













VOCATIONAL TRAINING – 2nd & 3rd June 2022

Monolithic Concrete Construction using Tunnel Formwork

Climate Smart Buildings (CSB)

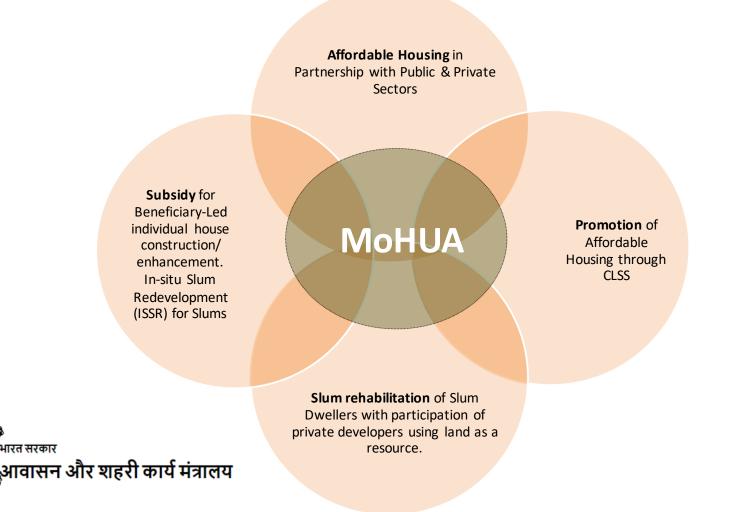
Cluster Cell Rajkot, Gujarat under Global Housing Technology Challenge - India (GHTC-India)

INTRODUCTION - MOHUA

'Housing for All' by 2022.

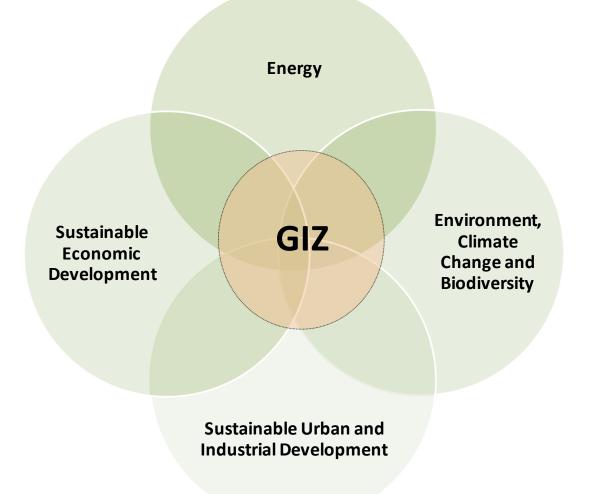
Under the Mission, Ministry of Housing and Urban Affairs (MoHUA), provides Central Assistance to implementing agencies through States and Union Territories for providing houses to all eligible families/beneficiaries by 2022.

Addressing the affordable housing requirement in urban areas through:

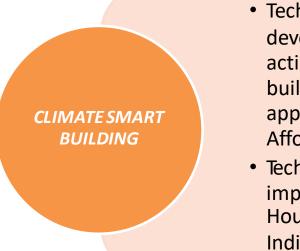


INTRODUCTION - GIZ

- 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

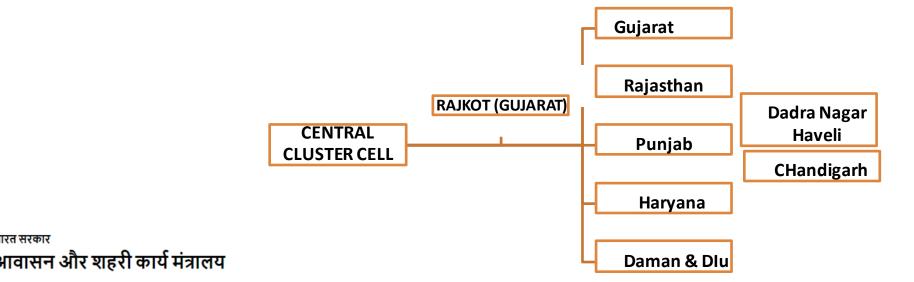


भारत सरकार

 Technical assistance in developing thermal comfort action plan for climate resilience building for mass scale application in selected states for Affordable Housing

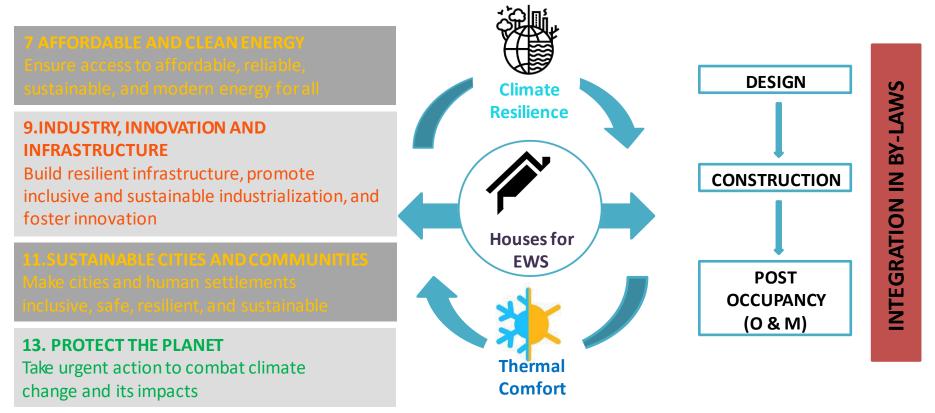
 Technical support in implementation of Global Housing Technology Challenge-India (GHTC-India)

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



AIM & CONCEPT













6 LHP ACROSS INDIA



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



• 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	Rajkot	Indore	Ranchi	Agartala (Triaura)	Lucknow
SI. No	Particulars	Units	(Tamil Nadu)	(Gujarat)	(Madhya Pradesh)	(Jharkhand)	(Tripura)	(Uttar Pradesh)
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







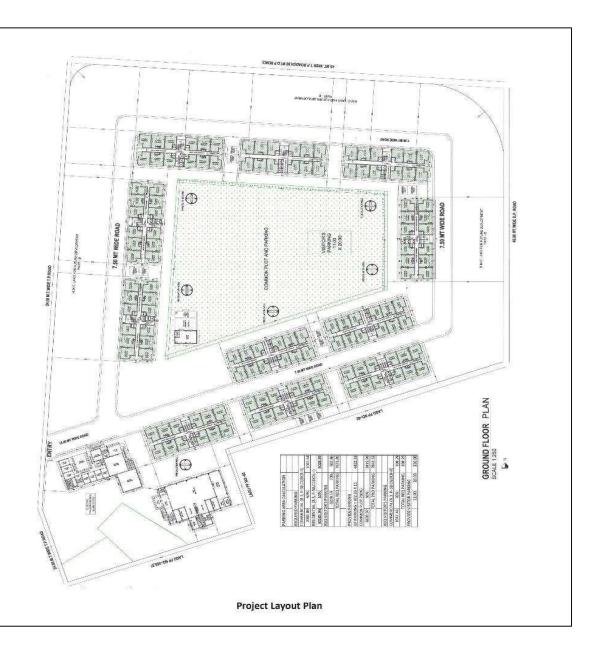


- Have a look at the project brief:
 - 1144 houses will be constructed in Stilt+13 configuration.
 - The total plot area is around 39,600 Sqm and carpet area of each house is approximately 39.77 Sqm.
 - There are 11 residential blocks.
 - The project also includes Community Centre and HealthCentre.

Typical floorplan



At each floor there are 08 dwelling units











- 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 Vlew

Typical Dwelling UnitPlan



Unit Plan









LHP RAJKOT

Video on Construction Technology and Construction Process at LHP Rajkot

https://youtu.be/eGBCorzlf2w









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	Dimonsion of the Ruilding	Width of Building -14.960m		
3	Dimension of the Building	Length of Building - 38.920m		
4	Floor Hoight	Height of Ground Floor -3.550m		
	Floor Height	Height of Typical Floor -2.950m		
5	Grade of Concrete	M40 for all Wall, Slabs and Beam		
J	used	elements and M25 for footings.		
6	Grade of Steelused	Fe-500		
7	Live Load as per IS:875 2015 (Part 2)	For General -2KN/m ²		
	Live Load as per 13.073 2013 (Fait 2)	Corridor -3KN/m ²		
8	Wall Load as per IS:875 2015 (Part 1)	Masonry considered as Block wall and Applied		
	Wall Load as per 15.075 2015 (1 alt 1)	load 1.6 KN/m ² on Slab		
9		External Wall -200 mm		
	Wall Size and loads Consider	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





- 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.



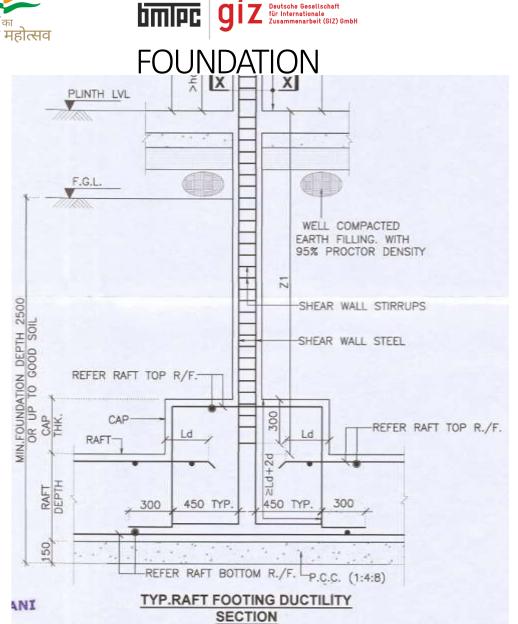






Concrete & Reinforcement Steel Specifications

- 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 230×600 mm is cast with M25 grade of concrete.









Foundation

Structural Elements

Shear Wall up to Plinth level





• Plinth beam is constructed above the shear wall.



• Plinth beam is constructed above the shear wall.



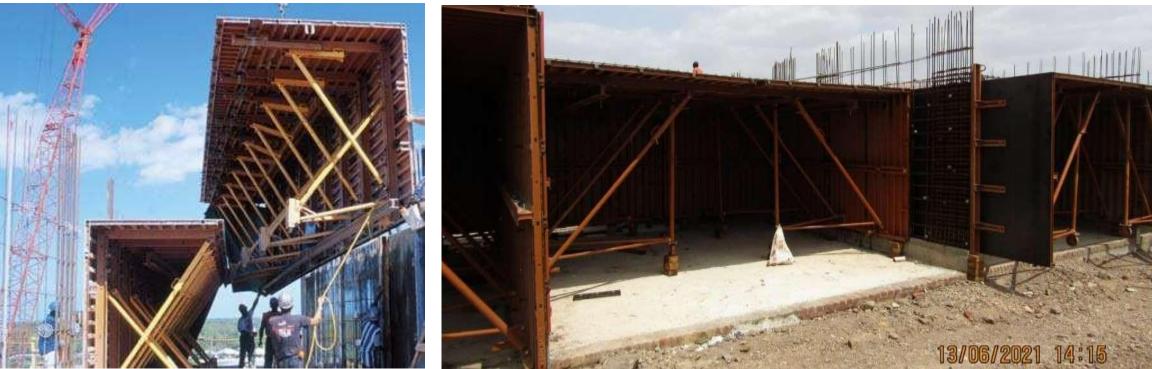




Structural System

Structural Elements

- 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.





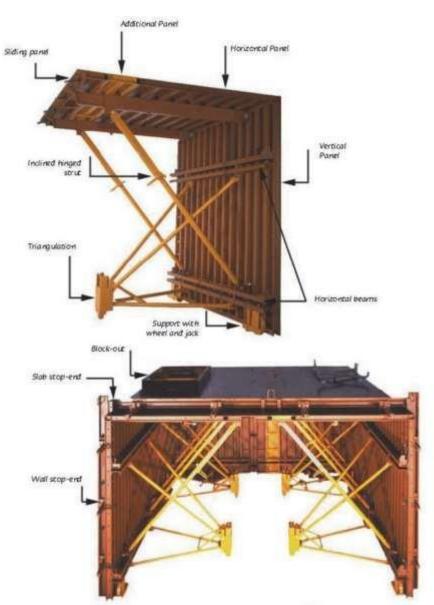




Structural Elements

Assembly of Tunnel Formwork

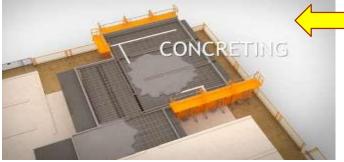


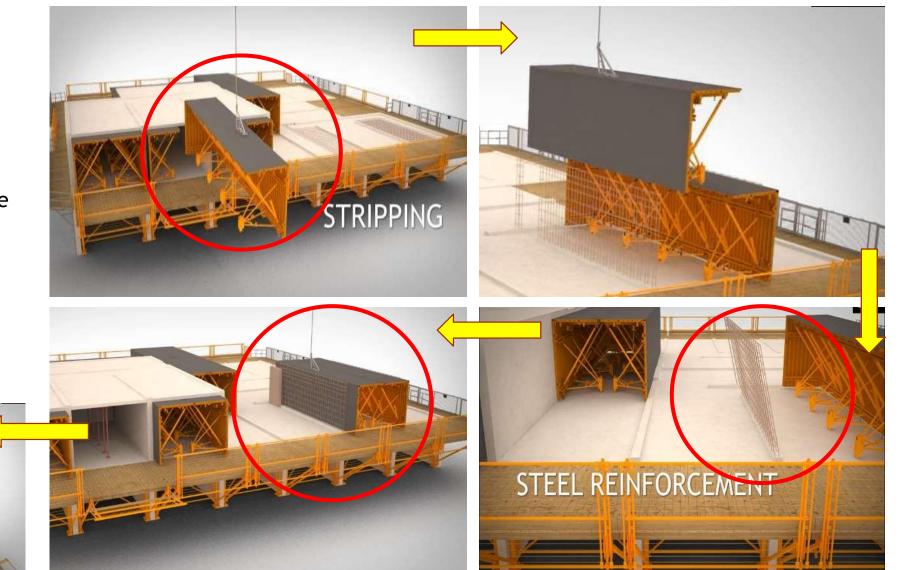




The on-site implementation of 24 hour cycle is divided into following operations.

- 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 preplanned in advance
- Economy in cost is achieved with large number of multistoried modular units.



Demonstration Housing Project at Ahmedabad, Gujarat



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

Details of Demonstration Housing Projects (DHPs)

Project Name	Demonstration Housing Project (DHP), Under PMAY(URBAN)			
Usage of the project	To be given to PMAY (U) Beneficiaries			
Nodal agency	Gujarat Housing Board			
Implementation Agency	BMTPC Building Material &Technology Promotion Council(Govtof India)			
Location of the project	TP 94, FP 3/1/1, Near Pandit Dindayal 2, Vivekanand Nagar, Hathijan, Ahmedabad, Gujarat.			
Project Type	EWS G +2			
No. of Dwelling units (DUs)	40 NoBlock A - 12 DUsBlock B - 09 DUsBlock C - 09 DUsBlock D&E - 10 DUs			
provisions	Each Unit consists of Living room, a Bed room, a Kitchen, a Bath room, a W.C, a Lobby, a Verandah and a Wash area			
Plot Area for DHP	3,400 Sq.mts.			
Carpet Area of a unit	35.78 Sq.mts.			
Total Built up Area of unit	51.5 Sq.mts. (Avg.)			
Total Covered Area	2178.85 Sq.mts.			
Technology being Used	Integrated Hybrid Solution-One (HIS-ONE) 33			

Details of Demonstration Housing Projects (DHPs)

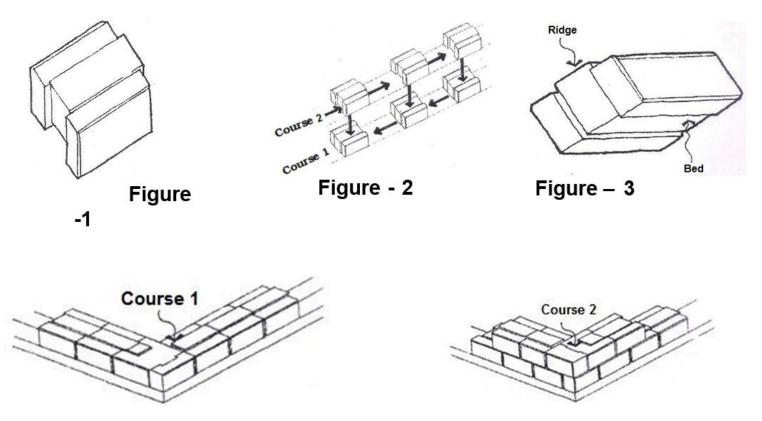
Infrastructure Components	Roads & Pavements, Boundary wall & Gate, Sewerage, External water supply, Drainage, Underground water tank, Rain water Harvesting, External Electrification, Solar street lights, Fire-fighting works, Landscaping, etc.		
Name of the Contracting Agency	M/s Matharoo Constructions, Sonipat, Haryana		
Total Tendered Cost	Rs 432.87 Lakhs		
Total Cost of Building Work	Rs 358.52 Lakhs		
Total Cost of Infrastructure Work	Rs 74.35 Lakhs		
Equivalent Cost per DU	Rs 10.82 Lakhs		
Date of Approval from AMC	16-09-2021		
Actual Date of Start of Work	October 2021		
Stipulated Date of Completion	June 2022		

TECHNOLOGY : Integrated Hybrid Solution-One (HIS-ONE)

HS-ONE is an Intermediate Building System (IBS) having three main components: walls, floor/roof and stairs. All 3 components are integrated to construct a building and hence named as "Integrated Hybrid Solution – ONE".

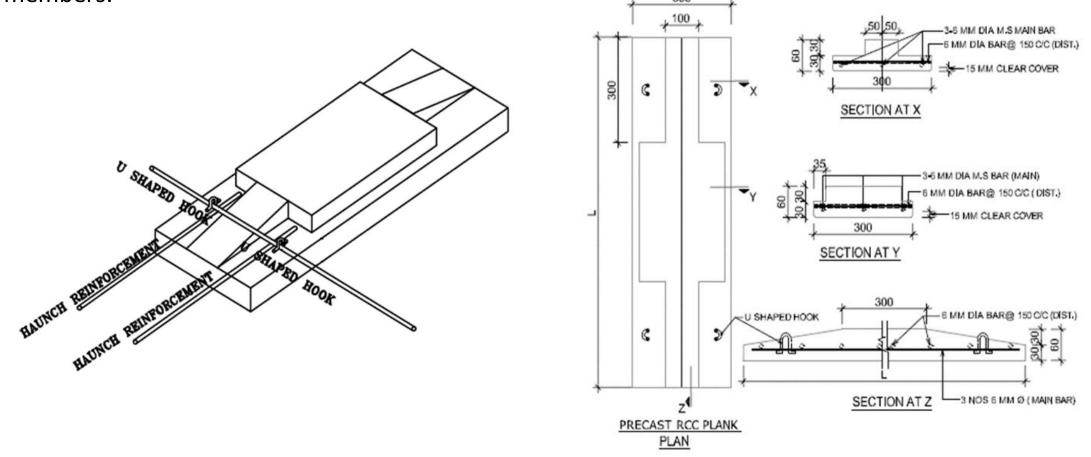
Walls :

Hydraform Prefabricated Mortar less Interlocking blocks are used for walling. The interlocking blocks are manufactured with a block making machine offsite or onsite in an open shed. The blocks can be of cementflyash block or cement-soil block.



TECHNOLOGY : Integrated Hybrid Solution-One (HIS-ONE)

Floors/Roof : Mechanized Precast R.C. Plank & Joist are used for casting Floors. The RC planks as well as joists are partially precast either offsite or on site. After placement as floor/roof elements, the haunches are filled with in-situ concrete. A layer of ferro cement course is laid with wire mesh reinforcement. The assembly provides monolithic behavior and diaphragm action to transfer horizontal loads to supporting members.



36

TECHNOLOGY : Integrated Hybrid Solution-One (HIS-ONE)

Ferro cement Elements: Mechanized precast/prefab Ferro-cement staircase, kitchen shelves, kitchen platforms, sunshades, lintel bands, water tanks, fines.





TECHNOLOGY : Integrated Hybrid Solution-One (HIS-ONE)

The Integrated Hybrid Solution – ONE uses the technologies, which can be bridged to erect a structure by using precast floor/roof system bridged with interlocking mortarless block wall system in a load bearing system upto G+3 structures. Both roof/floor and walling system can also be bridged with RC framed structure as well as steel structure in multistoried structure providing a complete solution for a building structure.

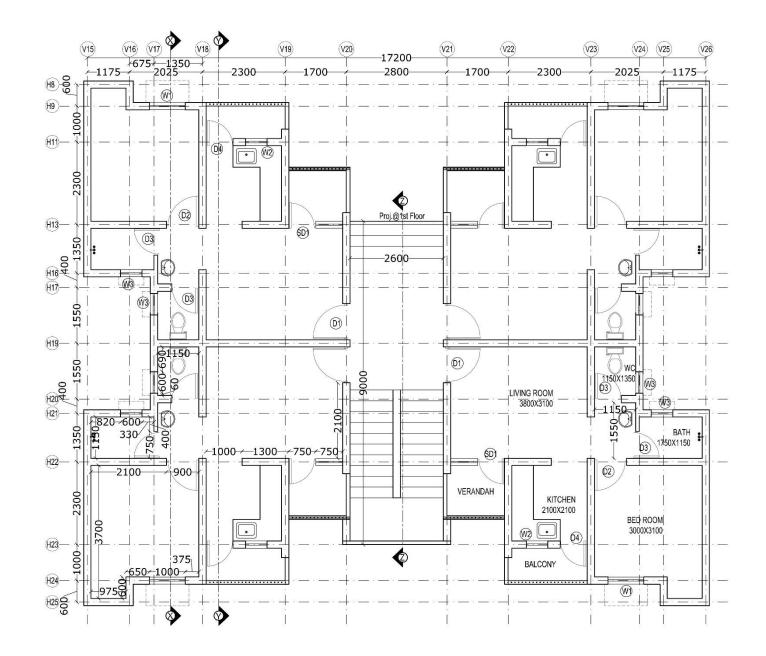


DEMONSTRATION HOUSING PROJECT (DHP) AT Ahmedabad, Gujarat — LAYOUT PLAN



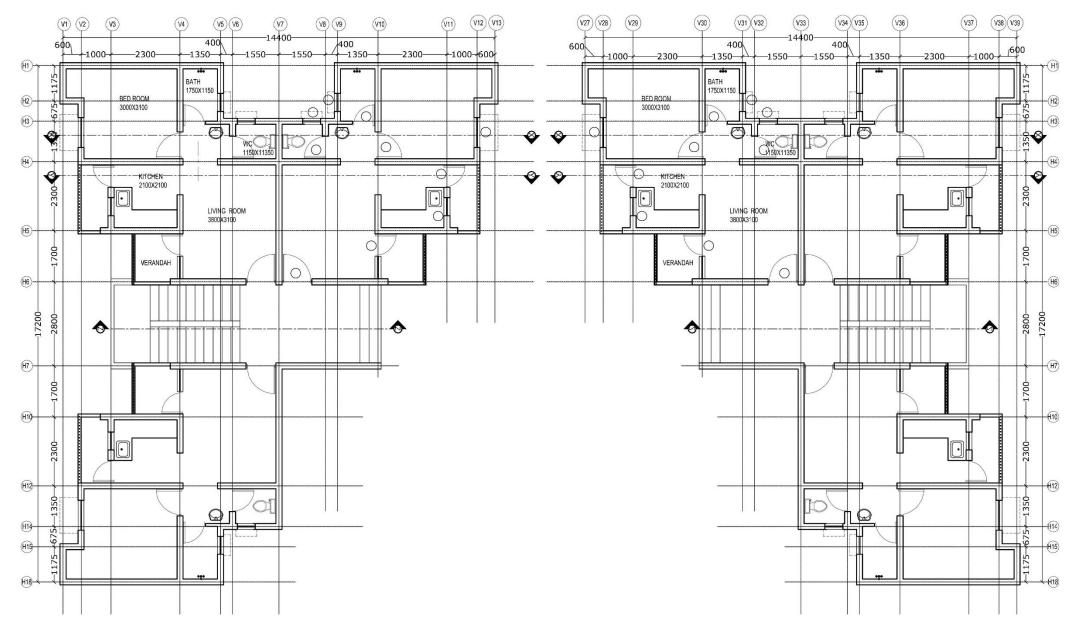


DEMONSTRATION HOUSING PROJECT (DHP) AT Ahmedabad, Gujarat – FLOOR PLAN BLOCKA



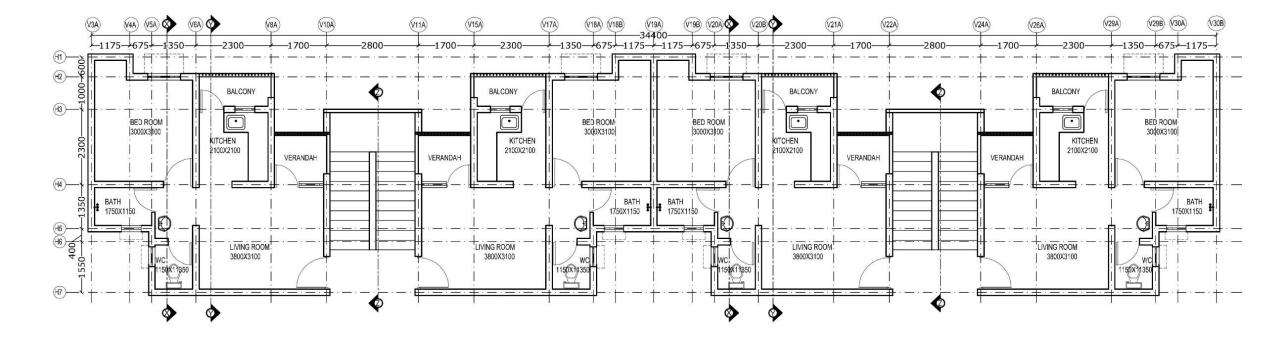
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DEMONSTRATION HOUSING PROJECT (DHP) AT Ahmedabad, Gujarat — FLOOR PLAN BLOCK B&C



42

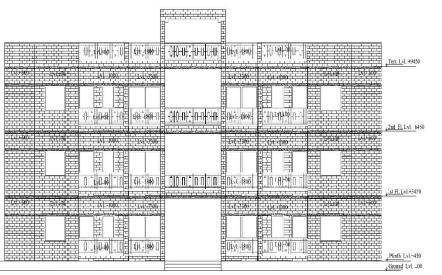
DEMONSTRATION HOUSING PROJECT (DHP) AT Ahmedabad, Gujarat — FLOOR PLAN BLOCK D&E



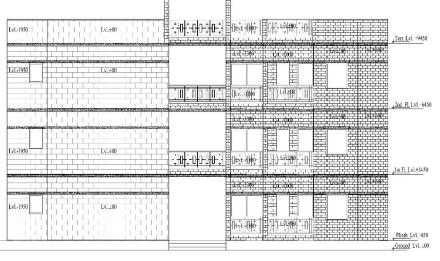
DEMONSTRATION HOUSING PROJECT (DHP) AT Ahmedabad, Gujarat – **ELEVATIONS**



Block D&E



Block A



Block B&C



LINE OUT WORK FOR PCC WORK

LINE OUT WORK FOR FOOTING



CONCRETING WORK OF FOOTING (1st LAYER)



CONCRETING WORK FOR FOOTING(2nd LAYER)

WALL MASONRY WORK AT FOUNDATION LEVEL(BRICK WORK)



HYDRAFORM BLOCK MAKING WORK

HYDRAFORM BLOCK



HYDRAFORM BLOCK WALL MASONRY WORK AT FOUNDATION LEVEL WITH MORTAR

HYDRAFORM BLOCK MASONRY WORK AT FOUNDATION LEVEL WITH MORTAR 49



SOIL FILLING WORK UPTO PLINTH LEVEL

WALL MASONRY WORK AT FOUNDATION LEVEL (HYDRAFOAM **BLOCK**) 50



SHUTTERING WORK FOR PLINTH BEND

SOIL FILLING AND LEVELLING UPTO PLINTH LEVEL



SAND FILLING AT PLINTH LEVEL

ANTI TERMITE TREATMENT WORK AT PLINTH LEVEL



WALL MASONRY WORK ABOVE PLINTH LEVEL

WALL MASONRY WORK UPTO LINTEL LEVEL OF GROUND **FLOOR** 53



WALL MASONRY WORK UPTO LINTEL LEVEL OF GROUND FLOOR

54



WALL MASONRY WORK ABOVE LINTEL LEVEL

PRE CAST PLANK



PRE CAST PLANK MAKING WORK

PRE CAST PLANK MAKING WORK FSLAB WOR ORK

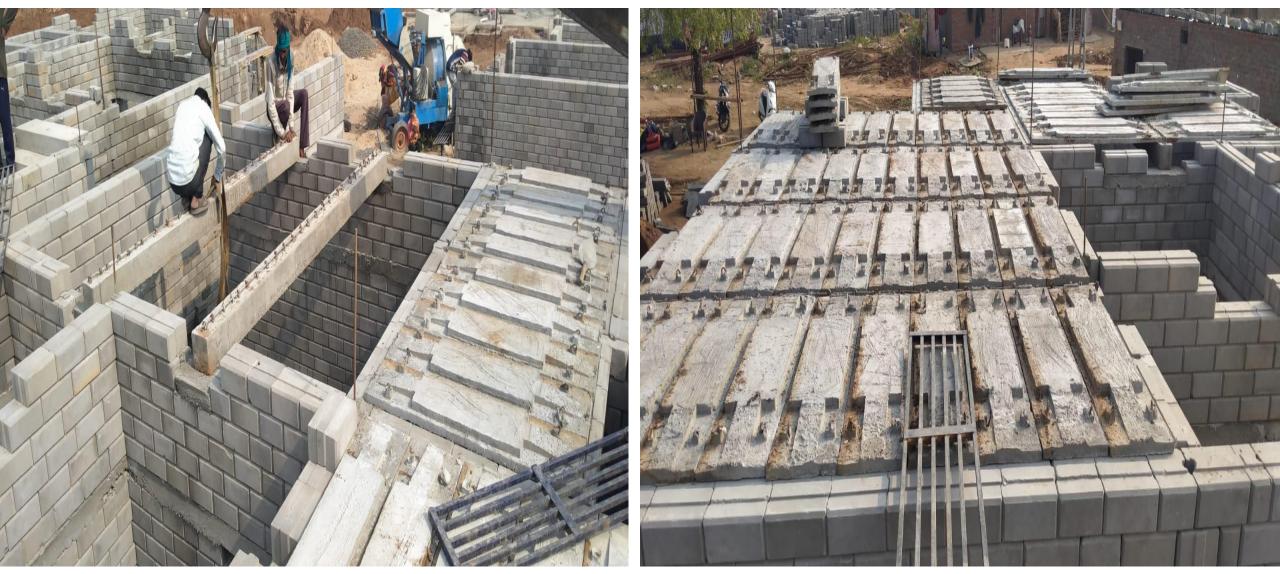


PRE CAST JOIST BEAM MAKING WORK FOR SLAB WORK

PRE CAST JOIST BEAM



JOIST BEAM AND PLANK INSTALLATION WORK FOR GROUND FLOOR SLAB **PLANK DEFLECTION TEST**



PLANK FIXING AND LINING FOR SLAB WORK

JOIST BEAM INSTALLATION WORK



PRE CAST STAIRCASE STEP MAKING WORK

PRE CAST STAIRCASE STEP FIXING WORK



CONCRETING WORK FOR 1st FLOOR LINTEL BEND

WALL MASONRY WORK AT FIRST FLOOR UPTO LINTEL LEVEL



PRE CAST SUNSHADE MAKING WORK FOR WINDOW CHAJJA SUNSHADE FIXING WORK FOR WINDOW



WALL MASONRY WORK ABOVE LINTEL LEVEL OF 1ST FLOOR



CONCRETING WORK FOR ROOF BEND AND HAUNCH PART FOR 1st SLAB WORK

REINFORCEMENT JALI AND FERROCEMENT LAYER LAYING WORK FOR SLAB 64



WALL MASONRY WORK AT SECOND FLOOR UPTO LINTEL LEVEL



WALL MASONRY WORK AT SECOND FLOOR ABOVE LINTEL LEVEL JOIST BEAM AND PLANK INSTALLATION FOR 2nd FLOOR SLAB



STEEL BINDING WORK FOR SECOND FLOOR SLAB

FERROCEMENT LAYER LAYING ABOVE 2nd FLOOR SLAB



WALL MASONRY WORK FOR PERAPET WALL AT TERRACE LEVEL **INTERNAL PLASTER WORK**



ELECTRICAL CONDUITING WORK

INTERNAL PLUMBING WORK





BLOCK-C

BLOCK-DE



BOUNDARY WALL FOOTING WORK

BOUNDARY WALL FOOTING

Thank you