical raft foundation of varying sizes depending on the load.



Concrete & Reinforcement Steel Specifications

- Raft foundation with Shear wall upto Plinth level has been used.
- The raft foundation is designed for SBC of 25 T/m² as calculated in soil investigation report.
- After leveling of the ground 150 mm thick PCC is placed and depth of the raft footing is 750 to 900mm.
- M25 grade of concrete has been used with cover of 50mm. reinforcement has been placed as per the drawings.
- Above raft footing, shear wall of 200mm thickness is designed upto Plinth level. Grade of concrete in shear walls is M40.
- Above shear wall, plinth beam of 230 x 600 mm is cast with M25 grade of concrete.

FOUNDATION



Foundation

- Shear Wall up to Plinth level

Structural Elements



FOUNDATION



- Plinth beam is constructed above the shear wall.

FOUNDATION



- Plinth beam is constructed above the shear wall.

Structural System

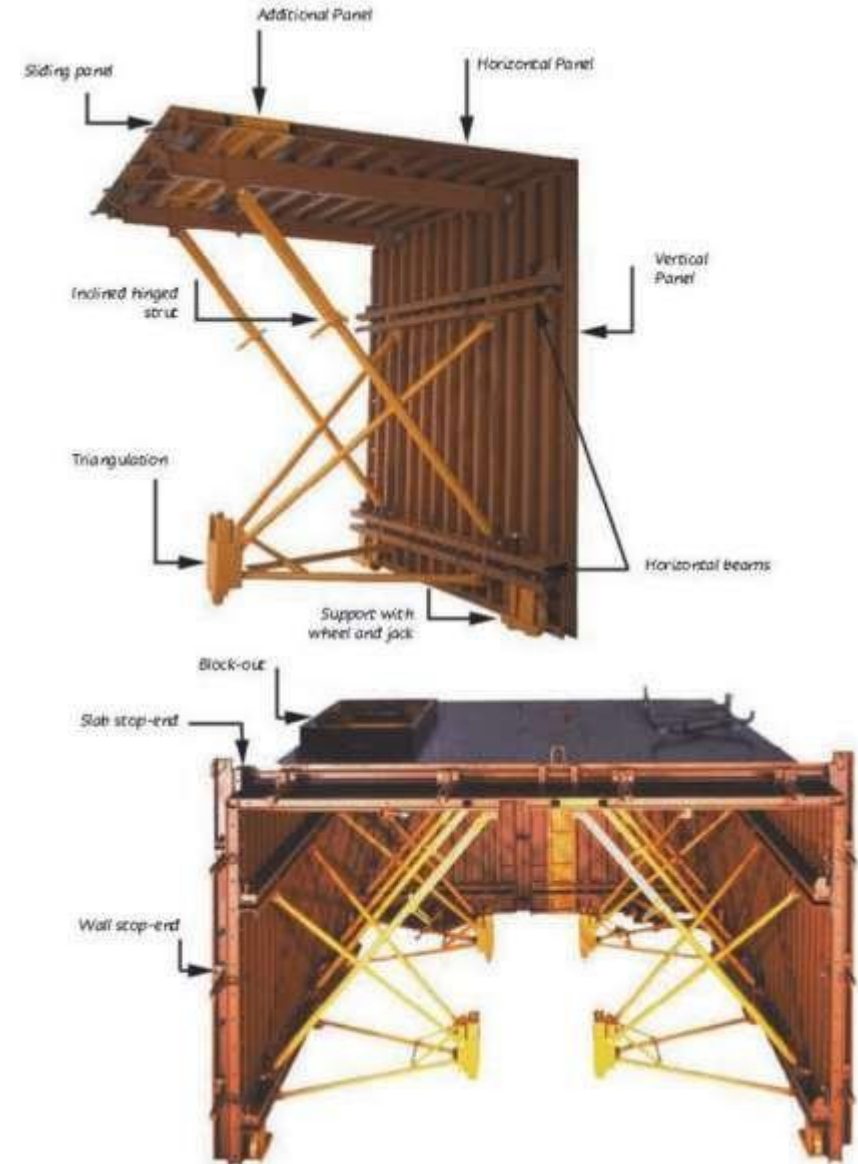
- Tunnel formwork is customized engineering formwork based on two half shells which are placed together to form a room or cell. Several cells make an apartment.
- The construction of structure is divided into phases. Each phase consists of a section of the structure that will be cast in one day. The phasing is determined by the programme and the amount of floor area that can be poured in one day.
- The infill walls are of Autoclaved Aerated Concrete (AAC) blocks and being used for partition walls.



Structural Elements

Structural Elements

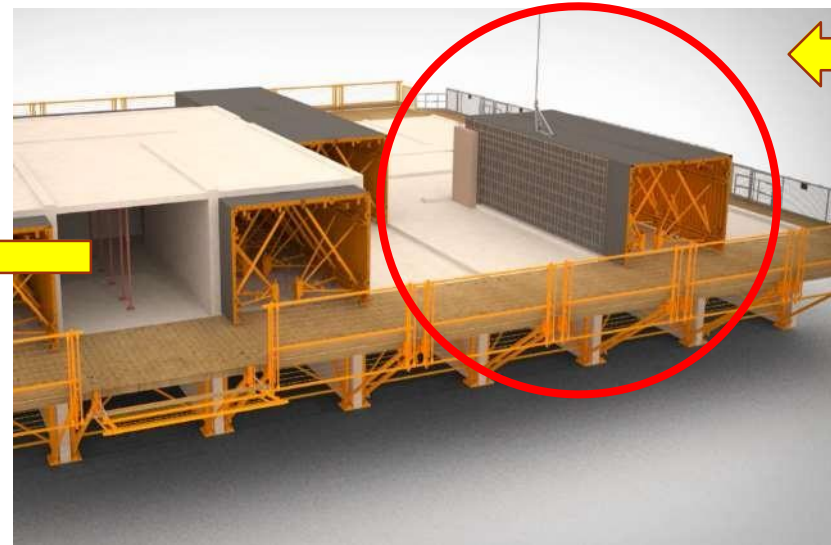
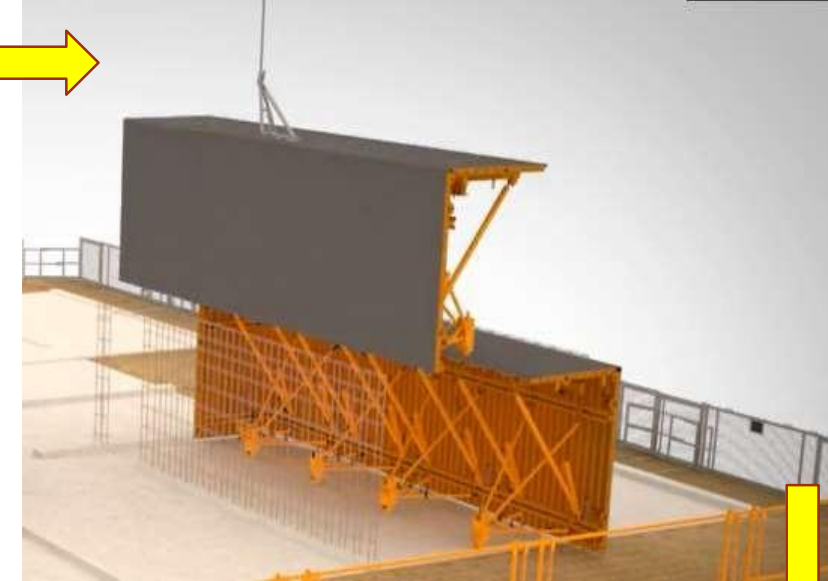
Assembly of Tunnel Formwork



WorkCycle with Tunnel Formwork

The on-site implementation of 24 hour cycle is divided into following operations.

1. Stripping of the formwork from the previous day.
2. Positioning of the formwork for the current day's phase, with the installation of mechanical, electrical and plumbing services.
3. Installation of reinforcement in the walls and slabs.
4. Concreting.



Structural System



- Placement of tunnel formwork for slab and wall



- Concreting after placement of reinforcement on slab and wall.

Structural System

- After placement of reinforcement, the slab is cast monolithically with the walls.



Placement and leveling of concrete

Structural Elements

- Finished Monolithic structure with shear wall and slab



Structural Elements

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.



Monolithic Concrete Construction using Tunnel Formwork

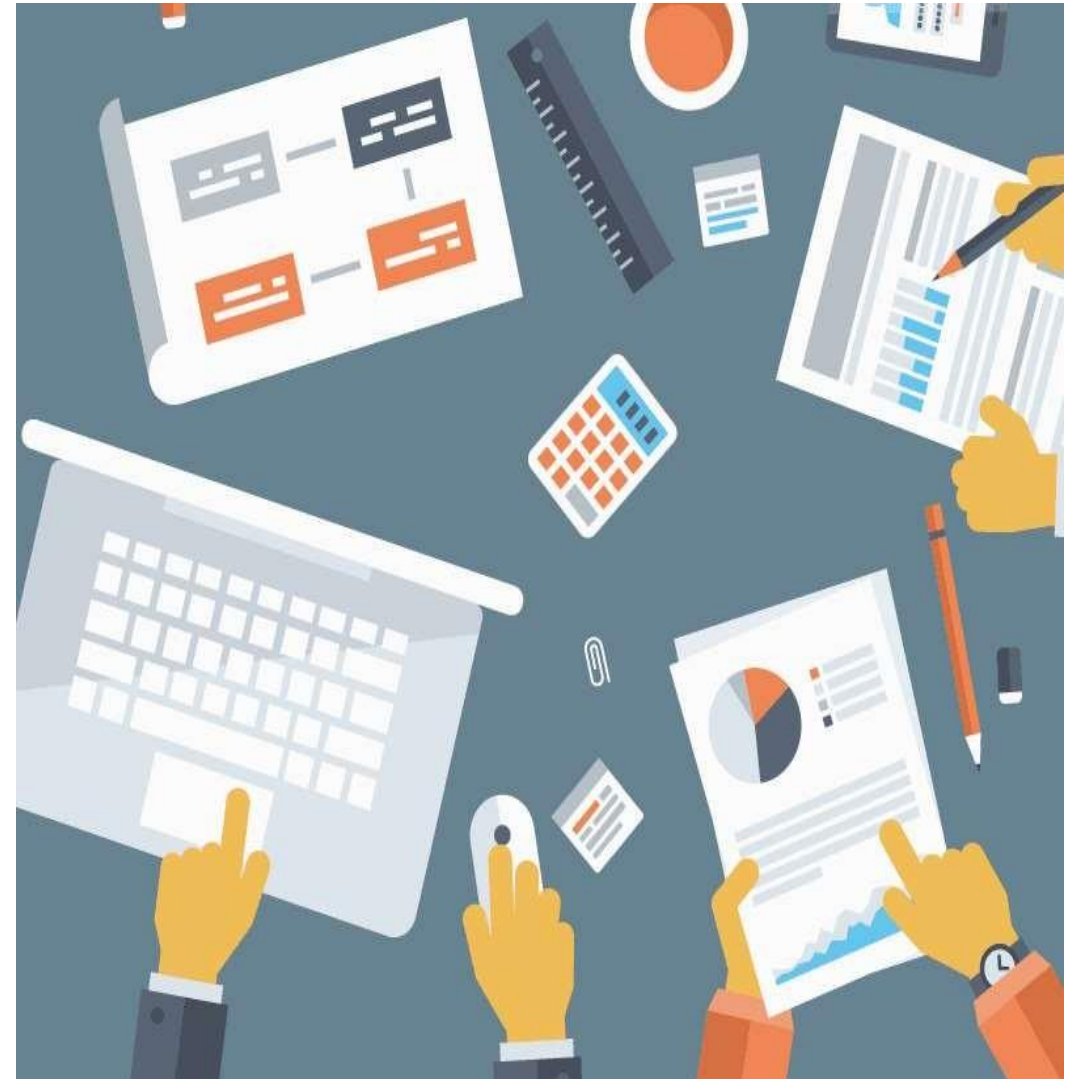
Advantages

- 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

Monolithic Concrete Construction using Tunnel Formwork

Limitations

- A lead time of about 3 months is required for initiation of work, as the formwork are custom designed, manufactured and prototype
- Approved before manufacturing required number of sets of formwork
- Post construction alterations are difficult
- All the service lines are to be pre-planned in advance
- Economy in cost is achieved with large number of multi storied modular units.



Thank You