प्रधान मंत्री आवास योजना-शहरी

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

Azadi Ka Amrit Mahotsav

bmtpc | giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

LIGHT HOUSE PROJECT: LIVE LABORATORIES

WEBINAR SERIES: e-learning & webcasting of LHPs for TECHNOGRAHIS

March - November 2022

An 'e-Learning series and webcasting of LHP's construction process' to widespread the knowledge about the technology, construction process, sustainability, and mass cum fast construction to TECHNOGRAHIs.

Webinar Session #08 at Light House Project Indore, Madhya Pradesh

Date: 18.5.2022, Wednesday | Time: 15:00 – 16:30

Light House Projects : Live Laboratories
Webinar Series

Emerging Construction Systems for Mass Housing

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

PMAY (U) Achievement (provisional)

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

स्वच्छ भारत एक कदम स्वच्छता की ओर

आज़ादी का अमृत महोत्सव

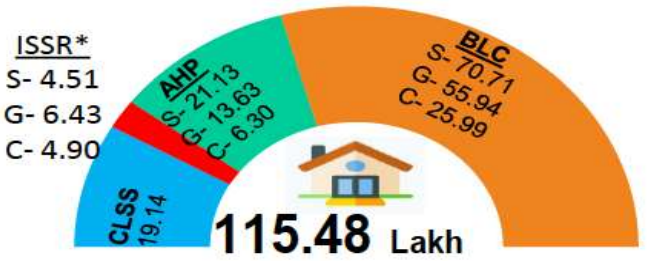
Overall Sanctions for 1.22 crore Houses

Construction of Houses (Nos in lakh)

Demand	Sanctioned	Grounded	Completed/ Delivered
112.24	122.00	95.13	56.33

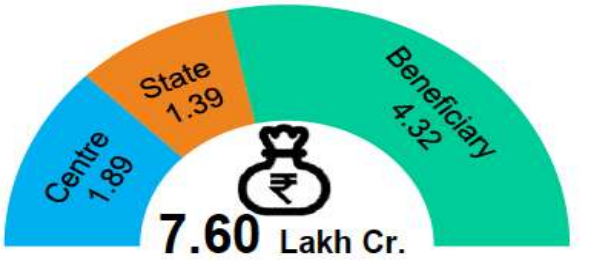
Financial Progress (₹ in Cr)

Committed	Released	Expenditure	UC Received
1,89,303	1,25,192	1,15,658	1,15,229

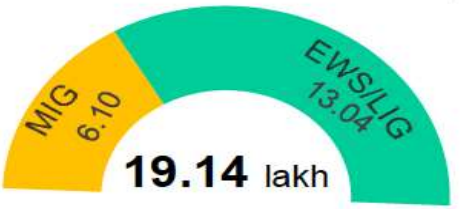


Houses in verticals (Nos in Lakh)

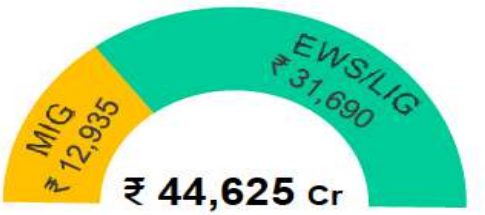
S- Sanctioned G- Grounded C- Completed



Investment Approved (Rs in Lakh Cr.)



Beneficiaries under CLSS (in lakh)



Interest Subsidy Released under CLSS (Rs in Cr.)

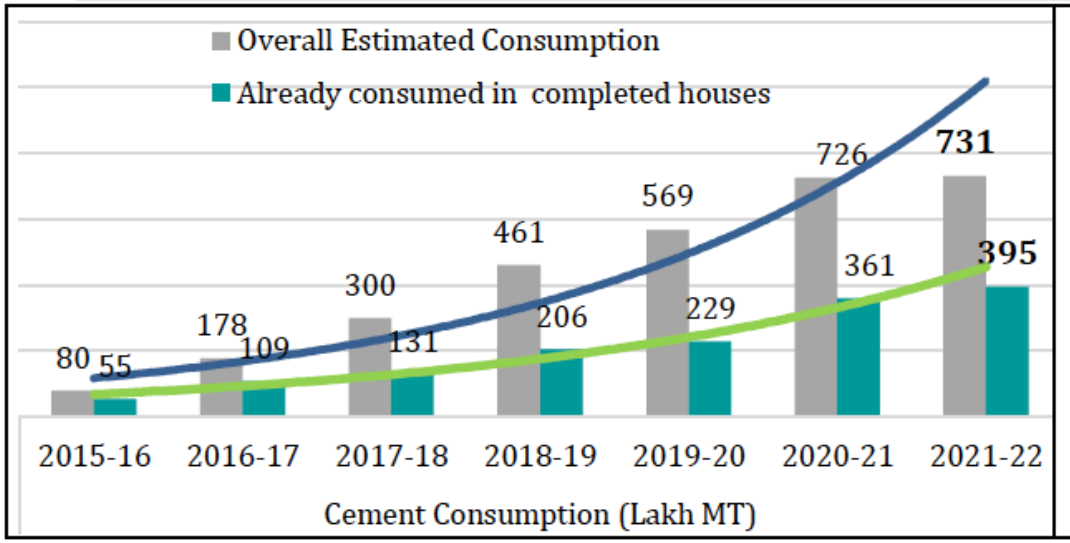
PMAY (U) Achievement (provisional)

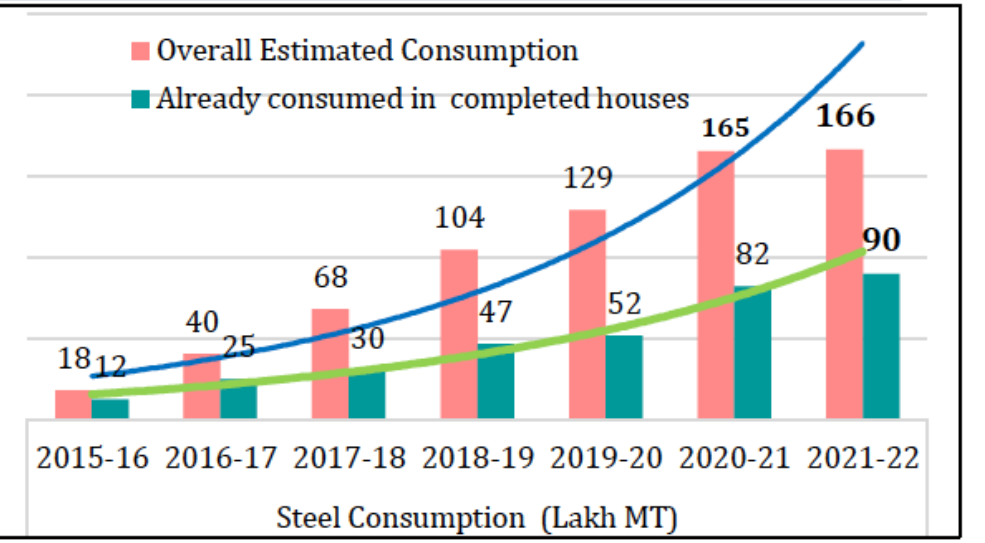
[as on 21st March, 2022]

16 lakh houses are being constructed using New Technologies

Generation of Employment

Details	Direct	Indirect	Total
Person days (Nos in Cr.)	204	448	**652**
Jobs (in lakh)	73	160	**233**





* *includes incomplete works of earlier NURM.*

सबका सपना, घर हो अपना

Global Housing Technology Challenge - India (GHTC-I)

https://ghtc-india.gov.in/

Global Housing Technology Challenge - India (GHTC-I)

Categories	Technology	Tech. Providers
1	***Precast Concrete Construction System - 3D Precast volumetric***	4
2	***Precast Concrete Construction System – Precast components assembled at site***	8
3	***Light Gauge Steel Structural System & Pre-engineered Steel Structural System***	16
4	***Prefabricated Sandwich Panel System***	9
5	***Monolithic Concrete Construction***	9
6	***Stay In Place Formwork System***	8
	Total	**54**

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GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Light House Projects

Hon'ble Prime Minister laid the foundation stone of six LHPs on 01.01.2021

bmtpc

Conventional Construction Systems

business as usual approach

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.

Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

Emerging construction systems help to build

SAFER structures

Sustainable Buildings

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

E Economical - low life cycle cost, better quality

R Resilient - disaster-resistant, structurally superior

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)

3D MONOLITHIC VOLUMETRIC Construction

Courtesy :

1

Precast Concrete Construction System – 3D Volumetric

1	Pre-cast concrete system with columns, beams, walls, slabs, hollow core slabs & also 3D Volumetric components	Katerra
2	Vertical structural modules cast in Plant/Casting yard are assembled together through casting of floor panel. The unit is transported & installed at site.	Moducast Pvt. Ltd
3	3D Modular casting using steel mould and high performance concrete of building modules in factory. These pods are transported to the construction site & assembled	Magicrete Building Solutions,
4	Modules with 3D Volumetric Precast concrete unit, various units make on house	Ultratech Cement Ltd,

Light House Project (LHP) at Ranchi, Jharkhand

(Technology: Precast Concrete Construction – 3D Volumetric Construction)

No. of Dwelling Units : 1008 Nos. (G+8)
No. of Block / Tower : 7 Blocks
Units in each Block / Tower : 144 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

Global Housing Technology Challenge - India (GHTC-I)

2

Precast Concrete Construction System – Precast components assembled at site

1	Precast Large Concrete Panel (PLCP) System with structural members (wall, slab etc.) cast in a factory/ casting yard and brought to the building site for erection & assembling	Larsen & Toubro
2	Pre-cast Concrete Structural system comprising of pre-cast column, beam, precast concrete / light weight slab, AAC blocks/ infill concrete walls.	B.G. Shirke Construction Technology Pvt. Ltd
3	Optimal Pre-cast concrete System through structural Analysis, design & equipment support	Elematic India,
4	Precast concrete construction system using precast walls with precast plank floor	PG Setty Construction Technology Pvt Ltd,
5	Precast components comprising of beams, coloumns, staircase, slab, hollow core slab etc. manufactured in plant & erected on site	Teemage
6	Pre-cast sandwich panel system & Light weight Pre cast Light Weight concrete slab	Nordicflex
7	Prefabricated Interlocking Technology (without mortar) with Roofing as Mechnized Precast R.C. Plank & Joist system	Adalakha Associates Pvt. Ltd
8	Large Hollow wall prefab concrete Panel (lightweight, interlocking, concrete panel) using factory produced large standard hollow interlocking concrete block	William Ling,

Light House Project (LHP) at Chennai, Tamil Nadu

(Technology: Precast Concrete Construction System-Precast Components)

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

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**

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Global Housing Technology Challenge - India (GHTC-I)

3

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

1	LGS Framing with various walling & roofing options	Mitsumi Housing Pvt. Ltd,
2	LGS Framing with various walling & roofing options	Everest Industries Ltd,
3	LGS Framing with various walling & roofing options	JSW Steel Ltd.,
4	LGS Framing with various walling & roofing options	Society for Development of Composites
5	LGS Framing with various walling & roofing options	Elemente Designer Homes
6	LGS Framing with various walling & roofing options	MGI Infra Pvt. Ltd.,
7	LGS Framing with various walling & roofing options	RCM Prefab Pvt. Ltd,
8	LGS Framing with various walling & roofing options	Nipani Infra and Industries Pvt. Ltd.,
9	LGS Framing with various walling & roofing options	Strawcture Eco
10	LGS Framing with various walling & roofing actions	Visakha Industries Ltd.
11	Prefabricated steel structural system with Dry wall system as AAC panels, PUF panels etc	RCC Infra Ventures Ltd.
12	Hot rolled steel frame with speed floor	Jindal Steel & Power Ltd.
13	Hot rolled steel section with AAC Panels as floor & slab	HIL Ltd.
14	AAC wall and roof panel system to provide integrated solution. AAC products are reinforced and used in both load and non-load bearing applications	Biltech Building Elements Ltd
15	AAC Panels are Wire mesh/ steel reinforced for use as wall & slab. Appears to be non load bearing panels to be used with structural framing.	SCG International India Pvt Ltd
16	Precast Light Weight Hollow-core wall Panel is a non-structural construction material with framed structures.	Pioneer Precast Solutions Private Limited

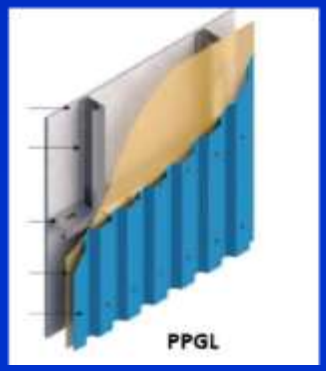
Light House Project (LHP) at Agartala, Tripura

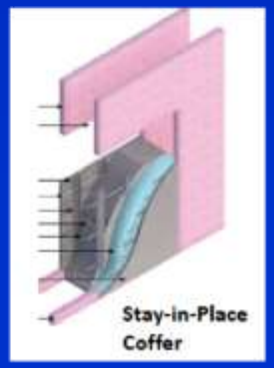
(Technology: Light Gauge Steel Structural System & Pre-Engineered Steel Structural System)

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)

PREFABRICATED SANDWICH PANEL SYSTEMS

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





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

SINGLE

DOUBLE

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4

Prefabricated Sandwich Panel System

1	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Worldhaus
2	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Bhargav Infrastructure Pvt.Ltd
3	EPS Cement sandwich Panel: wall & slab with EPS Cement sandwich Panel to be used with RCC or Steel structural frame. Load bearing upto G+1 storey	Rising Japan Infra Private Limited
4	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Bau Panel Systems India Pvt Ltd,
5	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	BK Chemtech Engineering
6	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	MSN Construction
7	Reinforced Expanded Polystyrene sheet core Panel with sprayed concrete as wall & slab	Beardshell Ltd.
8	Pre-fab PIR (Poly-isocyanurate) based Dry Wall Panel System" as non-load bearing wall	Covestro India Pvt. Ltd.,
9	Sandwich panels as wall & slab	Project Etopia Group

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

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

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

Global Housing Technology Challenge - India (GHTC-I)

5

Monolithic Concrete Construction

1	Aluminium formwork system for Monolithic Concrete construction	Maini Scaffold Systems
2	Aluminium formwork system for Monolithic Concrete construction	KumkangKind India Pvt. Ltd
3	Aluminium formwork system for Monolithic Concrete construction	S-form India Pvt. Ltd.,
4	Aluminium formwork system for Monolithic Concrete construction	ATS Infrastructure Ltd.
5	Aluminium formwork system for Monolithic Concrete construction	Innovative housing & Infrastructure Pvt. Ltd
6	Aluminium formwork system for Monolithic Concrete construction	MFS formwork Systems Pvt. Ltd.
7	Aluminium formwork system for Monolithic Concrete construction	Knest Manufacturers LLP
8	'Tunnel form' construction technology, an cast in situ RCC system, based on the use of high-precision, re- usable, room-sized, steel forms or moulds for monolithic concrete construction	Outinord Formworks Pvt. Ltd.
9	Aluminium formwork system for Monolithic Concrete construction	Brilliant Etoile

Light House Project (LHP) at Rajkot, Gujarat

(Technology: Monolithic Concrete Construction System)

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

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

6

Stay In Place Formwork System

1	Expanded-Steel Panel reinforced with all- galvanised Steel Wire-Struts serving both as the load- bearing steel structure and as the stay-in-place steel formwork filled with EPS-alleviated concrete	JK Structure
2	Factory made prefab Glass fibre reinforced Gypsum cage panels suitable for wall & slab with reinforcement & concrete as infill as per the requirement	FACT-RCF Building Products Limited
3	Structural Stay In Place Galvanized Steel formwork system for walling with the same bottom single layer formwork for slabs/ in-situ slab	Coffor Construction Technology Pvt.Ltd
4	Factory produced PVC Stay in place formwork with concrete & reinforcement in walling units with cast insitu RCC Slab	Joseph Jebastin (Novel Assembler)
5	Fully load bearing walls with 150 mm monolithic concrete core sandwiched inside two layers of EPS as walling The forms are open ended hollow polystyrene interlocking blocks which fits together to form shuttering system	Reliable Insupack
6	Ready to use Stay in place polymer formwork, light weight, with flooring slab (combination of ferro cement and natural stone) placed on RCC precast joists)	Kalzen Realty Pvt. Ltd
7	Fast Bloc, Insulated Concrete Form (ICF), acts as formwork for concrete and rebar, Co1oumn/post and beam construction, creating an strong skeleton in the walls.	Fastbloc Building Systems
8	Formwork system "Plaswall with Two fibre cement boards (FCB) & HIMI (High Impact Molded Inserts) bonded between two sheets of FCB in situ and erected to produce a straight-to finish wall with in-situ concrete	FTS Buildtech Pvt.Ltd

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

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

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)

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.

Adoption of New Technologies by States

AHP houses in Pune, Maharashtra using Precast Construction Technology

- Around **16 Lakh houses** are being built using innovative technologies under PMAY(U) & other state schemes.

State	Technology
Andhra Pradesh	EPS, Monolithic and Steel Technology
Chhattisgarh	Monolithic and Precast Technology
Gujarat	Monolithic, Precast (Waffle-crete)
Kerala	Glass Fibre Reinforced Gypsum (GFRG)
Maharashtra	Precast (3S) & Monolithic Technology
Odisha	Precast concrete construction
Jharkhand	Global Tender floated
Tamil Nadu	Precast Concrete Technology
States like Assam, Karnataka, Madhya Pradesh, Telangana & Uttarakhand have also expressed interest in Technology neutral bidding process	

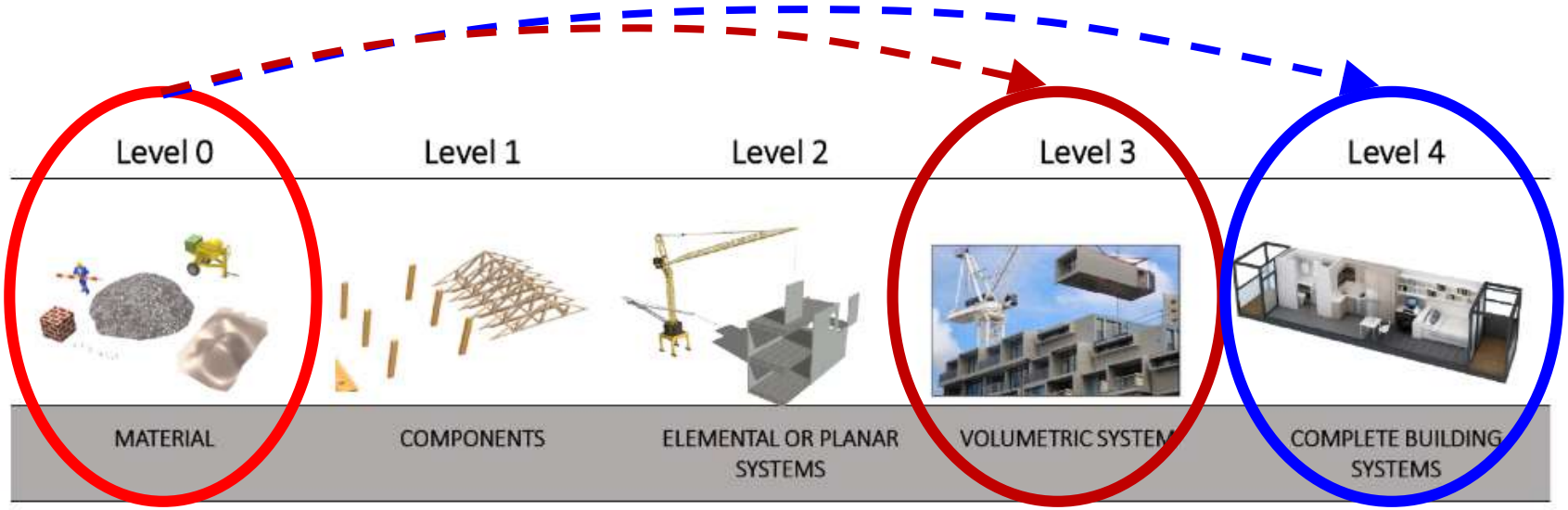
54
Alternate technologies Identified

54
technologies approved by CPWD

29
SoRs issued for alternate technologies by CPWD (22+7)

Looking Back / Rear view

Levels of Construction Technology



Level 0	Level 1	Level 2	Level 3	Level 4
Basic materials for site-intensive construction	Manufactured components	Linear or 2D components	3D components in the form of modules	Modular components - fully finished and delivered to site
✓ Involves more Labour ✓ Time consuming	✓ Fabricated in Factory ✓ Can't be build On-site ✓ Assist in construction speed & quality	✓ Series of Pre fabricated elements assembled to form the shell ✓ Requires on-site work	✓ Volumetric, forms a completed part of the building ✓ Involves more than one trade in the factory	✓ Finished interior & exterior surfaces ✓ Less on-site work

Source: Gibb., A.G.F., *Off-site Fabrication—Pre-Assembly, Pre-Fabrication, and Modularization*

Courtesy : hoMission Abode All

www.bmtpc.org

You can reach us at ska@bmtpc.org; info@bmtpc.org;

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"Creating Enabling Environment for Affordable Housing for All"

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LIGHT HOUSE PROJECT AT INDORE

GHTC-India Category:
Prefabricated Sandwich Panel System

Technology:
Prefabricated Sandwich Panel System with pre-engineered steel structural system

CONTENTS

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Global Housing Technology Challenge - India (GHTC-I)

Broad Category	***Technologies (Nos.)***
Precast Concrete Construction System - 3D Precast volumetric	4
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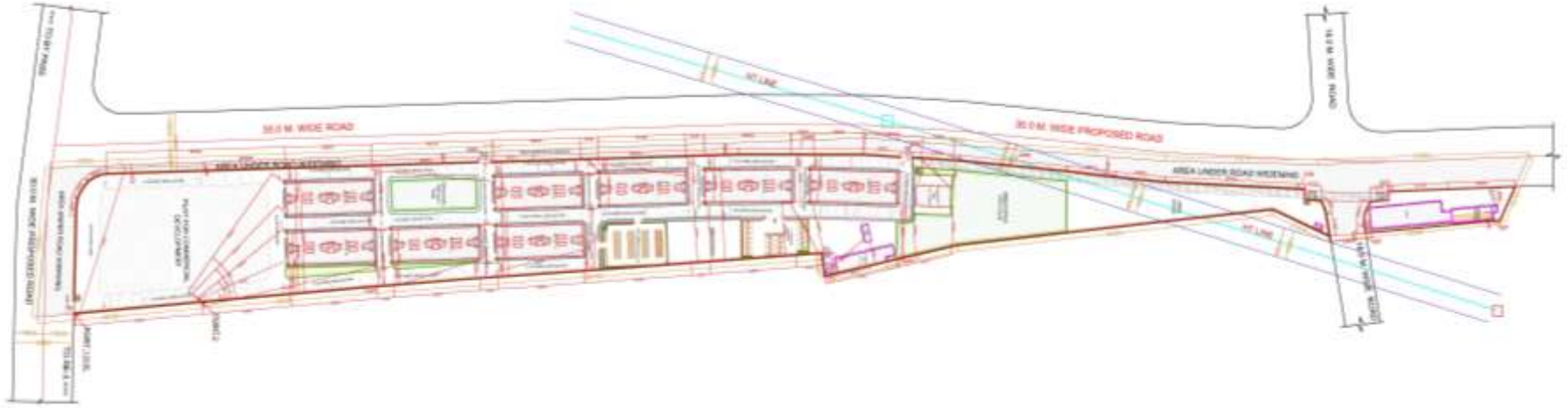
Total	54

Summary of Six Light House Projects (LHPs)

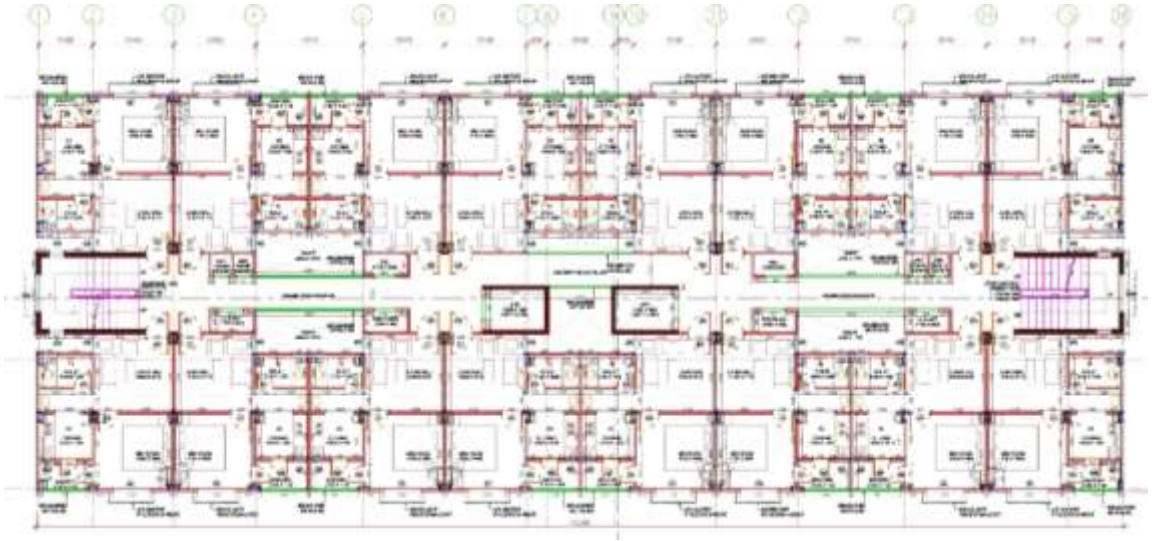
LHP Location			Chennai (Tamil Nadu)	Rajkot (Gujarat)	Indore (Madhya Pradesh)	Ranchi (Jharkhand)	Agartala (Tripura)	Lucknow (Uttar Pradesh)
Sl. No	**Particulars**	**Units**						
1	Name of Technology	Name	Precast Concrete Construction System-Precast Components	Monolithic Concrete Construction using Tunnel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

- Total Plot area is 41920 Sqm.
- Ground coverage of the project is15% and FAR achieved is 1.3.
- Proposed organized green space is 10.05%.
- The project also includes a community hall of 169.52 Sqm.



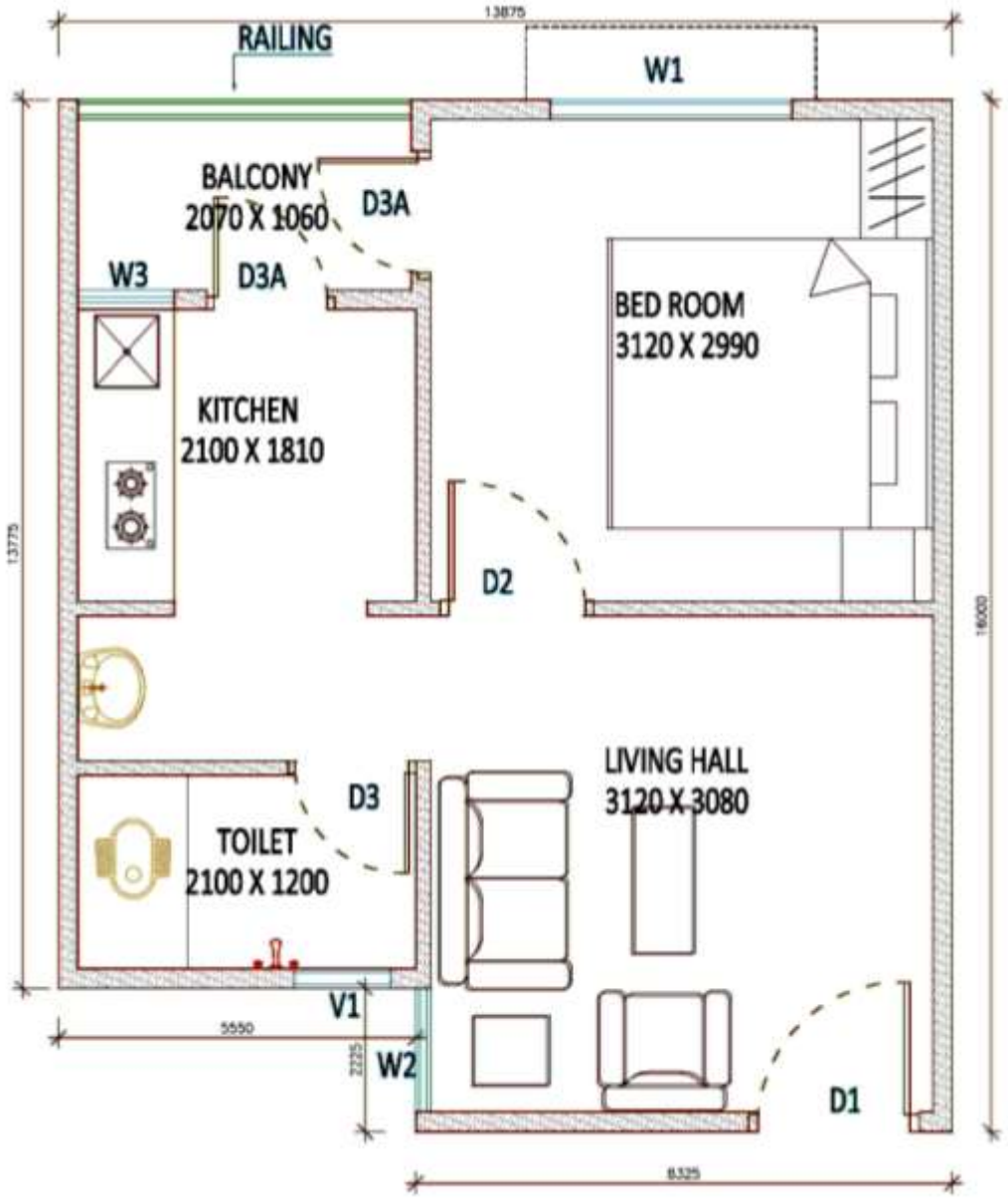
- There are 8 blocks in Stilt + 8 configuration with 1024 houses along with basic and social infrastructure.

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 living, one bed room, a kitchen, a toilet and a balcony. The carpet area of each unit is 29.04 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

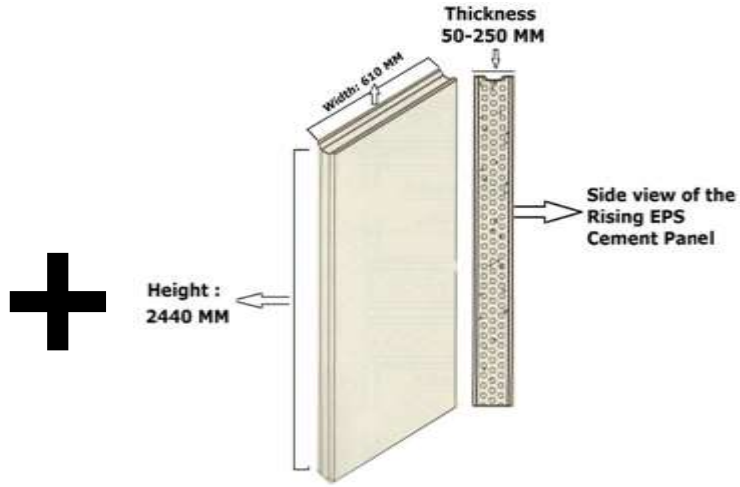
Technology being Used

Load bearing Structure

RCC Framed Structure

Steel Frame Structure

Prefabricated Sandwich System



The Sandwich Panel System are factory made wall panels replacing conventional brick/block & mortar walling construction and can be used as non-load bearing as well as load bearing applications.

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

Structural Elements

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

Foundation

- Conventional as per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Combined and Isolated RCC footing with RCC column up to plinth height.
- RCC shear walls for staircase and lift wells on RCC Raft foundation and water proofing with kota stone.
- Base plate and Anchor bolts of varying sizes and diameter as per structural design for erecting Pre-Engineered Steel structure.
- RCC plinth beam and grade slab at plinth level.

Structural system

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

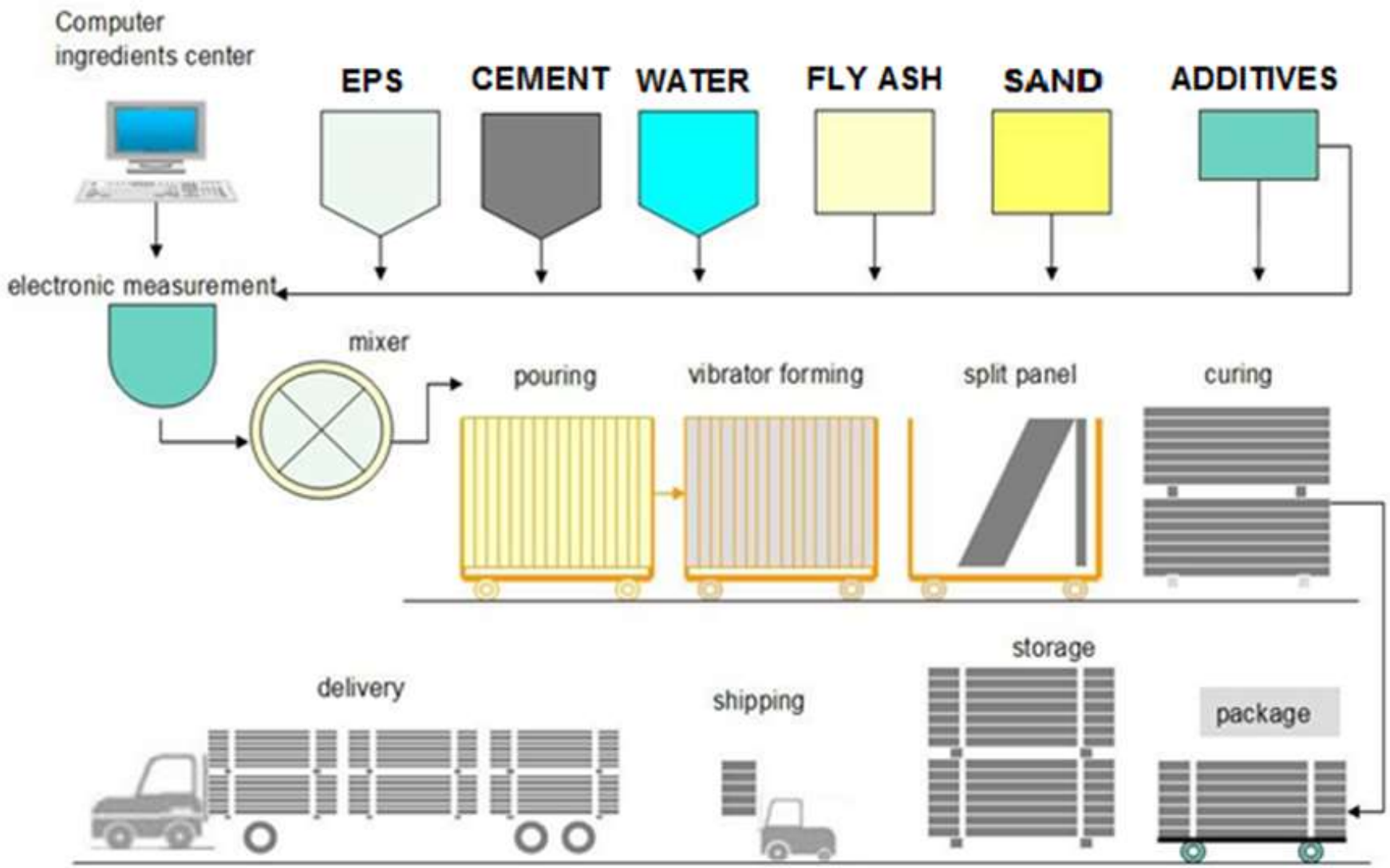
Floor/ Roof Slab

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

Wall Panels – Prefabricated Sandwich Panel System

- The panels are made of fibre cement / calcium silicate boards on both sides with infill core of light weight concrete made of EPS granule balls, cement, sand, flyash, adhesive and other bonding material.
- The core material in slurry state is pushed under pressure into the preset moulds.
- Once set, the panels are moved for curing and transported to the site.

Prefabricated Sandwich Panel System



- Flow Diagram of manufacturing plant for production of Prefabricated sandwich panel

Prefabricated Sandwich Panel System

- Photos of manufacturing plant

- **Typical Wall Panel Dimensions**

Length	2440 mm (may be increased upto 3000 mm)
Width	610 mm (may be altered as per requirement but should not be too wide since handling of the panels become difficult)
Thickness	50-250 mm. Dimensions

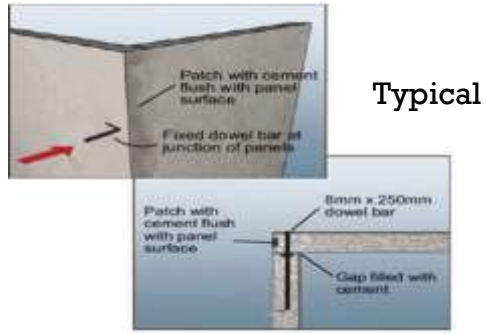
- In LHP at Indore, the height of panel is 3.0 mtr., width is 610 mm.
- The thickness of panels being used is 120 mm for external walls and 90 mm internal walls.
- The additional cladding at L and T joints are required with 60 mm thick panels to encase the steel structure.

Density and weight of Core and Wall Panels
(Size of Wall Panel : 3000 x 610 mm.)

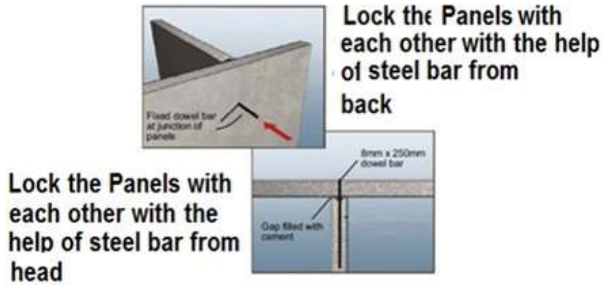
S No.	Thickness of Wall Panel (mm)	Density of Core (Kg/m^3)	Density of Wall Panel (Kg/m^3)	Weight of wall Panel (Kgs)
1.	60	580	670	74
2.	90	570	635	105
3.	120	560	615	135

Prefabricated Sandwich Panel System

- The panels have tongue and groove joints for construction of a building.
- U Type channels are used to hold the panels with the structure. Addition clip should be welded with steel columns and beams to hold U channel firmly with the columns / beams and floors. The thickness of the panel shall determine the size of U channel.
- Two panels are jointed with steel dowel bars at angel of 45 degree
- Joints between two panels are filled with exterior grade superfine ready-mix plaster and finished with putty after placing anti crack fibre tape to give uniform smooth surface ready for paint.



Typical L & T joints with panels



Performance Appraisal Certificate No.: 1032-S/2017 has been issued to M/s Rising Japan Infra Pvt. Ltd. by BMTPC.

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.

Essential Requirements

- The Joints of panels with each other need to be perfectly locked by materials such as cement, glue, dowel bars, exterior grade superfine ready-mix plaster etc. & mechanism such as leveling of panels etc. shall be perfect.
- Cutting / chiseling of panels for openings such as doors, windows, service conduits etc. required little training & special tools/ machines are required.
- The panels if used as floors / roofs, shall require screed concrete of minimum 50 mm thickness with nominal reinforcement/ GI wire mesh for monolithic action to avoid leakage though panel joints.
- Erection of panels shall be under supervision of trained staff.

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

Agency:
M/s KPR Projectcon Pvt. Ltd., Nasik

Technology Provider:
M/s Rising Japan Infra Pvt. Ltd., New Delhi

Design Basis

- Structural Frame as RC Steel Hybrid structure
  - Sub-structure up to the plinth level in RCC
  - Superstructure is using HR Steel built-up I sections with lift and staircase wells in RCC Shear wall
- Safe Bearing capacity: 40 T/m^2, depth of foundation 2.0 m.
- Isolated and combined RCC foundation as per IS1080-1985
- Raft foundation as per IS:2950 (Part-1)-1981 (reaffirmed 2008)
- Wind speed: High damage risk zone with basic wind speed (V_b=47m/sec)
- Design wind speed:

  $V_z=V_b.k_1.k_2.k_3.k_4$

  k_1 (Risk Coefficient)=1

  k_2 (Size factor)=as per height

  k_3 (topography factor)=1

  k_4 (importance factor)=1
- Wind Pressure (P_z) = 0.6.Vz^2
- Wind pressure is converted into design wind pressure and then distributed at each storey as wind force.

Design Basis

- Earthquake : Zone-III as per Seismic Zoning Map of India IS: 1893 (Part-1):2016
  - Designed as dual system with ductile RC structural walls and few special moment frames in structural steel in both direction, as per Table 9 (iii) (c) of IS 1893 (Part I): 2016.
  - Zone factor 0.16 (As per Table 3-IS:1893-2016), Importance factor 1.2 (As per Table 8-IS:1893-2016), Response Reduction Factor 4 (As per Table iii)c)-IS:1893-2016) and Damping Ratio 5%.
  - Design Horizontal Seismic Coefficient (A_h)

$$A_h=(Z/2).(S_a/g).(I/R)$$

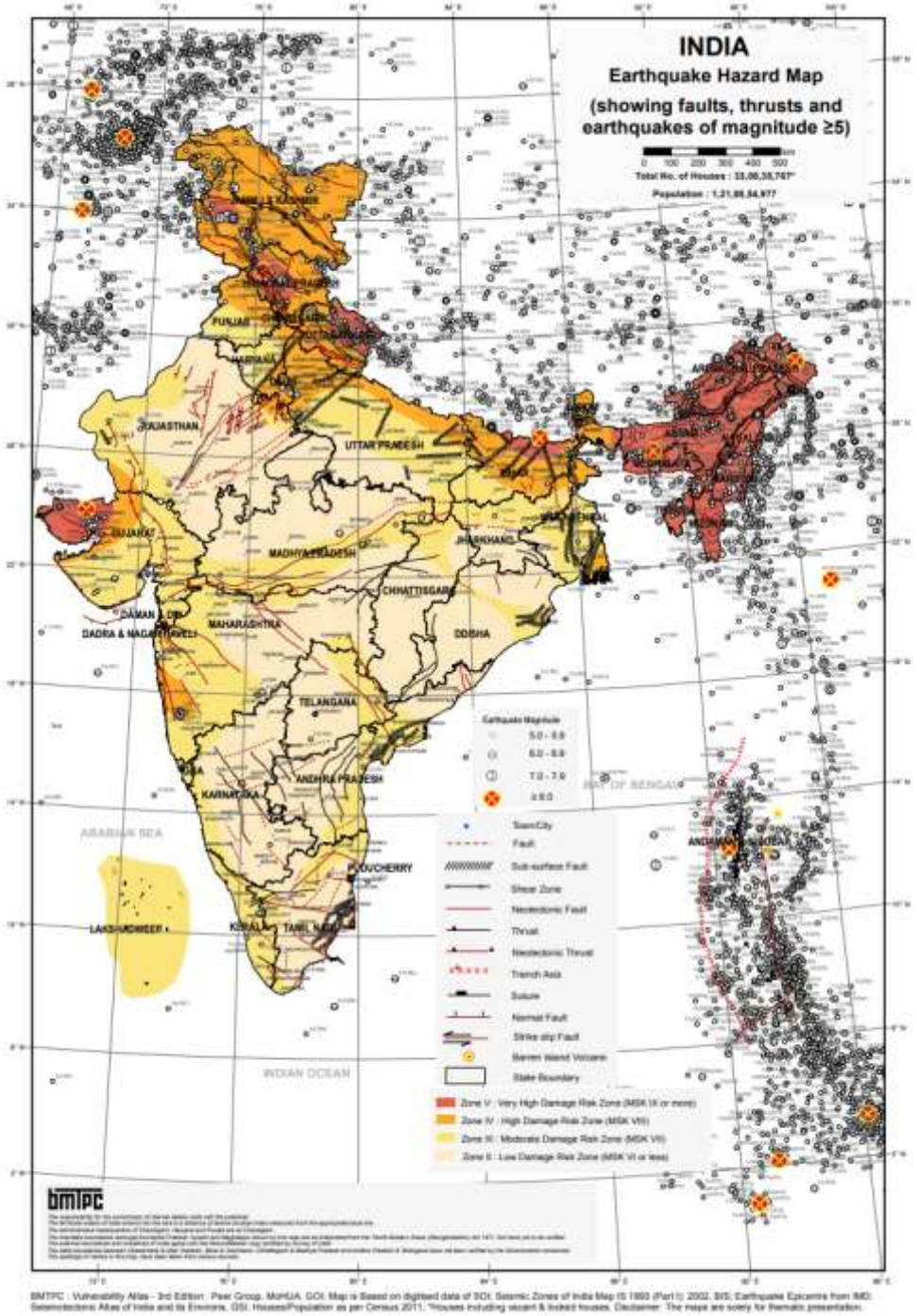
S_a/g is design acceleration coefficient for different soil types corresponding to natural period (T) of building

  - Design Lateral Force (V_B)

$$V_B=A_h.W$$

W is seismic weight of building

  - Linear dynamic analysis has been done to obtain the design lateral forces
  - Steel columns as pinned at top of RC pedestal / plinth beam and some columns – beams frames as rigid joint frames to cater lateral loads in addition to gravity loads and other as pinned jointed frames to cater gravity loads only.
  - Rigid diaphragms in horizontal direction at floor levels as per Cl.7.6.4 of IS:1893(Part-1):2016.
- Design has been carried out as per IS 456-2000, IS 800-2007 and NBC-2016.



Design Standards

Loads

Is:875 (part-1)-1987 (reaffirmed 2018)	Code of practice for design loads (other than earthquake)for buildings and structures part 1 dead loads - unit weights of building material and stored materials (incorporating is:1911-1967)
Is 875 : part 2 : 1987 (reaffirmed 2018)	Code of practice for design loads (other than earthquake) for buildings and structurres: part 2 imposed loads
Is 875 : part 3 : 2015	Design loads (other than earthquake) for buildings and structures - code of practice - part 3 wind loads
Is 1893: part 1 : 2016	Criteria for earthquake resistant design of structures - part 1 : general provisions and buildings

Design Standards

Structural Steel

Is 800 : 2007 (reaffirmed 2017)	General construction in steel - code of practice
Is 801 : 1975 (reaffirmed 2016)	Code of practice for use of cold formed light gauge steel structural members in general building construction
Is 806 : 1968 (reaffirmed 2017)	Code of practice for use of steel tubes in general building construction
Is 808 : 1989 (reaffirmed 2014)	Dimensions for hot rolled steel beam, column, channel and angle sections
Is 813 : 1986	Scheme of symbols for welding
18: 816-1969 (REAFFIRMED 1969)	CODE OF PRACTICE FOR USE OF METAL ARC WELDING FOR GENERAL CONSTRUCTION IN MILD STEEL
Is 1161:2014	Steel tubes for structural purposes
Is 2062:2011	Hot rolled medium and high tensile structural steel
Is 4000 : 1992 (reaffirmed 2017)	Code of practice for high strength bolts in steel structures
Is 4923:2017	Hollow steel sections for structural use — specification (second revision)
Is 11384 : 1985 (reaffirmed 2017)	Code of practice for composite construction in structural steel and concrete

Design Standards

RCC

Is 456 : 2000 (reaffirmed 2016)	Plain and reinforced concrete - code of practice
Is 3370 : part 1 : 2009 (reaffirmed 2019)	Concrete structures for storage of liquids - code of practice - part 1 : general requirements
Is 3370 : part 2 : 2009 (reaffirmed 2019)	Concrete structures for storage of liquids - code of practice - part 2 : reinforced concrete structures
Is 4326 : 2013 (reaffirmed 2018)	Earthquake resistant design and construction of buildings - code of practice
Is 5525 : 1969 (reaffirmed 2018)	Recommendations for detailing of reinforcement in reinforced concrete works
Is 1786 : 2008 (reaffirmed 2018)	High strength deformed steel bars and wires for concrete reinforcement - specification
Is 10262 : 2019	Concrete mix proportioning-guidelines
Is 13920 : 2016	Ductile detailing of reinforced concrete structures subjected to seismic forces - code of practice

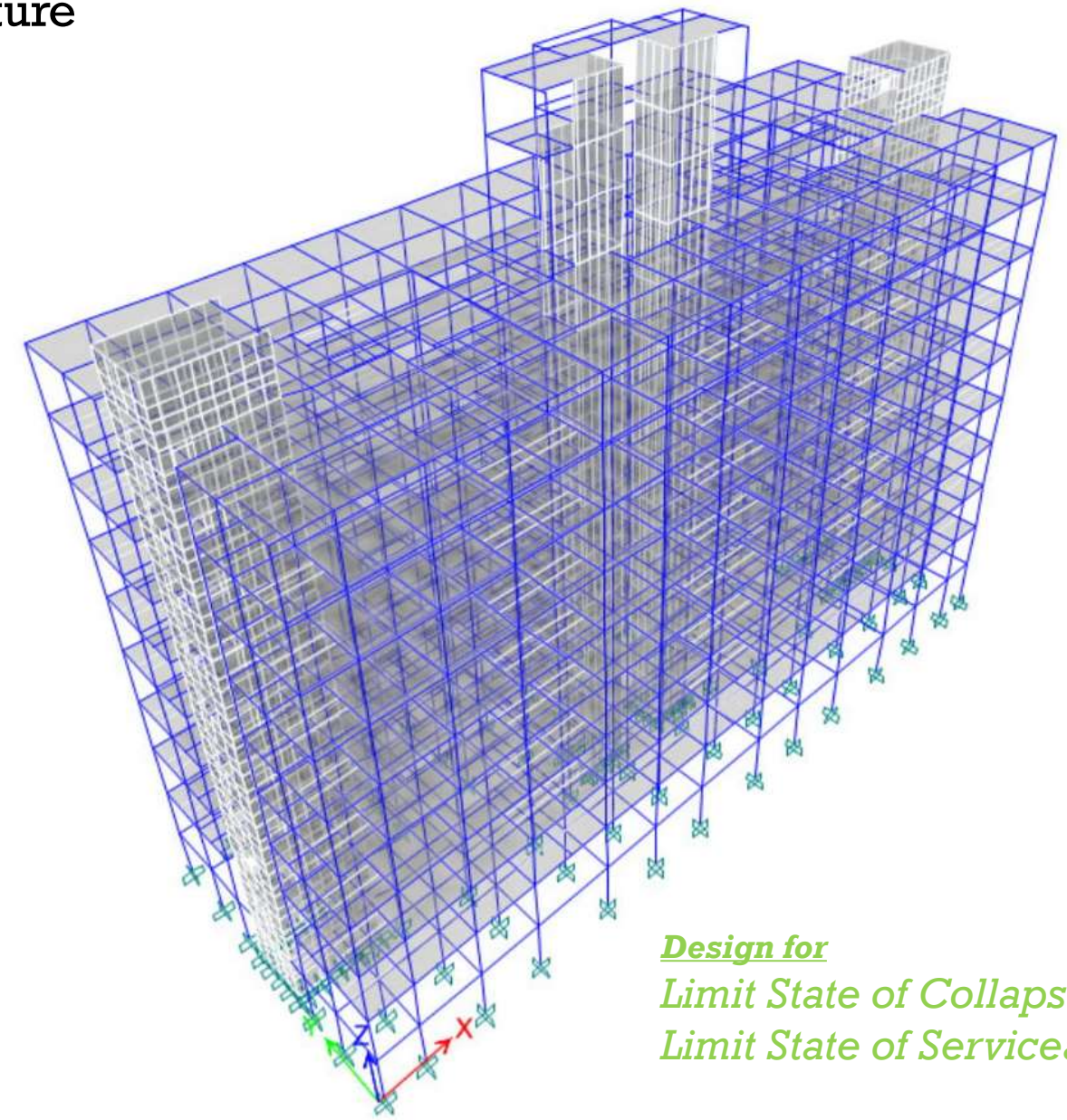
Design Standards

Foundation

Is 1080 : 1985 (reaffirmed 2016)	Code of practice for design and construction of shallow foundations om soils (other than raft, ring and shell)
Is 1904 : 1986 (reaffirmed 2015)	Code of practice for design and construction of foundations in soils: general requirements
Is 2950 : part 1 : 1981 (reaffirmed 2018)	Code of practice for design and construction of raft foundations - part 1 : design
Is 2974 : part 5 : 1987 (reaffirmed 2018)	Code of practice for design and construction of machine:foundations part 5 foundations for impact machines other than hammers (forging and stamping press, pig breakers, drop crusher and jolter)
Is 8009 : part 2 : 1980 (reaffirmed 2015)	Code of practice for calculation of settlement of foundations: part 2 deep foundations subjected to symmetrical static vertical loading

STRUCTURAL ANALYSIS & DESIGN

- 3D Model of typical tower with PEB Structure



- Load Combinations :
  - 1.5 (DL+LL)
  - 1.2 (DL+LL±EL/WL)
  - 1.5 (DL±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 for drawings

Design for

Limit State of Collapse

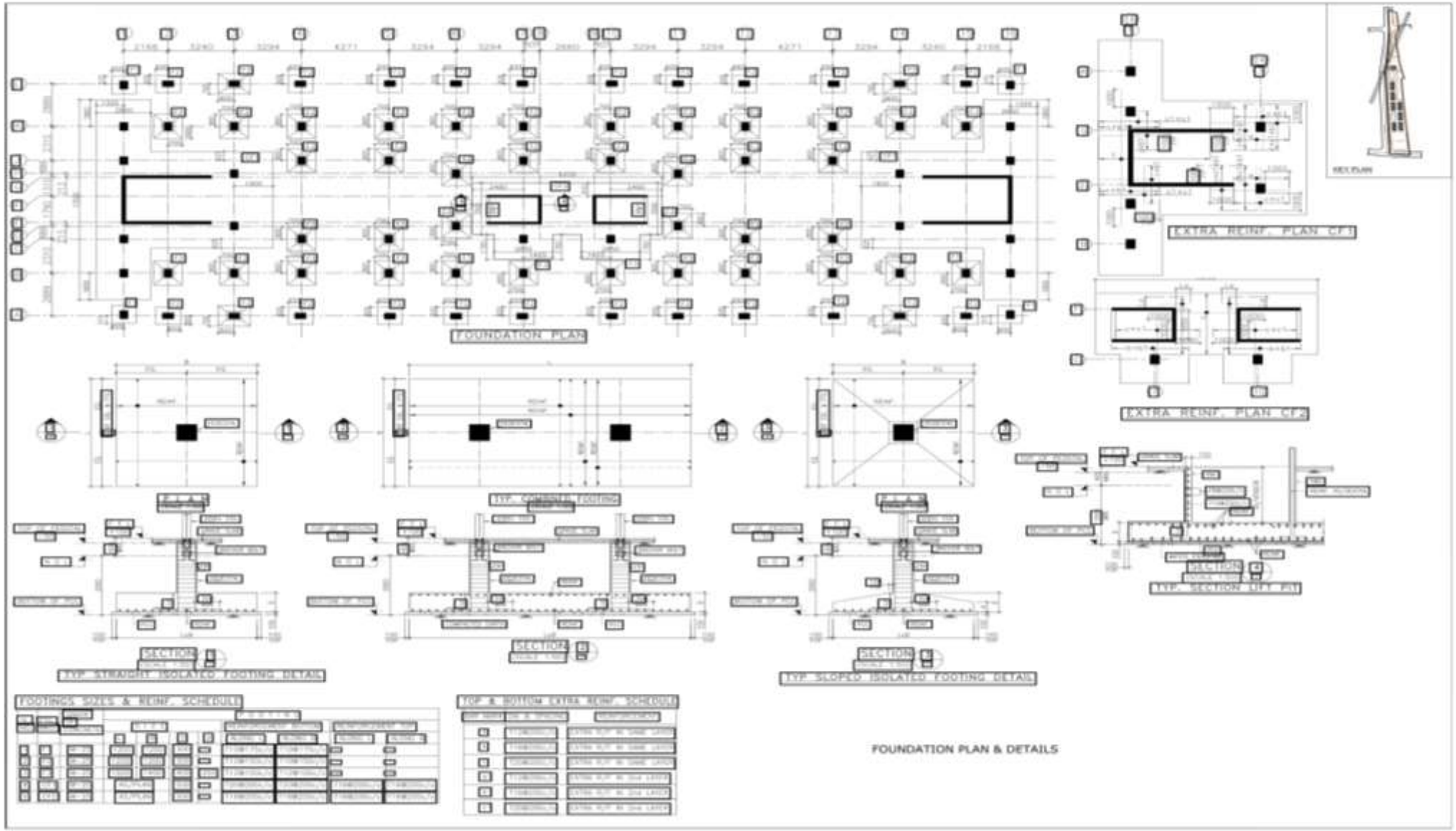
Limit State of Serviceability

Construction Sequence

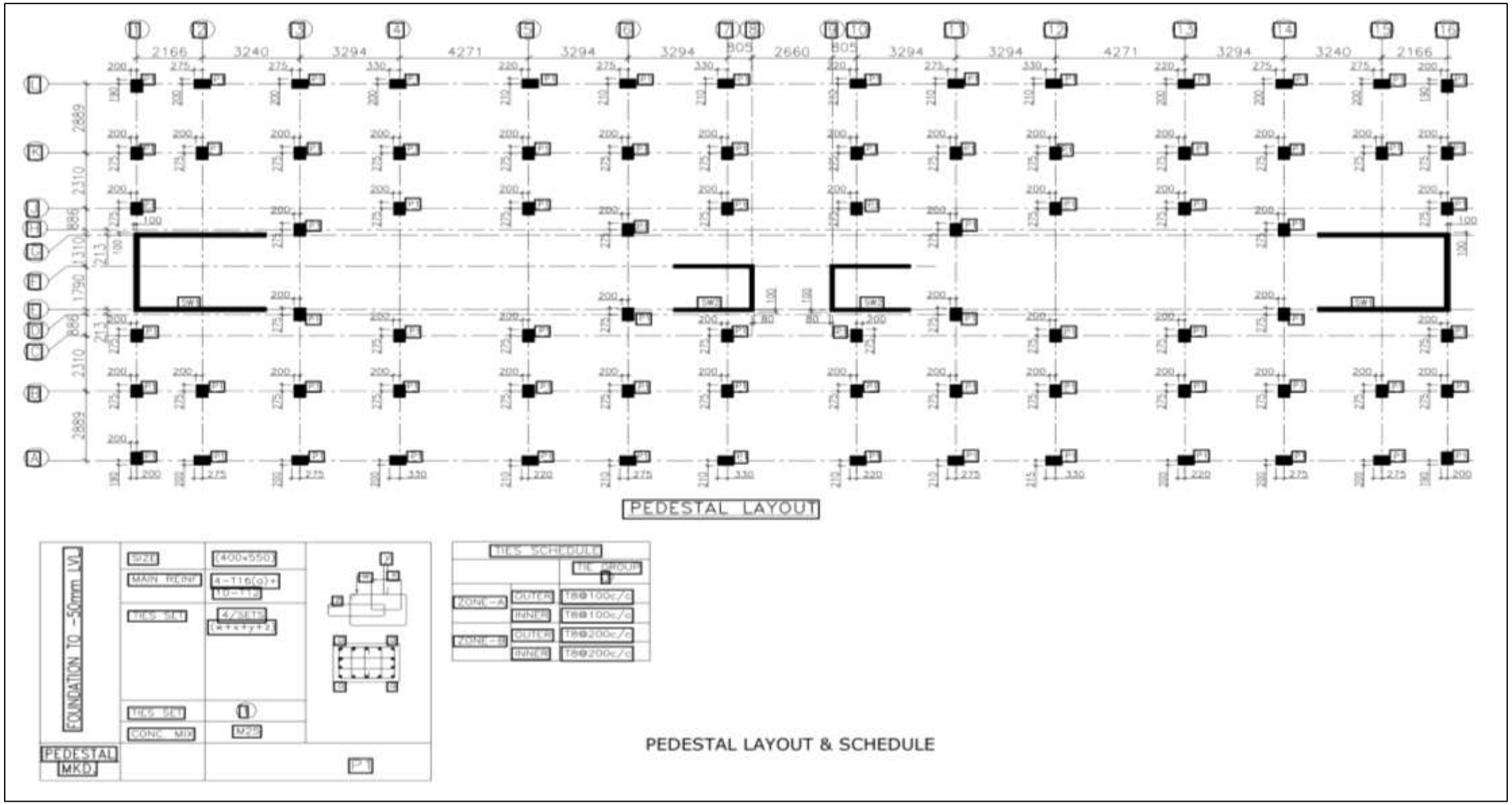
- Sub-Structure: Foundation
- Super-structure: Structural system
  Floors
  Wall Panels
- MEP: Plumbing & Electrical
- Finishing

FOUNDATION

Structural Drawings

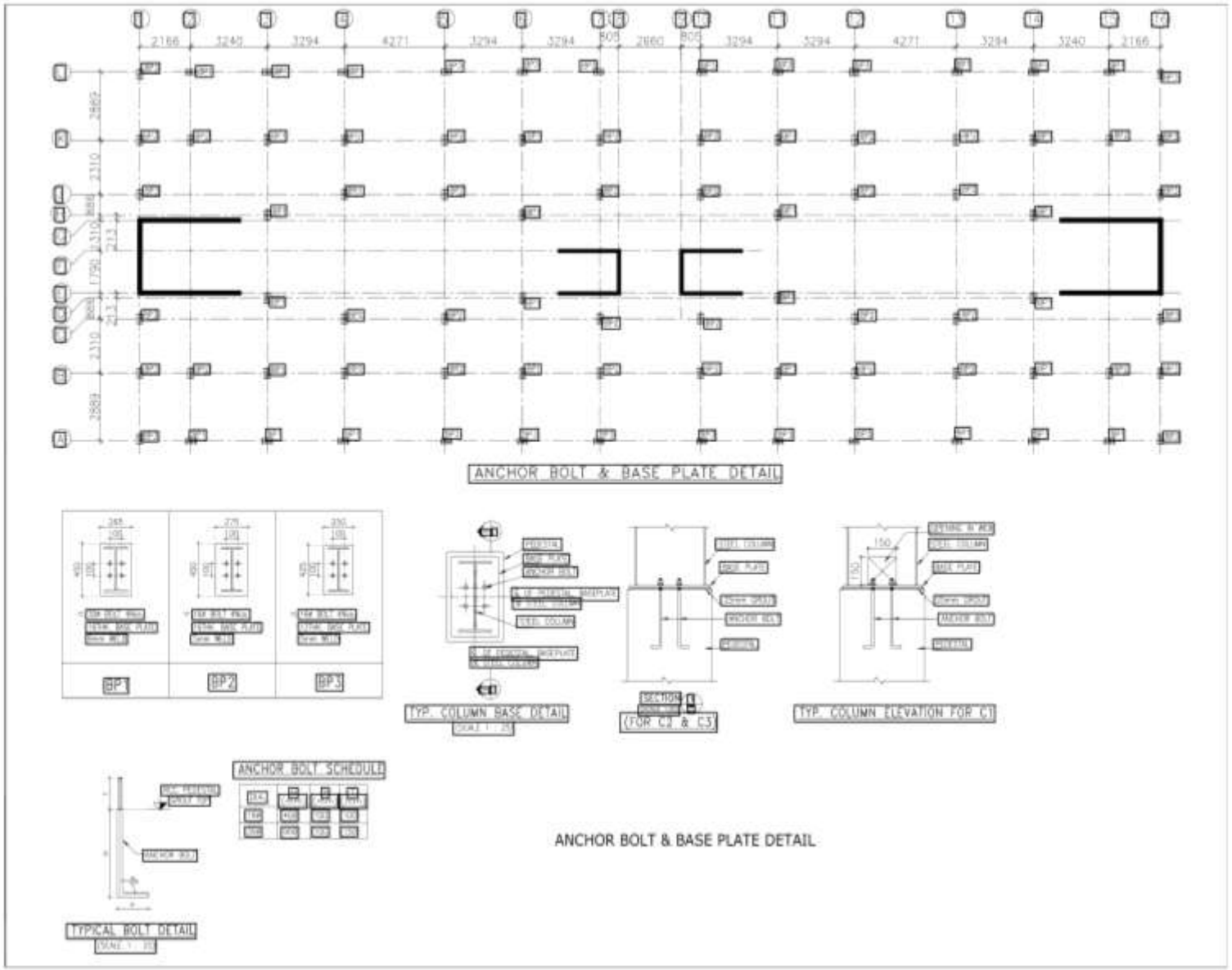


Structural Drawings



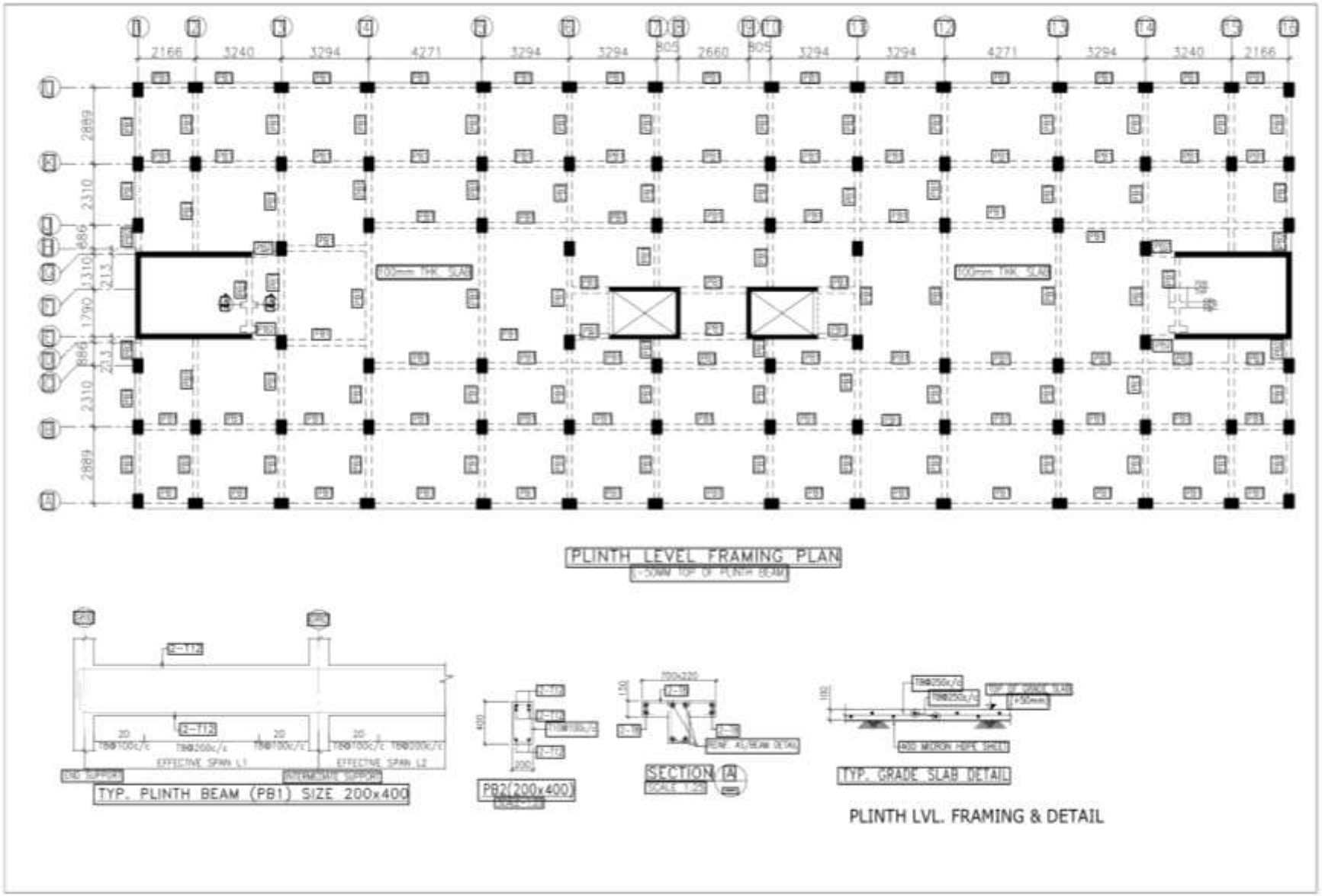
FOUNDATION

Structural Drawings



FOUNDATION

Structural Drawings



FOUNDATION

Concrete & Reinforcement Steel Specifications

Item	Concrete Grade
Isolated and combined RCC footing, Raft foundation, Plinth beam, Grade slab, Column up to Plinth level Shear walls, 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 (SGSIT, INDORE)

▪ Cement : Sand : Coarse Aggregate	:	1:2.2:3.5 by weight
▪ Water Cement Ratio W/C	:	0.45 by weight
▪ Aggregate Cement Ratio A/C	:	5.7:1 by weight
▪ % Coarse Aggregate in Total Corse Aggregate	:	50% (20 mm) 50% (10 mm)
▪ Consumption of Cement	:	350 Kg per cum of concrete
▪ Consumption of Plasticizer	:	1% by weight of cement
▪ Type of Cement	:	JK Cement (PPC)
▪ Type of Sand	:	Crushed Stone Sand
▪ Type of Aggregate	:	Angular
▪ Type of Plasticizer	:	Endura Flowcon 642

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.

FOUNDATION

- The project starts with layout and excavation.
- After the layout at site, the excavation of each block is done using mechanical excavators up to the required depth of foundation which is 2.0 m for each block.

FOUNDATION

- The foundation work starts with the PCC of 100 mm thickness (M10 Grade).

FOUNDATION

- Reinforcement and shuttering for Isolated and combined footings

FOUNDATION

- All building blocks has isolated & combined footings as per the structural design with M25 Concrete. The raft foundation with thickness of 500 mm has been constructed around staircase and lift well. All lift and staircase wells are provided with kota stone for water proofing

FOUNDATION

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

FOUNDATION

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

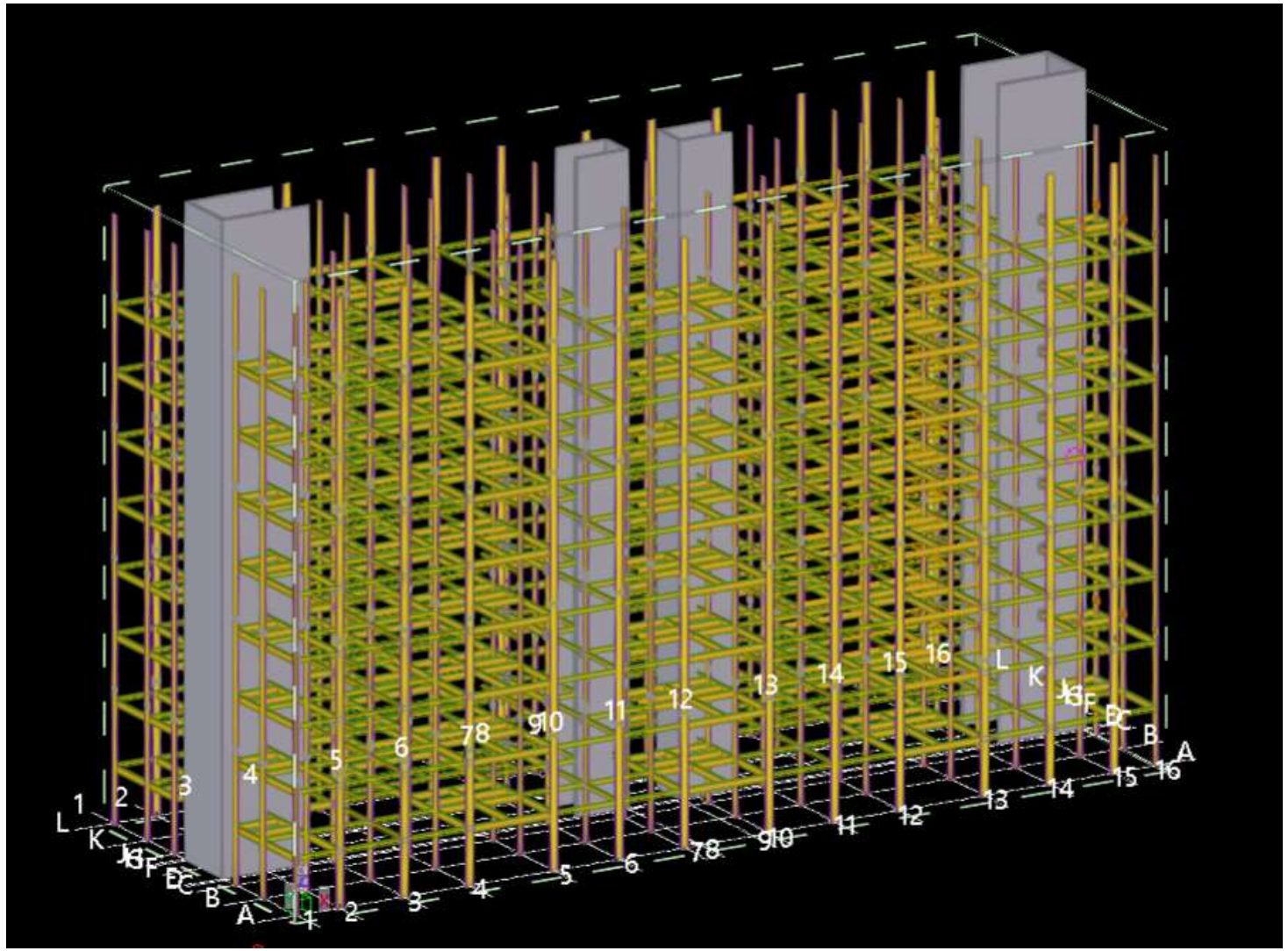
FOUNDATION

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

FOUNDATION

- Plinth beam shuttering work along with reinforcement cage

STRUCTURAL SYSTEM

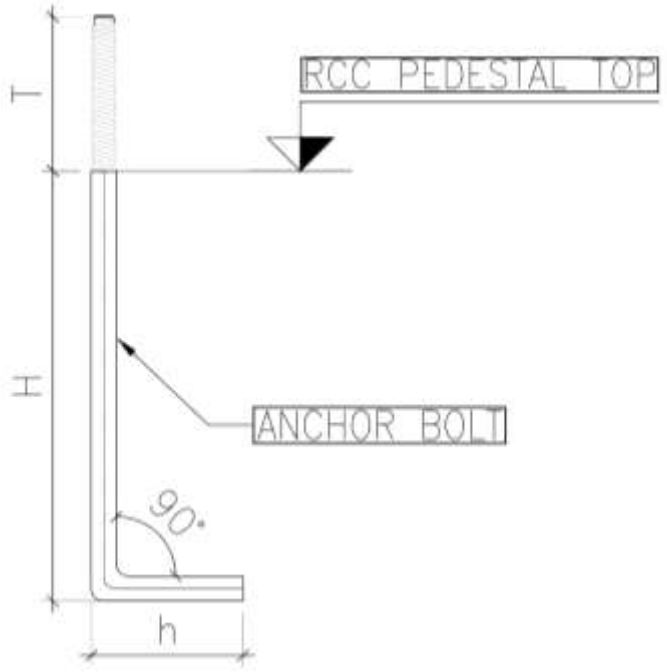


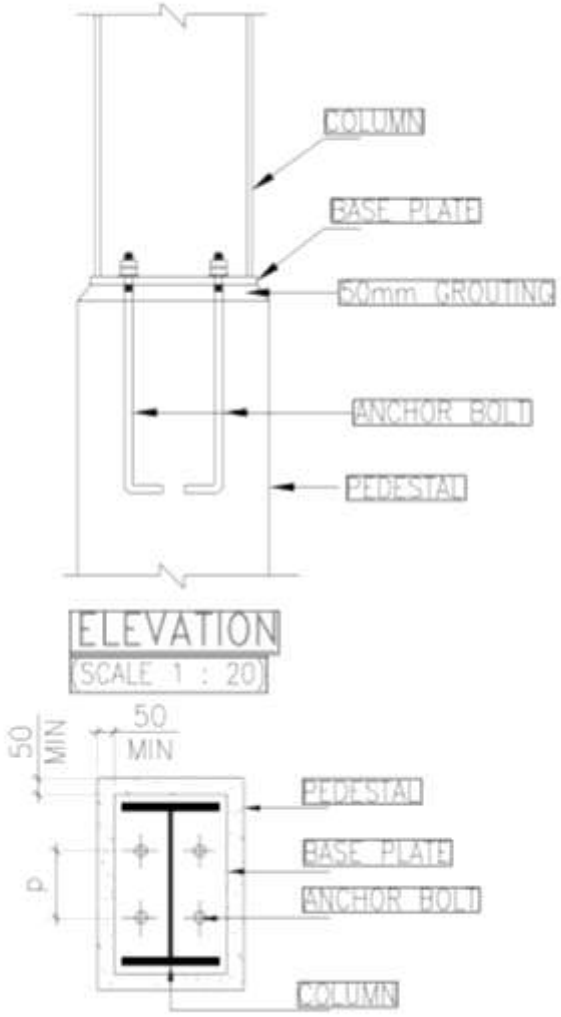
In the present lecture, the structural system and other details are being explained through drawings, sketches and text.

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

STRUCTURAL SYSTEM

- 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
30	900	100	150

Anchor bolt schedule

a) Typical anchor bolt detail

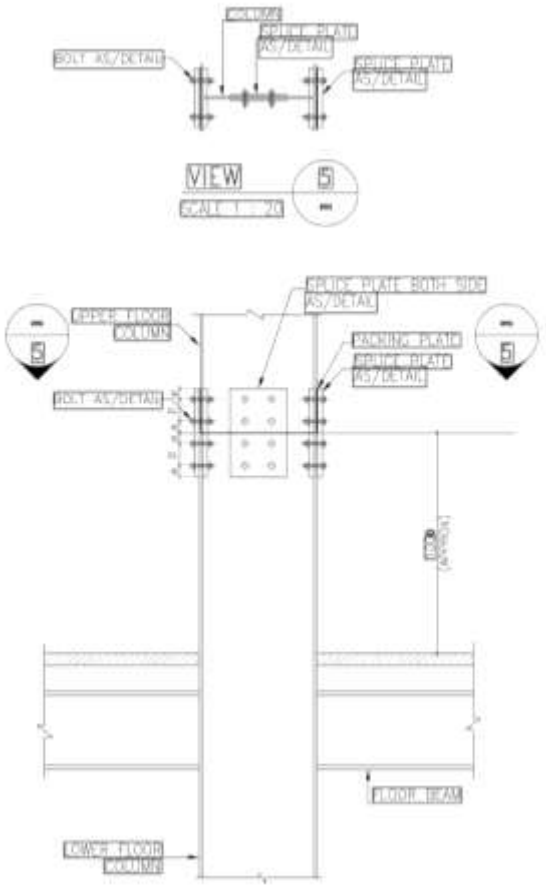
Anchor bolt is inserted below plinth level upto height H and projected above plinth up to height T

b) Typical base plate detail

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

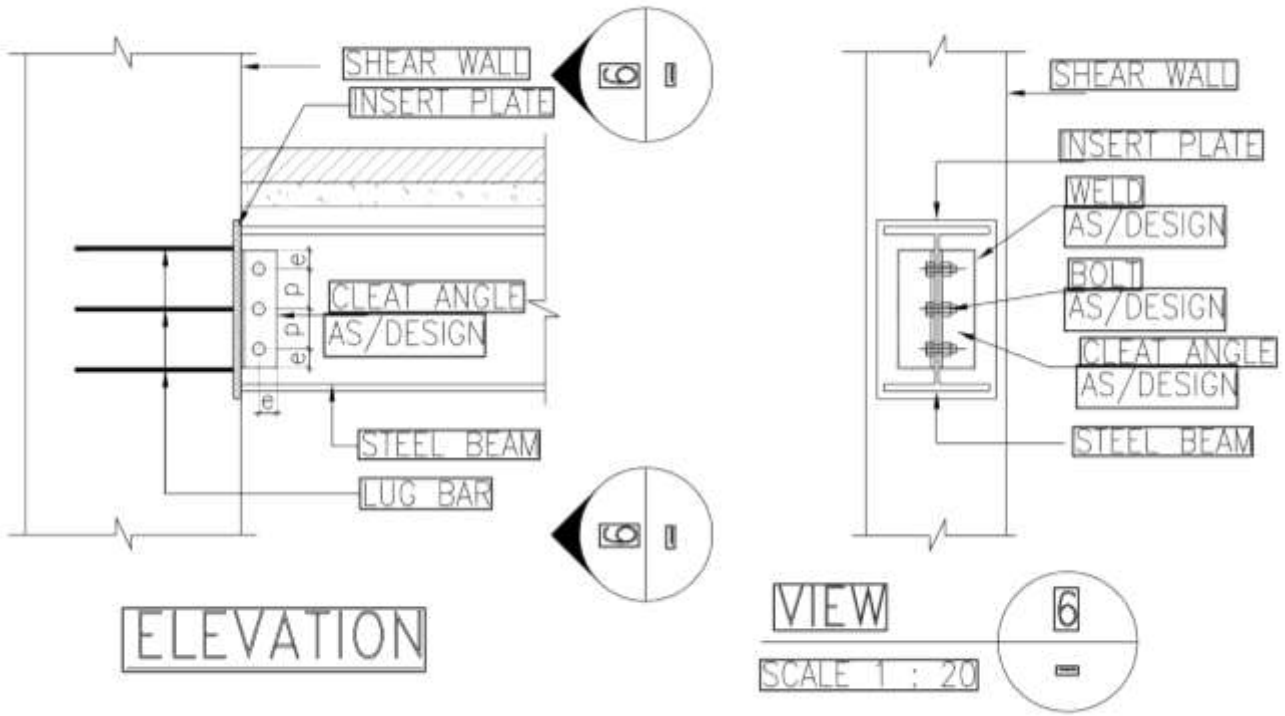
STRUCTURAL SYSTEM

- Column-Column Connections



a) Column Splice detail

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



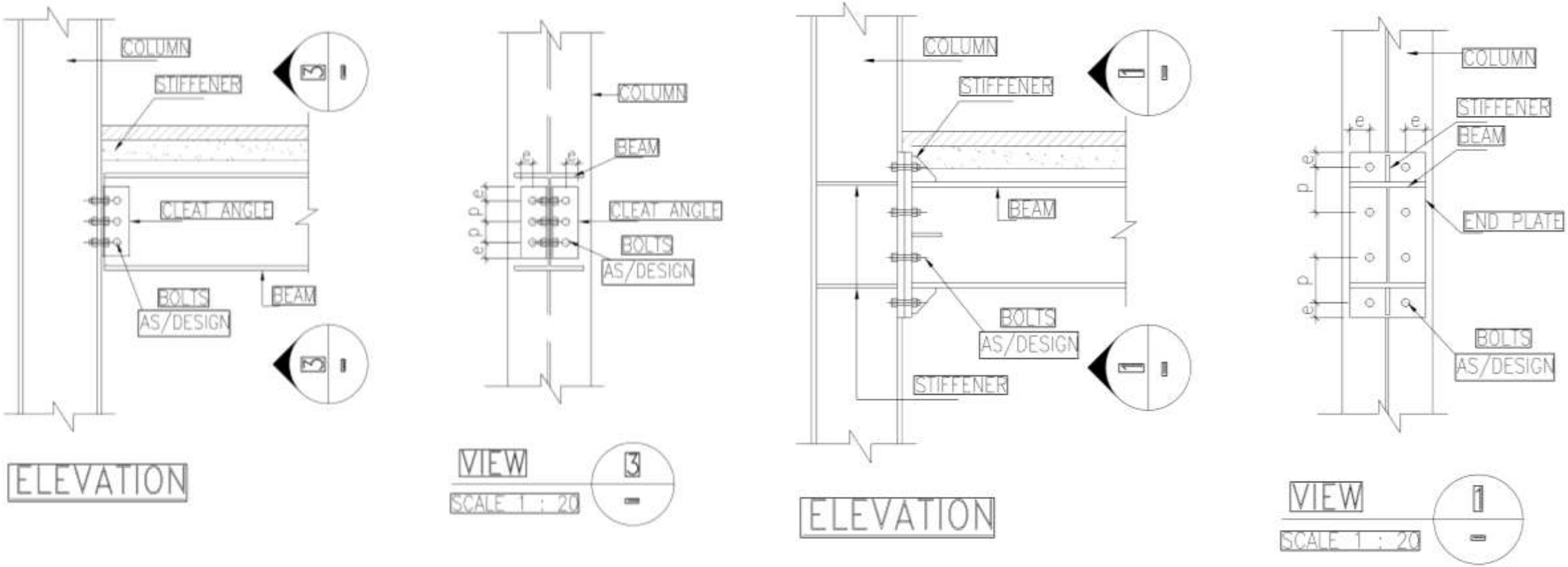
b) Shear wall to steel beam connection

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

A typical length of column being fabricated for the project is of 6m.

STRUCTURAL SYSTEM

- Typical beam column shear and moment connections



a) 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

b) Typical beam to column flange moment connection

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

STRUCTURAL SYSTEM

Structural Steel Material Specifications & other important considerations

- Fabrication and erection of structural steel Built-up I Section shall conform to the Section 17 of IS 800-2007 & IS 7205-1974.
- Tolerance for fabrication of steel structures shall conform to IS 7215 & tolerance for erection of steel structures shall conform to IS 12843.
- All material quality, testing, surface condition, protective treatment and other specifications shall comply with section 17 of IS 800-2007, IS 2062-2011
- All rolled/plate fabricated sections/connections plates shall be of yield strength of 345 MPa confirming to IS 2062-2011.
- All connection plates and base shall be of yield strength of 345MPa confirming to IS 2062-2011.
- Anchor/holding down bolts shall be of grade 4.6 FY=250MPa, MS black steel confirming to IS 5624-1993.
- High strength bolts shall be grade 8.8 in accordance with IS 1367-part III. Hole size shall be as following :
  - For bolts upto 24mm diameter -2mm greater than the bolt diameter
  - For bolts greater than 24mm diameter -3mm greater than the bolt diameter.

STRUCTURAL SYSTEM

Structural Steel Material Specifications & other important considerations

- For ordinary bolts connected parts shall be firmly drawn together if there is remaining gap which may affect the integrity of the joint, it shall be taken apart and a pack inserted.
- Welding shall be sub-merged ARC welding in accordance with IS 4353-1995
- Joints shall be prepared in accordance with IS 814-2004. Precautions shall be taken to ensure cleanliness of the connection prior to welding.
- For welding purpose use electrode 7018
- The profile metal deck shall be of grade 5350
- Provide temporary bracing or guys to provide lateral support to the structures and individual element until permanent frame is completely installed.
- Fabricated components which are stored prior to being transported or erected shall be stacked clear of the ground and arranged If possible so that water cannot accumulate. They shall be kept clean and supported in such a manner as to avoid permanent distortion.

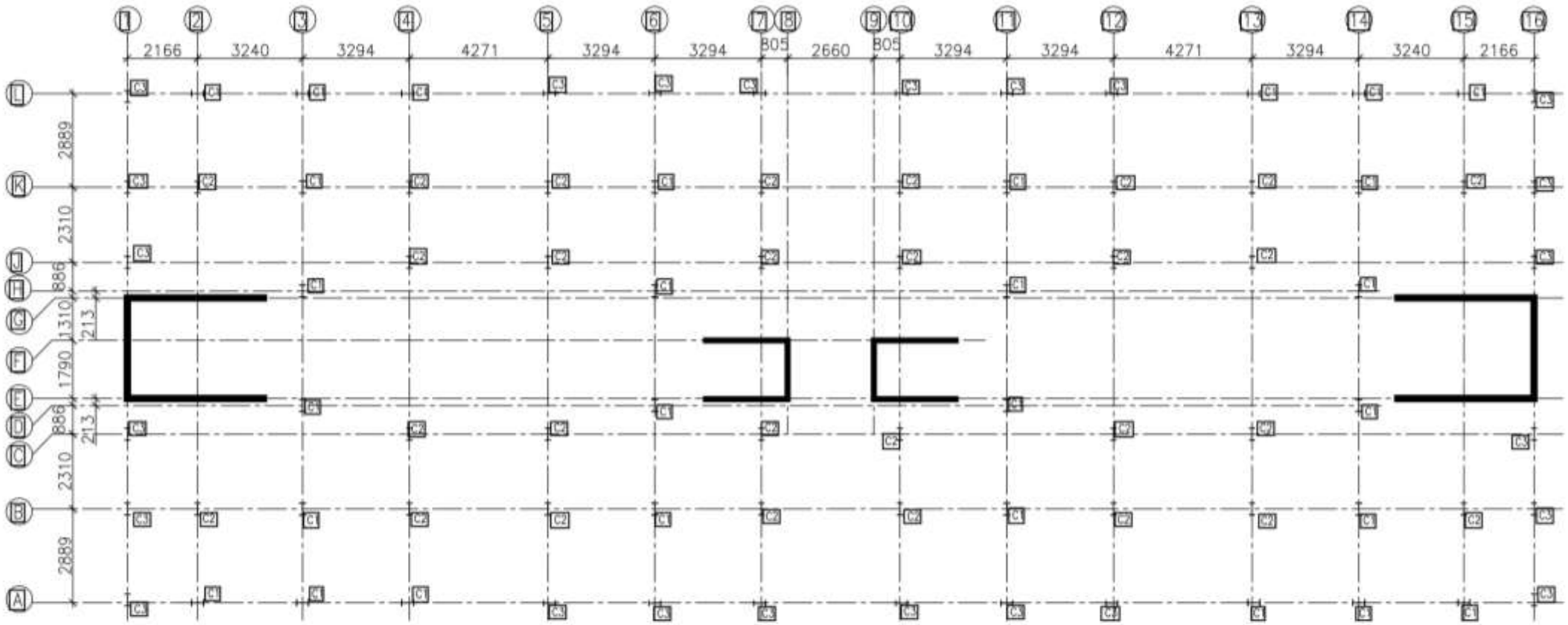
STRUCTURAL SYSTEM

Structural Steel Material Specifications & other important considerations

- Components shall be handled and stored in such a manner as to minimise the risk of surface abrasion and damage.
- Fasteners and small fittings shall be stored under cover in dry condition
- Any steel work damage during off-loading, transportation, storage or erection shall be restored to confirm to the IS 7969-1975
- Grouting shall be carried out under columns plates until a sufficient portion of the structure has been aligned, level, plumbed and adequately braced.
- Immediately before grouting, the space under column base plates shall be clean and free of all extraneous matter.
- Tensioning of high strength bolt shall be done as per clause 7.2 of IS 4000-1992 using a Torque Wrench.

STRUCTURAL SYSTEM

- Steel column layout in superstructure



STEEL COLUMN LAYOUT PLAN

STEEL COLUMN SCHEDULE

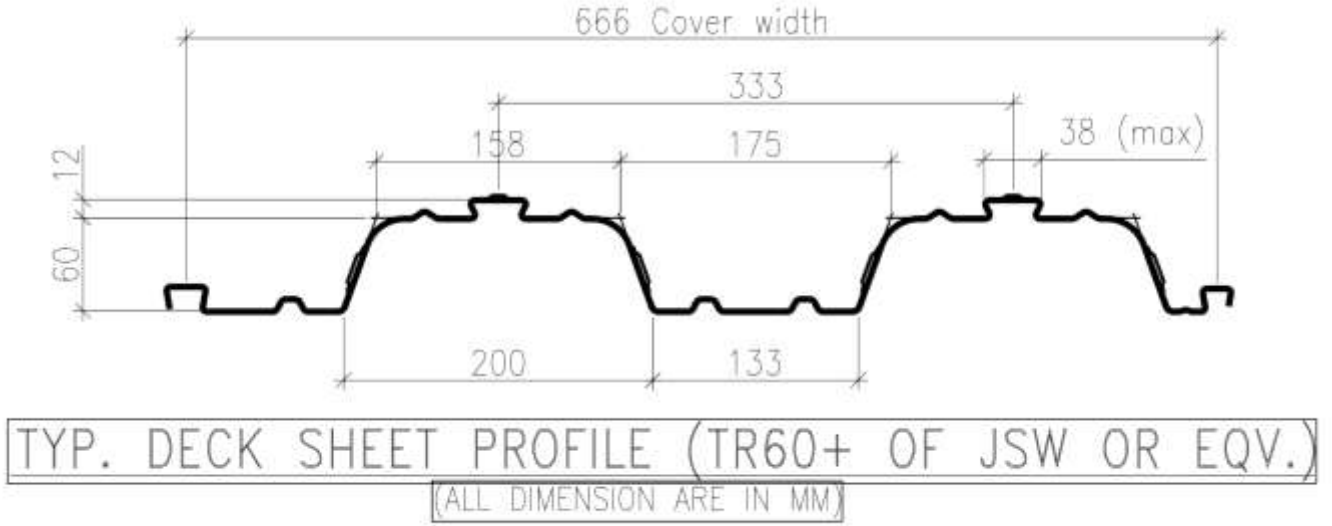
COL. MKG.	STILT TO 2ND FLOOR		2ND FLOOR TO 4TH FLOOR		4TH FLOOR TO 6TH FLOOR		6TH FLOOR TO TERMINATION	
	WEB	FLANGE	WEB	FLANGE	WEB	FLANGE	WEB	FLANGE
C1	350x10	200x16	350x10	175x16	350x8	175x16	350x8	175x16
C2	350x8	175x12	350x8	175x10	350x6	175x10	350x6	175x10
C3	350x6	175x10	350x6	175x10	350x6	175x10	350x6	175x10

STEEL COLUMN LAYOUT PLAN

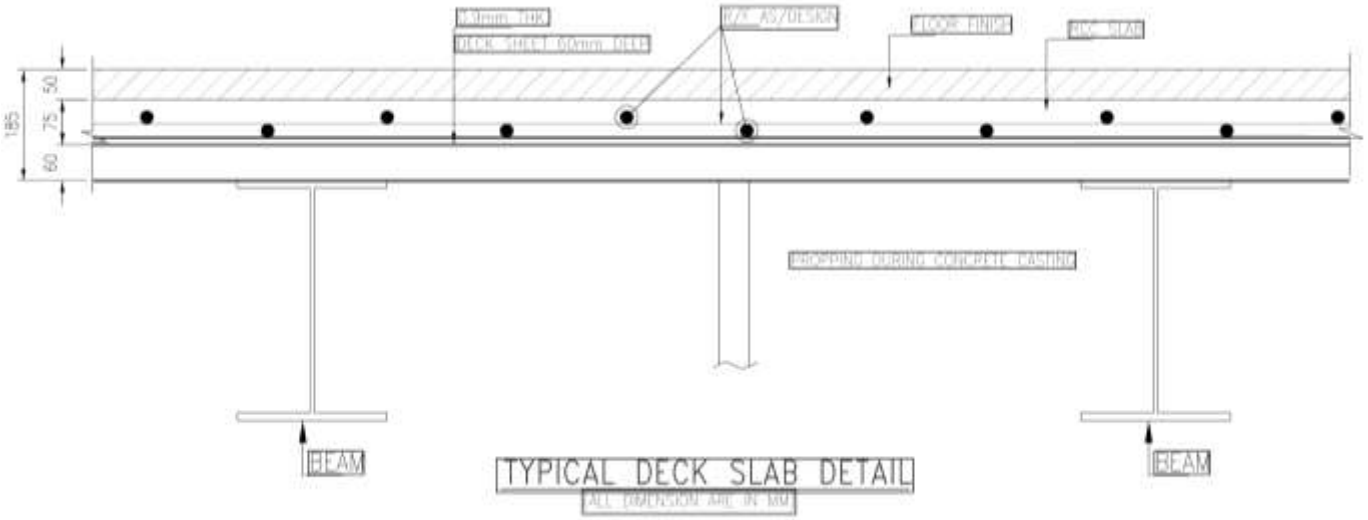
FLOORS

- 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.



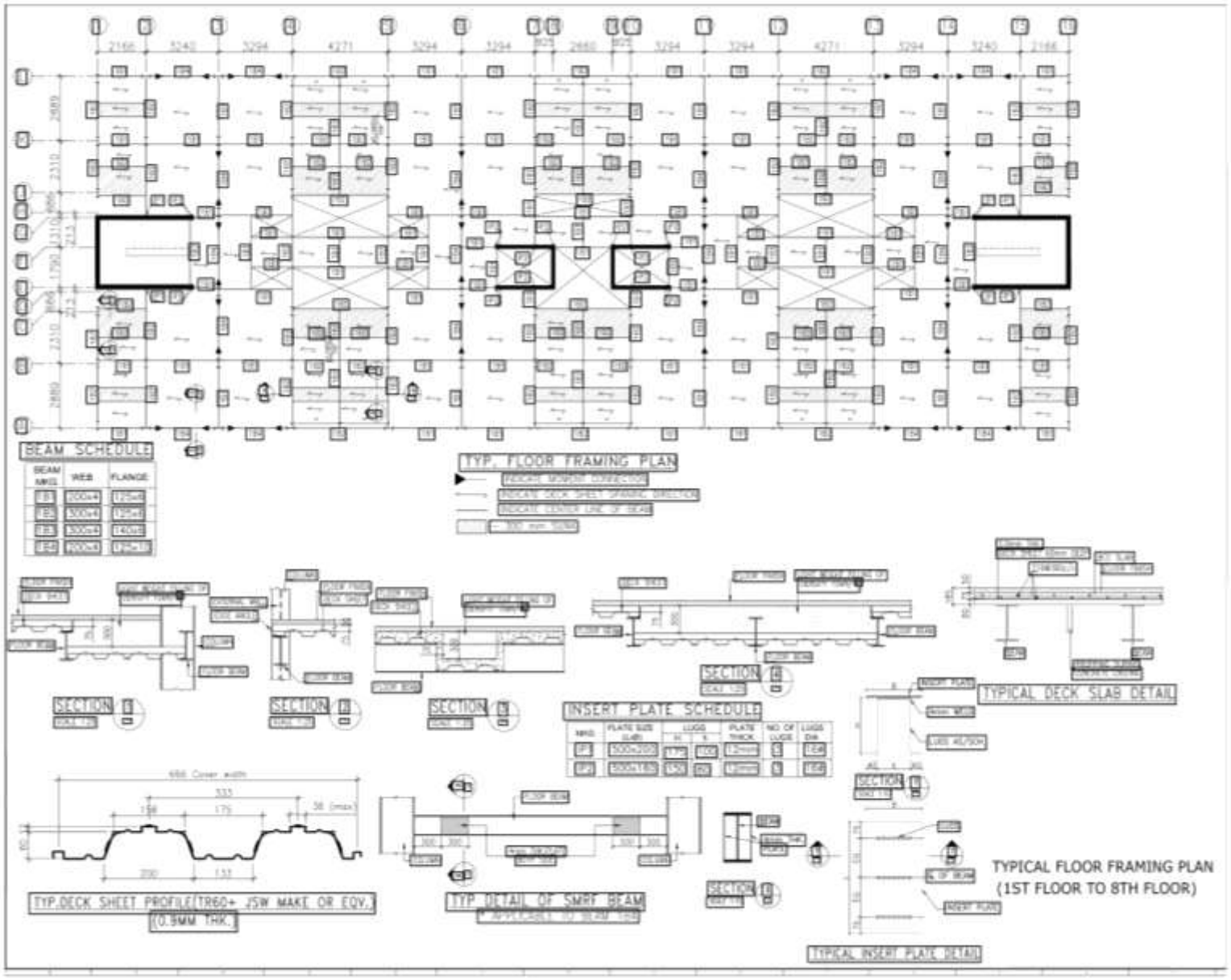
a) Typical deck sheet profile



b) typical deck slab detail

FLOORS

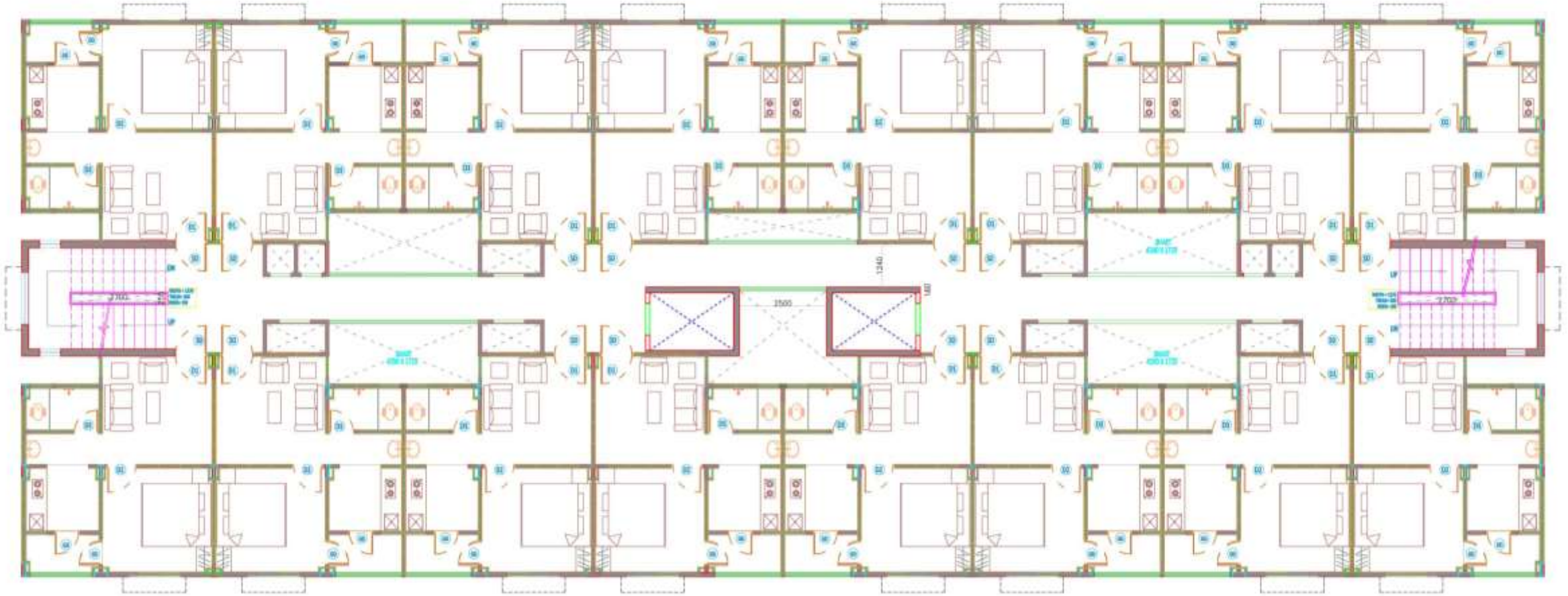
- Typical Floor Framing Plan



Wall Panels

A Typical plan of laying of panels with Steel Frame structure

Structural integrity and monolithic behavior of wall and structural frame is achieved in this technology through dowel bars.



Wall Panels

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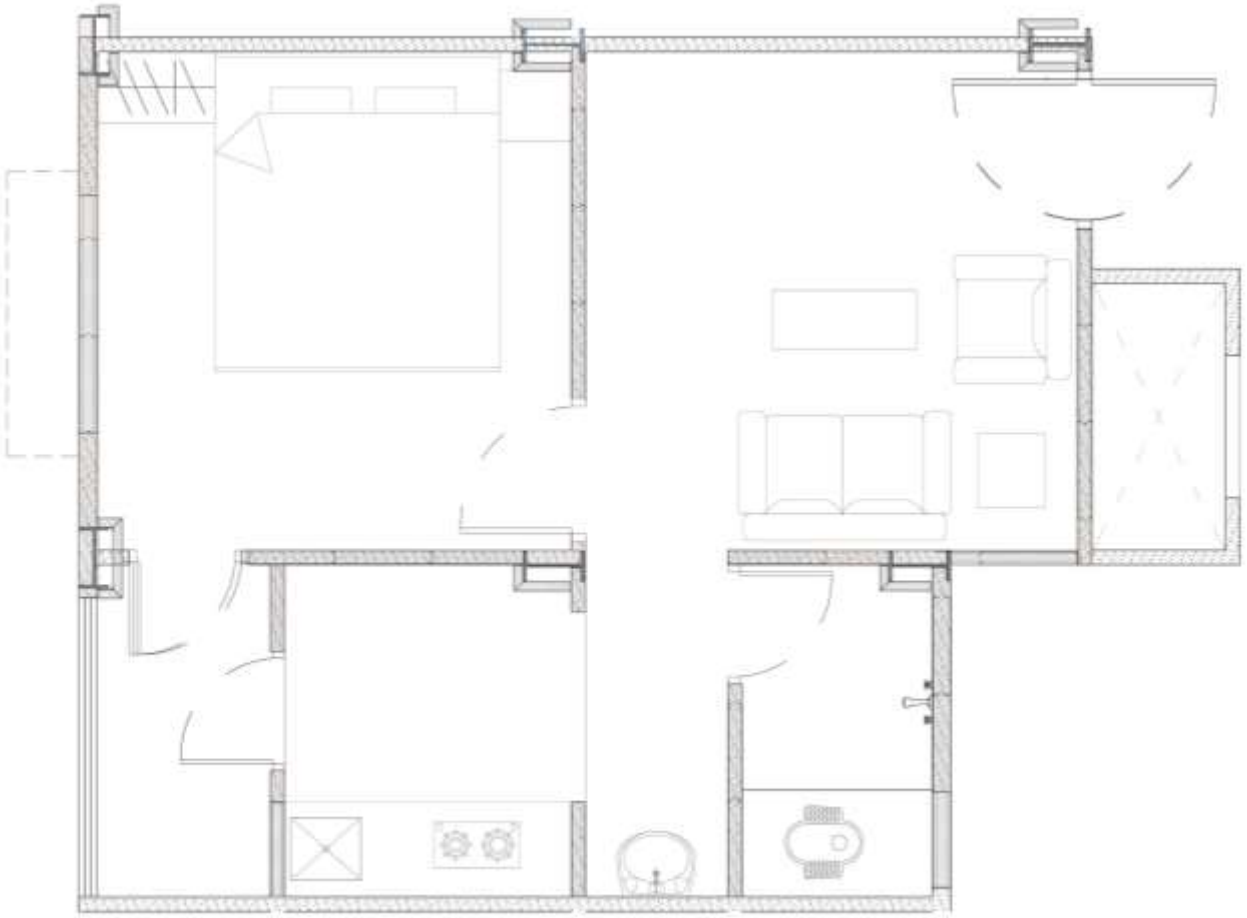
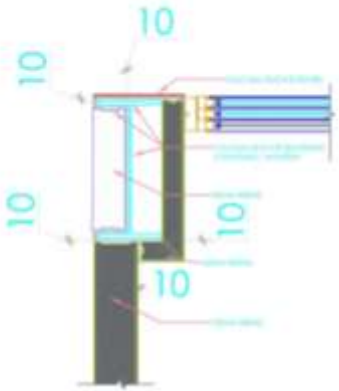
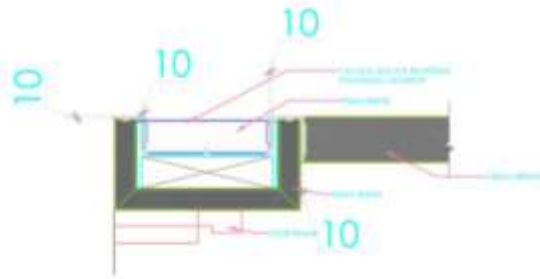


Corner detail



Mid Corner detail



WALL PANELS

Construction & Installation Process with Prefabricated Sandwich Panel System in the LHP

Construction is done in a following sequential manner:

1. Transportation of Prefabricated sandwich panels 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. Fixing of sandwich wall panels on floor with U channel, once the structural frame and floor is installed and aligned.
5. Erection of panels in plumb position, jointing of two panels with steel dowels at 45 degree. Fixing of panels with the steel beams and columns with the help steel dowels.
6. Filling of joints between two panels with the help of exterior grade superfine ready mix plaster.
7. Any crack fibre tape is paste on the joints with the help of putty.
8. For fixing electrical and plumbing services, grooves are made with the help of chisel , fix pipes and fittings and then filled with exterior grade superfine ready mix plaster
9. Upon installment of wall panels, flooring and ceiling, the finishing work is executed.

Wall Panels

- Typical view of Prefabricated sandwich panels and steel frame construction

MEP

- The plumbing and electrical services are incorporated as done in conventional method of construction i.e. chasing and filling

FINISHING ITEMS

- 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 Pipe Line,
- 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 Waste Management.

- A few completed buildings with the Prefabricated sandwich Panels abroad

PROGRESS TILL DATE

LHP, INDORE


Foundation


Foundation

Casting of plinth beam


Plinth beam and shear wall casting

Erection of steel coloumns

Erection of steel beams

Erection of steel coloumns & beams

Placing of deck slab and reinforcement

Screed concrete on deck slab

Fixing of Prefabricated sandwich panels

A view of block with Prefabricated sandwich panels

Fixing of gypsum board false ceiling

A view of block with shear wall and PEB structure

A view of blocks with shear wall and PEB structure

View of LHP project site

Live status of LHP site can be accessed at

https://ghtc-india.gov.in

CONTACT US:

Ministry of Housing and Urban Affairs,
Maulana Azad Road, Nirman Bhawan,
New Delhi - 110011
E-Mail: ghtc-mhua@gov.in /
ska@bmtpc.org
Call Us at: +91-11-23063266