प्रधान मंत्री आवास योजना-शहरी

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत

LIGHT HOUSE PROJECT AT RANCHI

GHTC-India Category

Precast Concrete Construction - 3D Volumetric

Technology

3D Modular Precast Magic Pods

CONTENTS

GLOBAL HOUSING TECHNOLOGY CHALLENGE INDIA

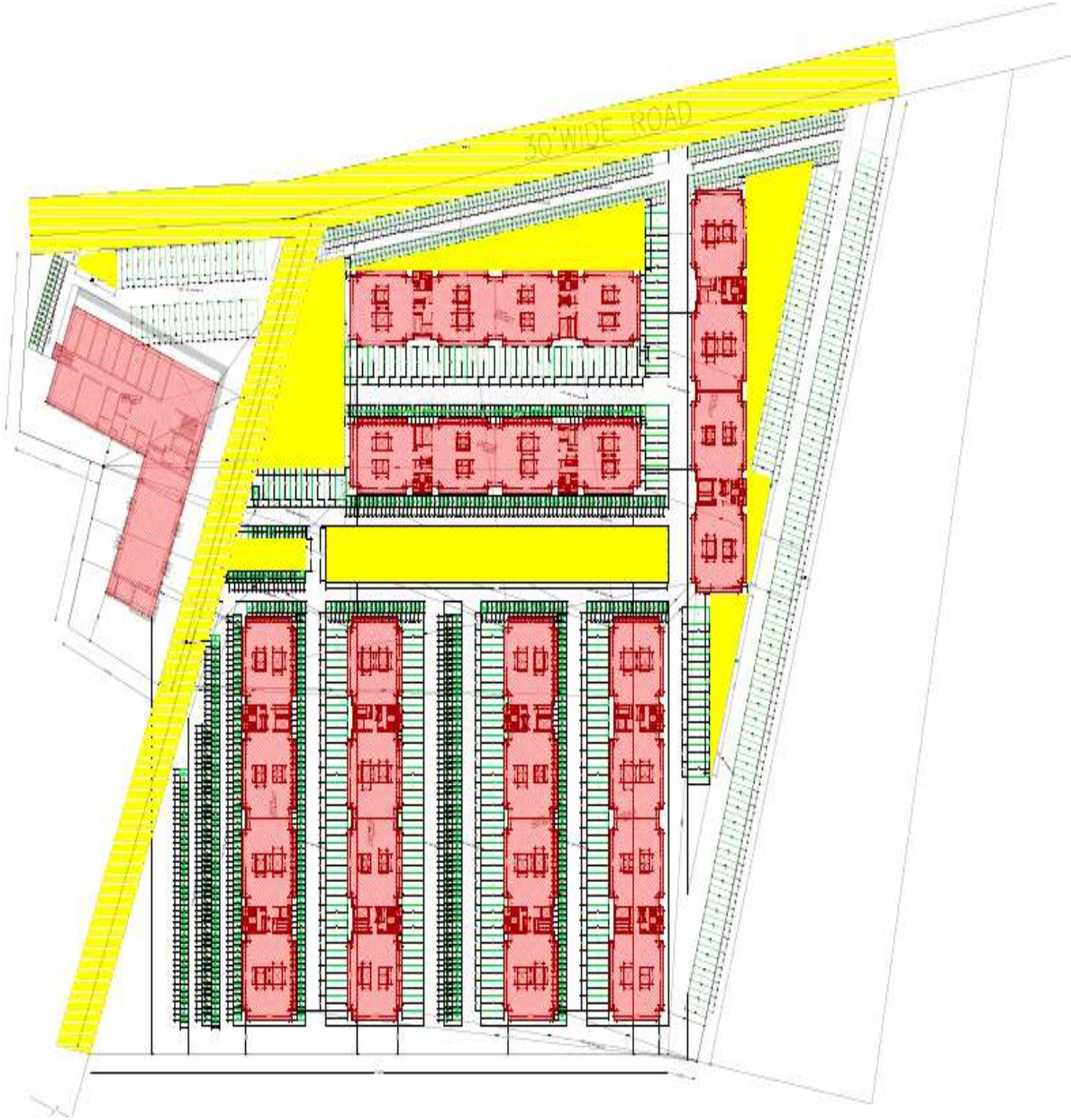
Global Housing Technology Challenge - India (GHTC-I)

Broad Category	*Technologies (Nos.)*
Precast Concrete Construction System - 3D Precast volumetric	4
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 (Tamil Nadu)	Rajkot (Gujarat)	Indore (Madhya Pradesh)	Ranchi (Jharkhand)	Agartala (Tripura)	Lucknow (Uttar Pradesh)
Sl. No	**Particulars**	**Units**						
1	Name of Technology	Name	Precast Concrete Construction System- Precast Components	Monolithic Concrete Construction using Tunnel Formwork	Prefabricated Sandwich Panel System	Precast Concrete Construction System – 3D Volumetric	Light Gauge Steel Frame System (LGSF) with Pre-Engineered Steel Structural System	Stay in Place Formwork System
2	No. of Houses	No.	1,152	1,144	1,024	1,008	1,000	1,040
3	No. of Floors	No.	G+5	S+13	S+8	G+8	G+6	S+13
4	Plot Area	Sqm	33,596	39,599	41,920	31,160	24,000	20,000
5	Per House Carpet Area	Sqm	26.58	39.77	29.04	29.85	30.00	34.50
6	Project Cost	INR (in Cr)	116.27	118.90	128.00	134.00	162.50	130.90
7	Per House cost (with infrastructure)	INR (in Lakh)	10.09	10.39	12.50	13.29	16.25	12.58

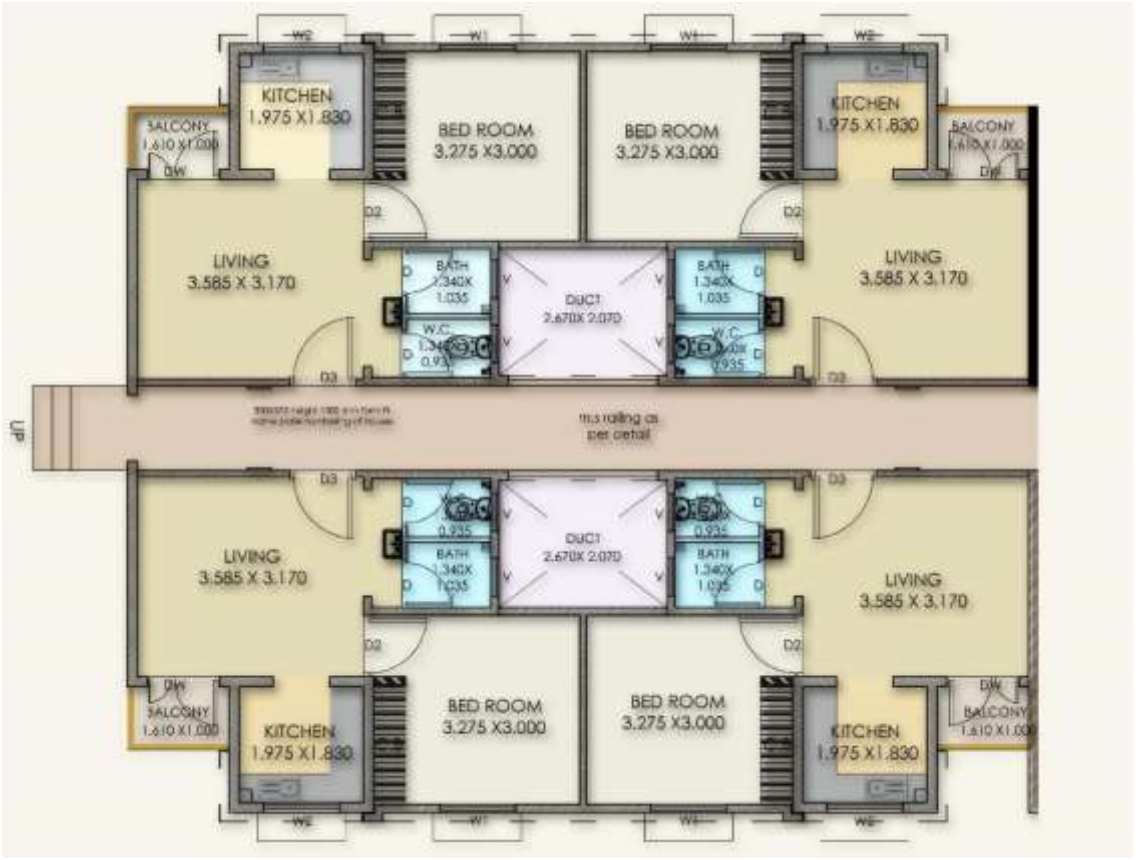
- There are 7 blocks in Ground + 8 configuration with 1008 houses along with basic and social infrastructure.
- Ground coverage of the project is 29.3% and FAR is 2.21.
- Green space is 20%.



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 hall, one bed room, a kitchen, WC, Bath and a balcony. The carpet area of each unit is 30.27 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 System conforming to NBC

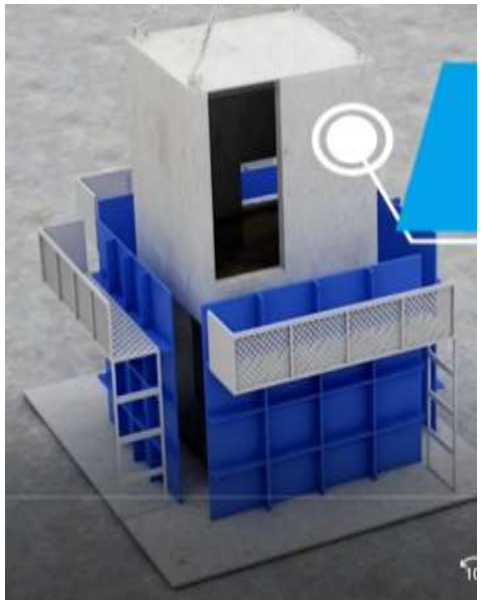
Prevalent Construction Systems

Technology being Used

Load bearing Structure

RCC Framed Structure

Precast Concrete Construction - 3D Volumetric



It is the modern method of building by which precast concrete structural modules like room, toilet, kitchen, bathroom, stairs etc. & any combination of these are cast monolithically in Plant or Casting yard in a controlled condition.

These Modules transported, erected & installed using cranes and are integrated together in the form of complete building unit.

Structural Elements

- Foundation
- Structural System comprising of 3D modules, walling panels & solid core pre-stressed slab

Foundation

- Conventional as per geo-technical investigations, bearing capacity, soil strata, water table, etc.
- Raft foundation with RCC shear wall upto plinth level.
- Grade slab at plinth level.

Structural system

Manufacturing of structural modules

- 3D Steel Moulds are created as suiting to various sizes of Building units (Pods).
- High strength steel as per the structural design is placed inside 3D moulds.
- Electrical and plumbing lines are set up. Block outs for doors and windows are also set up at the same time.
- The pods are cast into their final shape using high-performance concrete.
- Strict quality checks are taken for each pod before they are transported for erection and assembly at the site.

Casting Yard at Site

Casting Yard at Site

Casting Yard at Site

Advantages of the System

- Upto 90% of the building work including finishing is complete in plant/casting yard leading to significant reduction in construction & occupancy time
- The controlled factory environment brings resource optimization, improved quality, precision & finish
- The required concrete can be designed using industrial by-products such as Fly Ash, Ground granulated blast furnace slag (GGBS), Micro silica etc. resulting in improved workability & durability, while also conserving natural resources. In this project Ground granulated blast furnace slag & silica fume is proposed in concrete.
- With smooth surface it eliminates use of plaster
- The monolithic casting of walls & floor of a building module reduces the chances of leakage
- The system has minimal material wastage (saving in material cost), helps in keeping neat & clean construction site and dust free environment
- Use of optimum quantity of water through recycling
- Use of shuttering & scaffolding materials is minimal
- All weather construction & better site organization

Structural Elements

Essential requirements

- Space for casting yard is required in addition to site for actual construction. The project is not viable if the factory is located far away. Setting up of casting yard requires time in month/(s) depending on project size & delivery schedule
- Approach road to site for movement of high capacity trailers, Cranes etc.
- Site should have space for proper leveraging & functioning of cranes
- Requires skilled labour & strict supervision
- Plumbing & electrical services need to be pre-planned

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

Agency:
M/s SGC Magicrete LLP, Mumbai

Technology Provider:
M/s Magicrete Building Solutions

Design Basis

- Structural System
  - Sub-structure up to the plinth level in Cast In-situ RCC (Raft foundation with Shear wall upto Plinth level)
  - Superstructure is designed as Shear wall system
- Safe Bearing capacity: 180 KN/m2 , depth of foundation 2.0 m
- Raft foundation as per IS:2950 (Part-1)-1981 (reaffirmed 2008)
- Wind speed: Basic wind speed (V_b=39 m/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-II as per Seismic Zoning Map of India IS: 1893 (Part-1):2016
  - Designed as shear wall system with Response Reduction Factor=3 (Table-9 iv of IS: 1893 (Part-1):2016), Z=0.1,I=1.2, R=3, Damping Ratio=5%.
  - Design Horizontal Seismic Coefficient (A_h)

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

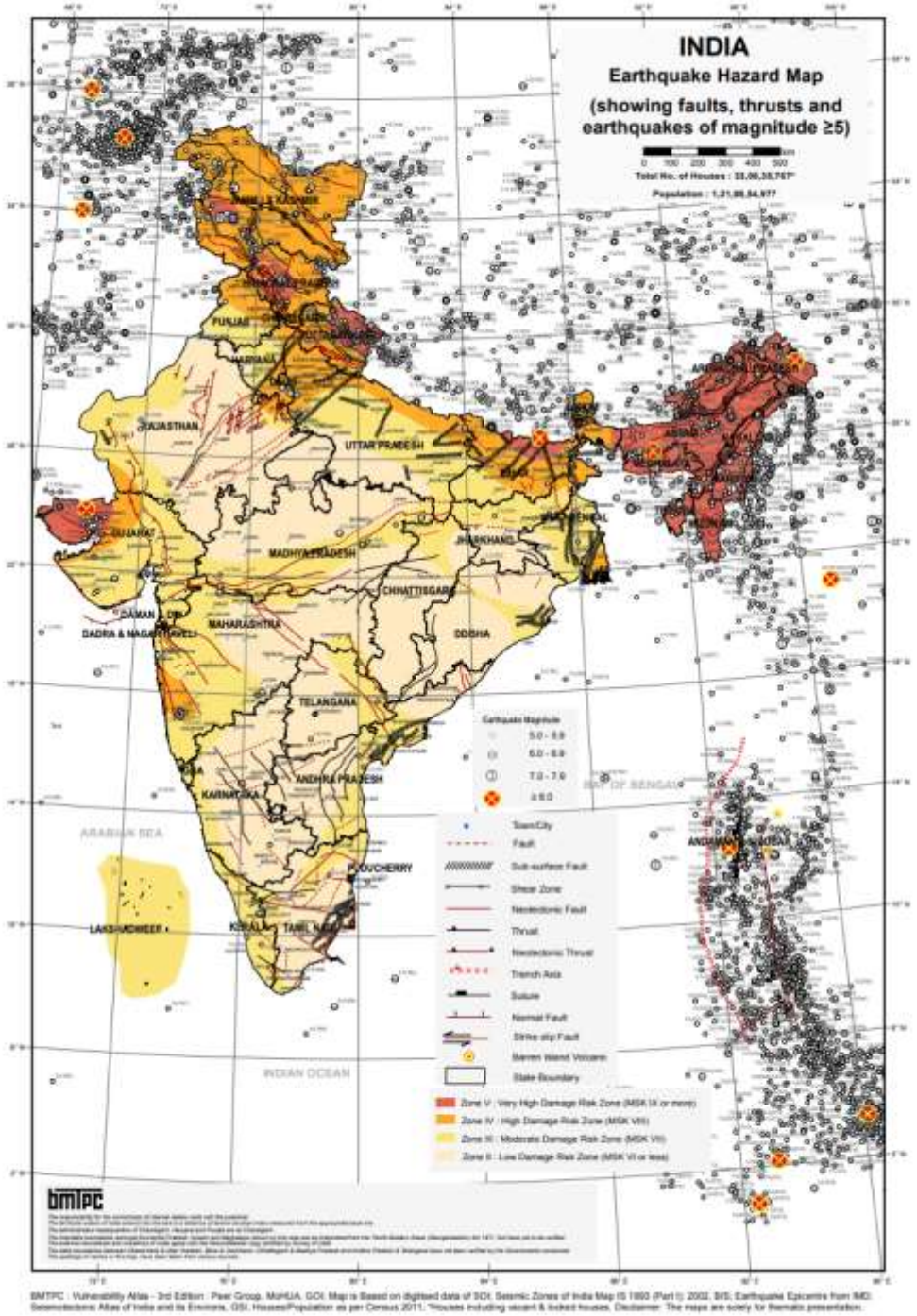
S_a/g is design acceleration coefficient for different soil types corresponding to natural period (T) of building

  - Design Lateral Force (V_B)

$$V_B=A_h.W$$

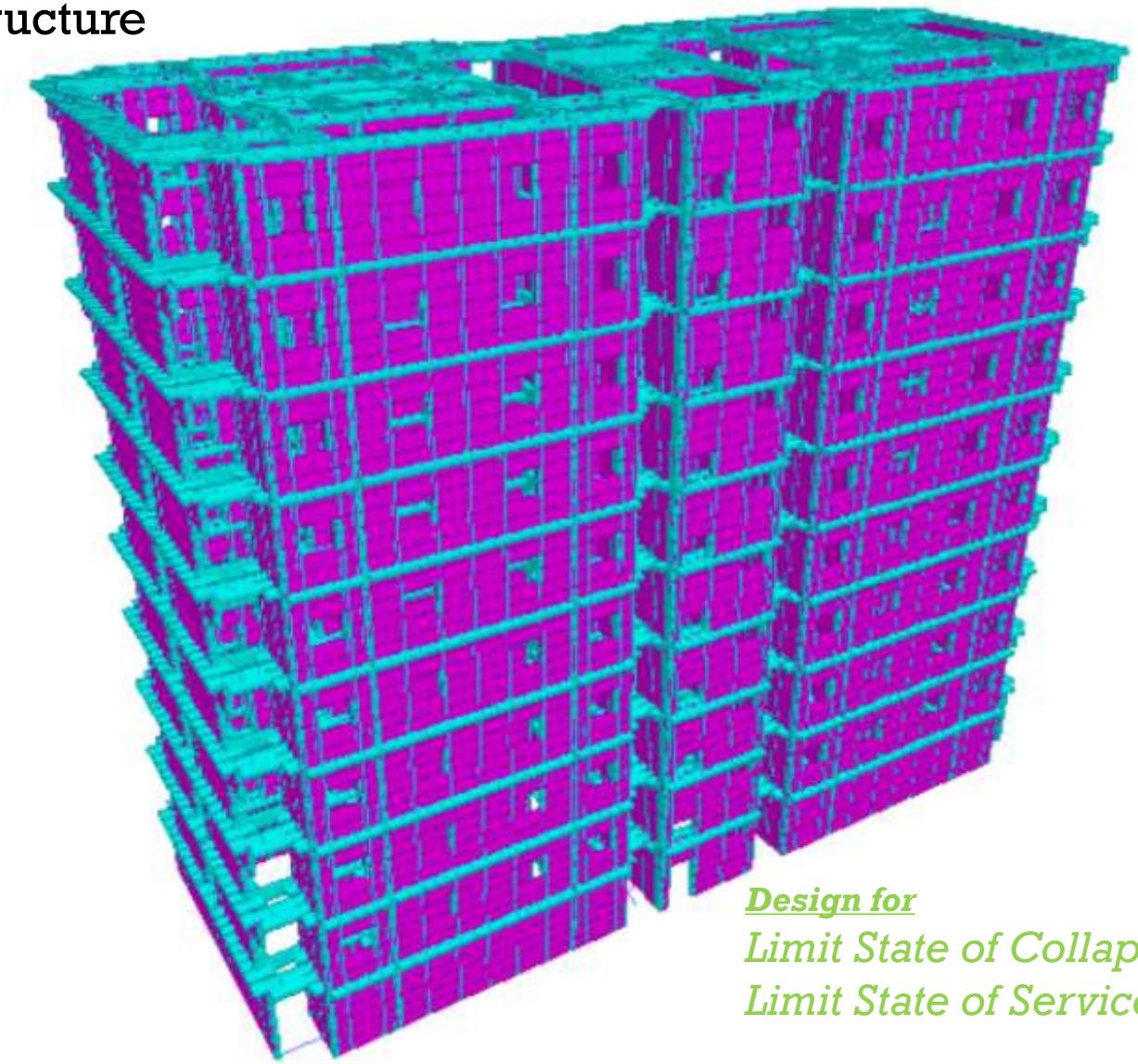
W is seismic weight of building

- Precast slabs have rebar lattice girders projecting above precast surface. Whenever, two or more panels are forming one slab of a room, such panels have in-situ topping of reinforced concrete laid over slab after erection and the thickness of such screed is as recommended in IS: 1893 / IS: 13920 there by making them "composite". Staircase is also of precast RCC.
- Design has been carried out as per IS 456-2000 and NBC-2016.



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 comprising of 3D modules, walling panels & solid core pre-stressed slab
- MEP: Plumbing & Electrical
- Finishing

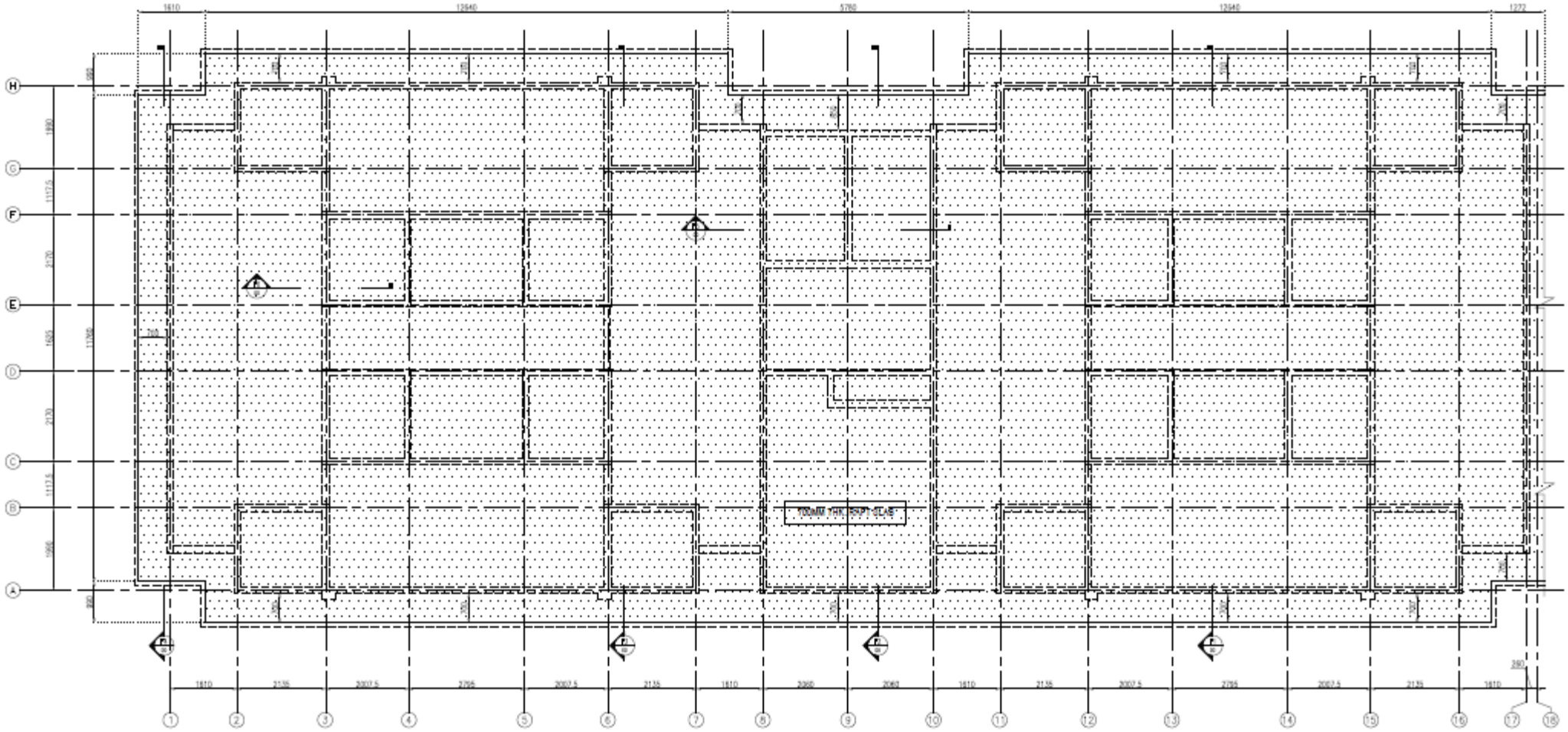
Construction Sequence

Construction sequence in the project;

- Making the designed foundation of the building ready, while manufacturing of precast concrete structural modules are taking place at the factory.
- Factory finished building units/modules are installed at the site with the help of tower cranes.
- Gable end walls are positioned to terminate the sides of building.
- Pre stressed slabs are installed as flooring elements.
- Rebar mesh is finally placed for structural screed thereby connecting all the elements together. Consecutive floors are built in similar manner to complete the structure.

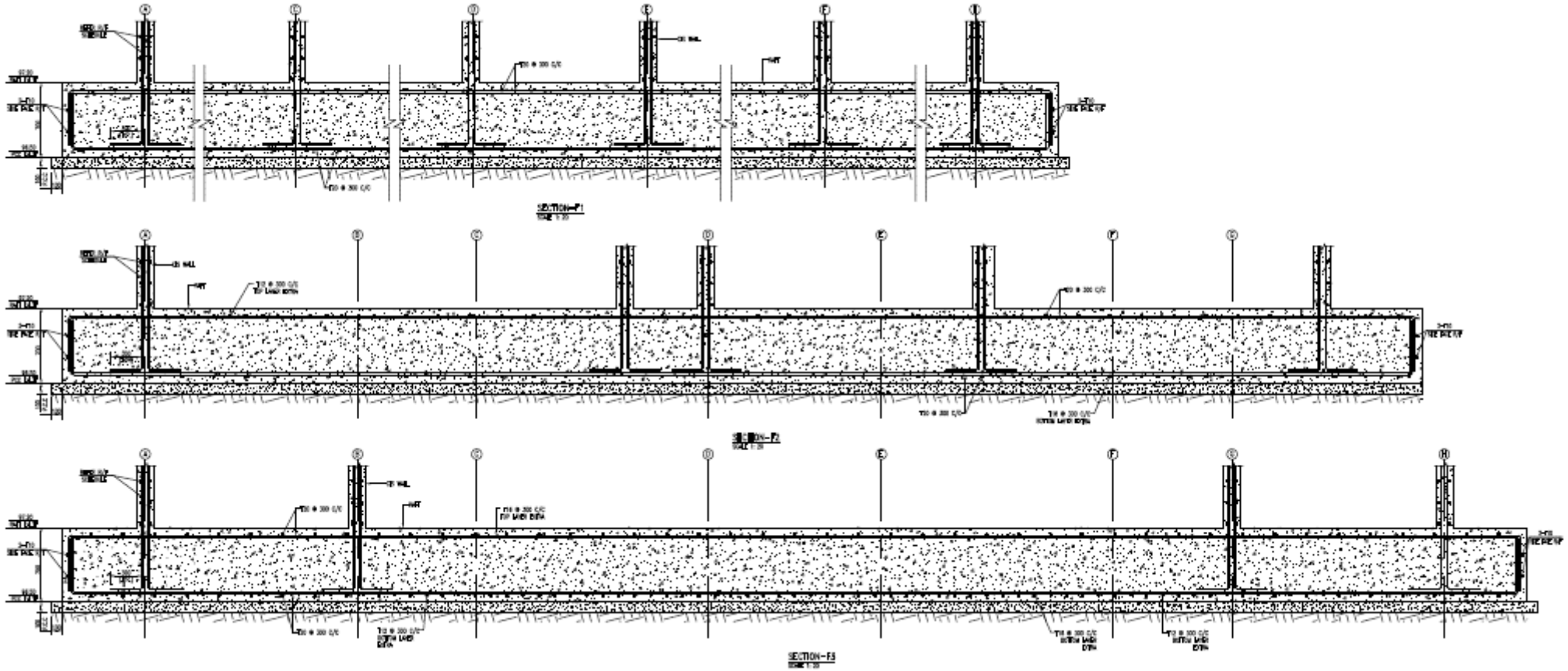
FOUNDATION

Structural Drawings



FOUNDATION

Structural Drawings



FOUNDATION

Concrete & Reinforcement Steel Specifications

Item	Concrete Grade
Raft foundation, Precast Shear wall, Precast Partition walls (Non-Load bearing)	M30
Precast Pre-stressed solid slab	M50
Structural Screed	M35

- Mix design for concrete and all Concrete work shall conform to IS 456-2000 & Liquid retaining structures shall conform to IS 3370:2009
- All Super structure precast walls, Reinforcement Steels are to be HYSD/TMT bars of Fe 500 as per IS 1786-2008.
- Flooring Pre-stressed solid slabs: fpu = 1860 N/mm2
- Structural Screed: Fe 500 of wire mesh

Concrete mix design

Cement Name	Conc. Grade	Water (kg)	Cement (kg)	W/C Ratio	Fly Ash (kg)	Coarse Aggregate (kg)		ADMIXTURE (kg)	YIELD (kg per cubic metre)
						10 mm	20 mm		
JK Lakshmi PSC	M-30	136	390	0.35	658	644	644	1.56	2473

28 days Target Strength: M30 38.25 Mpa

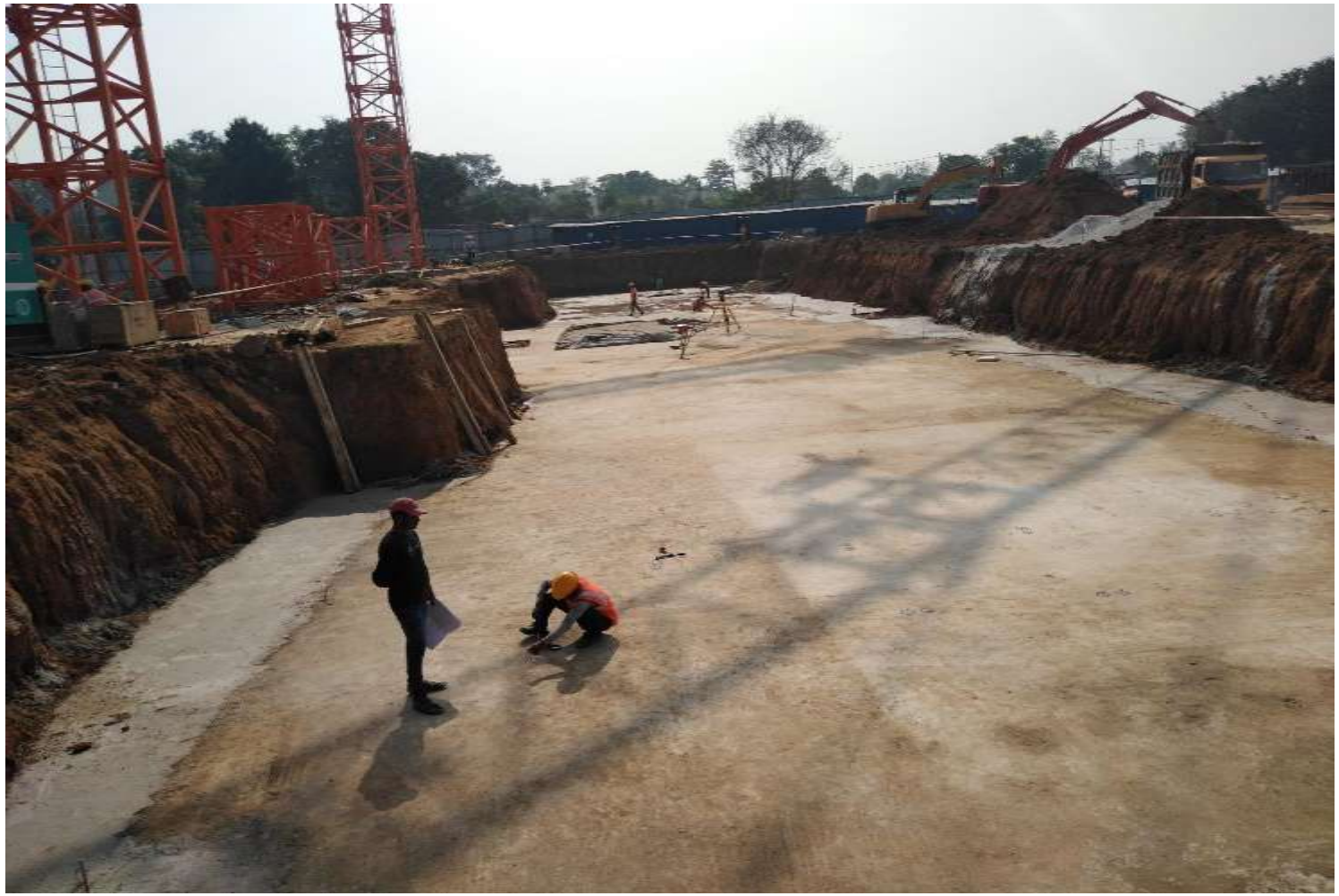
Design Slump range for the above mix: 100 mm

Portland slag cement has been used in the design mix of the Concrete, making the concrete **green and sustainable,** by conserving natural resources i.e. lime stone.

Batching Plant

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

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 blocks.

FOUNDATION

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

FOUNDATION

- Reinforcement and shuttering for raft foundation

FOUNDATION

- All building blocks have Raft foundation with 700 mm thick M-30 Concrete.

FOUNDATION

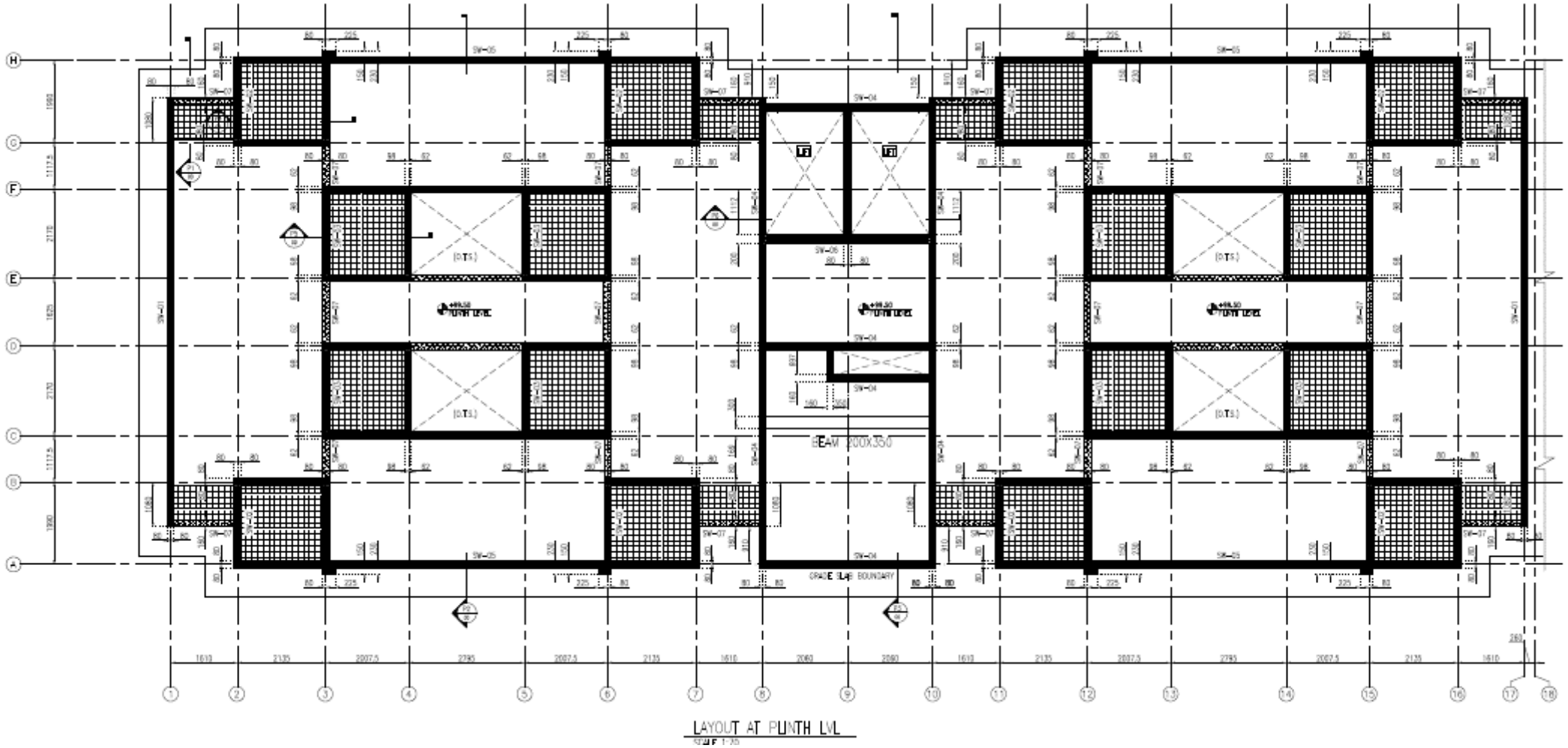
- Shear wall of M30 Grade Concrete are being cast upto plinth height over already laid cured raft.

FOUNDATION

- Deshuttering from wall.

STRUCTURAL SYSTEM

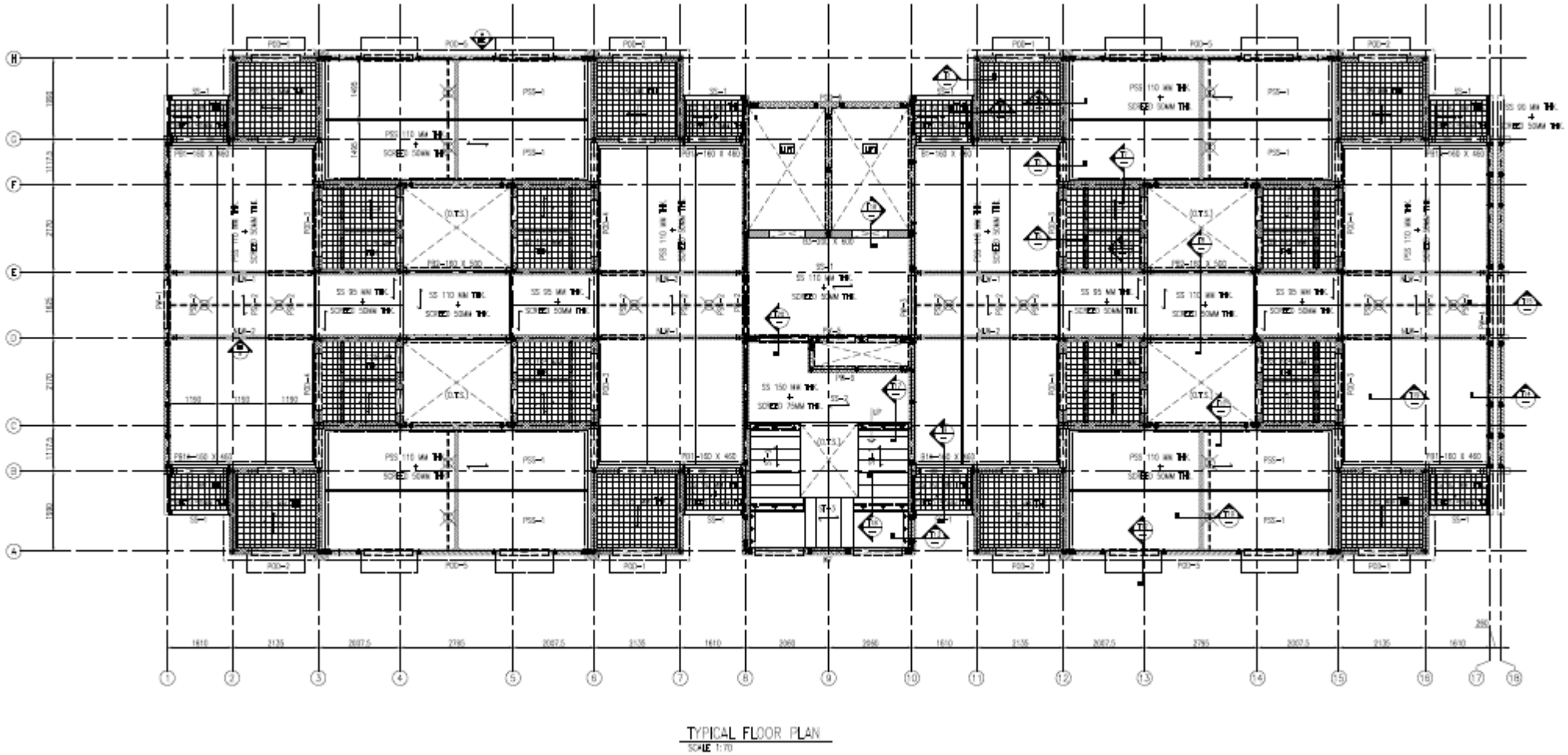
- Structural Plans and Connections



Plinth level Framing Plan

STRUCTURAL SYSTEM

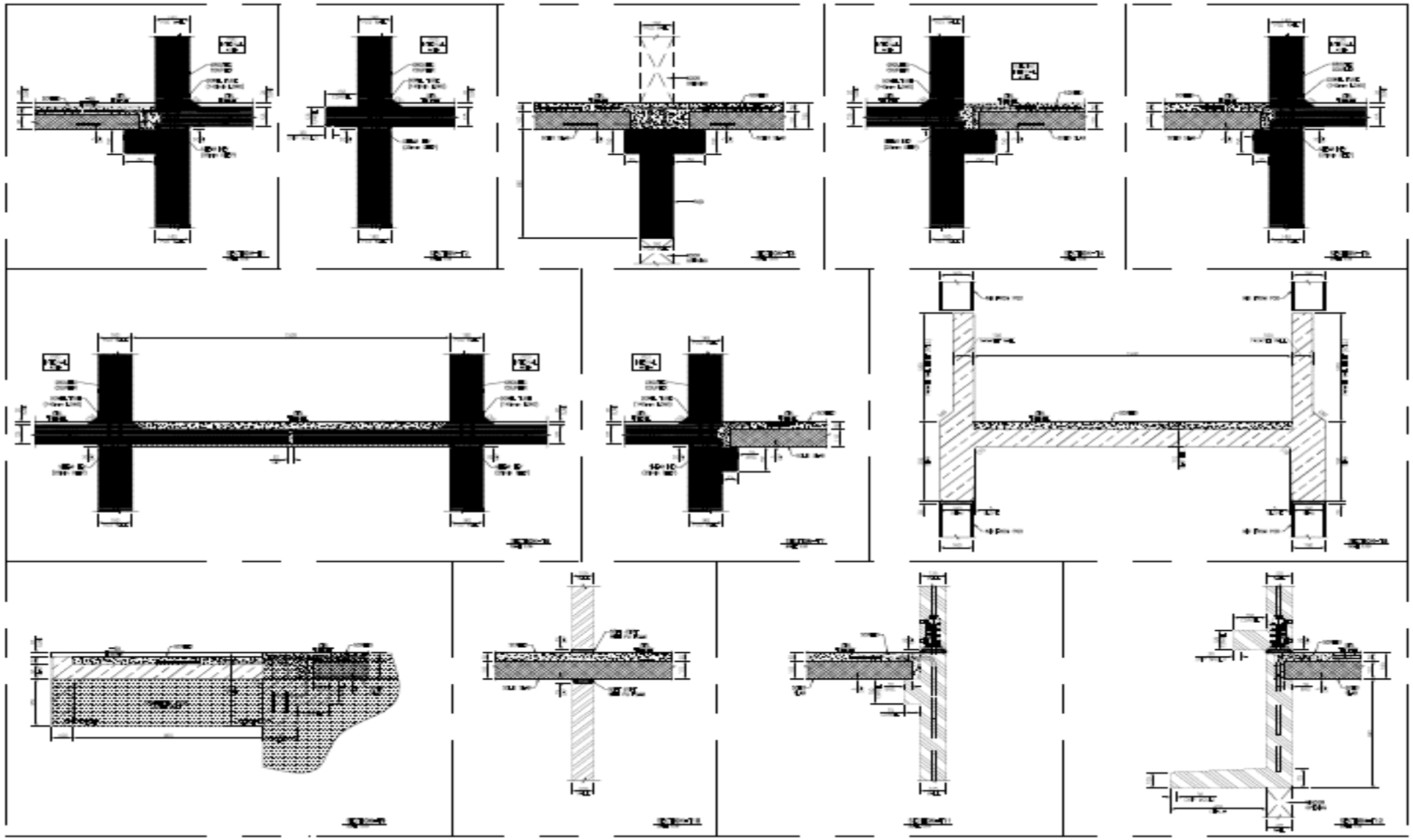
- Structural Plans and Connections



Typical Floor Framing plan

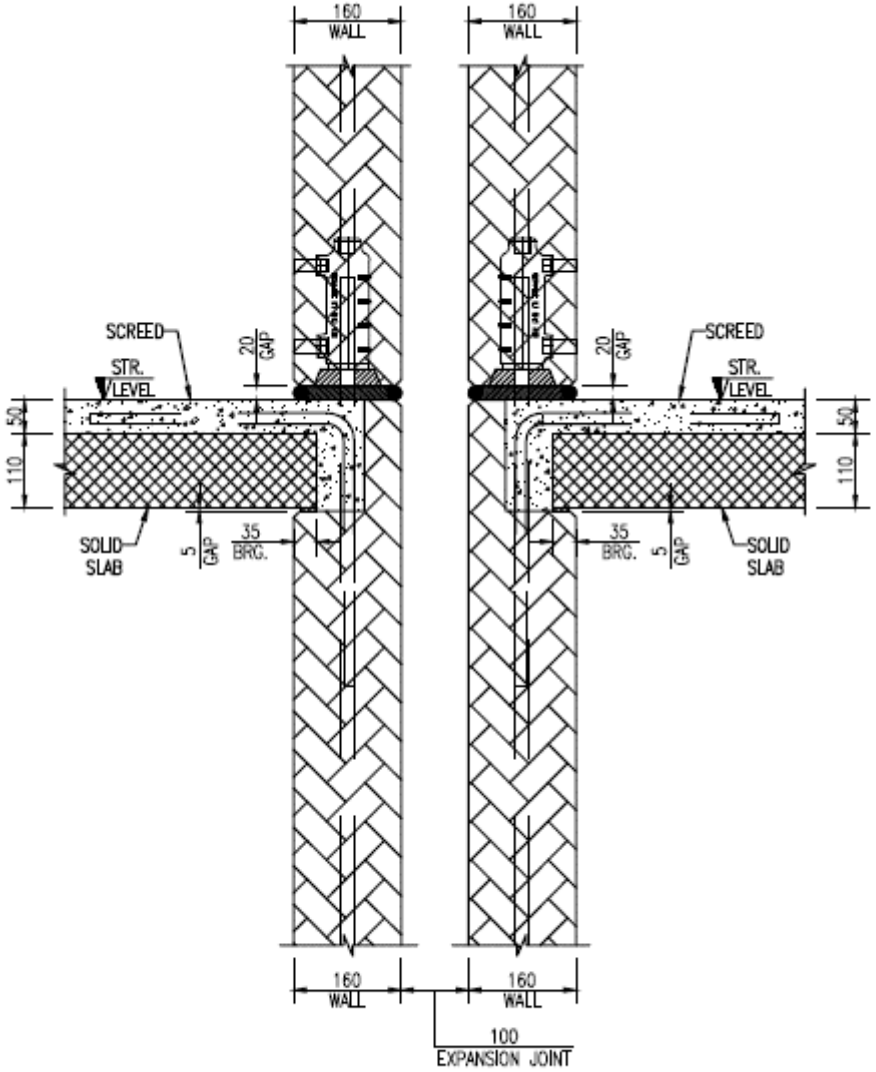
STRUCTURAL SYSTEM

- Typical Connection Details

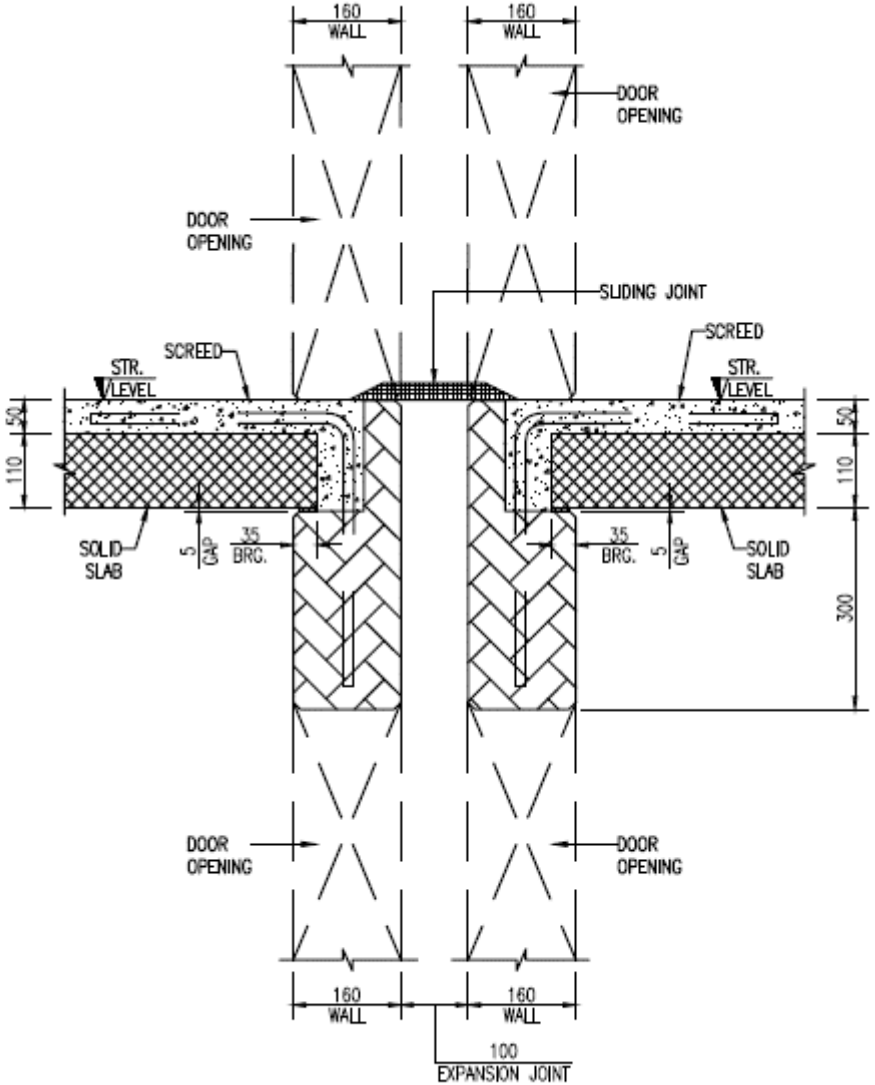


STRUCTURAL SYSTEM

- Typical Connection Details

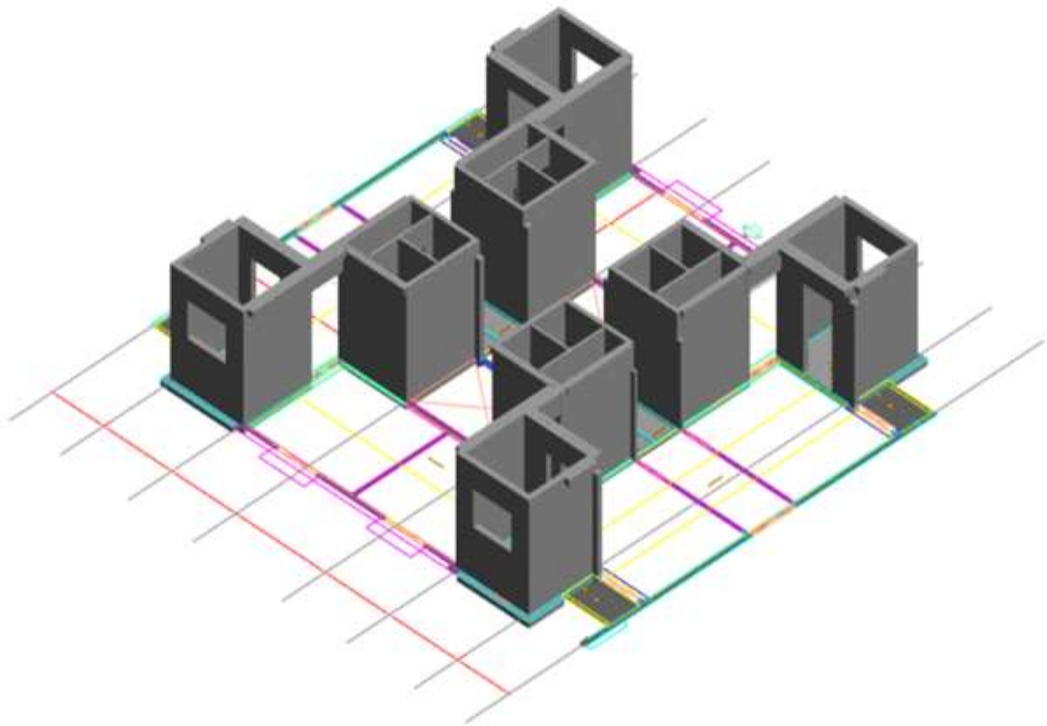


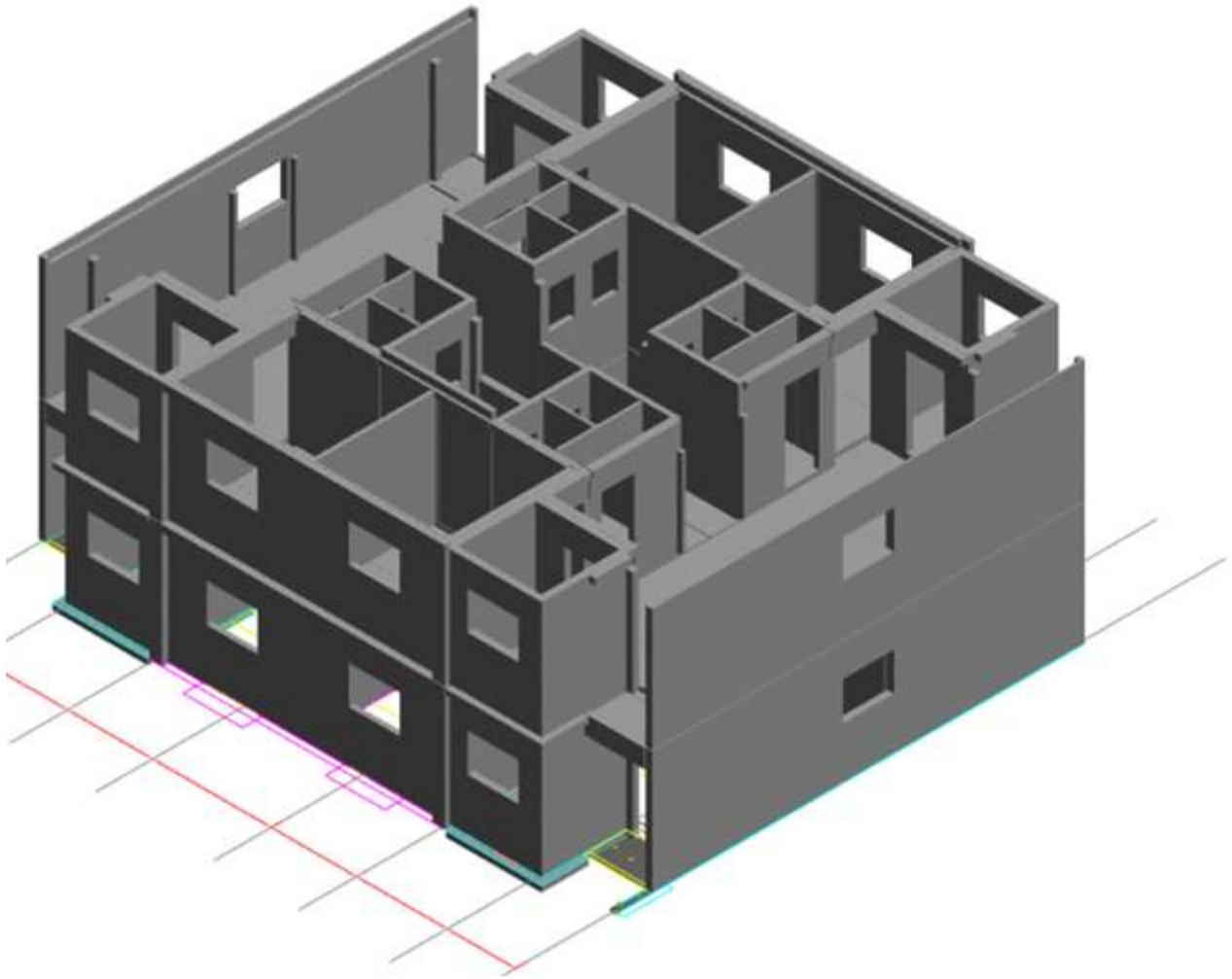
SECTION–T14
SCALE 1:10



SECTION–T15
SCALE 1:10

STRUCTURAL SYSTEM





Erection

- Erection of Components

Erection

Erection

Erection

Erection

Live status of LHP site can be accessed at

https://ghtc-india.gov.in

Further learning on the project will be covered in due course.

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