Reference: CEMOSA-IS/KOTA/AE/TL/2023/112 **Date: 21/07/2023**

To,
Sr. DEN/ (Station Development), Kota, West Central Railway, DRM office, Kota Jn.
West Central Railway,
Kota, Pin- 324002,
E mail: srdensdkota@gmail.com

Project Name: Project Management Services for the Major Upgradation of Kota Railway Station of West Central Railway

Subject: Regarding approval of contractor's submission of DBR (Structures).

Reference: 1) Contractor's letter no. ZMBPL-YFC JV/Kota/SD/ 468 dated 19.07.2023
2) Authority's Engineer letter no.: CEMOSA-IS/KOTA/AE/TL/2023/100 dated 19.07.2023

Dear Sir,

With reference to cited subject, Contractor has submitted the correctness certificate of structural DBR vide referred letter Sl. No.1 and got this approved by proof Consultant IIT Roorkee. The same has been checked and forwarded to you with approval from our end. This is for your information and further needful action from your end.

Thanking You and assuring our best services we remain;

Yours faithfully,

M/s Centro De Estudios De Materiales Y Control De Obra, SA. (CEMOSA) in JV with Introsoft Solutions

Dr. D.K. Srivastava
(Team Leader Cum Project Manager)
Major Upgradation of Kota Railway Station of West Central Railway
Kota (Rajasthan)-324002
Enclosure: As above
Copy to: 1) ZMBPL-YFC JV Kota for information.
2) CEMOSA in JV with Introsoft Solutions, New Delhi for information.

ZETWERK
MAXIMIZE MANUFACTURING

M/S ZMBPL-YFC (JV)

YFC

CINU74999KA217PTC128777,TheOrientalTowers,No.461,1stFloor,17thCrossRoad,
4thSector, Hsr Layout, Bengaluru, Karnataka 560102. P08046910888
Email -info@zetwerk.com, Web Site -www.zetwerk.com

ZMBPL-YFC JV/Kota -SD/463 **Date : 18/07/2023**

To,

The Team Leader (Project Manager)
CEMOSA INTROSOFT SOLUTIONS.

Sub: Major Up gradation of KOTA Railway Station on Engineering, Procurement and Construction (EPC) mode.
Regarding resubmission of Structure DBR (R6).

Ref:

1. Tender No. EPC-WCR-Kota-5-2022 closing date 11-07-2022 15:30 for Major Upgradation of KOTA Railway Station on Engineering, Procurement and Construction (EPC) mode.
2. Your bid ID 13996709 dated 11/07/2022 14:37 submitted by M/s ZETWERK MANUFACTURING BUSINESSES PRIVATE LIMITED-BANGALORE.
3. LOA Letter No. KOTA DIVISION-ENGG/EPC-WCR-Kota-5-2022/10197430059819 Dated 10.08.2022
4. Our letter no ZMBPL-YFC JV/Kota -SD/159 on dated 12.01.2023.
5. Our letter no ZMBPL-YFC JV/Kota -SD/159 on dated 16.02.2023.
6. Our letter no ZMBPL-YFC JV/Kota -SD/208 on dated 11.03.2023
7. Your letter no W/SD/Kota/ZMBPL-YFC/03 on dated 24.02.2023
8. Your letter no W/SD/Kota/ZMBPL-YFC/04 on dated 20.03.2023.
9. Your letter no W/SD/Kota/ZMBPL-YFC/04 on dated 06.04.2023.
10. Your letter no CEMOSA-IS/KOTA/AE/TL/2023/039 on dated 22.06.2023.
11. Your letter no W/SD/Kota/ZMBPL-YFC/06 on dated 17.07.2023.

Dear Sir,

With reference to the above cited subject, we hereby Re-submitting the Structure DBR(R6) with compliances, all comments are incorporated as described in letter no W/SD/Kota/ZMBPL-YFC/06 on dated 17.07.2023.

This is for your kind approval and necessary action please.
Thanking you & assuring our best services all the time.

For M/s ZMBPL-YFC (JV)

ZMBPL - YFC (JV) KOTA

Sajid Akhtar
Authorised signatory

CEMOSA-INTROSOFT (JV) RECEIVED Date 18/07/23

Received on 18/7/23
Ashish Gupta

C.C - **Sr. Divisional Engineer (SD)**
Enclosed : DBR & Compliance

Letter No. GDE/Zet/Kota/003 **Date 19.07.2023**

To,

Senior Division Engineer/ Station Development

Address: Office of Divisional Railway

Manager, Kota Division, West Central Railway

Kota (Rajasthan), India

RFP No: EPC-CESD-WCR-Kota-5-2022

NAME OF WORK: MAJOR UPGRADATION OF KOTA RAILWAY STATION on ENGINEERING, PROCUREMENT, AND CONSTRUCTION (EPC)

Sub: CERTIFICATE OF CORRECTNESS

I hereby Certify that I have prepared the following documents and that these documents are correct and do not contain any false statements, conditions, certification, or assurance.

01. Structure DBR

Ravi Shankar

Ravi

RAVI SHANKAR
M.TECH (STRUCTURES),DTU
B.TECH
MEMBER-AMICE
CONSULTING STRUCTURE ENGINEER
GLOBAL DESIGN ENGINEERS

Add-
H.No.- A-112; Sector-108
Noida; U.P-201304

For Global Design Engineers
Consulting Engineers & Project Manager

Subject: Major Upgradation of Kota Railway Station of Western Central Railway on Engineering, Procurement And Construction (EPC) – ***Compliance for DBR for structures***

Ref. letter: W/SD/Kota/ZMBPL-YFC/06 - dated 17/07/2023

Dear Sir,

This is with reference to the above-referred letter issued from Team leader cum project manager with respect to the observations on DBR for structures submitted by us.

In light of the same, please find our response tabulated below against each observation.

Sl. No.	DBR Item No.	NWR Observation	Our Compliance/Response
1	a	For the Building where there is no track crossing	Other than concourse, attached DBR is for building component.
	b	For the building where track crossing is involved i.e. concourse hall through roof .Documents for reference is attached	A Separate DBR shall be submitted for concourse.
2-		Reason for not incorporating the expansion joint may be explained. Please mention it is required as per IS -456 or not	**Since we are applying Temperature load as per IS 875 part-5, wherein cl 2.1 states structure should be designed for additional stresses due to temperature effects as appropriate.**

Name of Engineer :- **Ravi Shankar**

Qualification :- M.Tech.(Structures)

Address. Of Engineer :- A-112, Sector-108 Noida

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Global Design Engineers

Consulting Engineers & Project Managers

Date: 03.07.2023

To,
Team Leader (Project Manager)
CEMOSA INTROSOFT SOLUTIONS.

Sub: Major Upgradation of KOTA Railway Station on Engineering, Procurement and Construction (EPC) mode. **Regarding Resubmission of Structural Design Base Report (DBR)**

Ref:

1. Tender No. EPC-WCR-Kota-5-2022 closing date 11-07-2022 15:30 for Major Upgradation of KOTA Railway Station on Engineering, Procurement and Construction (EPC) mode.
2. Your bid ID 13996709 dated 11/07/2022 14:37 submitted by M/s ZETWERK MANUFACTURING BUSINESSES PRIVATE LIMITED-BANGALORE.
3. LOA Letter No. KOTA DIVISION ENGG/EPC-WCR-KOTA-5-2022/10197430057189 dated 10.08.2022

Dear Sir,

With reference to the above-cited subject, we are requested that we have already submitted Structural DBR vide Letter no ZMBPL-YFC JV/Kota/SD/411on dated 27.06.2023.
Hence we are requested please release a payment against it, We are heartily responsible if any change /review or any discrepancy found it, we promise that we will resubmit DBR after reviewed by the PMS structural Engineer/ authority WCR..

Ravi

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Name of Engineer	:-	Ravi Shankar
Qualification	:-	M.Tech.(Structures).
Registration No.	:-	AM194071
Address. Of Engineer	:-	A-112, Sector-108 Noida

Authorized Signatory.

STRUCTURAL DESIGN BASIS REPORT

MAJOR UPGRADATION OF KOTA RAILWAY STATION OF ENGINEERING PROCUREMENT AND CONSTRUCTION (EPC)

Client

M/s. ZMBPL-YFC JV

Oriental Towers No. – 461, 1st Floor, 4th Sector 17th Cross, HSR Layout, Bengaluru, India – 560102

Architect/Design Director

RAJIV GANDHI
ARCHITECT
LIC. No.-CA / 91/ 13852

Structural Conc.

RAVI SHANKAR
M.TECH (STRUCTURES),DTU
B.TECH
MEMBER-AIMCE
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Add-
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Proof Consultant

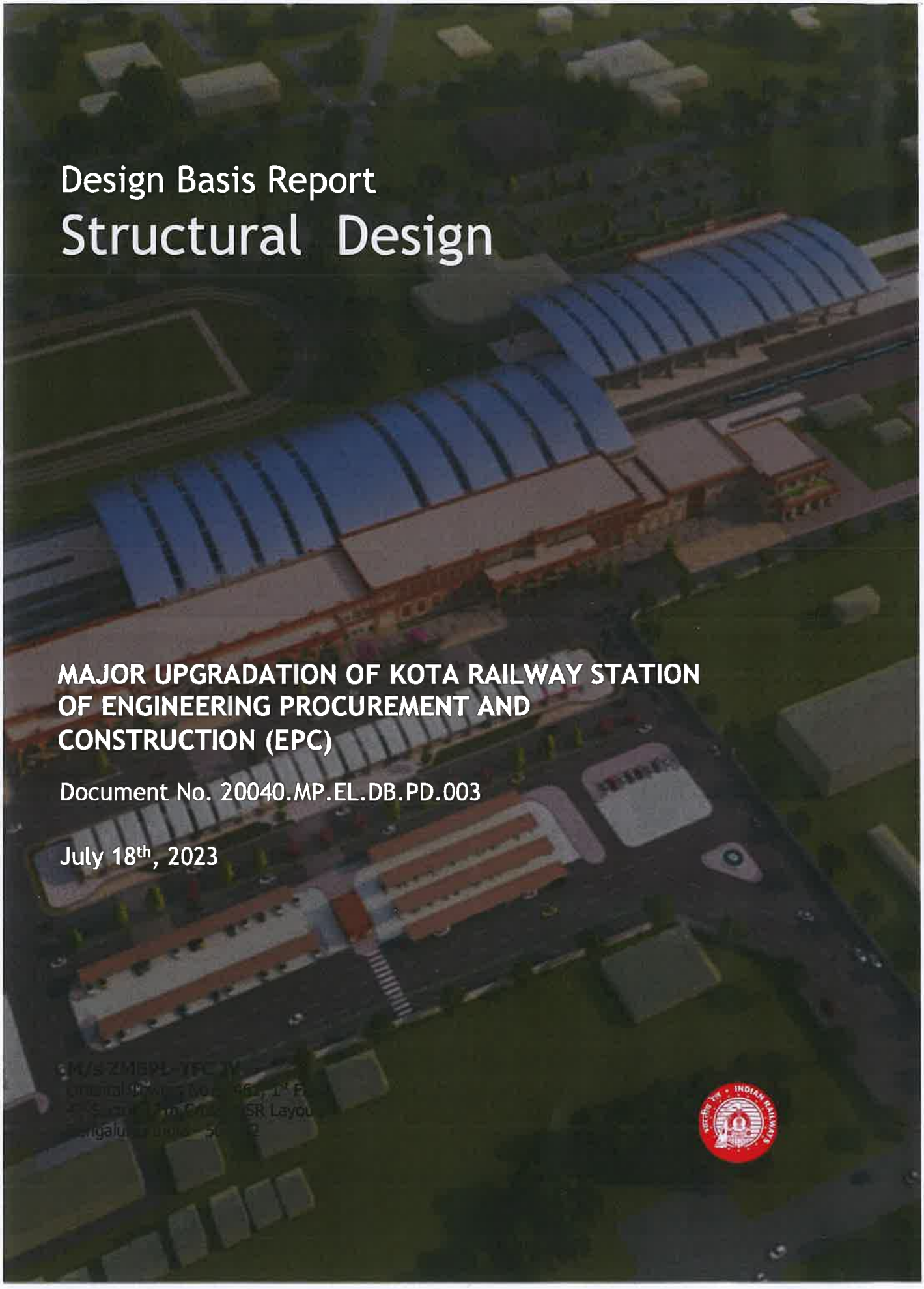
Dr. Sanjay Chikermane
Asst. Professor, IIT ROORKEE

Structural Consultant:

GLOBAL DESIGN ENGINEERS

H.No.-A-112; Sector-108, Noida, Gautam Buddha Nagar, Uttar pradesh-201304

CEMOSA-INTROSOFT (I) APPROVED Date



Design Basis Report
Structural Design

MAJOR UPGRADATION OF KOTA RAILWAY STATION OF ENGINEERING PROCUREMENT AND CONSTRUCTION (EPC)

Document No. 20040.MP.EL.DB.PD.003

July 18th, 2023

M/s ZMBPL-TPC JV

Document Control

Document Title	:	Design Basis Report – Structural Design
Document No	:	20040.MP.ST.DB.PD.003
Document Type	:	DBR – Structural Design
First Issue Date	:	21/11/2022
Department	:	DFA Architects– Railway Group

Version Control

Rev Code	Issue Date	Revision Description	Signatures			
			Originator	Checked	Approved	Date
R0	21/11/2022	**For Issuance**	Bhaskar	Santosh Varshney	Jaspreet Singh	21/11/2022
R1	26/12/2022	**For Issuance**	Bhaskar	Santosh Varshney	Jaspreet Singh	26/12/2022
R2	16/02/2023	**For Issuance**	Bhaskar	Ravi Shankar	Rajiv Gandhi	16/02/2023
R3	20/02/2023	**For Issuance**	Bhaskar	Ravi Shankar	Rajiv Gandhi	20/02/2023
R4	24/05/2023	**For Issuance**	Bhaskar	Ravi Shankar	Rajiv Gandhi	24/05/2023
R5	26/06/2023	**For Issuance**	Santosh	Ravi Shankar	Rajiv Gandhi	26/06/2023
R6	18/07/2023	**For Issuance**	Ubaid	Ravi Shankar	Rajiv Gandhi	18/07/2023

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CEMOSA-INTROSOFT (JV)
APPROVED
Date.....

Ravi

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Prepared for:

EPC Contractor
M/s ZMBPL-YFC JV
Oriental Towers No. – 461, 1st Floor, 4th Sector 17th Cross, HSR Layout, Bengaluru, India – 560102

Copy to:
Client
DRM – Kota Division
Kota Junction, New Railway Colony, Railway Station Area, Kota, Rajasthan - 324002

Prepared by:
Lead Detailed Designer

DESIGN FORUM
OF ARCHITECTS
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1. FOREWORD

This report details the basis of the structural design process, by way of familiarizing with the requirements of the project and understanding the architectural and services concepts. This report aims at formulating the main design parameters that the structural consultant has adopted in developing the structural analysis, design and detailing work of the building which will be compatible with the architectural theme, satisfy the functional needs, adhering to other applicable building norms and Indian Standards provisions to achieve safe, stable, strong and yet optimally economic structures.

The parameters adopted in this report are going to be the basis of the structural design calculations. Hence it is expected that the planning and design team members - architects, services consultants and project management team- give their feedback and approval to the parameters, suggestions, recommendations mentioned in the report.

By its nature, this is a "work-in-progress" document and will be updated & expanded during design development as the level of definition of various issues increases.

This report covers the minimum design requirement to establish the unified design basis that will form the overall design philosophy to be adopted in the structural design of the proposed building.

The design will aim to achieve.

- Structural & functional integrity.
- Desirable Structural performance under characteristic service design loads.
- Resistance to loads due to natural phenomena i.e., wind and earthquakes.
- Structural durability & maintainability

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2. PROJECT DESCRIPTION.

The project consists of a Multiple Buildings of a Railway Station. Refer Annex A for different types of Buildings to be constructed as per Phase wise construction.

1. FRONT SIDE STATION
2. REAR SIDE STATION
3. FOOT OVER BRIDGE (FOB)
4. CANOP FOR ARRIVAL HALL-2 AND DEPARTURE HALL

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Building Description:

S.No	Building Name	Type of Building	Structural system proposed	Floor Levels (mm)	Height of Building (m)	Importance Factor	Number of Floors for which structural design is performed
1.	Front Station Arrival Hall#1 (G+1)	RCC	Ordinary moment resisting frame system	Platform =+800 F. Fl. =+9050 Roof =+15050	+15.50	1.50	G+3
2.	Rear Station (G+1)	RCC		Platform =+800 F. Fl. =+9050 Roof =+15050	+15.50	1.50	G+3
3.	FOB	RCC & Steel		Platform =+800 FOB = Varies from +9.05 to +11.15 Thro' Roof = +19000	+19.00	1.50	FOB +Truss
4.	Canopy for Arrival Hall-2 and Departure Hall (G)	RCC		Single storey	+9.05	1.50	Ground

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3. LIST OF CODES

In the analysis, design and detailing of the building, the following Indian Standards have been used.

a) Imposed Loads:

IS875	Code of Practice for Design Loads for Buildings and Structures Part 1 –Dead Loads (1987) Part 2 - Imposed Loads (1987) Part 3 - Wind Loads (2015) Part 5 – Special Loads and Load Combinations (1987)

b) Design for Earthquake Resistance:

IS1893:2016	Criteria for Earthquake Resistant Design of Structures
IS4326:1993	Code of Practice for Earthquake Resistant Design and Construction of Buildings
SP22	Explanatory Handbooks on Codes for Earthquake Engineering
IS15988:2013	Seismic Evaluation and Strengthening of Existing Reinforced Concrete Buildings

c) Design of Concrete Elements:

IS 383	Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete
IS 456:2000	Plain and Reinforced Concrete – Code of Practice
IS1786	Specification for High Strength Deformed Steel Bars and Wires for Concrete
SP 34:1987	Handbook on Concrete Reinforcement & Detailing.
IS 3370	Code of practice for concrete structure for storage of liquid (Part I to IV)

d) Structural Steel Elements:

IS 800:2007	Use of Steel in Construction–Code of Practice
IS 2062-2011	Steel for General Structural Purpose
IS: 1161-2014	Steel Tubes for structural purposes – Specification
IS 4923-2017	Hollow Steel Section for Structural use
IS: 814-2004	Welding Code
IS: 4000-1992	For High strength bolts
IS: 11384-1985	Code for Composite construction in structural steel and concrete

IS:5369-1975, IS 6755-1980, IS:5372-1975, IS:5374-1975, IS:814-2004, IS:6649- 1985, IS:1278-1972, IS:7280-1974, IS:3613-1974, IS:6419-1966 and IS:2016-1967 for Washers in steel structures.

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All structural steel shall confirm to IS -2062-2011.

M.S. Rolled/Build up Members	E350 B0
M.S. tubular section ERW type(round, square or rectangular hollow tube sections)	E345 confirming to IS: 4923/IS 11
Connections Plates	E350 B0
Bolts	Gr—4.6 / 8.8 / 10.9 (or) Approved Equivalent as per latest code for hsfg bolt , HTS Code: 7318.15 - Threaded Screws And Bolts Others, With Or Without Their Nuts Or Washers, Of Iron Or Steel
Nuts	Class – 8 / 10 (or) Approved Equivalent ,

	HTS Code: 7318.15 - Threaded Screws And Bolts Others, With Or Without Their Nuts Or Washers, Of Iron Or Steel
Washers	As per IS:2016(1967), IS:5369(1975), IS:6649(1985) , HTS Code: 7318.15 - Threaded Screws And Bolts Others, With Or Without Their Nuts Or Washers, Of Iron Or Steel
Anchor Rods/(Anchor bolts)	Gr—4.6 / 8.8 (or) Approved Equivalent (or) ASTM F1554
Welding Electrodes	E70XX, Low Hydrogen for Grade 350 (Conforming to IS: 814) or Approved ,Also as per RDSO guideline to be done

Structural steel shall be confirm to RDSO code (specification for fabrication and erection of steel girder bridges and locomotive turn-tables)

e) Earthwork:

IS 3764-1992 Code of Safety for Excavation Work

f) Soil and Foundation:

IS1080	Code of Practice for Design and Construction of Spread Foundations
IS1904	Code of Practice for Design and Construction of Foundations in Soils
IS2950	Code of Practice for Design and Construction of Raft Foundation (Part –1)
IS2911	Code of Practice for Design and Construction of Pile Foundations

g) Reinforcement:

IS 2502	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS 8112	Specification for 43 Grade Ordinary Portland cement
IS 9103	Specification for Admixtures for Concrete
IS 10262	Recommended Guidelines for Concrete Mix Design
SP16	Design Aids for Reinforced Concrete to IS456
SP24	Explanatory Handbook on IS Code for Plain Reinforced Concrete, IS45

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SP34	Handbooks on Concrete Reinforcement and Detailing
SP7	National Building of India

h) Indian Railway Standards (IRS) Codes and Manual

IRS	Manuals for Standards and Specifications for Railway Stations 2009 issued by Ministry of Railways, Railway Board
IRS	Indian Railway Works Manual 2000 issued by Ministry of Railways, Railway Board
IRS	Indian Railways Permanent Way Manual
IRS	Indian Railways Telecom Manual 2007
IRS	Indian Railways Coaching Maintenance Manual
IRS	Indian Railways Medical Maintenance
IRS	Indian Railways Manual of AC Traction Maintenance and Operation, Volume – I
IRS	Indian Railways Manual of AC Traction Maintenance and Operation, Volume – II (Part 1)
IRS	Indian Railways Manual of AC Traction Maintenance and Operation, Volume – II (Part II)
IRS	Indian Railways Manual of AC Traction Maintenance and Operation, Volume – III
IRS	Signal Engineering Manual, Part I
IRS	Signal Engineering Manual, Part II
IRS	Indian Railways Schedule of Dimensions 1676mm Gauge (BG), Revised 2004
IRS	All Pertinent IRS Specifications issued by the various Directorates of the Ministry of Railways (e.g., Signal Directorate, Bridges and Structures Directorate, track Directorate, Telecom Directorate, Traction Installation Directorate, Electrical Directorate, etc.)
IRS	IRS Bridge Rules for Loading
IRS	IRS Codes of Practice for Steel Bridges
IRS	IRS Code of Practice for Plain, Reinforced and Pre-stressed Concrete for general Bridge Construction
IRS	IRS Code of Practice for Design of Substructures and Foundation of Bridges
CT-38	RDSO Guidelines for Noise and Vibrations

i) Indian Road Congress Standards (IRC)

IRC 5	Standards Specifications and Code of Practice for Road Bridges, Section I - General Features of Design
IRC 6	Standards Specifications and Code of Practice for Road Bridges, Section II – Load and Stresses
IRC 11	Recommended Practice for the Design of Layout of Cycle Tracks
IRC 19	Standards Specifications and Code of Practice for Water Bound Macadam
IRC 112	Standards Specifications and Code of Practice for Road Bridges, Section III – Cement Concrete (Plain and Reinforced)
IRC 22	Standards Specifications and Code of Practice for Road Bridges, Section IV – Composite Construction
IRC 24	Standards Specifications and Code of Practice for Road Bridges, Section IV – Steel Road Bridges
IRC 37	Guidelines for the Design of Flexible Pavement
IRC 45	Recommendations for Estimating the Resistance of soil below the maximum Scour Level in the design of Well Foundations of Bridges
IRC 48	Tentative Specifications for Bituminous Surface Dressing Using Pre-Coated Aggregates
IRC 78	Standards Specifications and Code of Practice for Road Bridges, Section VII Parts 1 and 2, Foundations and Substructure
IRC 87	Guidelines for the Design and Erection of False Work for Road Bridges
IRC 89	Guidelines for the Design and Erection of River Training and Control Works for Road Bridges

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4. LOADING PARAMETERS

a) Dead Loads

Self-weight of the structural members and finishing/filling materials will be calculated based on the following properties:

Materia l	Unit Weight
Reinforced Concrete	25.0 kN/cu.m
Plain Concrete	24.0 kN/cu.m
Steel/Structural Steel	78.5 kN/cu.m
Density of toughened glass sheet	25.0 kN/cu.m
Density of AAC Blocks	7.50 kN/cu.m
Soil filling (Moist)	21.0 kN/cu.m
Soil Filling (Dry)	18.0 kN/cu.m

Other dead loads due to stationary building elements, which arise due to walls, filling in sunken areas etc. have beenaccounted for based on architectural drawings.

For all Structures Light Weight AAC Block with Plaster is considered. For Detail Loading Plans refer Annexure D.

Super Imposed Dead Loads (SIDL)

The super imposed loads that are envisaged to act permanently (wherever applicable) are as follows:

Description	UDL (KN / sqm)
Floor Finish	1.5 (For 75mm floor finish)
Weatherproof course	Depends on the thickness and kind of material to be used for weatherproofing.
Ceiling and Services	1.0
Dry wall Partitions	To be calculated as per Architectural details.
200 thick AAC Blocks	1.4
100 thick AAC Blocks	0.70
12mm cement plaster	0.25
Sunken portions in toilets, kitchen, balconies	2.5 (For 100 mm screed)
False flooring (wherever applicable)	2.0
ıter (soil depth of 1m)	20.0 (as per Architectural layout) or as per actual
Partition Wall Load	To be calculated as per Architectural details.

Note:

- Brick work load & Façade load shall be considered as per actuals and line loads shall be applied on supporting beam.
- Façade loads shall be computed from supplier's data of glazing as per Contract Agreement. Line loads shall be applied on supporting structural beam accordingly.

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b) Imposed Loads

Self-Weight of slab / beam / Columns will be as per the dimensions adopted in the respective drawings.
The following are the imposed gravity loads adopted in addition to the self-weight of the structure. *(Self-weight of slab / beam / columns will be as per the dimensions adopted in the respective DFA Architects*

wings.)

Sl. No.	Location	Live Load (KN/m^2)
1.	*STATION BUILDING & CANOPY*	
	Kitchen	4.0
	Toilet	4.0
	Corridor, staircase, balcony, Shop, restaurants	5.0
	Waiting Area, Parking	5.0
	Offices	5.0
	Guest Rooms, Suites Rooms	4.0
	Terrace Floor (Accessible)	4.0
	Terrace Floor (Non-Accessible)	1.5

Note:- final load on roof shall be maximum of solar load or panel.

In addition to the above, following guidelines shall be followed:

- Pressure coefficient for the local effects shall be used for calculation of forces on local areas affecting roof sheeting, glass panels and individual claddings including the fixtures as per clause 7.3 of IS 875 (Part3) - 2015.
- Dynamic effect on flexible slender structural element shall be investigated as per clause 9.0 of IS 875 (Part3) -2015.
- Adequate diagonal bracing with strong end connections shall be provided in steel framing in both the horizontal and vertical planes to improve their lateral load resistance.
- Wind load on Façade shall be applied on supporting beam as line load considering enclosed beam as per IS:875 (Part 3) – 2015 and NBC-2016.

C) Seismic Loads

The seismic load calculations will be carried out in accordance with IS 1893(Part 1): 2016.
As per I.S:1893-2016, Kota lies in Zone II.

The Design Base Shear is given by
Vb = (Z/2)x(I/R)x(Sa/g)xW

Where,

- Zone Factor 'Z' =0.10
- Importance factor 'I' will be taken as '1.5' as per table listed in Cl 4.
- Response reduction factor 'R will be taken as '3.0' as the structure would be designed as a 'RC building with ordinary moment resisting frame system (OMRF)
- *Sa / g* is the normalized Response Spectrum value for the structure which is the function of the fundamental time period of vibration of the structure and the type of the founding soil.
- *W* is the Seismic Weight of the building, which will be calculated in accordance with the relevant clause in, *IS 1893(Part 1): 2016.*
- Damping value 5% of critical damping value is considered. Space frame analysis of the structure will be carried out using response spectrum method.
- The seismic Analysis will be carried out in accordance with IS 1893(Part 1): 2016.Based on the type of external action and behaviour of structure, the analysis can be classified as below.

  i. Linear Static Analysis (Equivalent Static Analysis)
  ii. Linear Dynamic Analysis (Response Spectrum Method)
- All detailing practices and provisions are and will be governed by IS:1893 and IS:456 and SP34-1987. Ductile detailing Code I.S.Code 13920 is optional in Seismic Zone-II.
- The approximate fundamental translational natural period Ta in seconds in X - Y direction is given by;

  T_a=0.075h $^{0.75}$ (For RCC moment frame).

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d) Wind loads

Wind loads have been calculated in accordance with IS 875: (Part-3)

2015.Design wind speed V_z $=V_b*k_1*k_2*k_3*k_4$

V_b (Basic wind speed) =47m/sec

k_1(risk coefficient) =1.07 (for 50 yrs mean probable design life)

k_2 =1.01 (w.r.t. Terrain category 3 and height 20m considered from Ground Floor

k_3 (Topography factor) =1.00

k_4 (Importance factor) =1 (All other structures; Clause 6.3.4)

Pz = 0.6 * Vz^2
where
Pz = Wind pressure at ht. z in N/m^2
Vz = Design wind speed at any ht. z in m/s
Vz = 47 * 1.07 * 1.01 * 1.0 * 1.0 = 50.7929 m/s

Wind pressure (p_z) = 0.6 * $(50.7929)^2$ = 1547.95 N/m^2=1.547 KN/m^2

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e) Vibration loads

The measures taken for the vibration control will be based on the vibration analysis of structure and the tests done at the site.

5. SEPARATION / EXPANSION JOINTS AND TEMPERATURE LOADS

Temperature effects shall be considered as per Cl.2 of IS:875-Pt.
Data for 'TL' is guided by Thermal Contours given in Fig.1 & 2 of IS:875:Part-V
No expansion joints shall be provided. Instead, additional thermal stresses shall be taken care of in design of structure.
I.S. 875 (Pt-5)-1987 deals with 'Other Loads', such as Temperature stresses.
Expansion and contraction due to changes in temperature of the materials of a structure shall be considered in design. Provision shall be either made to relieve the stress by provision of expansion/ contraction joint in accordance with I.S.:3414-1968 (Code of practice for design and installation of joints in buildings)or design the structure to carry additional stresses due to temperature effects as appropriate to the problem.
The temperature range varies for different regions and under different duration and seasonal conditions. The absolute minimum and maximum temperatures which may be expected in different parts of the country are given in Fig.-1 and 2 respectively of I.S. 875 (Pt-5)-1987. These figures shall be used as guidance in ascertaining the maximum variation in temperature.
Alternately the recorded data of the place may be adopted from authentic source.
The temperatures indicated in Fig.-1 and 2 are the air temperatures in the shade. The range of variation in temperatures of the building may be appreciably greater or less than the variation of air temperature and is influenced by the condition of exposure and the rate at which the materials composing the structure absorb or radiate heat. This difference in variation of materials and air shall be given due consideration.
Structural Analysis shall take into account (a) Changes of the mean temperature in relation to initial temperature and (b) the temperature gradient through the section.
Following considerations have been taken for temperature loads
• Considering maximum and minimum temperature 49 degree and 0 degree respectively as shown in map in IS 875-part 5.
2/3 * (49 – 0) = 32.83 say 33 ° C.
Considering long term modulus of concrete to be half, the net temperature load to be
Applied = 33/2 = 16.5 ° C (say 18-degree)
• Maximum casting temperature = 33 ° C. (As per standard specifications)
Minimum casting temperature = 15 ° C. (As per standard specifications)
Difference = 49-33 = 16 and 49-16 = 33
Therefore, maximum temperature of concrete = 33 ° C.
Considering long term = 33/2 = 16.5 ° C.
Considering above calculations a conservative value of 17° C shall be used.

Since we are applying Temperature load as per IS 875 part-5, wherein cl 2.1 states structure should be designed for additional stresses due to temperature effects as appropriate.

6. CLEAR COVER TO REINFORCEMENT

By considering fire safety and durability aspects, cover to reinforcement for various structural members will be considered as maximum of the two values considered for durability and fire resistance criteria as follows.

Structural Elements	Minimum Concrete Cover
Footing/Raft	50 mm
Column / Shear Wall	40 mm
Beam	30 mm
Slab	25 mm

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7. GRADE OF CONCRETE

Following grades are proposed for the project.

Element	Levels	Characteristic Cube strength (N/mm²)
Foundation	-	35
Beams / Slabs (Rest Building)	All Levels	35
Columns/Shear Walls	All Levels	40

- Ordinary Portland Cement (OPC) of grade 43 confirming to *IS 1489(part-I):1991* shall be specified for all grades of concrete.
- The reinforcement to be used in the construction is of high strength deformed bars conforming to IS:1786 (Fe500D/550D)

Grade	E Value as per code(N/mm²)
M20	22361
M25	25000
M30	27386
M35	29580
M40	31623
M45	33541
M50	35355

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8. EXPOSURE CONDITION

SR. No.	Structural member	Clear cover (mm)	Min Dimension(mm)	Remarks
1	Foundation / Pile	50	As per the structural design following minimum requirements given in relevant IS Code.	Severe condition
2	Columns	40		For all conditions
3	Shear walls	40		For all conditions
4	Beams,	30		2.0-hour fire resistance
5	Slabs	25		2.0-hour fire resistance
6.	RCC Retaining wall	45 (Soil face)		Severe
		30 (Inside face)		Moderate
7.	Water tank walls	45 (Soil face)		Severe
		30 (Inside face)		Moderate
8.	Staircase Waist slab	25		2.0-hour fire resistance

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9. ANALYSIS APPROACH

By looking through the Architectural perspective and functional needs of the building, having higher loads and larger spans of column grids with respect to construction Time, feasibility of various Constructional Methodologies has been proposed as listed below:

1.) Top-down Construction
2.) Bottom to Top Construction (Conventional)

As per Client's instructions, Bottom to Top Construction methodology is considered.

After preliminary sizing of various structural members (such as R.C.C. Columns/Shear Walls, Slabs and Beams), a 3D computer model of the entire building structure will be generated to carry out structural analysis by considering all the effects of vertical and lateral loads (i.e., Gravity, Wind and Earthquake).

The 3D Model will be analysed by using the "ETABS Nonlinear Version20.3.0" software. ETABS Nonlinear Version 20.3.0 has been thoroughly tested, validated and recognized internationally by several organizations and is well suited for the analysis of building systems.

Geometrical dimensions, member properties and member-node connectivity, including eccentricities will be modelled as per actual. Variation in material grades, if present, will also be considered.

Seismic and Wind forces will be generated by the software based on parameters, coefficients and factors assigned to the model in accordance with the relevant codes.

The permissible values of the load factors and stresses are utilized within the purview of the Indian Standards.

The stiffness modifiers of the elements in the analytical models are to be adjusted to comply with the cracking level under service and ultimate loads, accordingly two separate models will be run, i.e., SLS model Serviceability design check and ULS for Strength design. Following table shows the values of Property modifiers to be adopted for respective cases: -

Structural Element	Servicemodel	Ultimate model	Element type	Notes
Walls	1.00	1.00	Shell	F11
	0.90	0.70		F22, F21, M11, M12 M22
Beams	0.70	0.35	Line	I22, I33
Columns	0.9	0.7	Line	I22, I33
Slabs	0.10	0.10	Shell	M11, M12 & M22
Slabs	1.00	1.00	Membrane	M11, M12 & M22
Spandrels	1.00	1.00	Shell	F22
	0.70	0.35		F11, F12, M11, M12 M22

The computer analysis will evaluate individual internal member forces and the reactions at foundation level.

Global deformation and drift patterns of the entire structure as well as deflection and sway of individual members and joints will also be evaluated by the 3D model analysis.

This data will then be used to verify adequacy of the member sizes adopted.

A sufficient number of iterations will be done to achieve the most appropriate and optimized structural member sizes.

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Consideration adopted for Rear Station, Front Station Arrival Hall 1, and Canopy for Arrival Hall 2 and Departure Hall 3D Etabs model.

1. Fixed supports are considered at base level.
2. Semi rigid diaphragm is assigned to the floor slab.
3. The floor slabs are modeled as membrane element.
4. Design eccentricity is considered as per Cl 7.8.2 of IS 1893-2016
5. Foundation analysis and design shall be performed using SAFE software.

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10. LATERAL LOAD AND SERVICEABILITY LIMITS

Story displacement and drifts under lateral loads (seismic and wind) will be checked from 3D-ETABS model. The displacement response due to seismic forces (Δs) obtained from the analytical model represents building elastic response. However, seismic codes account for the inelastic response by magnifying the obtained elastic displacements with correction factor.

The dynamic characteristics of the buildings will be evaluated through the investigation of the natural periods, mode shapes and modal mass participation ratio.

Eigen Vector analysis will be initially investigated to determine the elastic periods and the modes of vibration. This simple analysis is also useful as an initial validation tool of the analytical models.

The mass participation ratio of the building will be investigated to judge their dynamic characteristics. The number of mode shapes considered in the analysis will also be checked to ensure that they satisfy the requirement for the considered number of mode shapes to be used to obtain a combined mass participation ratio of at least 90% of the actual mass in each of the orthogonal horizontal direction of the model.

The following serviceability criteria will be applied are as follows.

Items (For Buildings)	**Deflection limit**
Deflection for Wind	H/500
Deflection for Seismic force	H/250
Inter Storey drift	h/250
Immediate deflection (DL + LL)	Span/350 or 20mm
Long term deflection	Span/250

Items (Steel Structure)	**Deflection limit**
Deflection for Wind/ Live (Purlin)	Span / 150
Deflection for Wind/ Live (Rafter)	Span / 180
Deflection of Steel Girder for Live Load	Span / 240

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11. LOAD COMBINATIONS

SERVICE LOAD COMBINATIONS FOR SLS MODEL

SR. NO.	LOAD COMBINATIONS	LOAD FACTORS			
		D.L	L.L	$SPEC_X$	$SPEC_Y$
1.	DL+LL	1.00	1.00	-	-
2.	DL±$SPEC_X$	1.00	-	±1.00	-
4.	DL±$SPEC_Y$	1.00	-	-	±1.00
6.	DL+LL±$SPEC_X$	1.00	0.80	±0.80	-
8.	DL+LL±$SPEC_Y$	1.00	0.80	-	±0.80
2.	DL±$WIND_X$	1.00	-	±1.00	-
4.	DL±$WIND_Y$	1.00	-	-	±1.00
6.	DL+LL±$WIND_X$	1.00	0.80	±0.80	-
8.	DL+LL±$WIND_Y$	1.00	0.80	-	±0.80

ULTIMATE LOAD COMBINATIONS FOR ULS MODEL

SR. NO.	LOAD COMBINATIONS	LOAD FACTORS			
		D.L	L.L	$SPEC_X$	$SPEC_Y$
1.	DL+LL	1.50	1.50	-	-
2.	DL±$SPEC_X$	1.50	-	±1.50	-
2.	DL±$SPEC_Y$	1.50	-	-	±1.50
2.	DL±$SPEC_X$	0.9	-	±1.50	-
2.	DL±$SPEC_Y$	0.9	-	-	±1.50
4.	DL+LL±$SPEC_X$	1.20	1.20	-	±1.20
4.	DL+LL±$SPEC_Y$	1.20	1.20	-	±1.20
2.	DL±$WIND_X$	1.50	-	±1.50	-
2.	DL±$WIND_Y$	1.50	-	-	±1.50
2.	DL±$WIND_X$	0.9	-	±1.50	-
2.	DL±$WIND_Y$	0.9	-	-	±1.50
4.	DL+LL±$WIND_X$	1.20	1.20	-	±1.20
4.	DL+LL±$WIND_Y$	1.20	1.20	-	±1.20

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LOAD COMBINATIONS FOR TEMPERATURE LOAD

SR. NO.	LOAD COMBINATIONS	LOAD FACTORS		
		D.L	L.L	TEMP
1.	DL+LL+TEMP	1.05	1.275	1.05
2.	DL+ TEMP	1.4	-	1.4
3.	DL+LL+TEMP	1.4	1.7	1.4

Suffixes x, y and z in the above table indicate the direction in which the force is applied.

All members will be designed for the largest value of the design forces obtained due to positive as wellas negative values of reversible forces (Wind and Earthquake).

STEEL STRUCTURES

The Design of steel structures shall be done by Limit/working State method, in accordance with the provisions of IS: 800-2007 and other relevant IS codes as applicable to specific structures. All structures will be framed structure. Basic consideration for structural framing will be stability, rigidity, building usage, ease of fabrication / erection and overall economy. Additional bracings / moment connections will be used to assure stability of structures. Structure will be designed such that the surfaces of all parts will be accessible for inspection, cleaning, painting and maintenance. The load combinations for steel design shall be as per IS: 800-2007.
For Design of Steel Connections, Ram Connection Software will be used. All Connections/Joints in Steel Structureswill be designed and checked for relevant loads.
Intumescent paint shall be used for Fire rating (exposed steel structures).

12. STABILITY OF STRUCTURES

For the purpose of stability of the structure against overturning, the restoring moment shall not be less than 1.2 times the maximum overturning moments due to dead load plus 1.4 times the maximum overturning moments due to imposed loads.

In case where dead load provides the restoring moments only 0.9 times in dead load shall be considered. The restoring moments due to imposed loads shall be ignored.

The factor of safety against sliding shall not be less than1.40.

Factor of safety against buoyancy shall be not less than 1.20 ignoring the superimposed loading.

13. SOFTWARE USED

3D Structural analysis for entire building will be carried out on ETABS (Version 20.3.0) software.

And following software will be engaged for reinforcement designs of different structural element.
Floor Plate analysis : SAFE Version 16.0.2
Structural Steel : STAAD, ETABS and Ram Connection
Drawings : AutoCAD

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14. GEOTECHNICAL DATA AND BREIF

SOIL REPORT

PNT DESIGNS (Pvt.) Ltd.

A

REPORT ON

GEOTECHNICAL INVESTIGATION WORK FOR "MAJOR UPGRADATION OF KOTA RAILWAY STATION ON ENGINEERING PROCUREMENT AND CONSTRUCTION (EPC) MODE."

(BH-1, BH-3, BH-7, BH-8, BH-9, BH-10, BH-12, BH-13 & BH-14)

For :
M/S ZETWERK MANUFACTURING BUSINESSES PRIVATE LIMITED
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No. Proj/PNT/22-23/1102-Vol-3

ISO 9001 : 2015 & Govt. Approved Quality Certified Lab.

PNT DESIGNS (Pvt.) Ltd.

GEOTECHNICAL INVESTIGATION REPORT FOR DETERMINATION OF ALLOWABLE BEARING PRESSURE FOR

"MAJOR UPGRADATION OF KOTA RAILWAY STATION ON ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) MODE"

ABSTRACT

1. OPEN FOUNDATION :

The Net Allowable Bearing Pressure of open foundation is tabulated as follows :

Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
BH-01	--	--	4.50m	6.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	11.00 t/m²	
	--	--	4.50m	5.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	8.50 t/m²	
	--	--	4.50m	6.50 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	9.00 t/m²	
	--	--	4.50m	6.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	8.00 t/m²	
BH-03	--	--	4.50m	8.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.00 t/m²	
	--	--	4.50m	6.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	9.50 t/m²	
	--	--	4.50m	8.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.00 t/m²	
BH-07	--	--	4.50m	8.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	11.50 t/m²	
	--	--	4.50m	6.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	9.00 t/m²	

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Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
	--	--	4.50m	8.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	9.50 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	8.50 t/m²	
BH-08	--	--	4.50m	8.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.00 t/m²	
	--	--	4.50m	6.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	9.50 t/m²	
	--	--	4.50m	8.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.00 t/m²	
BH-09	--	--	4.50m	5.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.00 t/m²	
	--	--	4.50m	4.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	5.50 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	10.50 t/m²	
	--	--	4.50m	5.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.00 t/m²	
BH-10	--	--	4.50m	8.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.50 t/m²	
	--	--	4.50m	[illegible]	Isolated (4.0 x 4.0m)
	--	--	5.50m	[illegible]	
	--	--	4.50m	[illegible]	Raft (8.0 x 15.0m)
	--	--	5.50m	10.50 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.50 t/m²	

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Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
BH-12	--	--	4.50m	10.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	13.50 t/m²	
	--	--	4.50m	8.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	11.00 t/m²	
	--	--	4.50m	9.50 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	11.00 t/m²	
	--	--	4.50m	8.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	10.00 t/m²	
BH-13	--	--	4.50m	10.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	13.50 t/m²	
	--	--	4.50m	8.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	10.50 t/m²	
	--	--	4.50m	10.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	11.50 t/m²	
	--	--	4.50m	9.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	10.00 t/m²	
BH-14	--	--	4.50m	9.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	13.50 t/m²	
	--	--	4.50m	8.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	10.50 t/m²	
	--	--	4.50m	10.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	11.50 t/m²	
	--	--	4.50m	9.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	10.00 t/m²	

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2. PILE FOUNDATION (*Under Reamed Pile*):

The Allowable load carrying capacity of the under reamed pile are given below :

BH-01, BH-03 & BH-09

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.5xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	600	12.8	22.9	29.9	40.0
2	50	125.0	600	16.8	29.3	35.4	47.8
3	60	150.0	600	26.5	--	47.5	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L. = 11.50 m
Length of Pile below Cutoff = 11.00 m
Length of Pile (Design) below Soft Layer= 6.00 m
Thickness of Soft Layer from GL = 5.50 m

BH-07, BH-08, BH-12, BH-13 & BH-14

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.5xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	600	20.5	28.6	27.0	35.1
2	50	125.0	600	24.9	34.9	31.8	41.7
3	60	150.0	600	35.1	--	42.3	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L. = 9.00 m
Length of Pile below Cutoff = 8.50 m
Length of Pile (Design) below Soft Layer= 6.00 m
Thickness of Soft Layer from GL = 3.00 m

3

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BH-08 & BH-10

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.5xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	600	18.2	27.5	28.7	37.9
2	50	125.0	600	22.7	34.1	33.8	45.3
3	60	150.0	600	33.1	--	45.3	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L = 10.00 m

Length of Pile below Cutoff = 9.50 m

Length of Pile (Design) below Soft Layer= 6.00 m

Thickness of Soft Layer from GL = 4.00 m

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THE STRATA AT GLANCE

Borehole No.	Type of strata	Depth
1	2	3
BH-01	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	3.00-16.50m
BH-03	Filled Up	0.00-3.00m
	Low Plastic Clay (CL) mixed with Sand	3.00-9.00m
	Silty Sand (SM)	9.00-10.50m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	10.50-16.50m
BH-07	Filled Up	0.00-3.00m
	Low Plastic Clay (CL)	3.00-4.50m
	Clayey Sand (SC)	4.50-6.00m
	Low Plastic Clay (CL)	6.00-9.00m
	Silty Sand (SM)	9.00-16.50m
BH-08	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	3.00-16.50m

4

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Borehole No.	Type of strata	Depth
1	2	3
BH-09	Filled Up	0.00-2.80m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	2.80-16.50m
BH-10	Filled Up	0.00-2.90m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	2.90-16.50m
BH-12	Filled Up	0.00-2.70m
	Medium Plastic Clay (CI)	2.70-3.00m
	Low Plastic Clay (CL) mixed with Sand	3.00-4.50m
	Silty Sand (SM)	4.50-6.00m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	6.00-16.50m
BH-13	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	3.00-16.50m
BH-14	Filled Up	0.00-3.00m
	Low Plastic Clay (CL) mixed with Sand	3.00-10.50m
	Silty Sand (SM)	10.50-12.00m
	Low Plastic Clay (CL)	12.00-16.50m

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A

REPORT ON

GEOTECHNICAL INVESTIGATION WORK FOR "MAJOR UPGRADATION OF KOTA RAILWAY STATION ON ENGINEERING PROCUREMENT AND CONSTRUCTION (EPC) MODE."

(BH-15, BH-16, BH-17, BH-18, BH-19, BH-20, BH-22, BH-23 & BH-24)

For :
M/S ZETWERK MANUFACTURING BUSINESSES PRIVATE LIMITED
PLOT NO E-96, BASNI, , 2ND PHASE BASNI,
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By :
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Mob.09929866699, 9414188818

No. Proj/PNT/22-23/11492-Vol-2

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PCT

GEOTECHNICAL INVESTIGATION REPORT FOR DETERMINATION OF ALLOWABLE BEARING PRESSURE FOR

"MAJOR UPGRADATION OF KOTA RAILWAY STATION ON ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) MODE"

ABSTRACT

1. OPEN FOUNDATION :

The Calculated Net Allowable Bearing Pressure of open foundation is tabulated as follows :

Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
BH-15	--	--	4.50m	8.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.00 t/m²	
	--	--	4.50m	6.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	8.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.00 t/m²	
BH-16	--	--	2.00m	6.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	3.00m	10.00 t/m²	
	--	--	4.00m	13.00 t/m²	
	--	--	2.00m	5.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	11.50 t/m²	
	--	--	2.00m	7.00 t/m²	Raft (8.0 x 15.0m)
	--	--	3.00m	9.00 t/m²	
	--	--	4.00m	11.00 t/m²	
	--	--	2.00m	6.00 t/m²	Raft (10.0 x 20.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	10.00 t/m²	

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Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
BH-17	--	--	2.00m	6.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	3.00m	10.00 t/m²	
	--	--	4.00m	13.00 t/m²	
	--	--	2.00m	5.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	3.00m	7.50 t/m²	
	--	--	4.00m	11.50 t/m²	
	--	--	2.00m	6.00 t/m²	Raft (8.0 x 15.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	11.00 t/m²	
	--	--	2.00m	6.00 t/m²	Raft (10.0 x 20.0m)
	--	--	3.00m	7.50 t/m²	
	--	--	4.00m	10.00 t/m²	
BH-18	--	--	2.50m	7.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	3.00m	9.50 t/m²	
	--	--	4.00m	13.00 t/m²	
	--	--	2.50m	6.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	3.00m	7.50 t/m²	
	--	--	4.00m	12.00 t/m²	
	--	--	2.50m	7.50 t/m²	Raft (8.0 x 15.0m)
	--	--	3.00m	9.00 t/m²	
	--	--	4.00m	11.50 t/m²	
	--	--	2.50m	7.00 t/m²	Raft (10.0 x 20.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	10.50 t/m²	
BH-19	--	--	2.50m	6.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	12.50 t/m²	
	--	--	2.50m	5.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	3.00m	6.50 t/m²	

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Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
	--	--	4.00m	9.50 t/m²	
	--	--	2.50m	7.00 t/m²	Raft (8.0 x 15.0m)
	--	--	3.00m	8.00 t/m²	
	--	--	4.00m	10.00 t/m²	
	--	--	2.50m	6.50 t/m²	Raft (10.0 x 20.0m)
	--	--	3.00m	7.00 t/m²	
	--	--	4.00m	9.00 t/m²	
BH-20	--	--	4.50m	6.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	10.50 t/m²	
	--	--	4.50m	5.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	8.00 t/m²	
	--	--	4.50m	6.50 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	8.50 t/m²	
	--	--	4.50m	6.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	8.00 t/m²	
BH-22	--	--	4.50m	8.00 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	12.00 t/m²	
	--	--	4.50m	6.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	8.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	10.00 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	9.00 t/m²	
BH-23	--	--	4.50m	5.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	9.00 t/m²	
	--	--	4.50m	4.50 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	7.00 t/m²	
	--	--	4.50m	6.00 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	8.00 t/m²	

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Location of Borehole	Existing Ground Level	Founding Level	Depth of Foundation Df (m) (below Existing GL)	Net Allowable Bearing Pressure (t/m²)	Type of foundation
	--	--	4.50m	5.50 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	7.00 t/m²	
BH-24	--	--	4.50m	7.50 t/m²	Isolated (3.0 x 3.0m)
	--	--	5.50m	11.00 t/m²	
	--	--	4.50m	6.00 t/m²	Isolated (4.0 x 4.0m)
	--	--	5.50m	8.50 t/m²	
	--	--	4.50m	7.50 t/m²	Raft (8.0 x 15.0m)
	--	--	5.50m	9.00 t/m²	
	--	--	4.50m	7.00 t/m²	Raft (10.0 x 20.0m)
	--	--	5.50m	8.00 t/m²	

2. PILE FOUNDATION (*Under Reamed Pile*):

The Allowable load carrying capacity of the under reamed pile are given below :

BH-15, BH-20, BH-22 & BH-24

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.6xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	600	22.1	29.5	25.9	33.3
2	50	125.0	600	26.6	35.8	30.4	39.6
3	60	150.0	600	36.8	--	40.4	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L =	9.00	m
Length of Pile below Cutoff =	8.50	m
Length of Pile (Design) below Soft Layer=	6.00	m
Thickness of Soft Layer from GL =	3.00	m

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BH-16, BH-17, BH-18 & BH-19

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.5xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	620	28.7	37.2	27.7	36.2
2	50	125.0	620	34.1	44.6	32.6	43.0
3	60	150.0	620	46.3	--	43.4	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L. = 7.50 m

Length of Pile below Cutoff = 7.00 m

Length of Pile (Design) below Soft Layer= 6.20 m

Thickness of Soft Layer from GL = 1.30 m

BH-23

S. No.	Pile Dia. (cm)	Bulb dia. (cm)	Design Length of pile (cm)	Allowable Load carrying capacity (after Deducting Negative Skin Friction) (t)		Safe Uplift Resistance (t)	
	D	Du = 2.5xD		Single Under Reamed	Double Under Reamed	Single Under Reamed	Double Under Reamed
1	45	112.5	600	10.8	19.2	27.6	36.0
2	50	125.0	600	14.2	24.6	32.4	42.8
3	60	150.0	600	22.6	--	43.2	--

Note :

Pile Shaft for Skin Friction should be ≥2 x Du, hence pile of other dia. is not recommended

Length of Pile below Existing G.L. = 11.50 m

Length of Pile below Cutoff = 11.00 m

Length of Pile (Design) below Soft Layer= 6.00 m

Thickness of Soft Layer from GL = 5.50 m

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THE STRATA AT GLANCE

Borehole No.	Type of strata	Depth
1	2	3
BH-15	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL)/ Low Plastic Clay mixed with Sand	3.00-16.50m
BH-16	Filled Up Material	0.00-0.80m
	Medium Plastic Clay (CI)	0.80-1.50m
	Low Plastic Clay (CL) mixed with Sand	1.50-10.00m
BH-17	Filled Up Material	0.00-0.70m
	Medium Plastic Clay (CI)	0.70-1.50m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	1.50-10.00m
BH-18	Filled Up Material	0.00-1.00m
	Medium Plastic Clay (CI)	1.00-1.50m
	Low Plastic Clay (CL) mixed with Sand	1.50-10.00m
BH-19	Filled Up Material	0.00-1.30m
	Medium Plastic Clay (CI)	1.30-1.50m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	1.50-10.00m
BH-20	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	3.00-16.50m
BH-22	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	3.00-16.50m
BH-23	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	3.00-15.00m
BH-24	Filled Up Material	0.00-3.00m
	Low Plastic Clay (CL) / Low Plastic Clay mixed with Sand	3.00-16.00m

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15 OTHER DATA

Specific requirements of floor and wall cut-outs for services, sinking of floors in services, toilet areas, external architectural features, and entrance canopies will be provided as required by Architects and Service Consultants. The relevant information will be obtained from them in the form of drawings.

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16 Annexure A

ETABS ANALYSIS

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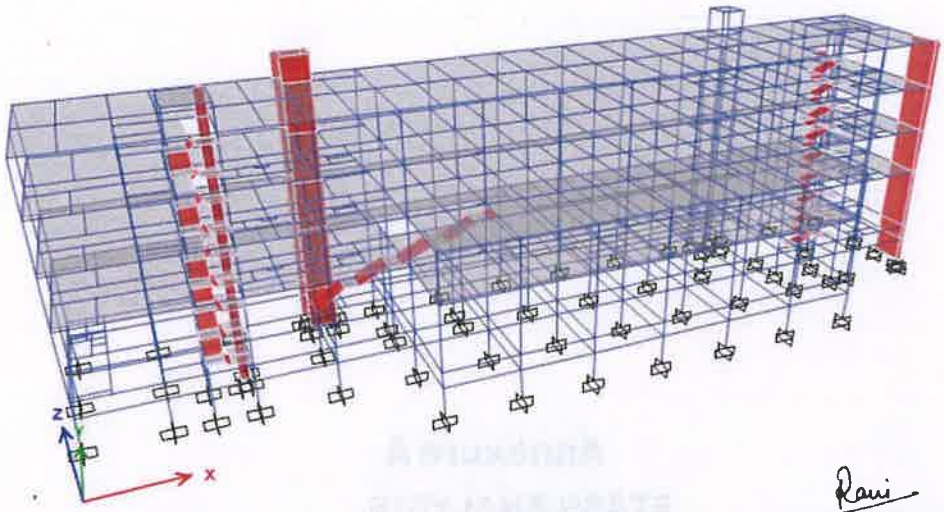
16. A. ETABS ANALYSIS MODEL OF REAR STATION



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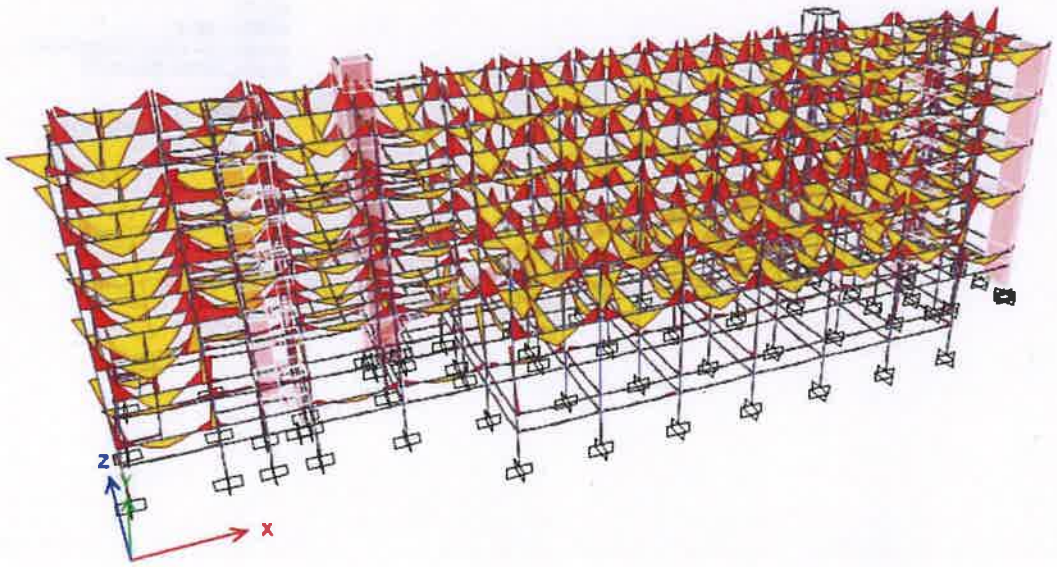
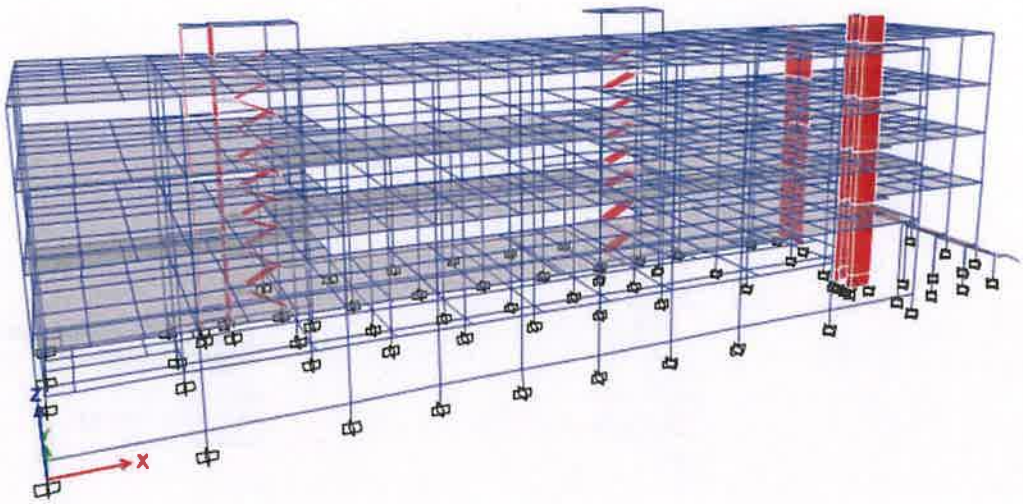
16. B. BENDING MODEL OF REAR STATION (DL+LL)



16. A. ETABS ANALYSIS MODEL OF FRONT STATION



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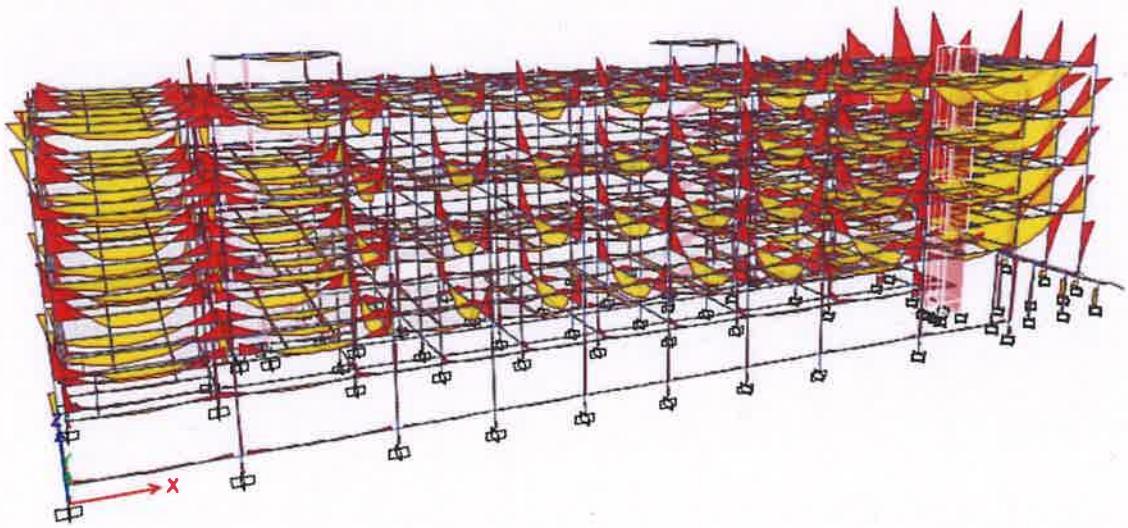
17. B. BENDING MODEL OF REAR STATION (DL+LL)



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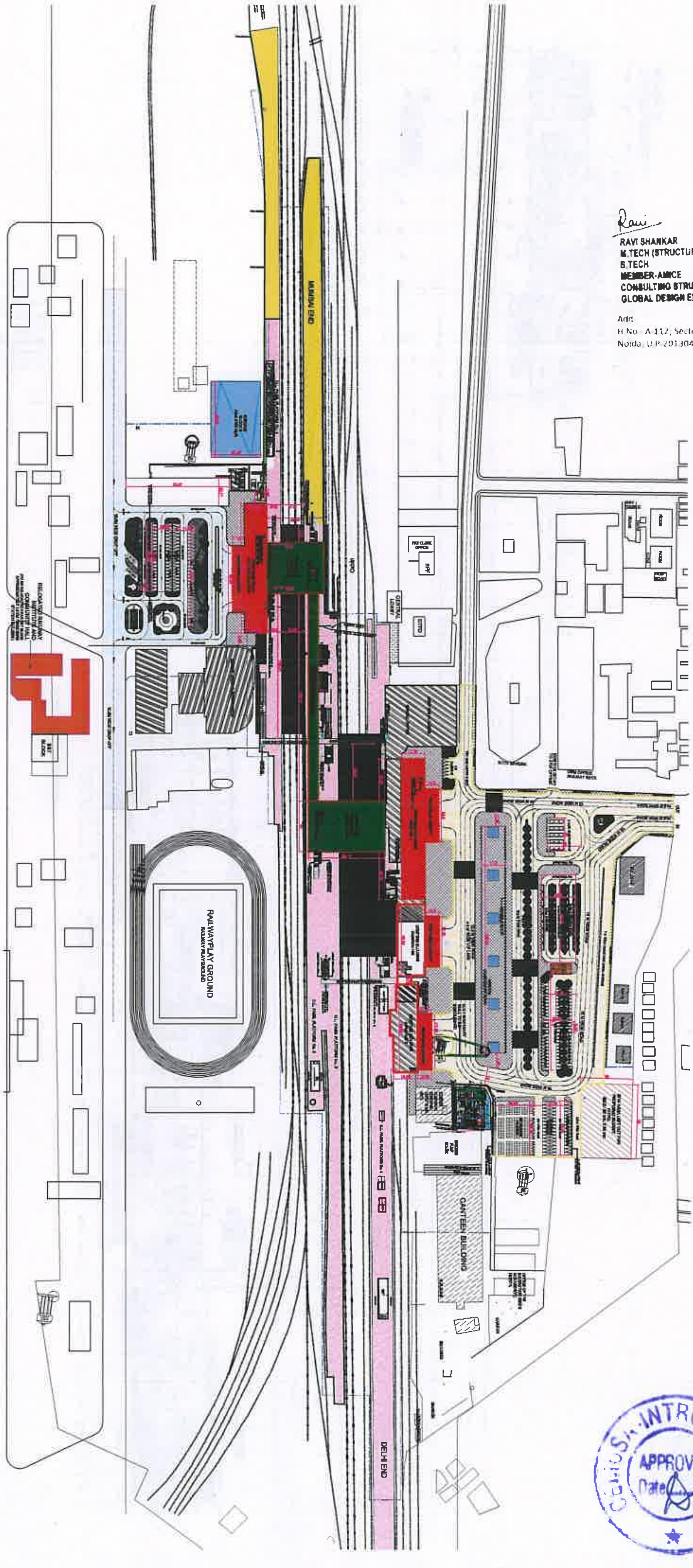
17 Annexure A

ARCHITECTURAL DRAWINGS



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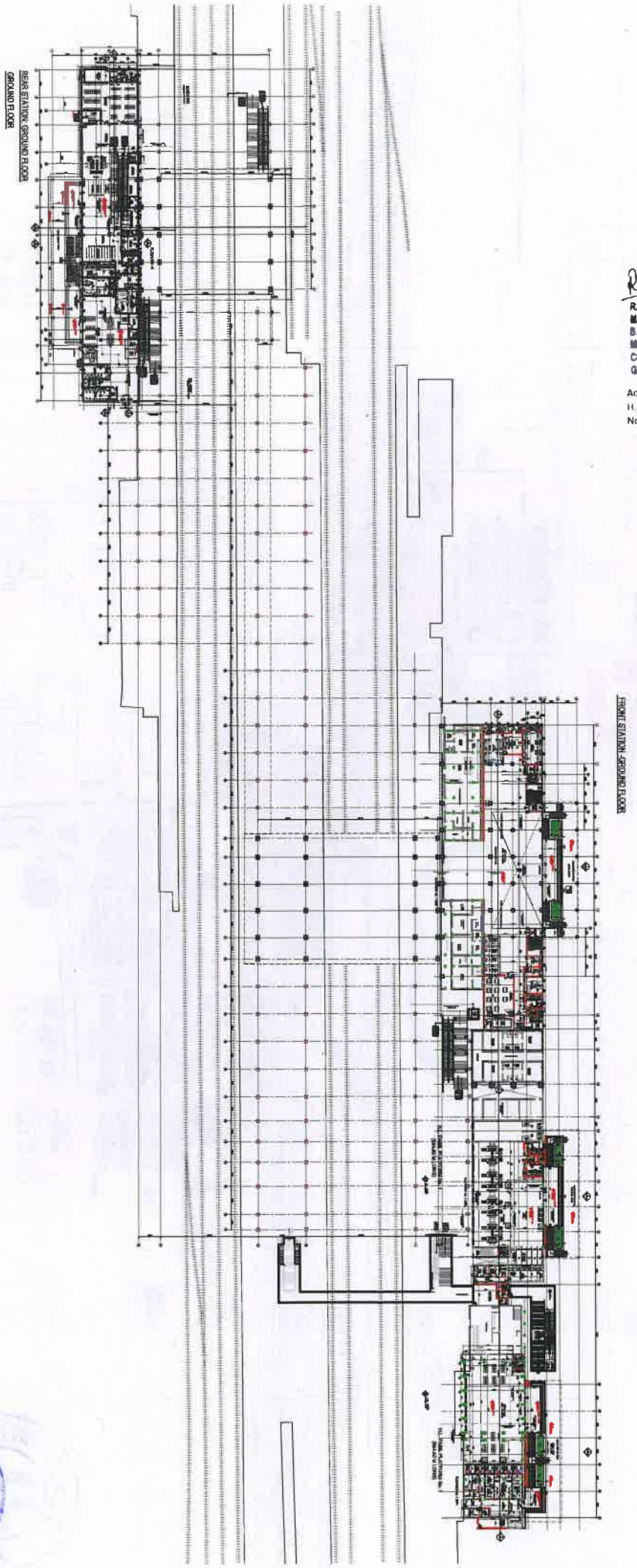

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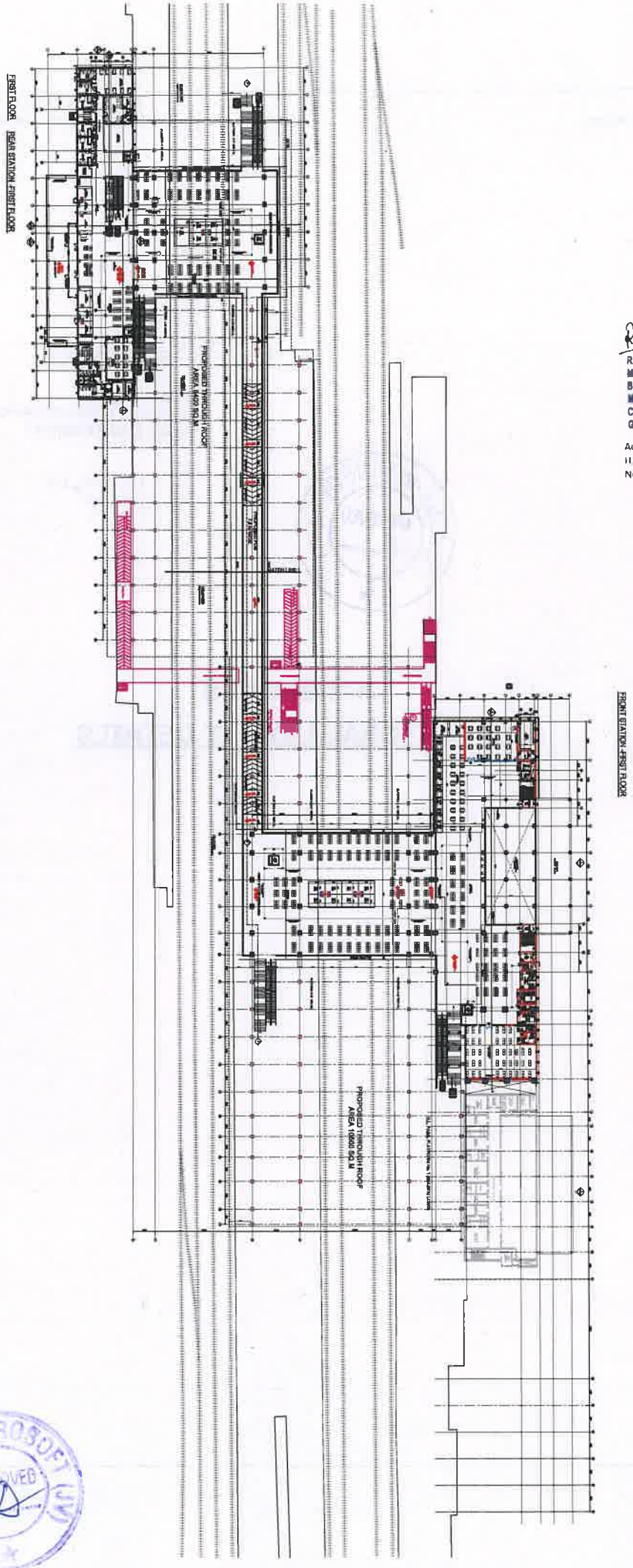

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CEMOSA-INTROSOFT (JV)
APPROVED
Date.....

18. Annexure B

STRUCTURAL LAYOUT DETAILS

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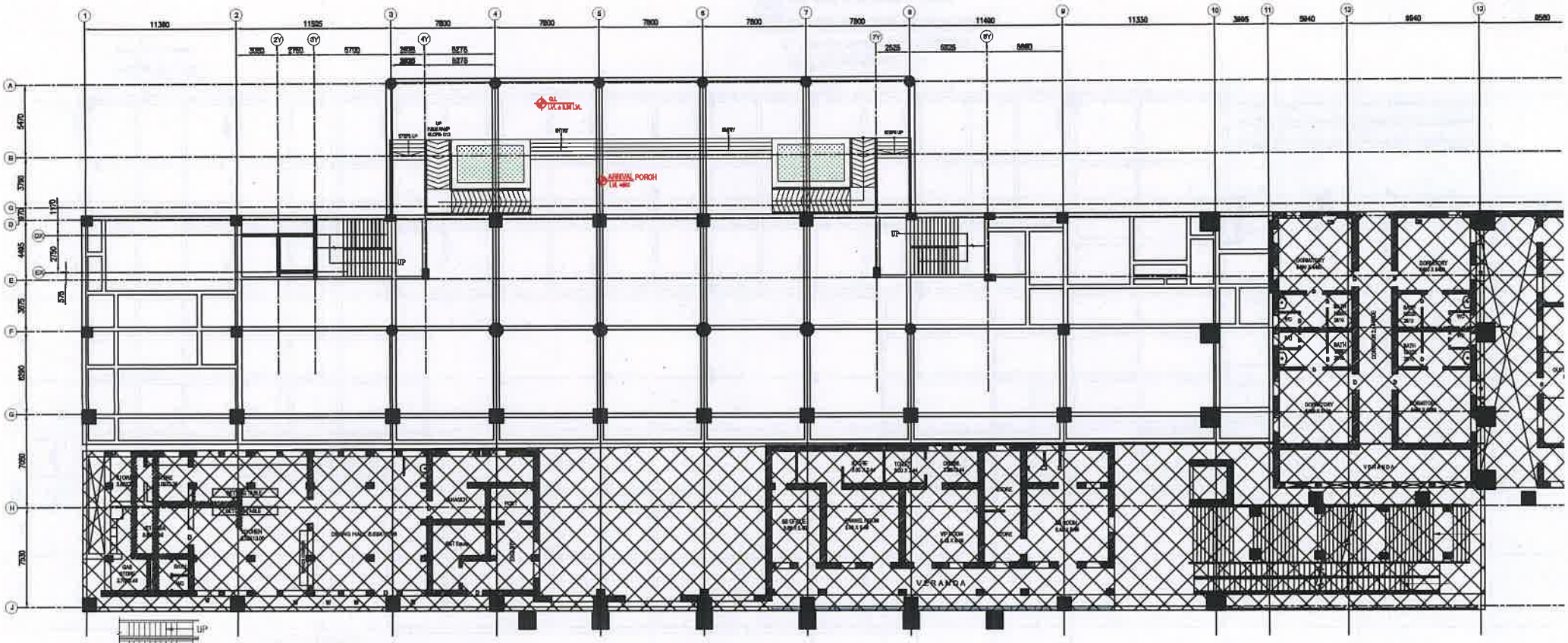
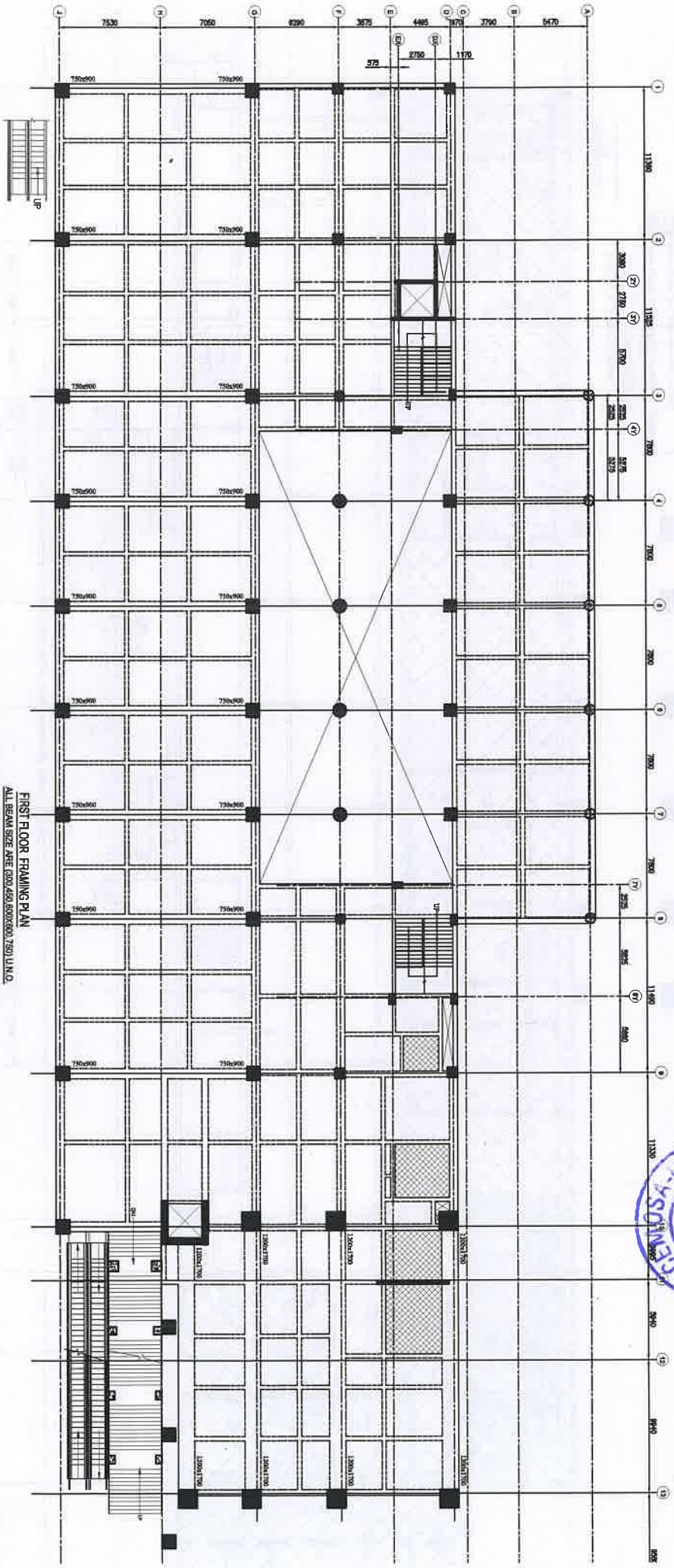


PLINTH LVL. FRAMING PLAN

ALL BEAM SIZE ARE (300,450X600)U.N.O.

HATCH INDICATE COLUMN THROUGH FOUNDATION TO TERMINATION.

HATCH INDICATE COLUMN/RETAINING WALL TERMINATE.



HATCH INDICATE COLUMN THROUGH FOUNDATION TO TERMINATION

HATCH INDICATE COLUMN/RETAINING WALL TERMINATE

HATCH INDICATE AREA 400MM SUNKEN

FIRST FLOOR FRAMING PLAN

ALL BEAM SIZE ARE (300,450,600X600,750) U.N.O.

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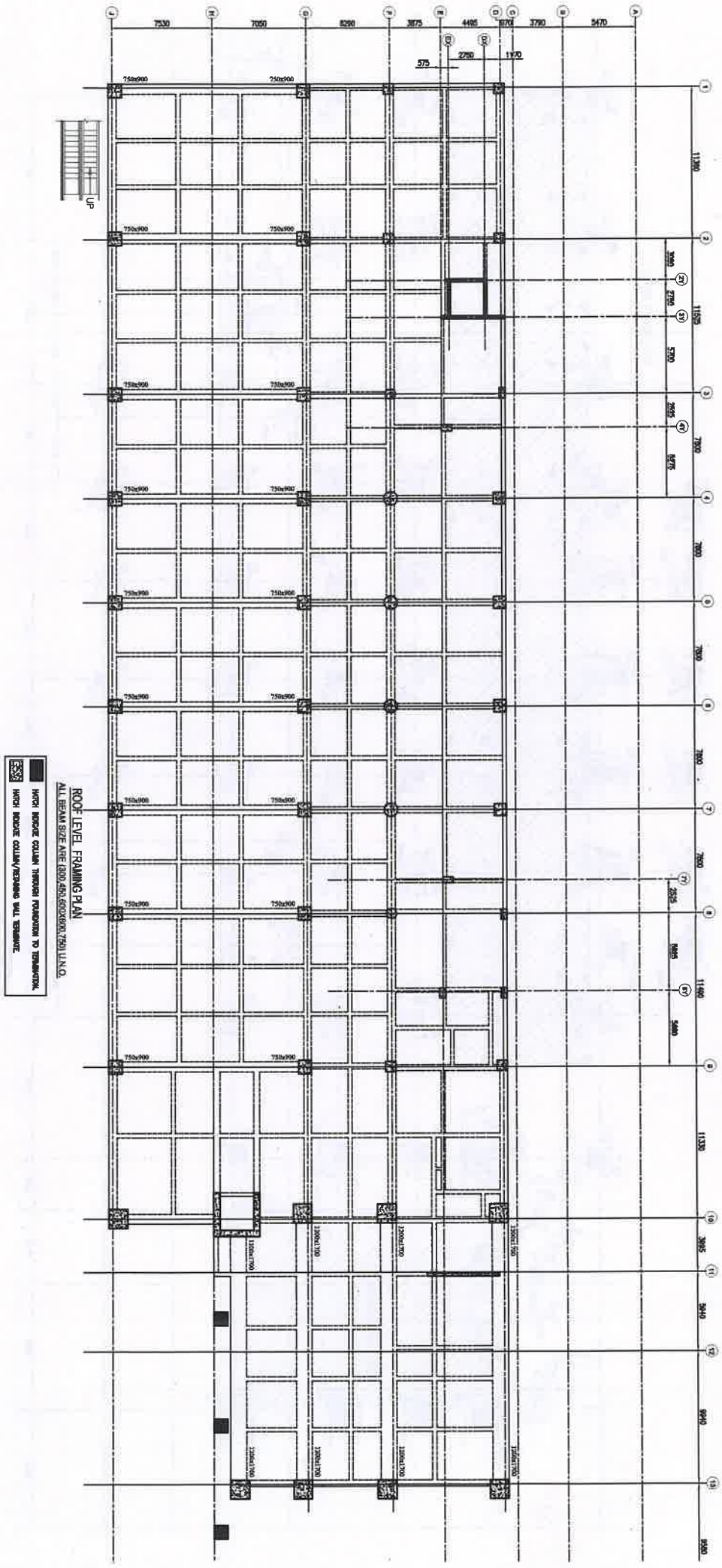

ROOF LEVEL FRAMING PLAN

ALL BEAM SIZE ARE (300,450,600X900,750) U.N.O.

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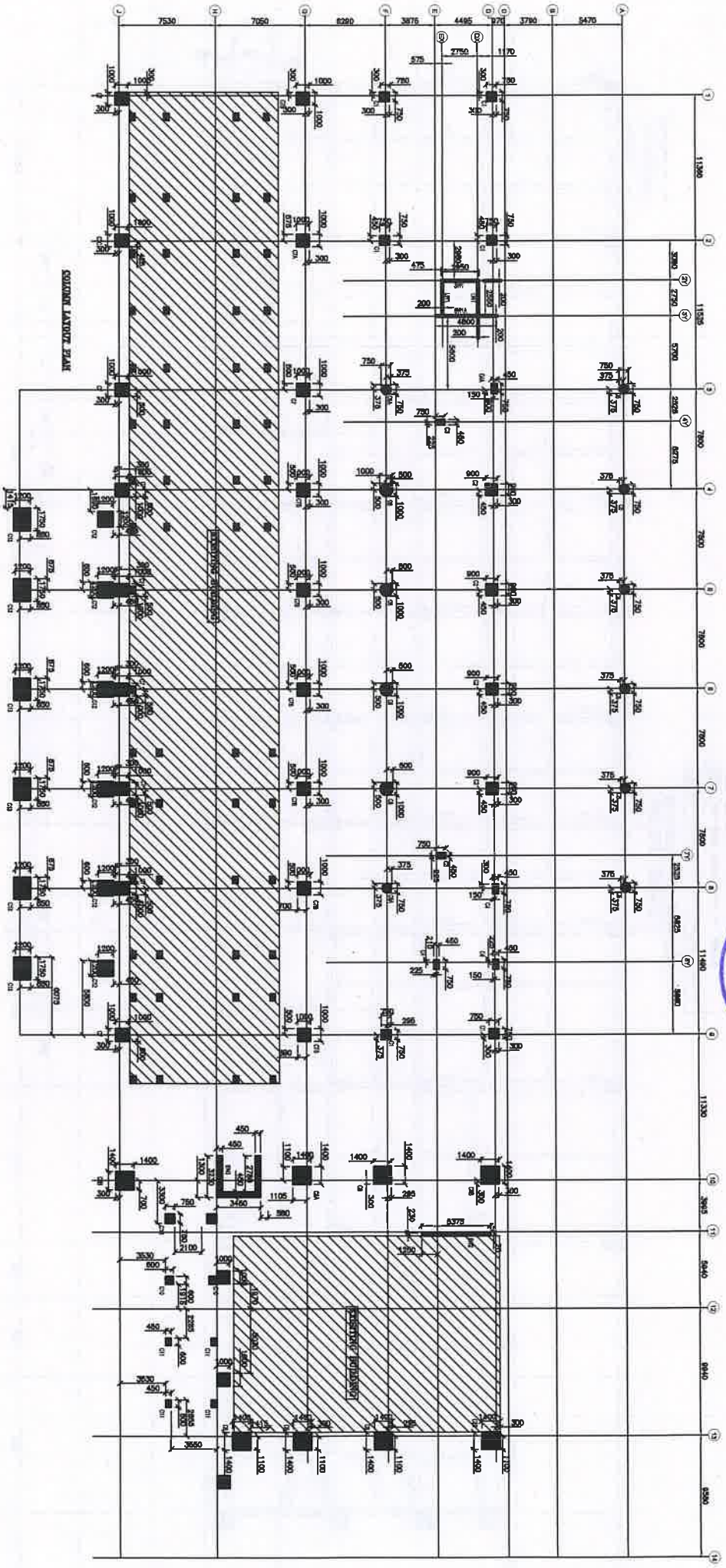

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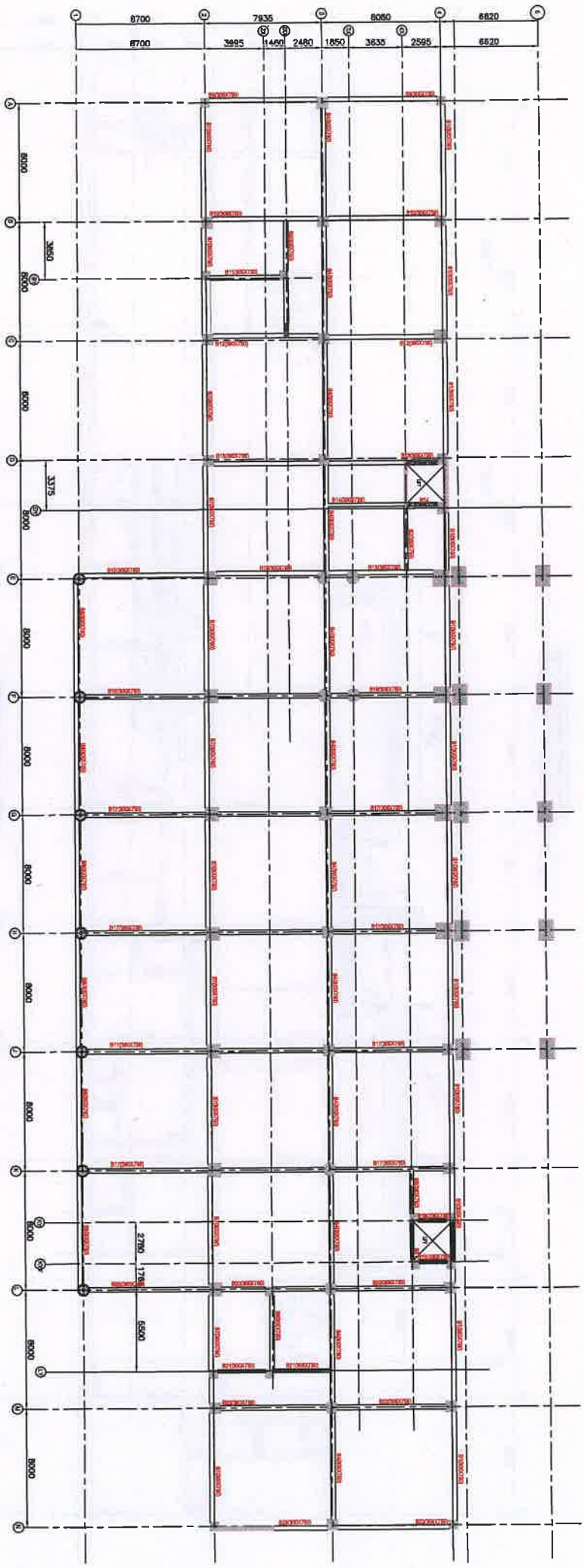

FRAMING PLAN AT TOR LVL-1250

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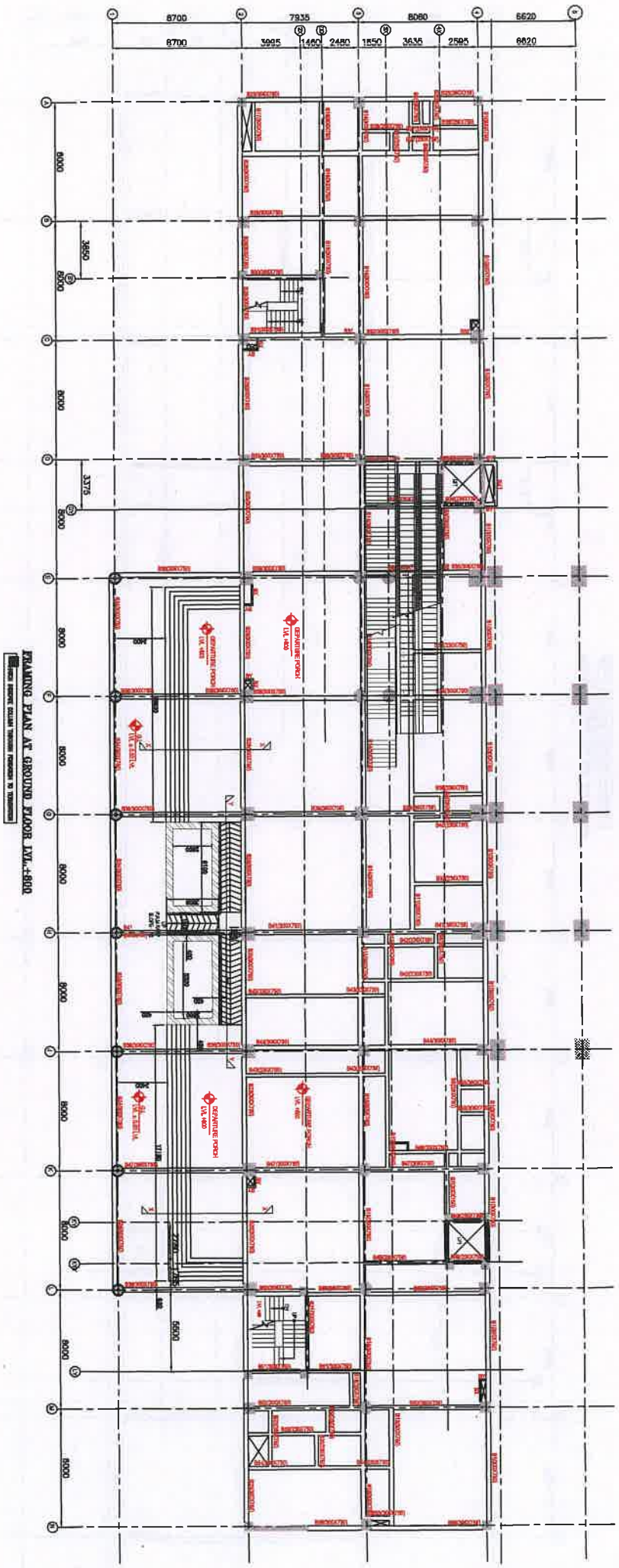

FRAMING PLAN AT GROUND FLOOR LVL +600

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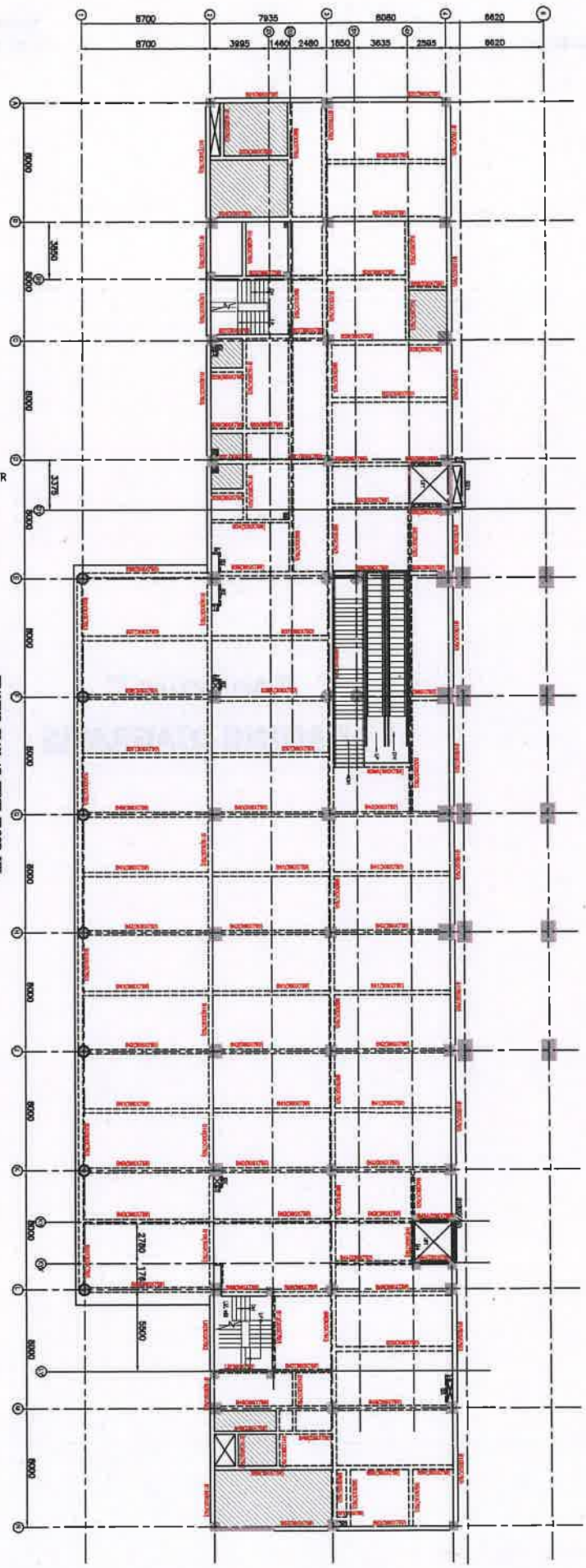

FRAMING PLAN AT FIRST FLOOR LVL
ALL SLAB THK. ARE 150MM (U.N.O.)
PROVIDE CANTILEVER AS/CANTILEVER SCHEDULE

19. Annexure C

LOADING DIAGRAMS

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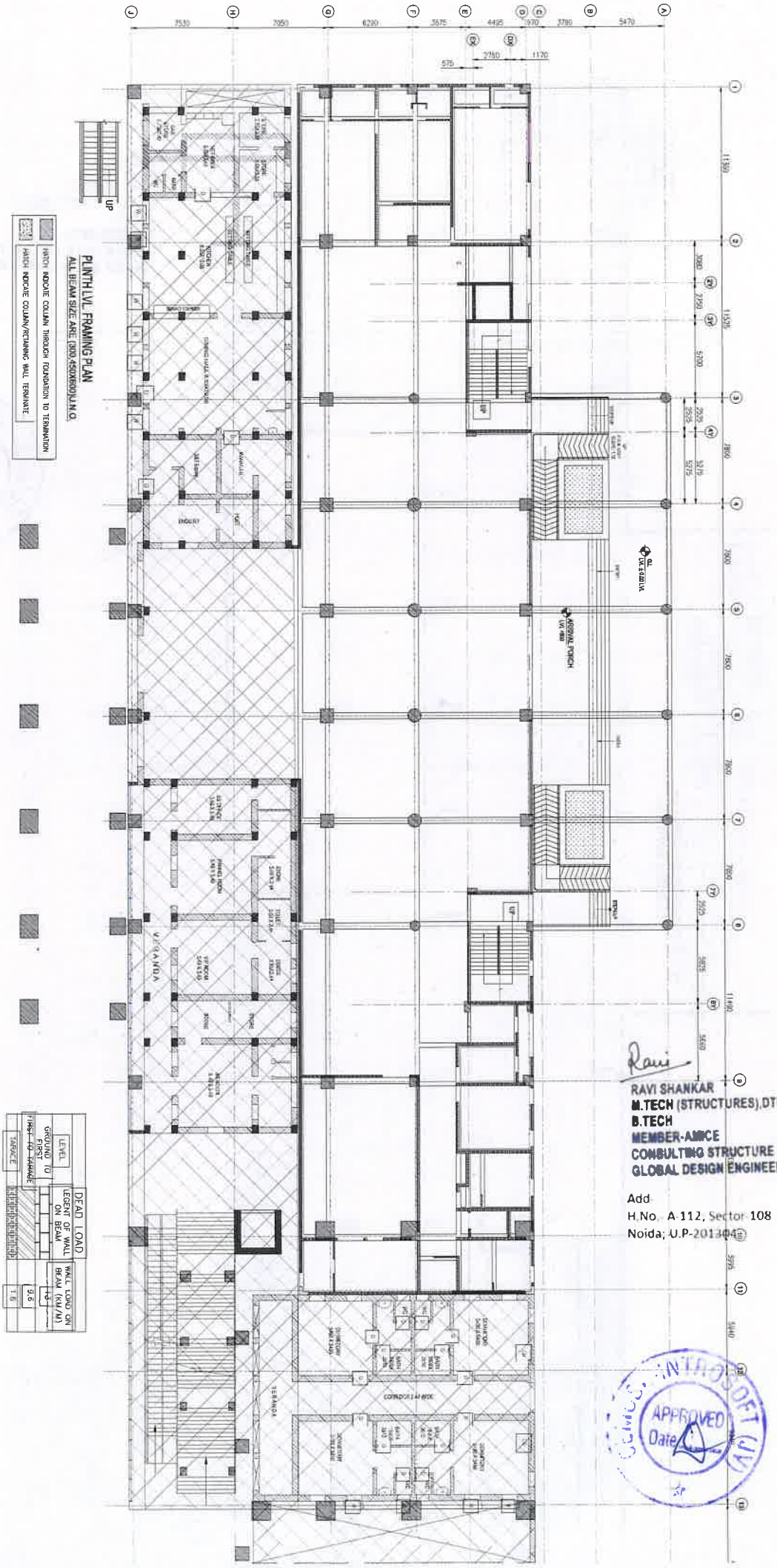

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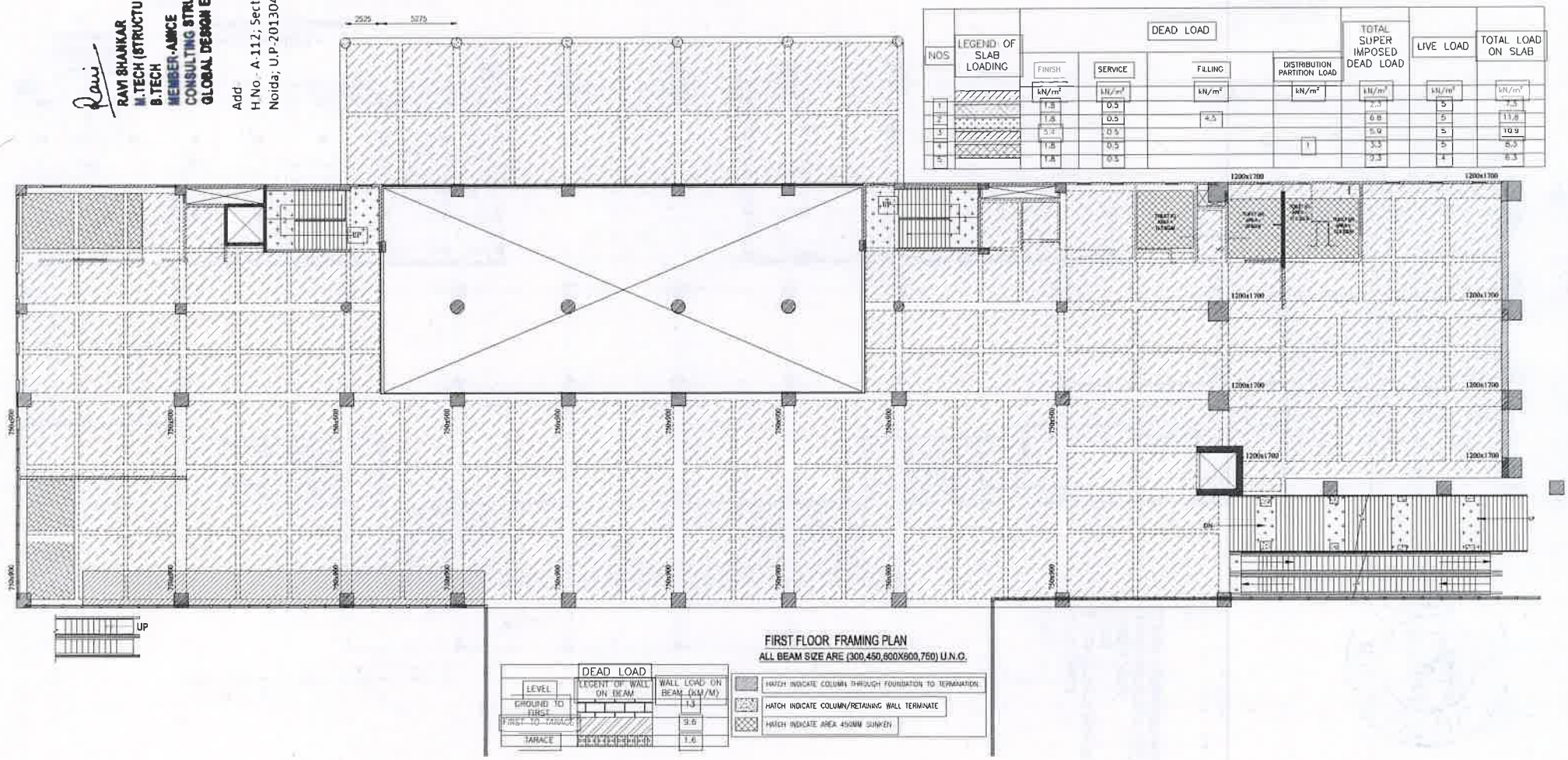
INTROSOFT (JV) APPROVED Date CEMOSA



FIRST FLOOR FRAMING PLAN

ALL BEAM SIZE ARE (300,450,600X600,750) U.N.O.

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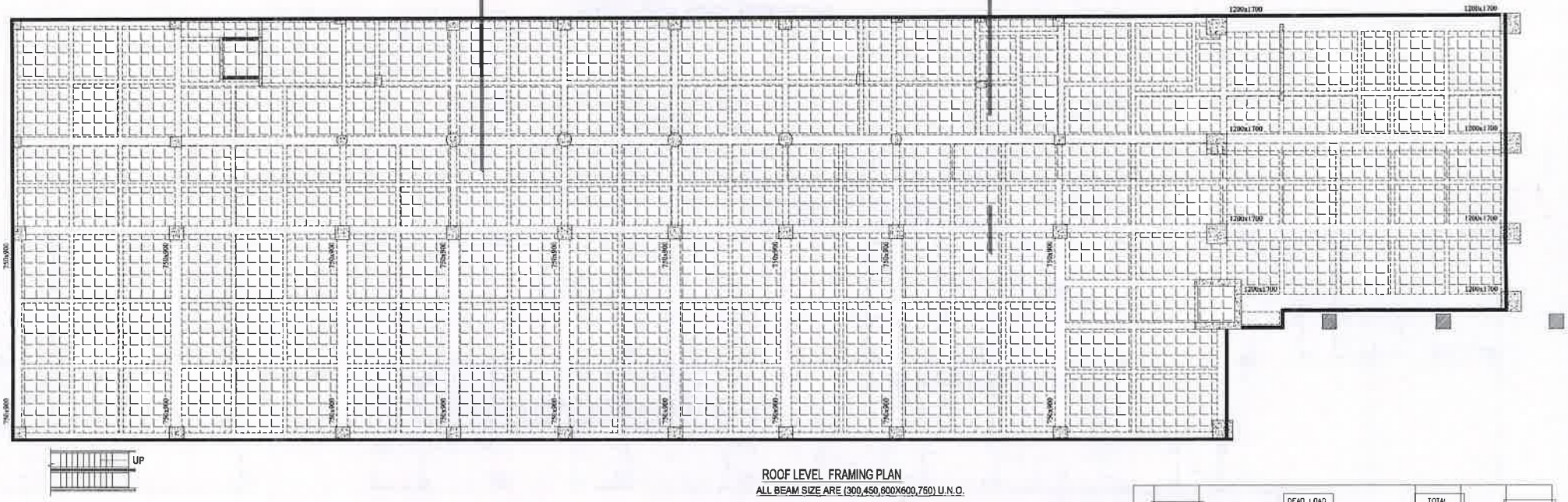
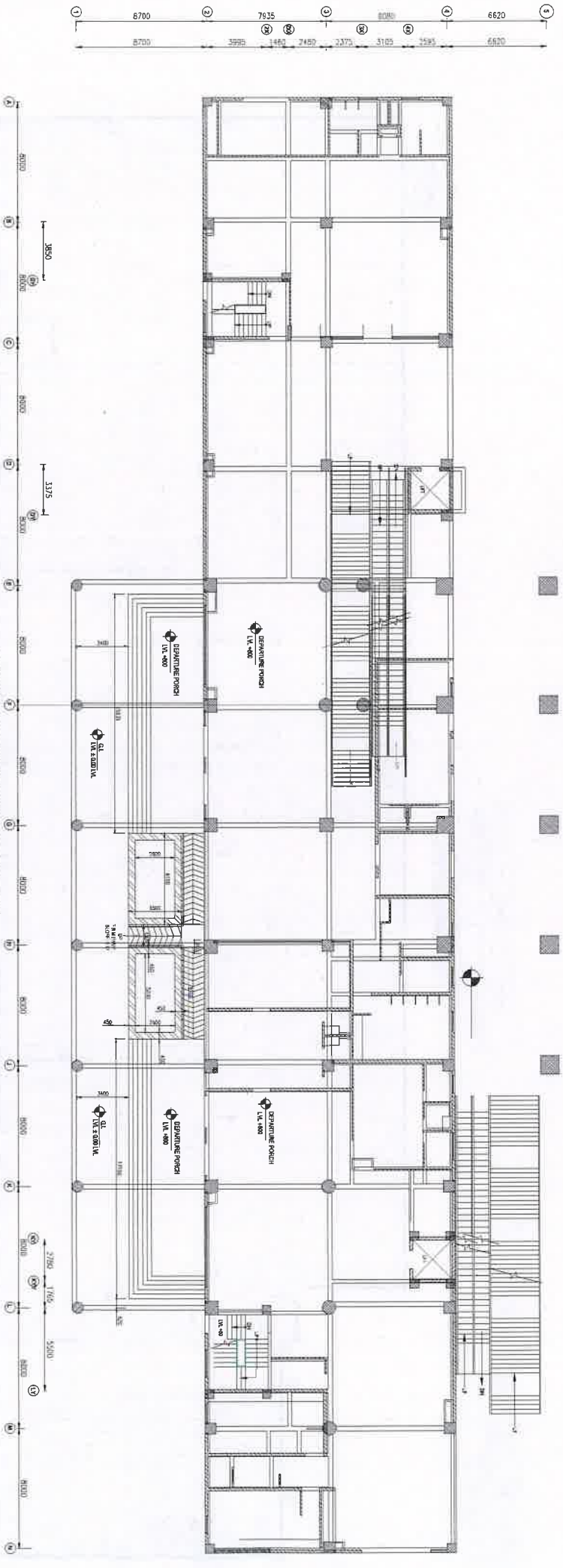


ROOF LEVEL FRAMING PLAN

ALL BEAM SIZE ARE (300,450,600X600,750) U.N.O.

	HATCH INDICATE COLUMN THROUGH FOUNDATION TO TERMINATION.
	HATCH INDICATE COLUMN/RETAINING WALL TERMINATE

NOS	LEGEND OF SLAB LOADING	DEAD LOAD				TOTAL SUPER IMPOSED DEAD LOAD	LIVE LOAD	TOTAL LOAD ON SLAB
		FINISH	SERVICE	PLUMB				



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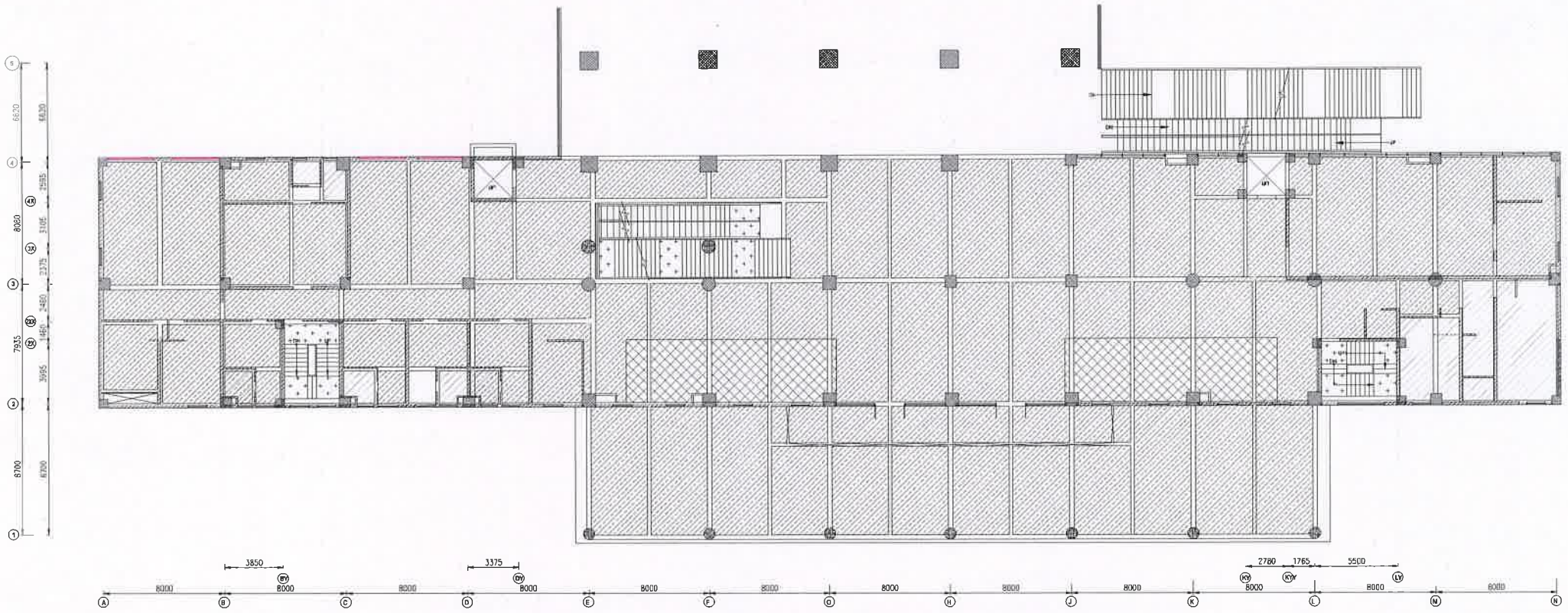

NOS	LEGEND OF SLAB LOADING	DEAD LOAD				TOTAL SUPER IMPOSED DEAD LOAD	LIVE LOAD	TOTAL LOAD ON SLAB
		FINISH kN/m²	SERVICE kN/m²	FILLING kN/m²	DISTRIBUTION PARTITION LOAD kN/m²	kN/m²	kN/m²	kN/m²
1		1.8	0.5	4.5		2.3	5	7.3
2		1.8	0.5			6.9	5	11.9
3		2.4	0.5			5.9	5	10.9
4		1.8	0.5			3.3	5	8.3
5		1.8	0.5			2.3	4	6.3

FRAMING PLAN AT FIRST FLOOR LVL.+9250

DEAD LOAD		
LEVEL	LEGEND OF WALL ON BEAM	WALL LOAD ON BEAM (kN/M)
FIRST TO TARACE		9.6

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