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Civil & Structural Consultants
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e-mail : buroindia@buroengineers.in, admin@buroengineers.in
CIN : U45201TN2005PTC055334

STRUCTURAL STABILITY CERTIFICATE

PROPOSED CONSTRUCTION OF HIGH RISE BUILDING WITH 59.82M HEIGHT CONSISTING OF EXTENDED DOUBLE BASEMENT FLOOR + STILT FLOOR + 18 FLOORS (INDOOR GAMES, PARTY HALL, GYM @ 18TH FLOOR) RESIDENTIAL BUILDING WITH 122 DWELLING UNITS AT JAWAHARLAL NEHRU ROAD, KOYAMBEDU, AMINJIKARAI TALUK, CHENNAI - 600107, COMPRISED IN T.S NOS. 1/4, 1/5, 1/17, 1/18, 1/19,1/20,1/21,1/23,1/24, 1/25, 1/31 AND 1/32, BLOCK NO.64,KOYAMBEDU VILLAGE, WITHIN THE LIMITS OF GREATER CHENNAI CORPORATION.

This is to certify that the Proposed Construction of high rise building with 59.82m height consisting of Extended Double Basement floor + Stilt floor + 18 floors (Indoor games, Party hall, Gym @ 18th floor) Residential building with 122 dwelling units at Jawaharlal Nehru Road, Koyambedu, Aminjikarai Taluk, Chennai - 600107, Comprised in T.S nos. 1/4, 1/5, 1/17, 1/18, 1/19,1/20,1/21,1/23,1/24, 1/25, 1/31 and 1/32, Block no.64, Koyambedu Village, within the limits of Greater Chennai Corporation is stable against all possible Gravity, Seismic loads, Wind loads and other Combination of loads as per the relevant IS Codes and other Codes in vogue which the structure is intended to with stand.

Check has been made and ensured that it is structurally safe & sound for the intended purposes. Also hereby certify that the following,

1. Foundation & its Shear wall/Columns are designed considering Double Basement + Stilt+ 18 Floor structure with LMR, OHT and Head room as per Architectural plans considering the relevant Residential Building loading as per BIS.

2. The minimum grade of concrete used in the design of structural element is M30.

3. The Analysis and design carried out for the intended Residential Building loading as per the code of practice IS 875 Part 1 to 2, wind forces as per IS 875-2015 (Part3) and seismic forces as per the seismic code of practice IS 1893-2016.

4. Design of Structural elements & detailing carried out as per the stipulations made as per the code of practice IS 456-2000 & IS-13920-2016.

5. Bored Cast In-situ Pile Foundation is designed considering the sub soil condition reported & the recommendation laid down in the Soil Investigation report No. GT-2453 dated 16-11-2022, carried out by M/s. GEO MARINE CONSULTANTS (P) LTD, Chennai.

The Building will be structurally stable when used for the purpose for which it is designed.

Date : 15.05.2024
Place : Chennai

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- Design Information and criteria
- Analysis summary report
- Design of Pile Foundation
- Design of RCC Wall
- Design of RCC beam
- Design of RCC Slab

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BURO ENGINEERS	APPASWAMY KOYAMBEDU, Chennai	DESIGN BRIEF REPORT-R0

Design Information and criteria

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1.0 PROJECT INFORMATION

1.1 Introduction:

This Design Brief Report (DBR) is for the Proposed Apartments at Koyambedu, Chennai, for Appaswamy Real Estates LTD.

The proposed residential building having 2 Basement + Stilt floor + 18 Upper floors.

This report provides the information on Codes of Practice, Design loading, Material Strength considered for the Design and Analysis of the building. In addition this report includes Structural system, Foundation system, Method statement of structural analysis which will be adopted for design and analysis for the building.

1.2 Facilities:

The proposed building is primarily a residential building housing apartments on typical floors and car parking facilities on Basement and Stilt floors.

2.0 STORY INFORMATION

Story	Facilities
Basement-2 & Basement-1	Parking. (Car & Two wheeler Parking)
Stilt Floor	Parking, Meter room, Association room
Extended Podium	Landscape area, Fire drive way, Generator, Transformer
Typical floor (1st to 17th)	Residential units. comprises of 7 flats in each floor
18th Floor	Residential units. comprises of 3 flats, Party hall, Gym, Home theatre, Swimming pool, Indoor games.
Terrace	Open terrace, OHT & LMR

2.1 Floor to Floor Height:

Basement 2	3.35m
Basement 1	3.66m
Stilt Floor	3.05m
1st to 17th Floor	3.12m
18th Floor	3.66m

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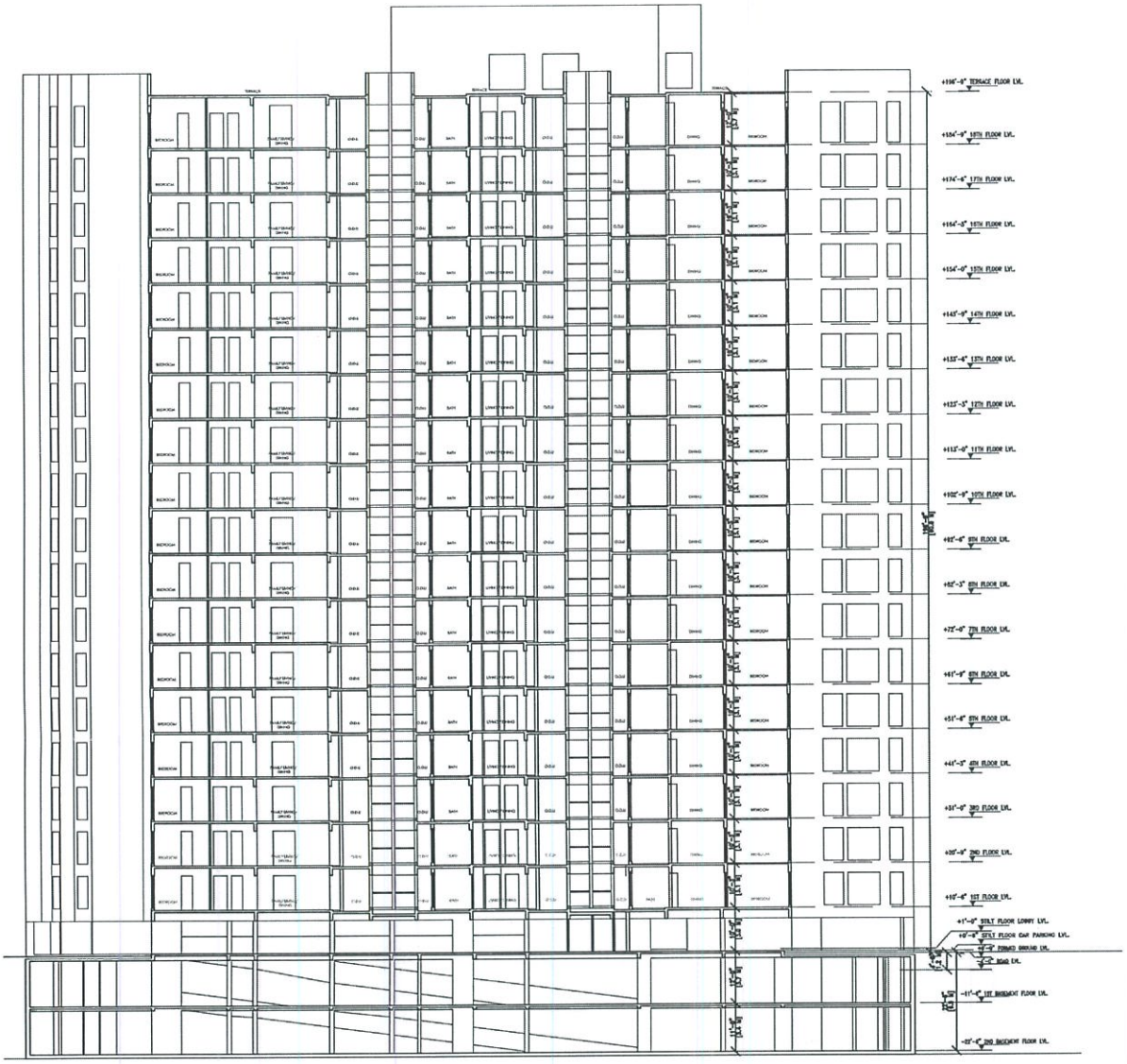
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Stilt Floor	Parking, Meter room, Association room
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SECTION - A

SECTIONAL VIEW

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3.0 CODES OF PRACTICE

The relevant Indian Standard codes below are followed.

3.1 Code, Standards and References:

All design of structures shall comply with the requirements specified in the following.

a. Relevant Indian Standard Codes of Practice
b. National Building Code.
c. Local Building regulations.
d. Other relevant International codes where required.

All applicable latest edition of codes and standards will be referred and adopted in the analysis of structures and the design and detailing of structural members. All structural elements design shall be carried out primarily based on. Indian Standards and Codes with latest revision, with amendments if any, as on date.In addition, other international codes and standards shall also be referred when required and relevant.

In the analysis, design and detailing of the building, the following Indian Standard codes of latest amendment will be used.

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CODE	DESCRIPTION
IS 875(Part 1) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material
IS 875 (Part 2) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Imposed Loads
IS 875 (Part 3) 2015	Code of practice for Design Loads (other than earthquake) for buildings and structures – Wind Loads
IS 875 (Part 5) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Special Loads and load combinations
IS 456 – 2000	Code of Practice for Plain and Reinforced Concrete
IS 16700 – 2023	Criteria for Structural Safety of Tall Concrete Buildings
IS 1343 – 2012	Code of Practice for Prestressed Concrete

IS 1893 – 2016	Criteria for earthquake resistant design of structures
IS 4326 –1993	Code of practice for Earthquake Resistant Design and Construction of Buildings
IS 3370 – 2009	Code of Practice for Concrete structures for the storage of liquids
IS 1904-1986	Code of Practice for design and construction of Foundation in Soils
IS 1080 – 1985	Code of Practice for design and construction of shallow Foundation
IS 2950 - 1981	Code of Practice for design and construction of Raft Foundation
IS 800 – 2007	Code of practice for General Construction in steel
BS 8110 : 1997	Plain and reinforced concrete-code of practice(British standard)
ACI 318	Plain and reinforced concrete-code of practice (American standard)
IS 13920: 2016	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces
SP24	Explanatory Hand book on Indian standard code of practice
SP34	Handbook on concrete reinforcement and detailing

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4.0 COVER AND FIRE RATING

Cover to reinforcement considered for various elements

Structural element	Exposure condition	Fire rating in hours	Cover	
Pile cap	Severe		75 (Bottom)	50 (Top)
Basement- 2 Floor slab	Severe		50 (Bottom)	25 (Top)
Basement wall	Severe		45 (Soil side)	30 (Building side)
Column		2	40	
Shear wall		2	30	
Beam (Simply supported)		2	40	
Beam (Continuous)		2	30	
Slab (Simply supported)		2	35	
Slab (Continuous)		2	25	

5.0 STRUCTURAL SYSTEM

Floor system: The structural Floor system for the super structure is R.C Wall with Beam and slab. The slab thicknesses are to be 125mm/150mm/175mm/200mm. And for the Sub structure floor system is R.C Wall with Beam/slab and Flat slab system.

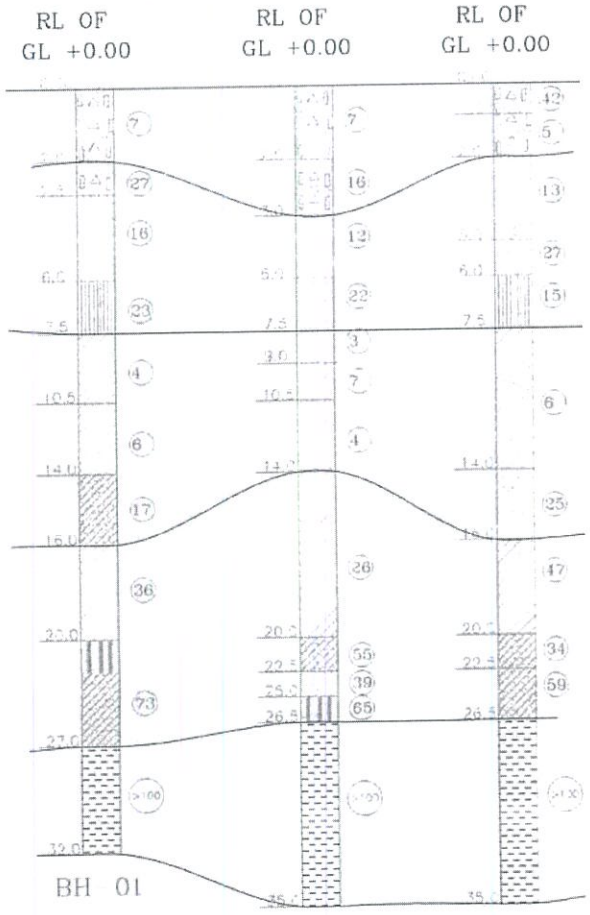
Lateral load resisting system:

Ductile RC structural wall system.

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6.0 GEO TECHNICAL INFORMATION & FOUNDATION SYSTEM

The profile of the soil layer as observed in the boreholes is given in below Figure.



LEGEND

- SILTY CLAY (CI)
- CLAYEY SILTY SAND (SC)
- SILTY SAND (SM)
- SILTY CLAY (CH)
- SANDY SILTY CLAY (CL)
- FILLEDUP SOIL
- Clayey Sandy SILT (MI)
- SHALE(CH)

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The top soil up to 2.0m is filled up soil. The underlying layer is silty clay layer from 2.0 to 20.0m with underlying layer of Clayey silty sand and silty sand at depths varying from 20.0 to 26.5m. From 26.50m to 35.0m is Shale layer. Water table was met with at 1.0m below ground level.

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Secant Pile System

The Residential development has two basement with depth of excavation approximately 7.30m, We have Proposed Secant Pile as retaining system & Strutting system as stabilizing structural system.

Pile foundation:

For the building adopted foundation system is pile foundation, with reference to Geo Marine Consultants (P) LTD soil investigation report the recommendation of safe carry capacity of bored cast-in-situ piles are as follows and the same capacities are considered in foundation design,

TABLE:- 5.1 RECOMMENDED SAFE LOAD CARRYING CAPACITIES OF BORED CAST-IN SITU PILES

Sl.No	Reference Bore hole No.	Length of Pile below E.G.L	Assumed Length of Cut-Off Below E.G.L	Length of Pile below Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1	BH-02	28.0	9.0	19.00	500	1200	600	32
2					550	1300	650	35
3					600	1500	750	38
4					650	1700	800	41
5					750	2000	900	45
6					800	2300	1000	50
7					900	2700	1100	55

Uplift pressure:

As the water table is 1.0m from the Existing Ground level, the basement-2 slab is designed for the water uplift pressure.

On behalf of CMDA HRB. Panel the Structural design Calculations are Generally Reviewed.

31/5/24

Superintending Engineer, P.W.D.,
Planning and Designs Circle,
Chepauk, Chennai-5.

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7.0 MATERIAL GRADES

Materials specified will confirm to the latest edition of the relevant Indian Standards. Specifications for materials will include for sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical specifications.

7.1 Concrete

Durability provisions for concrete structures shall be as per 'Extreme' conditions of environment in accordance with IS 456:2000.

Keeping the durability and structural requirements, the proposed Compressive Strength of structural concrete at 28 days, for various structural elements/members are as indicated in the below table

Structural Elements		Compressive Strength at 28 days		Concrete grade	
Minimum grade of concrete for any structural member is considered as		30 N/Sq.mm		M30	
All Structural concrete for :					
Columns, Shear walls & Core walls	Podium Columns	35 N/Sq.mm		M35	
	Tower Walls and Columns	50 N/Sq.mm	40 N/Sq.mm	M50	M40
Pile		30 N/Sq.mm		M30	
Pile cap		40 N/Sq.mm		M40	
Beams and slabs		35 N/Sq.mm		M35	
Overhead Water Tank, UG Water Tank, STP & Pump room		30 N/Sq.mm		M30	

7.2 Reinforcement

All reinforcement shall confirm to IS: 1786-2008 having minimum yield strength of 550 N/sq mm (Fe 550D).

Young's Modulus (Es)	200,000N/Sq.mm
Yield Stress (fy)	550 N/Sq.mm
Diameters {in mm} (d)	8, 10, 12, 16, 20, 25 & 32
Density ('ϒ)	78.5 kN/cum

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ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
16TH - 18TH FLOOR	V28	14910	220	2240	200	0.8

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	550	415

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	14910	-900	14910	1340	2240	200
Bottom	Leg 1	14910	-900	14910	1340	2240	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	1120	0.0025	0.0022	Comb-19(1)	933.3579	18.6672	-27.7719	448000
Bottom	1120	0.0025	0.0022	Comb-19(1)	988.7794	-25.8457	-365.166	448000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	Comb-19	631.2886	575.261	-176.0894	118.8832	442.2223
Bottom	Leg 1	500	Comb-19	682.7351	293.0886	-176.0894	119.8092	443.1484

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	Comb-19(1)	933.3579	-27.7719	2.25	8
Top–Right	Leg 1	0	Comb-19(1)	933.3579	336.3077	4.09	8
Bottom–Left	Leg 1	0	Comb-19(1)	988.7794	-365.166	4.39	8
Botttom–Right	Leg 1	0	Comb-19(1)	988.7794	35.1396	2.42	8

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ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
18TH - ROOF	V28	14910	220	2240	200	1

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E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
31622.78	40	1	550	415

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1.15	1.5	0.04	0.0025	0.8	Yes	Yes

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Bottom	Leg 1	14910	-900	14910	1340	2240	200

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	2011	0.0045	0.0022	Comb-19	153.4757	70.9157	339.1927	448000
Bottom	1120	0.0025	0.0022	Comb-19(1)	301.031	-35.7092	-297.9014	448000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	500	Comb-19	153.4757	339.1927	-174.8224	132.1795	455.5186
Bottom	Leg 1	500	Comb-19	213.8008	57.306	-174.8224	111.3684	434.7075

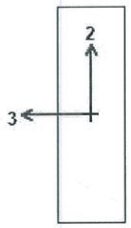
Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	Comb-1	0	0	0	0
Top–Right	Leg 1	0	Comb-19(1)	235.9421	310.8555	2.39	8
Bottom–Left	Leg 1	0	Comb-19(1)	301.031	-79.0404	1.14	8
Botttom–Right	Leg 1	0	Comb-19	295.3967	57.306	1	8

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ETABS Concrete Frame Design (TVB32)

IS 456:2000 Beam Section Design (Summary)



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Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
TYPICAL FLOOR	B255	2081	B 200x650	ENVELOPE	0	3958	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	650	200	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	550	415

Design Code Parameters

γ_c	γ_s
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-201.4985	0.0164	147.4515	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-201.4985	0.0411	151.8206	-201.5396

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-201.5396		776	0	776	187
Bottom (-2 Axis)		151.8206	567	567	0	187

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
147.4515	58.5274	89.0555	92.8173	407.9

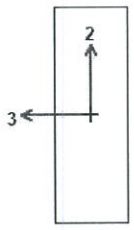
Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.0011	147.4515	130	580	0

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ETABS Concrete Frame Design (THB83)

IS 456:2000 Beam Section Design (Summary)



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Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
TYPICAL FLOOR	B28	924	B 200x600	ENVELOPE	2010	4020	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	600	200	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
29580.4	35	1	550	415

Design Code Parameters

γc	γs
1.5	1.15

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Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
56.515	0.0004	17.0905	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
56.515	0.001	56.516	0

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	0		0	0	0	0
Bottom (-2 Axis)		56.516	220	220	0	172

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
17.0905	36.4589	44.4	31.1944	221.69

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.0004	17.0905	130	530	0

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DESIGN OF SLAB : **TS16**

Panel Name : One longer edge discontinuous Code : 6

Clear Longer span, ly = 4500 mm

Clear Shorter span, lx = 4000

ly / lx = 1.13 < 2, Hence, Twoway slab.

Effective Longer span = 4596.00 mm

Effective Shorter span = 4096.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 96.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Weathering course =	0.000	kN/m^2
Floor finish =	1.200	kN/m^2
Partitions =	0.000	kN/m^2
	0.000	kN/m^2
Self weight =	3.125	kN/m^2
w_{DL} =	4.325	kN/m^2

Imposed Load (Not fixed) :

Assuming the Roof is inaccessible,

Occupancy classification as per IS: 875(Part 2) - 1987 :

Live load =	2.000	kN/m^2
w_{LL} =	2.000	kN/m^2
Total load, $w = w_{DL} + w_{LL}$ =	6.325	kN/m^2

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Span Moments:

Along Shorter span:	$BM = \alpha_x w l_x^2$ =	0.034	x 6.33 x 4.096^2 =	3.63	kNm	M_{ux1} =	5.44	kNm
Along Longer span:	$BM = \alpha_y w l_x^2$ =	0.028	x 6.33 x 4.096^2 =	2.97	kNm	M_{uy1} =	4.46	kNm

Support Moments:

Along Shorter span:	$BM = \alpha_x w l_x^2$ =	0.046	x 6.33 x 4.096^2 =	4.84	kNm	M_{ux2} =	7.26	kNm
Along Longer span:	$BM = \alpha_y w l_x^2$ =	0.037	x 6.33 x 4.096^2 =	3.93	kNm	M_{uy2} =	5.89	kNm

Check for section :

Factored Max. BM, Mu = 7.26 kNm / m

For M30 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.139

Effective depth required = 41.88 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{ux1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 121.38 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

A_{st} reqd at support :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{\ 1 - \sqrt{(\ 1 - [4.6\ M_{ux2}/(f_{ck}\ bd^2)])}\}\ b\ d =$ 163.17 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{1 - \sqrt{(\ 1 - [4.6\ M_{uy1}/(f_{ck}\ bd^2)]\ )}\}\ b\ d =$ 98.94 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

A_{st} reqd at support :

$A_{st} = [\ 0.5f_{ck}/f_y\ ]\ \{\ 1 - \sqrt{(\ 1 - [4.6\ M_{uy2}/(f_{ck}\ bd^2)])}\}\ b\ d =$ 131.58 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Min Ast = 0.12% Gross section area = 150 mm^2 / m

Distribution steel = 0.5 x (0.12/100) x 1000 x 125 = 75.00 mm^2 / m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2 / m OK

Max Spacing = 3d or 300 mm whichever is less = 288 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 154.06 MPa

MF = $1/(0.225+0.00322\ fs - 0.625 \log 10\ (l/pt)) \leq 2$ = 2.000

Type of Slab = Continuous

Effective Shorter span = 4096.00 mm

Basic Value = 26

Allowable l/d = 52.00

Actual l/d = 42.67 Hence OK

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DESIGN OF SLAB : **TS59**

Panel Name : One longer edge discontinuous Code : 6

Clear Longer span, ly = 4150 mm

Clear Shorter span, lx = 4000

ly / lx = 1.04 < 2, Hence, Twoway slab.

Effective Longer span = 4246.00 mm

Effective Shorter span = 4096.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 96.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Weathering course =	0.000	kN/m^2
Floor finish =	1.200	kN/m^2
Partitions =	0.000	kN/m^2
	0.000	kN/m^2
Self weight =	3.125	kN/m^2
w_{DL} =	4.325	kN/m^2

Imposed Load (Not fixed) :

Assuming the Roof is inaccessible,

Occupancy classification as per IS: 875(Part 2) - 1987 :

Live load =	2.000	kN/m^2
w_{LL} =	2.000	kN/m^2
Total load, $w = w_{DL} + w_{LL}$ =	6.325	kN/m^2

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Span Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.030 x 6.33 x 4.096^2 = 3.13 kNm M_{ux1} = 4.70 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.028 x 6.33 x 4.096^2 = 2.97 kNm M_{uy1} = 4.46 kNm

Support Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.039 x 6.33 x 4.096^2 = 4.15 kNm M_{ux2} = 6.22 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.037 x 6.33 x 4.096^2 = 3.93 kNm M_{uy2} = 5.89 kNm

Check for section :

Factored Max. BM, Mu = 6.22 kNm / m

For M30 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.139

Effective depth required = 38.78 mm < Effective depth available, OK

Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{ux1}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 104.35 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

A_{st} reqd at support :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{ux2}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 139.26 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{uy1}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 98.94 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

A_{st} reqd at support :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{uy2}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 131.58 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Min Ast = 0.12% Gross section area = 150 mm^2/m

Distribution steel = 0.5 x (0.12/100) x 1000 x 125 = 75.00 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Max Spacing = 3d or 300 mm whichever is less = 288 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 132.45 MPa

MF = $1/(0.225+0.00322\,fs - 0.625 \log 10\,(1/pt)) \le 2$ = 2.000

Type of Slab = Continuous

Effective Shorter span = 4096.00 mm

Basic Value = 26

Allowable l/d = 52.00

Actual l/d = 42.67 Hence OK

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