



Ministry of Housing and Urban Affairs Government of India







RESILIENT, AFFORDABLE AND COMFORTABLE HOUSING THROUGH NATIONAL ACTION

## "Training on emerging construction technologies & thermal comfort"

Location: LHP, Agartala | Date: 30th June & 1st July 2022

Climate Smart Building Cell - Light House Project Agartala

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Indo German Energy Programme: https://www.giz.de/en/worldwide/15767.html GHTC - India: https://ghtc-india.gov.in/



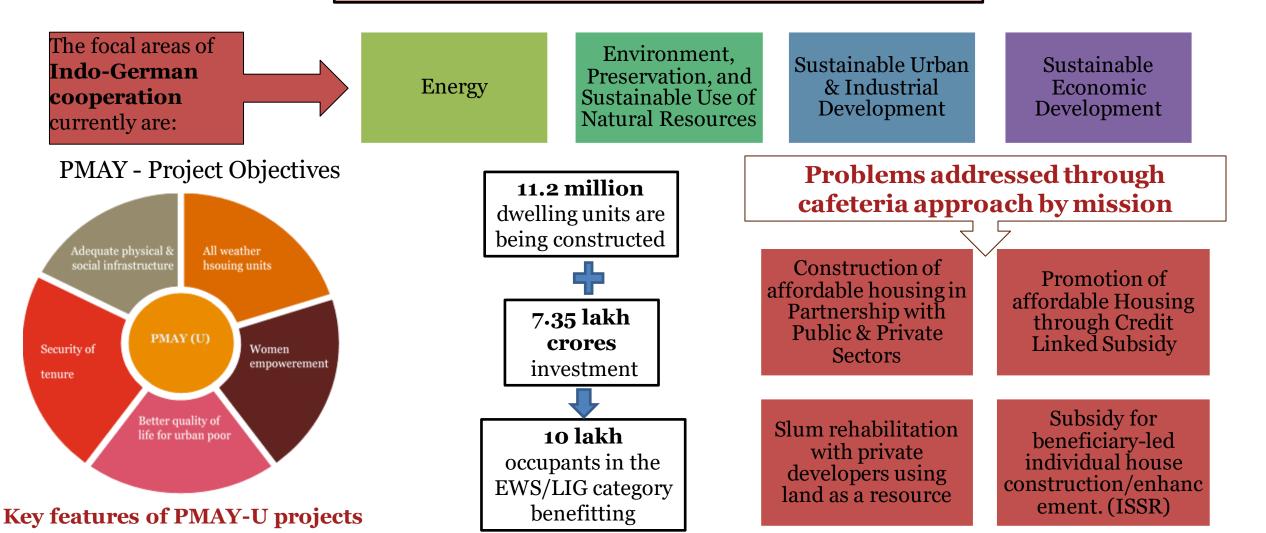




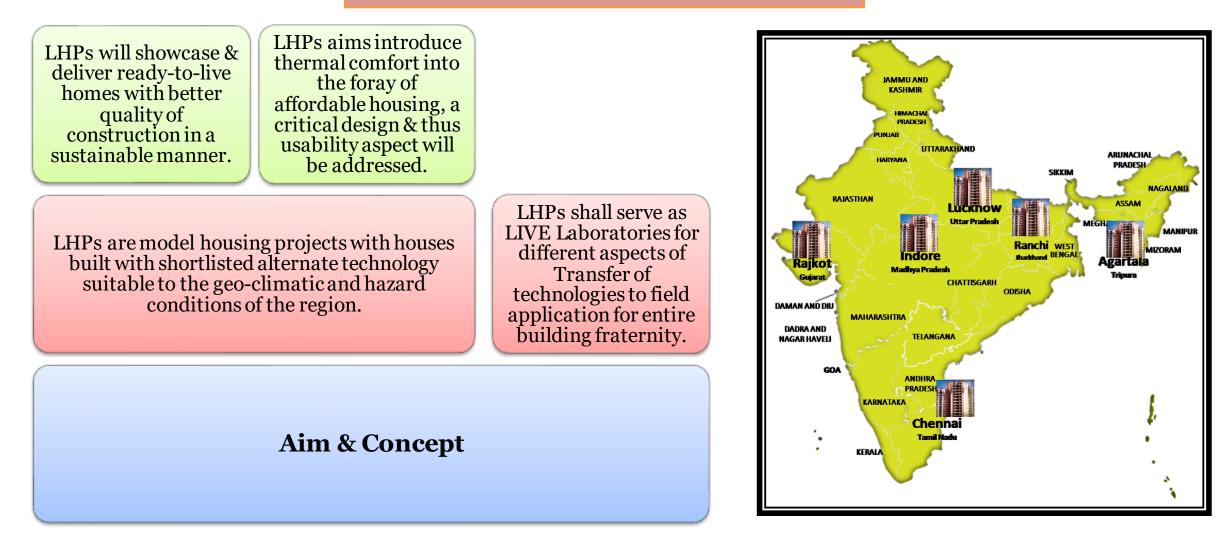




#### **<u>GIZ: Tasks Planned with MoHUA</u>**



#### Light House Projects (LHPs)





3

#### GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

#### **Global Housing Technology Challenge - India (GHTC-I)**

Broad Category	Technologies (Nos.)
Precast Concrete Construction System - 3D Precast volumetric	4
Precast Concrete Construction System - Precast components assembled at site	8
Light Gauge Steel Structural System & Pre-engineered Steel Structural System	16
Prefabricated Sandwich Panel System	9
Monolithic Concrete Construction	9
Stay In Place Formwork System	8
Total	54

#### **Summary of Six Light House Projects (LHPs)**

LHP Location		Chennai	Rajkot	Indore	Ranchi	Agartala (Tripura)	Lucknow	
SI. No <sup>.</sup>	Particulars	Units	(Tamil Nadu)	(Gujarat)	(Madhya Pradesh)	(Jharkhand)	(Tripura)	(Uttar Pradesh)
1	Name of Technology	Name	Precast Concrete Construction System- Precast Components	Monolithic Concrete Constructio n 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











# Videos of 5 LHPs

- Chennai LHP
- Indore LHP
- Rajkot LHP
- Ranchi LHP
- Lucknow LHP

# LGHTHOUSEPROECT ATAGARTALA

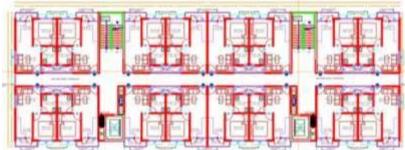
GHTC-India Category Light Gauge Steel Structural System & Pre-engineered Steel Structural System

**Technology** Light Gauge Steel Framed (LGSF) System with Pre-engineered Steel Structural System

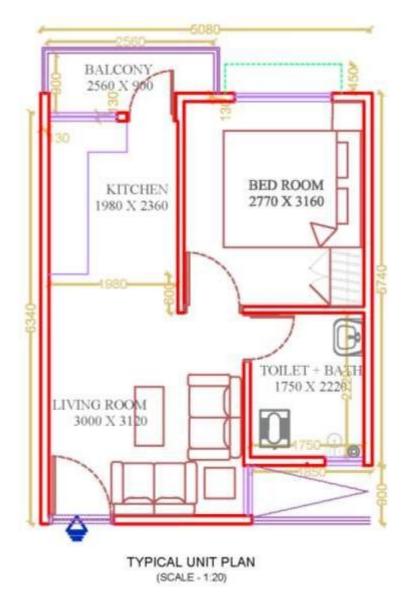
- Total Plot area is 24168 Sqm.
- Ground coverage of the project is 29% and FAR achieved is 2.43
- Proposed organized green space is 31%.
- The project also includes Anganwadi, Health Centre and community hall of 480 Sqm, 700 Sqm and 500 Sqm respectively in G+1 configuration



Typical floorplan



 16 dwelling units each in A & G Block; 22 Units in B Block; 18 Units in C Block and 24 units each in D,E & F per floor with a provision of lifts and staircase.  There are 7 blocks in Ground + 6 configuration with 1000 houses along with basic and social infrastructure. Typical DwellingUnitplan



Each dwelling unit consists of one living, one bed room, a kitchen, a toilet and a balcony. The carpet area of each unit is 30.03 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**



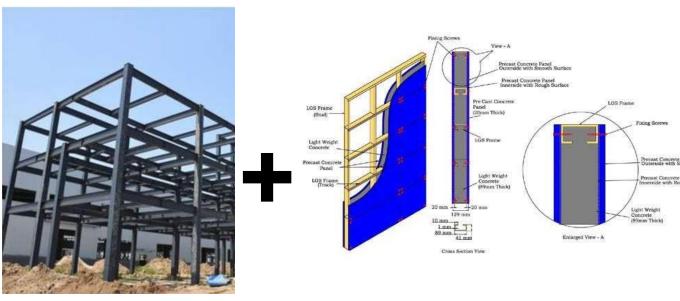
## Steel Frame Structure

#### Light Gauge Steel Framed Walling System



**RCC Framed Structure** 





Light Gauge Steel Framed System (LGSF) is based on factory made galvanised light gauge steel components. The components/sections are produced by cold forming method and assembled as panels at site forming structural or non structural steel framework of a building of varying sizes of wall and floor.

In order to meet structural requirements, Hybrid system comprising of Light Gauge Steel Frame System with Pre-Engineered Steel Structural System has been adopted in the present project.

- Foundation
- Structural System
- Floor/ Roof Slab
- Wall Panels



#### Foundation

- Pile Foundation (Bored Cast-in-situ Concrete Piles) as per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- RCC Raft on the Piles and then RCC pedestal on the Raft
- Anchor bolts and Base plate of varying sizes and diameter as per structural design for erecting Pre-Engineered Steel Structure.
- RCC plinth beam and grade slab at plinth level.
- RCC shear walls for staircases and lift on RCC raft and water proofing with kota stone.



#### Structural system

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



#### Floor/ Roof Slab

 The floor/ roof is deck slab which comprises of deck sheet, reinforcement with concrete screed



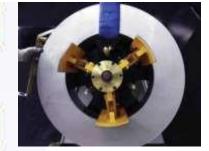


#### Wall Panels – Light Gauge Steel Frame System

- LGSF is a "C" cross-section made of galvanised light gauge steel with built in notch, dimpling, slots, service holes etc. and produced by computerized cold roll forming machine.
- These frames are assembled using self driven metal screws to form into LGSF wall and roof structures of a building.
- Provisions for doors, windows, ventilators and other cut outs as required are incorporated in the LGSF.
- Cement concrete panels are fixed on both side of the wall and then filled with light weight concrete.
- Cement fibre board as an alternative to the above panels are used for cladding with infill of rockwool.



Receiving GI Coils, Inspection and Store



Loading the coils in Decoiler

Loading NC files and Operation of computerized Roll forming machine.

Production of frames, Marketing & Labeling





Inspection of frames.

Packing of frames wall wise Marking & Labeling

Dispatch to construction site.

Flow Diagram of manufacturing plant for fabrication of Light Gauge Steel Frame System

#### Light Gauge Steel Frame System





Photos of manufacturing plant

#### Wall Frame

- Factory finished custom designed cold form Light Gauge Steel Framed structure comprising of steel wall panel, trusses, purlins etc are manufactured out of minimum 0.75 mm thick steel sheet as per design requirements.
- The steel sheet shall be galvanized (AZ-150 gms Aluminium Zinc Alloy coated steel having yield strength 300- 550 Mpa) conforming to AISI specifications and IBC 2009 for cold formed steel framing and construction.
- IS 800-2007 (Code of practice for general construction in steel) and IS: 801- 1975 (Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction.

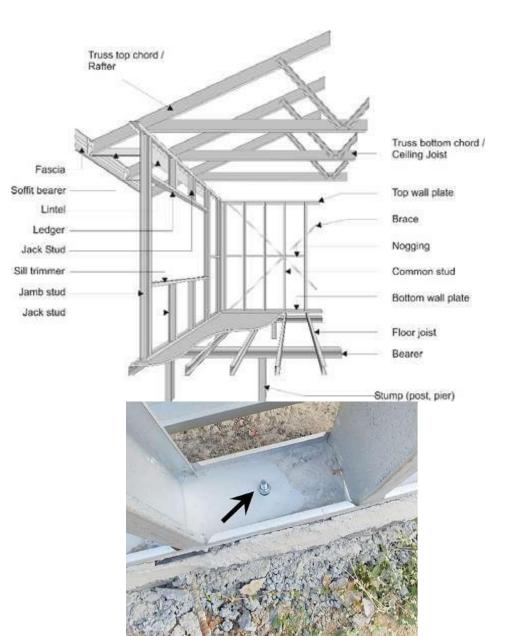




#### Light Gauge Steel Frame System

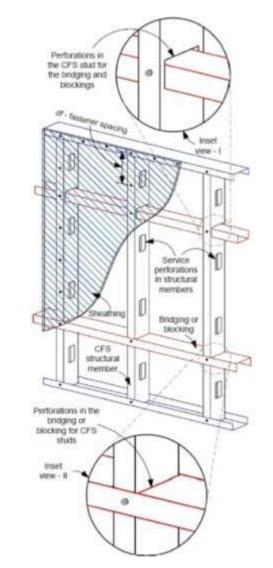
#### Wall Frame...contd.

- The framing section shall be cold form C-type having minimum web depth 89 mm x 39mm flange x 11mm lip in required length as per structural design
- Duly punched with dimple/slot at required locations as per approved drawings.
- The slots will be along centre line of webs and shall be spaced minimum 250mm away from both ends of the member.
- The frame can be supplied in panel form or knock down condition in specific dimensions and fastened with screws extending through the steel beyond by minimum of three exposed threads.
- All self drilling tapping screws for joining the members shall have a Type II coating in accordance with ASTM B633(13) or equivalent corrosion protection of gauge 10 & 12, TPI 16 & 8 of length 20mm.
- The frames shall be fixed to RCC slab or Tie beam over Neoprene rubber using self expanding carbon steel anchor bolt of dia as per approved drawings, design subject to minimum 12mm diameter and 121mm length conforming to AISI 304 and 316 at 500mm c/c with minimum embedment of 100mm in RCC and located not more than 300mm from corners or termination of bottom tracks complete in all respects.



#### Wall Frame...contd.

- Fasteners and Connectors
  - Frame assembly screws: Shall be galvanized steel screws self-drilling type of size 10 x 25 mm having Truss-head and shall be as per ASTM C 1513-10.
  - Wall Erection Screws: Shall be galvanized steel screws self-drilling type of size 8 x 25 mm having Hex Washer head and shall be as per ASTM C 1513-10.
  - **Precast Concrete Panels Fixing Screws:** Shall be of galvanized steel screws self-drilling type of size 8 x 50 mm having CS head and shall be as per ASTM C 1513-10.
  - Wall and Foundation Anchor Bolt: Shall be of high tensile galvanized steel of size 10 x 100 mm/ 10 x 150 mm and 12 x 100 mm/ 12 x 150 mm and shall be as per ASTM C 1513-10.



Cold-formed steel structural members with perforations (service openings and opening for continuity members)

#### • Wall Frame...contd.

- Cladding of LGSF Panels
  - 20mm thick Precast Concrete (M20) Panels (PCP) are used as facing sheets for construction of walls on both sides. Metal moulds, concrete mixing machine and vibration tables are used for manufacturing the panels at onsite or offsite.
  - The panels are designed to withstand the concrete weight pumped in between the gap of the panels without failure and buckling.
  - The steel reinforced precast concrete panels (PCP), has one side rough surface and the other side smooth surface. The PCP's are fixed on either side of Light Gauge Steel Frame Structures (LGSFS) with studs and tracks using mechanical fasteners. While fixing, the rough side of the panels are facing inside and smooth side is facing outside. Each PCP is fixed with 6 screws.
  - Light weight concrete is pumped in to the gap between two PCPs. The concrete bonds with the rough surface of the panels. Thus, the LGSFS and PCPs are firmly joined to make a monolithic steelconcrete structure.

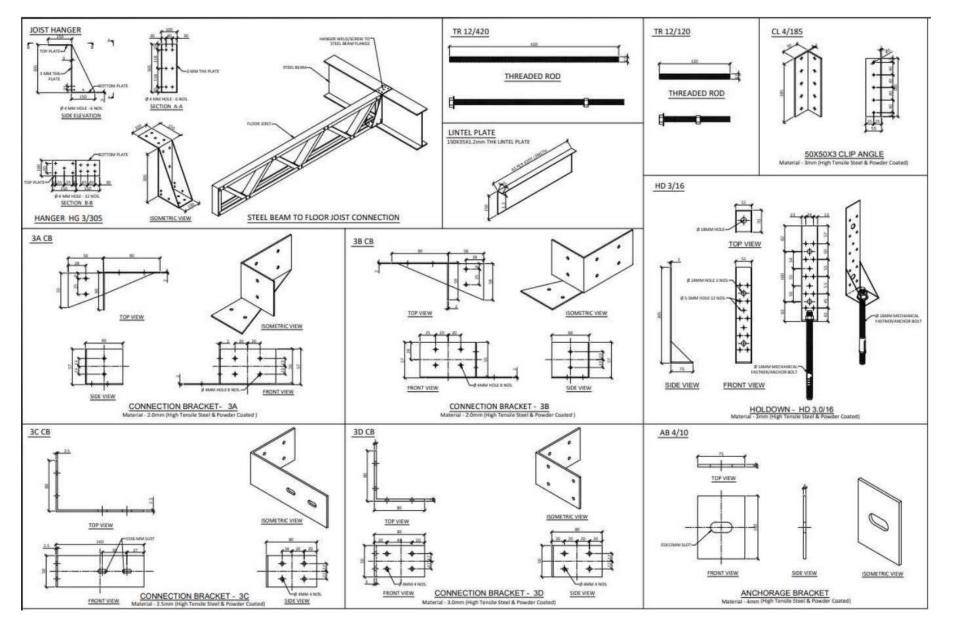


#### • Wall Frame...contd.

- Core of wallpanels
  - The concrete used for infill wall is light weight and free flow.
  - The density shall be 1500-1800 Kg/m<sup>3</sup> after adding/mixing foam or EPS beads as per the design mix. The light weight concrete shall be of grade M5 to M10 as required.
  - The light weight concrete shall be mixed and used at site.



Structural connections of LGSF panels



#### 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.

#### Prefabricated Sandwich PanelSystem

#### **Essential Requirements**

- The labours are required to be trained for fabrication/assembly works
- Plumbing & electrical services need to be pre-planned.
- Door and Window position shall not be changed after pouring of light weight concrete.
- Erection of panels shall be under supervision of trained staff.
- Post construction alteration is difficult.
- Proper care should be taken for fixing of tiles on the walls.
- Electrical cables need to be properly insulated with minicircuit breakers.



Being first time mass scale field implementation of new technology the Light House Project at Agartala is on **Design & Build Basis** 

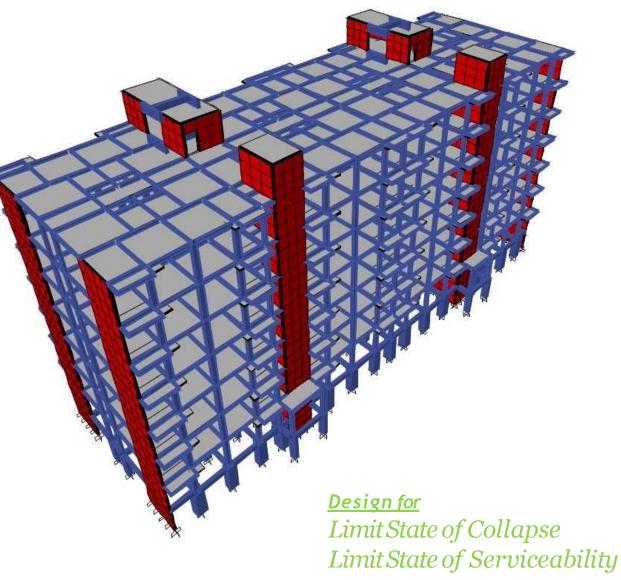
Technology Provider and Construction Agency: M/s Mitsumi Housing Pvt. Ltd., Ahmedabad

# STRUCTURAL ANALYSIS & DESIGN

- 3D Model of typical tower with PEB Structure
- Load Combinations :
  - 1.5 (DL+LL)
  - 1.2 (DL+LL<u>+</u>EL/WL)
  - 1.5 (DL<u>+</u>EL/WL)
  - 0.9DL +1.5EL/WL

(EL/WL implies Earthquake/Wind Load in +X, -X, +Y, and -Y, directions . Lateral forces shall be considered acting from all directions but one at a time.)

- Steel structural system can be easily modeled in the CAD software such as STAADPRO, ETABS, SAFE, SAP, ABACAS and others for detailed structural analysis.
- 2D/ 3D Static and dynamic linear and non-linear analysis can be carried out using these softwares.
- The softwares can also be used for structural design as per Indian Standards.
- AUTOCAD fordrawings



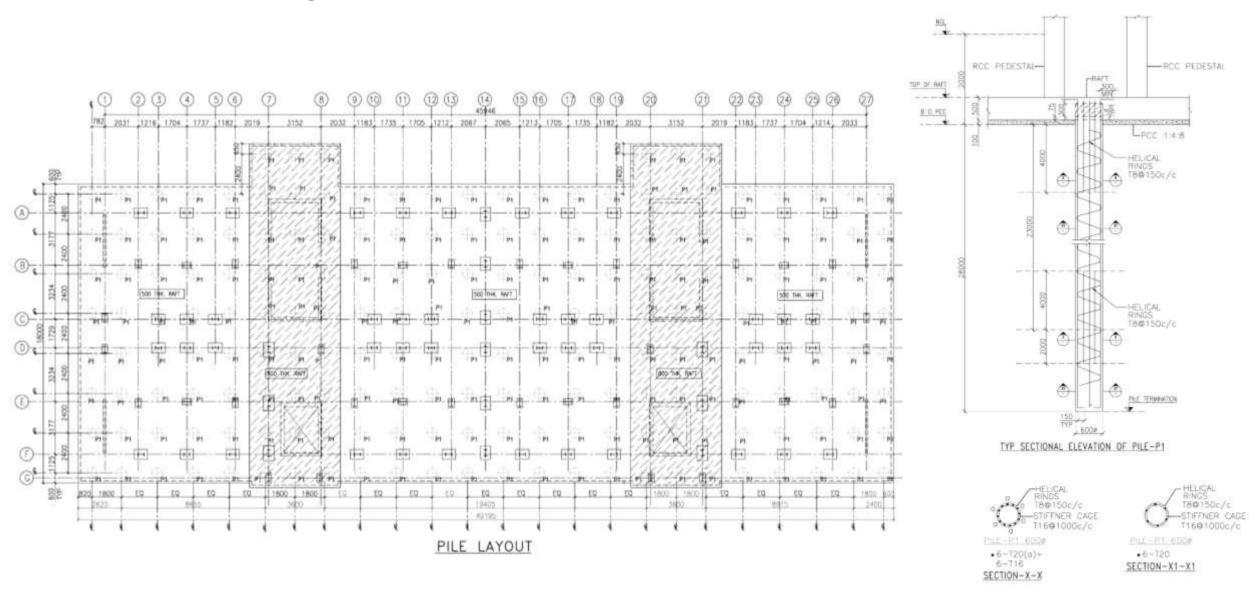
# **Construction Sequence**

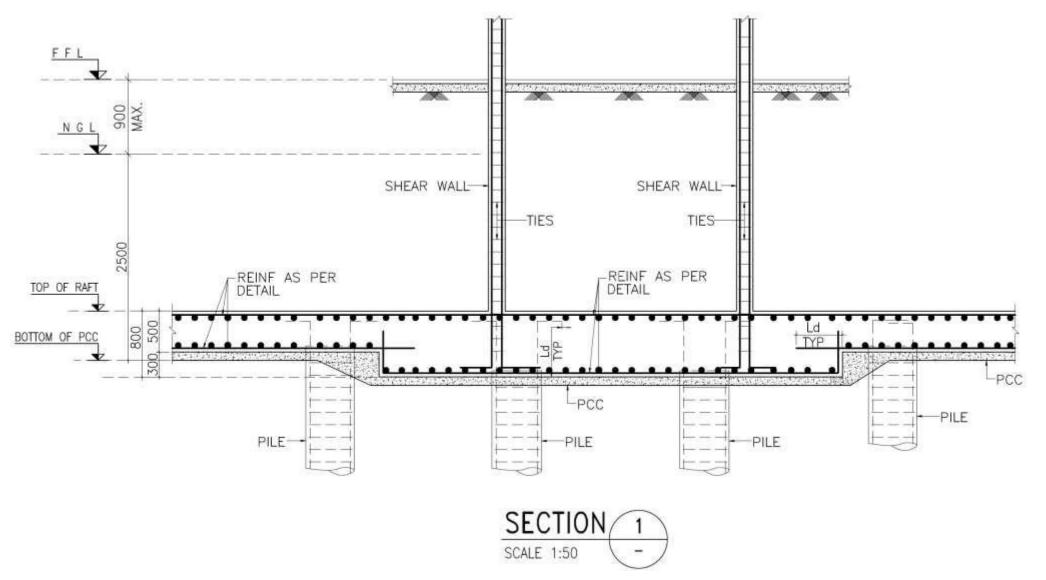
Foundation

- Sub-Structure:
- Super-structure: Structural system
   Floors
   Wall Panels
   MEP: Plumbing & Electrical
- Finishing

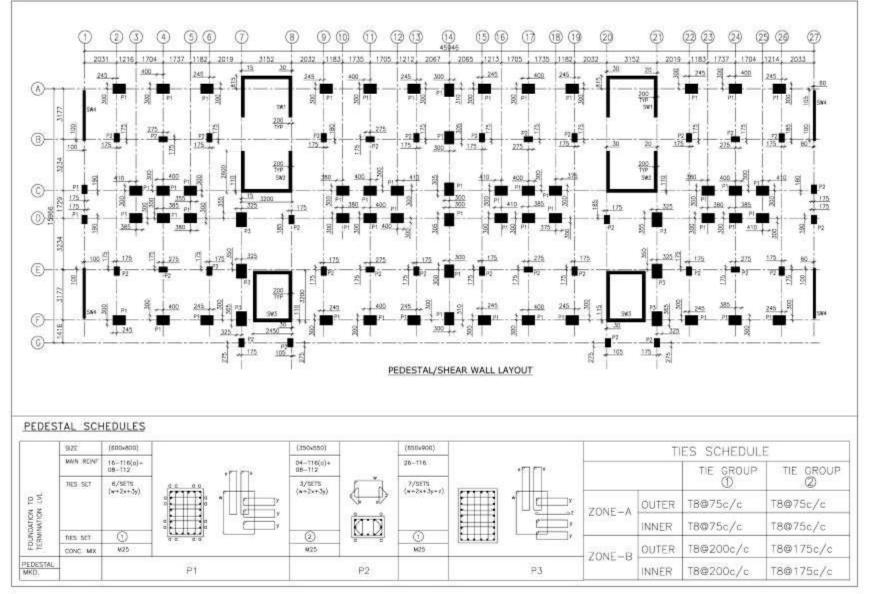
#### **Structural Drawings**

# FOUNDATION



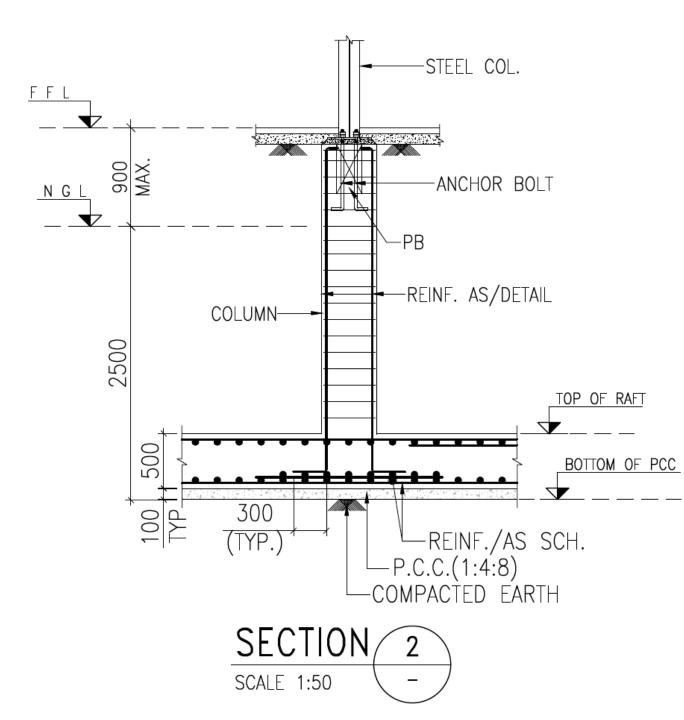


• A section showing the placing of raft on the piles.



• The RCC raft is casted on the piles. Then concrete pedestal are casted in M25 concrete.

# FOUNDATION

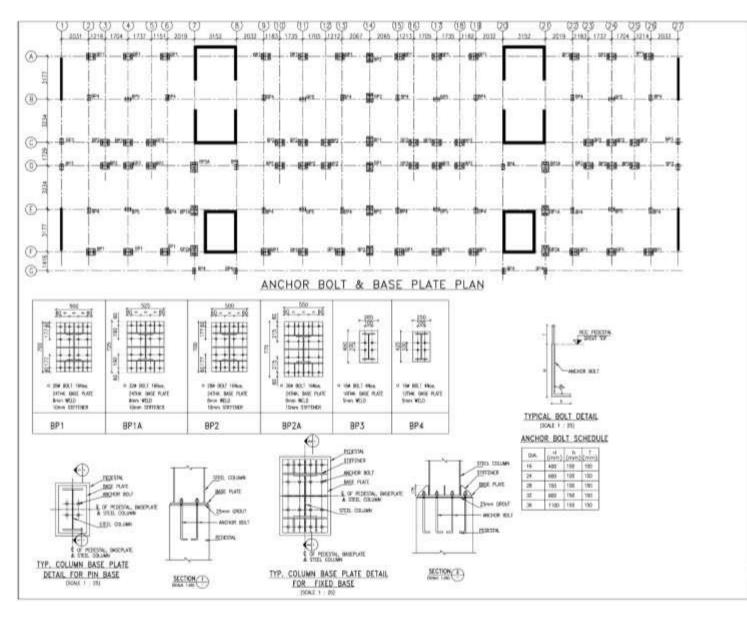


 A section of the foundation showing the raft, concrete pedestal, location of the anchor bolts & base plate and steel column in superstructure.

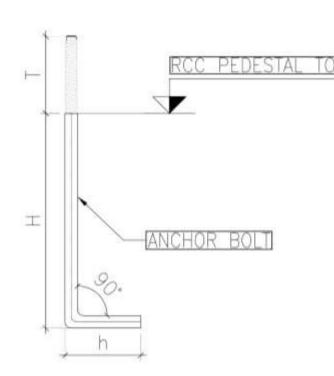


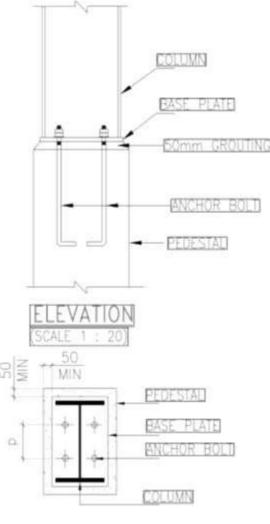
• Fixing of anchor bolts with templates over which factory made built up columns with base plate will be erected.

#### Anchor Bolt & Base Plate Plan



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





Dia (mm)	H (mm)	h (mm)	T (mm)	
16	400	100	100	
24	500	100	150	
28	700	100	150	
32	900	150	150	
36	1100	150	150	

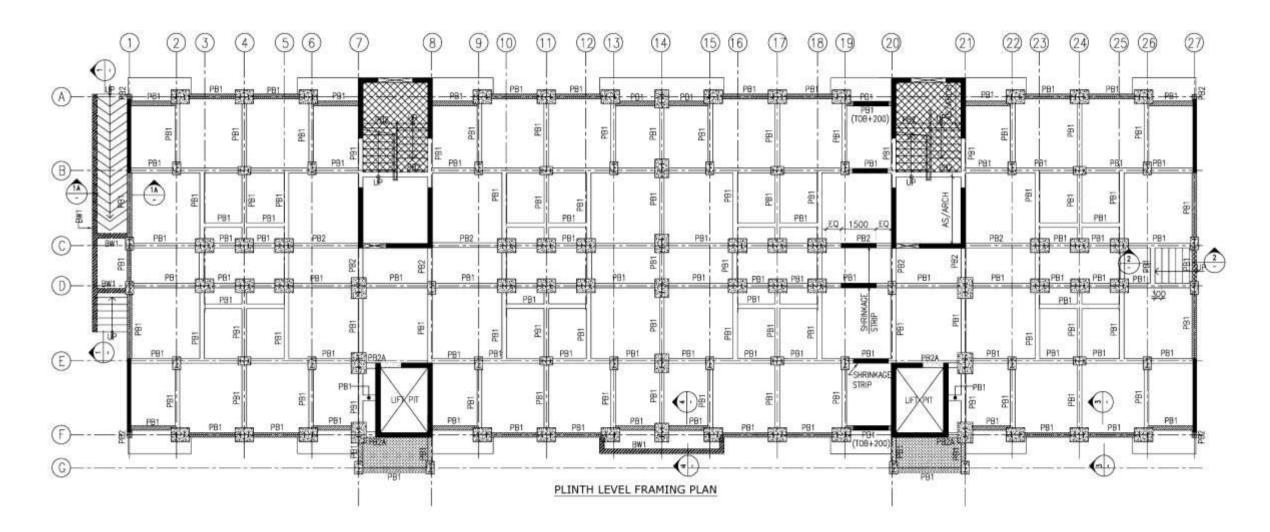
Anchor boltschedule

#### a) Typical anchor bolt detail

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

#### b) Typical base plate detail

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



• On concrete pedestal, plinth beam are casted in M25 concrete and backfilling is done.



• The project starts with layout and marking of piles on field.

 After the layout at site, the boring of piles is undertaken with the help of Hydraulic Rigs. The depth of the borehole is 30m from NGL and diameter of pile is 600 mm. Total number of piles in the project is approx. 1750.



• Steel Cages with helical reinforcement are prepared at site and inserted in the pile holes.



- After flushing of bore hole with bentonite slurry, pouring of M 30 Grade concrete through trimming pipe in piles is undertaken.
- Laying of Raft in M30 concrete as per the structural design with reinforcement is to be completed in concrete above the piles.































#### **Concrete & Reinforcement Steel Specifications**

ltem	Concrete Grade
Piles, raft, shear wall	M30
Plinth beam, Grade slab, Pedestals, Water tank, Sewage Treatment Plant (STP)	M25

- Mix design for concrete and all Concrete work shall conform to IS 456-2000 & Liquid retaining structures shall conform to IS 3370:2009
- Reinforcement Steels being used is TMT bars of Fe 500 as per IS 1786-2008.

#### Concrete mix design M25 and M30 (IIT Delhi)

Amrit Cement		Eine Anoregete		Coarse Aggregate		Plasticizer	Slump		Comp. Strength	
Water	Cement	Zone-IV	Zone-II	10mm	20mm	Tustienter	Initial	After I hour	7 days	28 days
165	387	217	506.4	434	651	1.25%	170	145	31.63	40.89
			the second second		658	1.00%	155	120	24.52	34.52
Dalmia Cement		1					Slump		Comp. Strength	
		Fine Aggregate				and the second s				
			iesana		ggregate	Plasticizer	100	mp After I	1	
Water	Cement	Fine Ag Zone-IV	gregate Zone-II	Coarse A 10mm	vggregate 20mm	Plasticizer	Initial	After I hour	7 days	28 days
			iesana			Plasticizer 1.25%	100	After 1	1	
	Water 165 170	Water Cement 165 387 170 347	Water         Cement         Fine Age           165         387         217           170         347         219.4	Water         Cement         Fine Aggregate           165         387         217         506.4           170         347         219.4         512	Water         Cement         Fine Aggregate         Coarse A           165         387         217         506.4         434           170         347         219.4         512         439	Water         Cement         Fine Aggregate         Coarse Aggregate           165         387         217         506.4         434         651           170         347         219.4         512         439         658	Water         Cement         Fine Aggregate         Coarse Aggregate         Plasticizer           165         387         217         506.4         434         651         1.25%           170         347         219.4         512         439         658         1.00%	Water         Cement         Fine Aggregate         Coarse Aggregate         Plasticizer         Sh           165         387         217         506.4         434         651         1.25%         170           170         347         219.4         512         439         658         1.00%         155	WaterFine AggregateCoarse AggregatePlasticizerSlumpWaterCementZone-IVZone-II10mm20mmInitialAfter 1 hour165387217506.44346511.25%170145165387217506.44206581.00%155120	Water         Cement         Fine Aggregate         Coarse Aggregate         Plasticizer         Slump         Comp.           Water         Cement         Zone-IV         Zone-II         10mm         20mm         Initial         After 1 hour         7 days           165         387         217         506.4         434         651         1.25%         170         145         31.63           165         387         217         506.4         420         658         1.00%         155         120         24.52

28 days Target Strength: M30- 38.25MPa 28 days Target Strength: M25- 31.65MPa

# Dynamic Load Test





#### **Batching Plant**

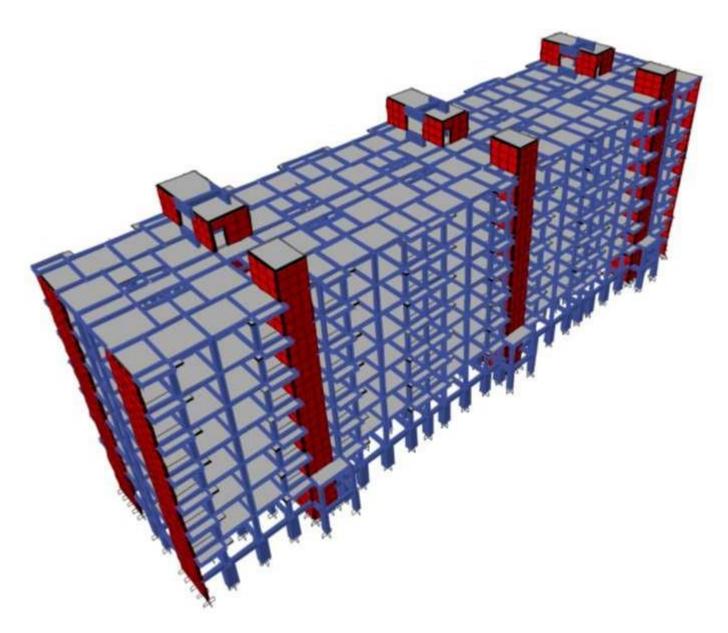


To bring resource efficiency, optimization of building materials and for quality control, a computerized batching plant has been established at site.

#### **Concrete Testing**



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.

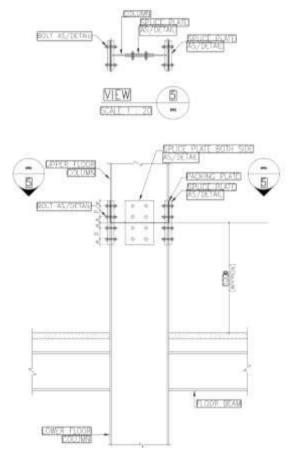


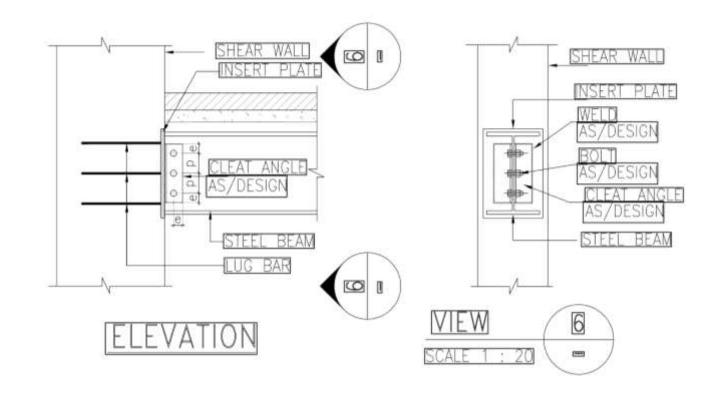


In the present lecture, the structural system and other details are being explained through drawings, sketches and text.

The work on super-structure is yet to start and actual on-ground picture will be covered subsequently.

Column-Column Connections





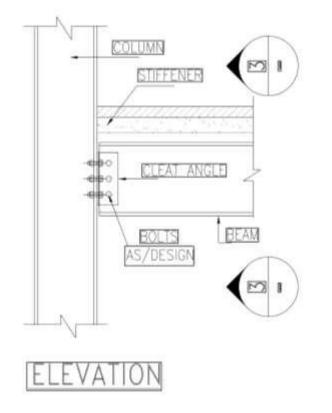
#### a) Column Splice detail

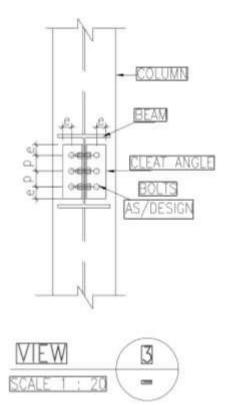
Columns are being spliced through nut & bolts connection along with plates both in web and flange portion

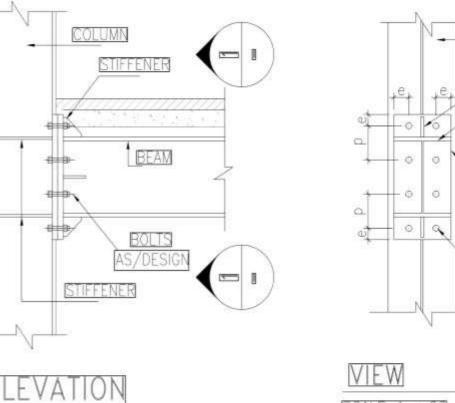
#### b) Shear wall to steel beam connection

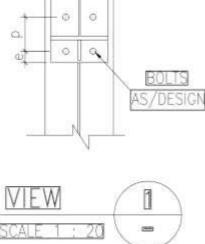
Insert plate along with lug bar are cast during the casting of shear walls and steel beam is connected to the wall with bolted connection through insert plate

Typical beam column shear and moment connections









ND PLAT

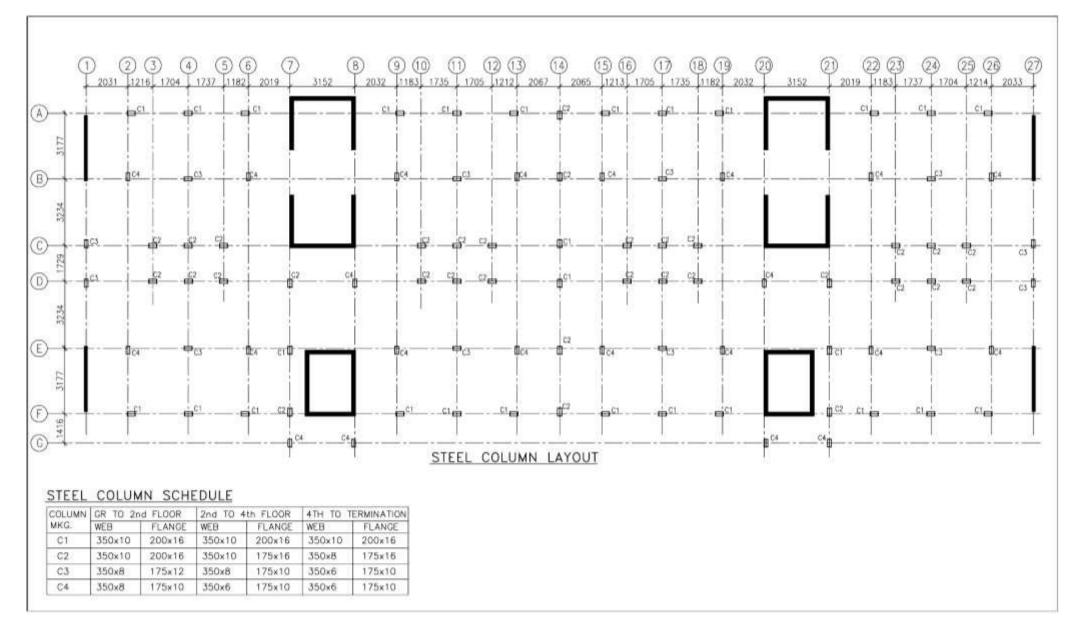
Typical beam to column flange a) shear connection

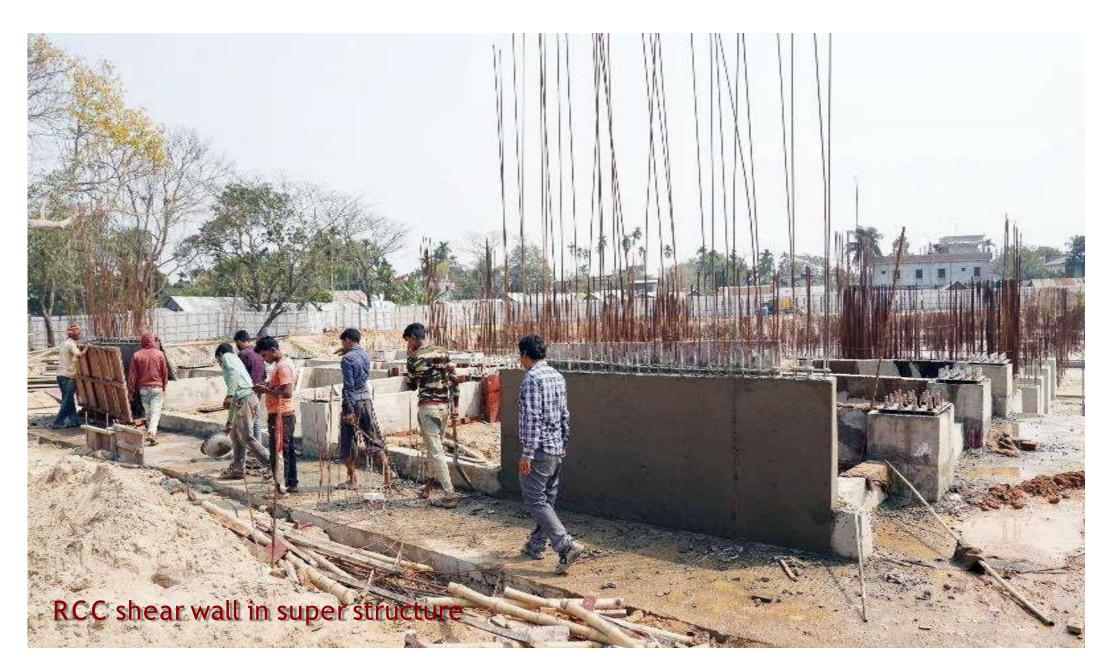
Steel beam is being connected to the column through cleat angle connected to the web portion of beam

b) Typical beam to column flange moment connection

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

Steel column layout in superstructure



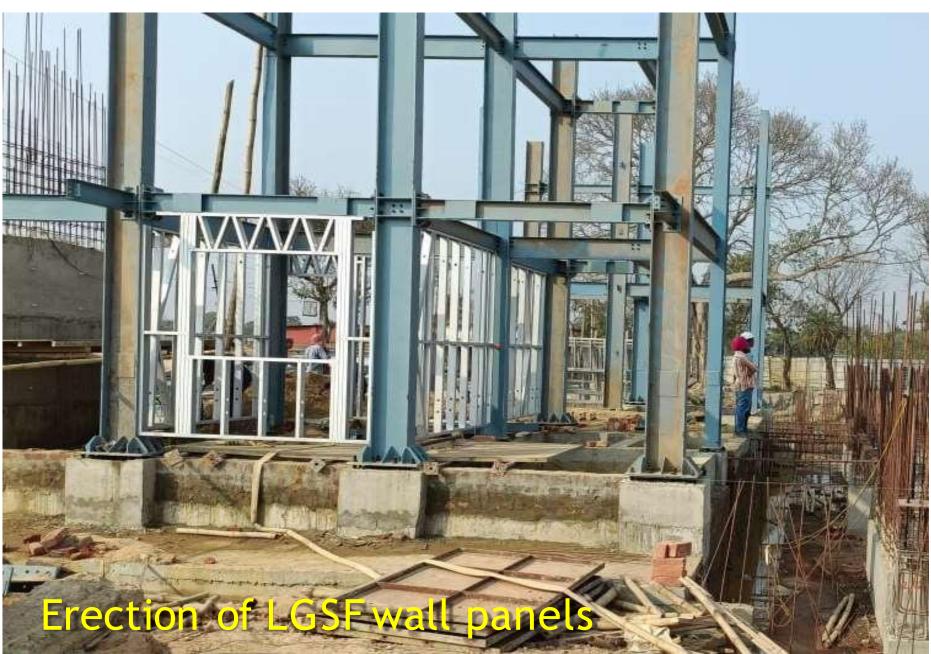








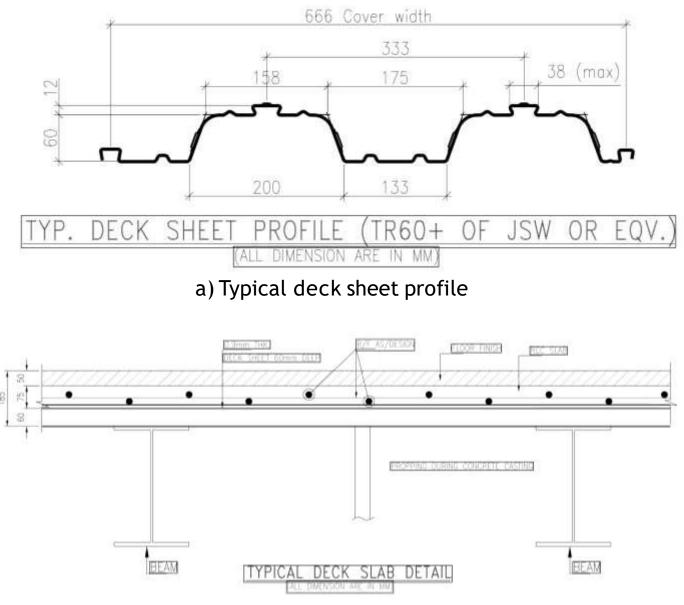




# FLOORS

#### Floor slab details : Deck slab

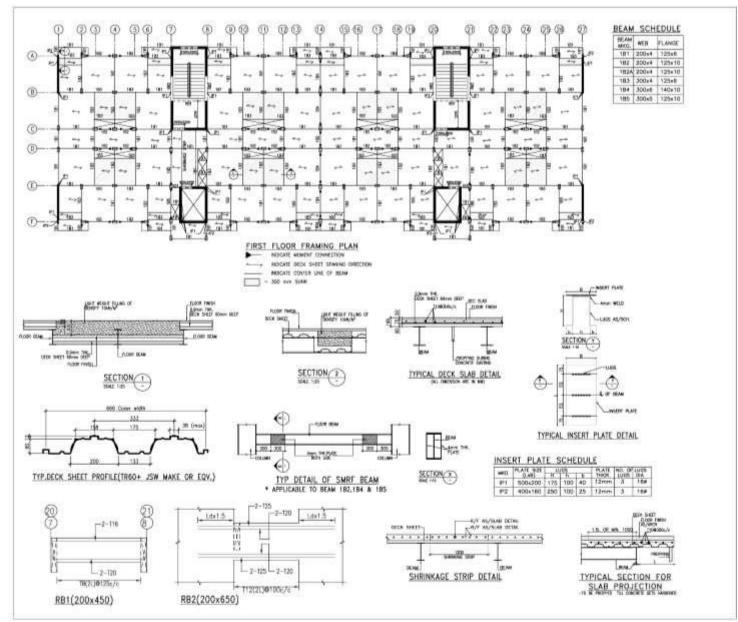
- After erection of steel beams and column (PEB Structure), steel deck sheet of thickness 0.9 mm are placed with required bearing on the beams.
- Concrete screed of 75 mm is poured on the deck sheet in M25 with reinforcement as per structural design.
- Structural design for reinforcement is as per IS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



b) typical deck slab detail

### FLOORS

#### Typical Floor Framing Plan



slab and reinforcement



# WALL PANELS

#### Construction & Installation Process with LGSF

Construction is done in a following sequential manner:

- 1. Transportation of LGSF and Steel Sections as per the design to the site.
- 2. Erection of built up sections for structural frames on RCC foundations using cranes and connections as designed (connection details already explained)
- 3. Installation of decking sheets on structural frame at floor level followed by pouring of concrete screed with nominal reinforcement.
- 4. Fabrication of LGSF frames with the connecting screws at site as per design.
- 5. The wall position shall be marked on the floor and the wall structure placed on the marking. After completing the same, straightness, square and the levels shall be checked by magnetic spirit level. The bottom track shall then be connected with the floor using anchor bolts at the required spacing.
- 6. The precast concrete panels shall be fixed on the LGSF wall structure on studs and tracks by using metal screws. The panels shall be fixed first on the outer side of the LGSFS wall. Electrical/plumbing pipes/conduits shall be fixed as designed and cut-outs for services shall be marked on the panel.
- 7. Self-compacting concrete of required grade/light weight concrete shall be mixed using concrete mixing machine and then pumped into the gap between two panels using a special pumping unit.
- 8. Upon installment of wall panels, flooring and ceiling, the finishing work is executed.



#### Wall Panels

• Typical view of LGSF panels and steel frame construction



## MEP

 The plumbing and electrical services are incorporated before laying of light weight concrete between the panels



# FINISHINGITEMS

- 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.



# **OTHER INFRASTRUCTURE ITEMS**

- The external infrastructure includes
- Laying of Sewerage PipeLine,
- 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 WasteManagement.



# Thank You