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DIGITALLY VERIFIED RECORD

BURO ENGINEERS (I) PRIVATE LTD.,
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21 years Service of Excellence

A PERAMAIYAN (M.E. Struct., M.I.E.,)
Registered Structural Engineer,
Chennai Metropolitan Development Authority,
Registration No.SE/GR-I/19/03/026,
31/14, Besant Avenue Road,
Adayar, Chennai — 600 020.

Email : peram@buroengineers.in
Mobile: +91 9962545630

STABILITY CERTIFICATE

The detailed engineering and structure design of the proposed residential building comprising **42 Flats (1 Basement + Stilt + 11 Floors + Roof) in project named "ISHA'S GEETHANJALI"** comprised in **Door No. H-46, H-47, H-48 & H-49, Old Survey No. 40/1 (Part), 40/2B (Part), T.S. No. 71, Ward No. 1, Block No. 11, situated at Thiruvanmiyur Neighbourhood Scheme Layout at Kamaraj Nagar, L.B. Road, Thiruvanmiyur, Chennai, Tamil Nadu – 600 041** has been done by me based on the report of Geotechnical investigation (soil test) done by GEOMARINE CONSULTANTS (P) LTD., Report no. _GT2468_ dated_17/12/24 and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earth quakes. I have checked various parameters and found that the proposed building would be safe.

3. It is further certified that:

(i) The minimum grade of concrete is M25.

(ii) The design and analysis has been done using the code of practice for plan and reinforced concrete as per IS 456, design loads as per IS Code No. 875 (2015) and design of earthquakes resistant structure as per IS Code No. 1893 (2016).

4. The building will be safe and sound when used for the purpose for which it is designed.

Date : 09-02-2026

Place : Chennai-600020

Stamp and Signature

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
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Encl: Structural Design Calculation

CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru. A. PERAMAIYAN** has enrolled as **Registered Structural Engineer Grade-I (SE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Structural Engg.)** and experience in the relevant field for **17years.**

He has been given the Registration No. **SE/GR-I/2019/03/026** Renewed on **22.03.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **21.03.2029.**



CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
CHENNAI-600 008.

22/3/24

(A. MEGANATHAN)
Superintendent

A. PERAMAIYAN, M.E., (Struct.), M.I.E.
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STRUCTURAL DESIGN CALCULATION REPORT

THE PROPOSED CONSTRUCTION OF EXTENDED BASEMENT FLOOR + STILT FLOOR + 11 FLOORS (INDOOR GAMES,MULTI-PURPOSE HALL & GYM @ 1st FLOOR LVL) RESIDENTIAL BUILDING WITH 74 DWELLING UNITS (WITH HEIGHT 30.00m) AT LATTICE BRIDGE ROAD, THIRUVANMAIYUR,CHENNAI AND COMPRISED IN T.S. NO. 71, BLOCK NO. 11 OF THIRUVANMAIYUR VILLAGE, VELACHERRY TALUK AND WITHIN THE LIMITS OF GREATER CHENNAICORPORATION.

CLIENT:

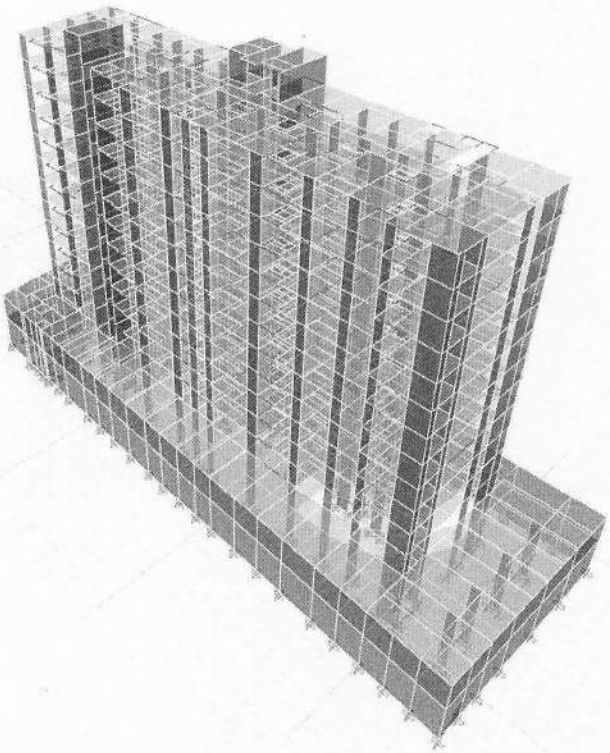
M/s. Isha Homes India (P) Ltd,
CHENNAI, TAMILNADU.

ARCHITECT:

INDRAJIT.S.KEMBHAVI,
BANGALORE, KARNATAKA.

STRUCTURAL CONSULTANT:

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REV NO.	DATE	DESCRIPTION	STATUS	PREPARED BY	REVIEWED BY	APPRVD. BY
R0	17.09.2025	Design Basis Report	OK	T.PRAKATHISH	PERAM	PERAM

Index

- Design Information and criteria
- 3D Model & Analysis summary report
- Design of Pile cap
- Design of Wall
- Design of Beam
- Design of Slab
- Structural Drawings

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DESIGN INFORMATION AND CRITERIA

1. INTRODUCTION

M/s. Isha Homes India (P) Ltd., has proposed to construct Residential Building comprises Two Basement + Stilt + 11th Floors + Roof at Lattice Bridge road, Thiruvanmaiyur, Chennai and Comprised in T.S NO. 71, Block no. 11 of Thiruvanmaiyur village, Velachery taluk and within the limits of Greater Chennai Corporation. Architecturally, it is designed with Two Basement +Stilt + 11 Floors + Roof structure. In which, the Two Basement + Stilt floor is designed to facilitate parking where as 1st floor to 11th floor are designed for Residential use.

This report covers design basis of Residential development comprises a Residential building having Two Basement+Stilt+1st Floor to11th Floor+Roof. In the Residential building the Basement & Stilt floors accommodates car parking and 1st floor to 11TH floors are designed for residential use. The covered area podium slab has been designed to accommodate landscape with 300mm filling whereas the stilt floor extended basement roof area has been designed for fire tender lorry movement. Architecturally, the building is designed to be a linear & rectangular in shape. Structurally the building is designed to be a framed structure with Columns, RC Walls, Beams and slabs, are directly connected to the columns/RC walls which are together forms a lateral load resisting system. Foundation is designed to be Raft Foundation at a depth of 8.4m below existing ground level.

The raft is connected monolithically with Basement wall forms the water tight basement structure shall be protected by applying the approved water proofing on positive side taking the water table likely to rise up to the ground level during peak monsoon. Superstructure is designed to be a shear wall structure with Slab connected directly to the shear walls and Beams are provided in few locations where opening/door is provided.

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 information on Structural system, Foundation system, Parameters & Method statement of structural analysis which will be adopted for design and analysis of the building.

2. CODES OF PRACTICE

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

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2.1 Design Loads (Other Than Earthquake Loads)

IS Code	Description
IS 875 (Part 1): 1987	Dead Loads (Unit Weight of Building Material and Stored Material)
IS 875 (Part 2): 1987	Imposed Load
IS 875 (Part 3): 2015	Wind Load
IS 875 (Part 5): 1987	Special Loads and Combinations

2.2 Design for Earthquake Resistance

IS Code	Description
IS 1893(Part-1) :2016	Criteria for Earthquake Resistance design of structures.
IS 4326: 1993	Earthquake Resistant Design and Construction of Buildings – Code of Practice
IS 13920: 2016	Ductile Detailing of Reinforced Concrete Structures subject to Seismic Forces - Code of Practice.
IS 16700: 2017	Criteria for Structural Safety of Tall Concrete Buildings

2.3 Design of Steel Structural Elements

IS Code	Description
IS 800: 2007	Code of Practice for General Construction in Steel
IS 2062: 1999	Steel for General structural purposes

2.4 Design of Concrete Elements

IS Code	Description
IS 456: 2000	Plain and Reinforced Concrete - Code of practice
IS 6403 -1981	Code of practice for determination of bearing capacities of shallow foundations.
IS 8009 -1976 (Part I):	Code of practice for calculation of settlement of foundations – Shallow foundation
IS 1904	Indian Standard Code of practice for design & construction foundations in Soil: General Rééquipements
IS 2950 (Part 1):1981 (Reaff. Nov 2013)	Code of practice for design and construction of raft foundations : Part 1 Design (second revision).

IS 2974	Code of practice for design & construction of machine foundation
SP 16	Structural use of concrete, Design charts for singly reinforced beams, doubly reinforced beams and columns.
SP 34	Hand book on Concrete Reinforcement & Detailing
SP 7(Part IV)-2015	National Building code of India
IS 1786-2007	Specification for high strength deformed bars and wires for concrete Reinforcement.
IS 432 (Part 2) 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete reinforcement – Hard Drawn Steel Wire
IS 3370 (part I)	Code of practice for concrete structure for the storage of liquids

3. DESIGN PARAMETERS

3.1 Materials of Construction

The building is predominantly Shear wall connected with slab/beam. The lateral load resisting system of Shear walls/Columns are well connected in orthogonal direction along with the centrally located Lift Core wall which are connected by floor slab is act as diaphragm in distribution of lateral forces.

3.1.1 Concrete Grade

Concrete grade shall be M35 for Basement wall, Basement slab, etc. whereas Shear wall, RC Column, RC beam & RC slab shall be M40 with minimum 28-day strength of 35 & 40 MPa respectively.

Concrete Mix M10 has been used in filling, plum concrete, levelling courses (PCC) and other non-structural items.

Density of reinforced concrete is assumed as 25 kN/cu.m.

Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 code provisions for durability and strength criteria. The approved design mix shall be used for producing concrete.

Grade of Concrete for various structural elements: (TOWER / NON TOWER)

Raft	M35
Basement Wall	M35
Basement Slab	M35
Columns	M40
Shear wall	M40
RC Beam	M35
RC Slab	M35

3.1.2 Cement

Ordinary Portland cement of grade 43 or higher confirming to IS 8112 and IS 12269 is specified for concrete M35 for Basement wall & Slab whereas the grade is to be M40 for RC shear wall, column, Beam, RC Slab etc. with cement content appropriate to the desirable compressive strength and slump. The design mix using the intended brand of cement together with material test report including tests on coarse aggregate, fine aggregate etc. shall be submitted to the consultant's review and approval.

3.1.3 Aggregates

The sizes of coarse aggregates confirm to IS 383. Nominal maximum size of coarse aggregate to be 20 mm, suitably graded as per the requirement of mix design. The fine aggregates confirm to the specifications of IS 383.

3.1.4 Water

Water used for construction shall complied with stipulations given in IS 456: 2000.

3.1.5 Reinforcement

High yield strength deformed bars conforming to IS 1786 with f_y = 550 N/ sq.mm has been used with elongation not less than 14.5 %.

3.1.6 Structural Steel

MS steel with yield strength f_y = 250 N/ sq.mm shall be used for Structural steel work wherever necessary which shall conform to IS 226 and IS 2062 for Indian steel sections.

3.1.7 Concrete Cover

Cover to reinforcement considered for various elements with Fire rating considered - 2hrs. are as follows.

a. Raft = 60mm
b. Column = 40mm
c. Shear Wall
   300mm thick. = 40mm
   200mm thick. = 30mm
d. Beam = 30mm (Bottom and sides)
e. Slab = 25mm (Top and Bottom)
f. Basement wall/Water tanks/Sump tank
   On water face = 40mm (Top and Bottom)
   On other face = 40mm (Top and Bottom)

3.1.8 Development Length

Unless otherwise specified in the good for construction drawing, the Development length of 50 times diameter of bar is to be considered in the BBS & Fabrication.

3.1.9 Soil Parameters

Based on the soil report No. GT-2468 dated 17.12.2024, there are 3 nos. of bore holes were done at different locations of the plot spread across the development which includes BH-01 to BH-03. All the bore holes are terminated at around 17m by reaching the hard layer or hammer rebound whichever reach earlier. The top layer up to 1m is sandy silty clay. Below it is very soft silty clay with sand mixture having "N" value in the range of 2 which continues up to 5m. From 5m it is a clayey silty sand that continues up to 7.5m having "N" value in the range of 8 to 19. Below it is a poorly graded sand-silty sand upto a depth of 9m having "N" value of 25. The same soil continues up to 12m with "N" value 40. Very dense clayey silty sand exists up to 14m having "N" value more than 100. Highly to moderately weathered rock encountered at a depth of 14m with "N" value more than 100. Below 2.25m and up to 3m it is very dense of fine to coarse sand with gravel with "N' value more than 100. Weathered rock continues below up to the termination depth of 17m with varying grade of rock such as W4, W3, W2 & W1 at 14m, 15m, 16m & 17m respectively. Ground water table is reported during the investigation period of November-2022 is around 0.5 below NGL. However, it is advisable to design the Basement structure/UG structure for the head of water up to Ground level as the water table likely to raises up to ground during peak monsoon.

3.2 Loading Standards

Table: Structural Configuration and Floor heights:

Building Floor Height Details	Two Basement+Stilt+11+ Roof
Basement-1 (Car Park)	4.875m

Stilt floor height (Car Park)	3.60m
Stilt Floor to 1st Floor height(Car Park)	3.00m
1st Floor to Roof height (Residential)	3.00m
Head Room	3.00m
LMR	2.05m
Type of Foundation	**Raft (Uniform)**
Grade of concrete for Raft	M35
Grade of concrete for Basement Wall	M35
Grade of concrete for Columns	M40
Grade of concrete for Shear Walls	M40
Grade of concrete for RC slabs	M35
Grade of concrete for RC beams	M35
Grade of Steel	Fe 550

Table: Unit Weight of Materials:

Material	**Floor Heights**
Plain Cement Concrete	25.00 kN/Cu.m
Brick Work	20.00 kN/Cu.m
Block Work (ACC Block)	**7.50 kN/Cu.m**
Mortar Finishing	20.00 kN/Cu.m
Dry soil	18.00 kN/Cu.m
Saturated soil	10.00 kN/Cu.m
Glass	28.00 kN/Cu.m
water	09.81 kN/Cu.m

Table: Gravity Load Calculations:

Floor Slab:		
Self weight of 125 mm thick Slab	0.125x25 = 3.125 kN/Sq.mt.	
Self weight of 150 mm thick Slab	0.150x25 = 3.750 kN/Sq.mt.	
Self weight if 175mm thick slab	0.175x25 = 4.375 kN/Sq.mt.	
Self weight if 200mm thick slab	0.200x25 = 5.000 kN/Sq.mt.	
Self weight if 225mm thick slab	0.225x25 = 5.625 kN/Sq.mt.	
Self weight if 250mm thick slab	0.250x25 = 6.250 kN/Sq.mt.	
Residential Building External/Internal Wall Line Load:		
Basement-1	= (0.2x4.425x7.5)+(0.03x4.425x20)	= 9.30 kN/m
Stilt Floor	= (0.2x3.15x7.5)+(0.03x3.15x20)	= 6.20 kN/m
First Floor to Roof	= (0.1x2.55x7.5) +(0.03x2.55x20)	= 3.45 kN/m
First Floor to Roof	= (0.2x2.55x7.5) +(0.03x2.55x20)	= 5.36 kN/m
Terrace Parapet Wall	= (0.2x1.25x7.5) +(0.03x1.25x20)	= 2.63 kN/m

3.2.1 Imposed Loads on Slab

The following are the imposed loads in the structural slabs, in addition to the self-weight and the floor finishes. *(Self-weight of slab will be as per the thickness mentioned in the respective drawings Floor finishes of 50mm thickness have been considered on all floors*

Table: Superimposed Dead Load (SDL) & Live Load (LL)

BASEMENT (Car Parks & Driveway)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	-
Services	0.6	-
Live Load	-	3.0
Partition Load	-	-
Total	**2.4**	**3.0**
BASEMENT (Lobby)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.80	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**1.80**	**3.0**
STILT FLOOR (Car Parks & Driveway)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.8	-
Services	0.6	-
Live Load	-	3.0
Partition Load	-	-
Total	**2.4**	**3.0**
STILT FLOOR (Fire Track)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Loaded Vehicle	20.0	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**20.0**	**3.0**
STILT FLOOR (Electrical Room)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	1.80	-
Services	-	-
Live Load	-	7.5
Partition Load	-	-
Total	**1.80**	**7.5**
STILT FLOOR (Pump Room)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**

Finishes	1.8	-
Services	-	-
Live Load	-	7.5
Partition Load	-	-
Total	**1.8**	**7.5**
STILT FLOOR (Ramp)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	2.4	-
Services	-	-
Live Load	-	5.0
Partition Load	-	-
Total	**2.4**	**5.0**
First Floor (Multipurpose Hall)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	2.4	-
Services	-	-
Live Load	-	5.0
Partition Load	-	-
Total	**2.4**	**5.0**
First Floor (Pre Function Area)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	2.4	-
Services	-	-
Live Load	-	5.0
Partition Load	-	-
Total	**2.4**	**5.0**
First Floor (Billards / TT Room)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	2.4	-
Services	-	-
Live Load	-	5.0
Partition Load	-	-
Total	**2.4**	**5.0**
First Floor (Gym / Yoga / Indoor Games)		
	SDL (kN/Sq.mt.)	**LL (kN/Sq.mt.)**
Finishes	2.4	-
Services	-	-
Live Load	-	5.0
Partition Load	-	-
Total	**2.4**	**5.0**
First Floor to 11th Floor (Bed / kitchen / living / dining Room)		

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.25	-
Services	-	-
Live Load	-	2.0
Partition Load	-	-
Total	**1.25**	**2.0**

First Floor to 11th Floor (Toilet)

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling	2.6	-
Services	-	-
Live Load	-	2.0
Partition Load	-	-
Total	**2.6**	**2.0**

First Floor to 11th Floor (Utility)

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling	2.2	-
Services	-	-
Live Load	-	2.0
Partition Load	-	-
Total	**2.2**	**2.0**

First Floor to 11th Floor (Balcony)

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes + Filling	2.6	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**2.6**	**3.0**

First Floor to 11th Floor (Corridor)

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.25	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**1.25**	**3.0**

First Floor to 11th Floor (Lobby)

	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	1.25	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**1.25**	**3.0**

First Floor to 11th Floor (Staircase)		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	3.0	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**3.0**	**3.0**

Roof Terraces		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes (weathering courses)	3.0	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**3.0**	**3.0**
LMR / OHT		
	SDL (kN/Sq.mt.)	LL (kN/Sq.mt.)
Finishes	20.0	-
Services	-	-
Live Load	-	3.0
Partition Load	-	-
Total	**20.0**	**3.0**

Permissible reduction in imposed load on each floor is considered for design of columns and foundation as per IS 875 Part (2), clause.3.2.

The proposed structure is a RCC framed structure with columns and shear walls predominantly forming vertical components. In which, the vertical structural systems are formed such that the RC wall & columns are transfers its base shear in proportion to its stiffness in their loading direction of wind & seismic.

3.3 Thermal Effects

Temperature variation produces stresses in the structure, as it tends to expand and contract. In the structures, with large geometrical dimensions, the effect of temperature is important in the behaviour and final design. Due to deformation of expansion & contraction - between Day time and nights, and between winter and summer - the effect on the durability of structure and on the supported finishes is significant to produce considerable results.

In this case, the size of the structure below ground level is about 96mx67m, structurally divided from the phase-II by an expansion joint whereas the size of the super structure is 87.5mx16.5m. The temperature effect over the building design has been captured by applying the differential temperature over the exposed area like roof & terraces.

3.3.1 Shrinkage Effects

The Building length is 96m below ground level and it is 87.5m above ground level. The temperature effect in the building has been considered in the design of structural elements as the length of building falls close to the limitation stimulated in IS 456: 2000, clause.27.2. However the shrinkage shall be controlled by introducing pour strip with adopting the sequence of construction appropriately.

3.3.2 Expansion Joints

Expansion joints are normally provided when the structure is more than 45m length as per IS-456-2000, clause 27.2. In this case, the size of the structure below ground level is about 77.66mx26.21m whereas the size of the super structure is 61.34mx16.94m. The temperature effect over the building design has been captured by applying the differential temperature over the exposed area like roof & terraces as the length of the building falls beyond the limitation stimulated in IS 456: 2000, clause.27.2. The differential temperature of 15° C has been applied over the exposed areas like Roof & Terraces.

4. PROPOSED APPROACH OF STRUCTURAL ANALYSIS

The building is a R.C.C columns connected by beams as framed structure. Slabs acting as rigid in-plane diaphragms have been considered in the model. After preliminary sizing of various structural members, a computer model of the structural frame of the building is generated for carrying out computer analysis for the effects of vertical and lateral loads that are likely to be imposed on the structure.

The building structure has been analysed using the ETABS v2018 software for the following computer models of the building floor analysis of all floors - for vertical loads with the entire building space frame. ETABS v2018 have been thoroughly tested, validated and recognized internationally by several organizations and are well suited for the analysis of building systems.

Geometrical dimensions, member properties and member-node connectivity, including eccentricities will be modeled in the analysis problem. Variation in material grades, if present, will also be considered. The permissible values of the load factors and stresses will be utilized within the purview of the Indian Standards.

The computer analysis will produce accurate individual member forces, reactions at foundation level and deflection pattern of the entire structure as well as individual members. This data will then be used to confirm/review the member sizes and arrive at the most appropriate design of the structural members. Some re-runs of the analysis program might be

required for arriving at the optimum structural space frame characteristics that satisfy the strength and stability criteria in all respects.

Design of different structural elements will be carried out using In-house developed spreadsheets and packages.

The following model assumptions used in E-TABS 3D modeling and the load applications are done as listed below,

Column	: Frame Element
RC Wall	: Shell Element
Beam Element	: Frame Element
Slab	: Shell Element

- Modulus of Elasticity of Concrete -5000$\sqrt{fck}$
- Consideration of Diaphragm - Rigid Diaphragm.
- Slab/Wall element considered as Shell element

The structural model and its behaviour has been checked for the following

a) Storey Drift.

b) Storey Weight/Column Loading.

c) Soft Storey Effect.

d) Deformation.

e) Design Forces.

The following methods of modeling are adopted in creating ETABS 3D model,

- The 3D ETABS model generated based on the shuttering drawing prepared using preliminary sizes.
- Sectional properties are assigned to all the structural elements as per the preliminary shuttering drawing.
- Mesh size assigned in size of 1m x 1m approx.
- External & Internal filler wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intended to distribute on slab directly. These loads are assigned under SDL type load case.
- Slabs are modelled as shell element in Flat Plate area and the same has been modelled as membrane in Beam-slab system which are assigned with horizontal diaphragms.

- Live Load reduction is considered in the design of Foundation and Column as per the Code: IS 875-1987 (Part-II), clause.3.2.1.
- Area design load i.e. Live load/SDL or any other load is applied at floor relevant to its usage.
- All lateral loads & parameters are assigned as per Codes IS 1893-2016 & IS 875-2015.
- Temperature loads are applied on to the terraces which are directly exposed to sun includes podium, Roof etc.
- Beams under Torsion is required to maintain Equilibrium will be designed for Torsion in accordance with IS 456-2000, clause 41.1 to 41.4 and for all other beams torsional stiffness is neglected in the analysis by applying stiffness modifier as 0.01 to torsional constant "J". Hence no specific design for Torsion is required for these beams.
- Chennai is zone-III. Hence ductile detailing is followed in the design and detailing of structural elements.
- Concrete cover to reinforcement complied accordance with IS 456-2000, Tabl.16 & 16A.
- All vertical wall elements are assigned with auto meshing/manual messing appropriately in order to achieve accuracy in results.
- UG Sump is designed for 0.2mm and STP is designed for the crack width of 0.1mm.
- Secondary beams are not designed for ductile detailing.
- Long term deflections are checked by manual calculation using excel spread sheet wherever necessary. Crack width calculation will be done using spread sheet wherever necessary.

Area Load & Application: Applied as uniformly distributed area load with intensity proportionate to its usage as mentioned in the Loading items in the DBR.

Line (Wall) Load & Application: Filler wall loads are calculated appropriately considering light weight Brick Work and Applied as uniformly distributed line load.

Lateral Load Resisting Systems: The Building is primarily shear wall structure with Floor Beams and slabs are connected rigidly. The vertical structural systems are formed such that the RC wall transfers its base shear in proportion to its stiffness in their loading direction for both wind & seismic. Hence Buildings with Ductile RC Structural walls adopted.

5.0 LATERAL LOADS

5.1 Wind Loads

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 (part 3) – 2015. The basis wind speed is considered in the analysis for Chennai, TN is 50 m/sec. The design parameters for wind load calculation are as follows,

Design Wind Pressure $Vz = 0.6\ Vz^2$

But $Vz = Vb*k1*k2*k3*k4$

Where Vz - Design Wind Speed

k1 – 1.0 probability factor or risk coefficient

k2 – 1.14, Terrain height (36.0m), structure size factor

(measured from stilt floor) with terrain Category–2

k3 – 1.0, Topography factor

k4 – 1.0, Importance factor for the cyclonic region, for all other

Structure as per IS 875-Part3, clause 6.3.4.

Hence the Design Wind Pressure = 0.6x (50x1.0*1.14*1.0*1.0)^2
= 1949.4 N/m^2 ≈ 1.950 kN/m^2

The design wind load will be calculated based on the surface area with the calculated design wind pressure and it shall be applied on surface area of the building in both the orthogonal direction.

As per IS-875-2015 clause 9.1(a), the building is classified as not a slender structure which doesn't requires wind dynamic analysis. But as per clause 9.1(b), wind dynamic analysis shall be carried out as the frequency is less than 1 Hz works out along the transverse direction. Hence wind dynamic analysis performed in ETABS along transverse direction.

5.2 Earthquake Loads

Chennai is classified under Earthquake Zone III (Moderate) as per the latest classification. The loading due to earthquake shall be assessed based on the provisions of IS 1893 – 2016 The design parameters adopted are as follows:

Seismic Zone III with seismic zone factor Z = 0.16 (Moderate) and Response reduction factor is to be 4.0 considering Building with RC Structural Wall as per IS: 1893-2016, Table-7 and Soil considered as Type-II Medium soil.

Base Shear Calculation for Static Analysis

As per IS 1893:2016, the total design lateral force or design seismic base shear (V_b) is determined by the following expression.

$$V_b = A_h W$$

Where Ah is Design horizontal acceleration spectrum value using fundamental natural period and W is Seismic weight of the building.

The Seismic weight is estimated based on Full dead load + 25 % Live load for Residential building i.e. for Live Load < 3 kN/Sq.mt. the reduction considered is 25%.

The Fundamental natural period of vibration (Ta) in seconds of a RC building is estimated by using the following formula, Ta = 0.09*h/(d)^0.5.

Where h is the height of the building in meters. d is the base dimension of the building at the plinth level, in m along the considered direction of the lateral force.

Height of the building = 36.0m (measured from Stilt floor)
d (along-y, length of the building) = 61.34 m
b (along-x breadth of the building) = 16.88 m
Ta (along x) = 0.09 x 36.0/(61.64)^0.5

= 0.4127 Sec.

Ta (along y) = 0.09 x 36.0/(16.88)^0.5

= 0.7887 Sec.

From IS 1893: 2002, Clause 6.4.2, Design horizontal seismic coefficient

$$Ah = \frac{Z\ I\ Sa}{2\ R\ g}$$

Where,

Z for Zone III = 0.16

I for Building has occupants more than 200 = 1.2 (Refer to IS 1893-2016, Table.8)

R for Building with Ductile RC Structural walls i.e. 4.0

as per (Table 9).

Sa/g (Hard soil) X-Dir. = 1.0/0.6345=1.576 (Refer to IS 1893-2016, page 13, Fig 1)

Sa/g (Hard soil) Y-Dir. = 1.0/0.7415=0.69 (Refer to IS 1893-2016, page 13, Fig 1)

Design horizontal seismic coefficient Ah_x = 0.0378

Base Shear Vb_x = 0.0378 W

Design horizontal seismic coefficient Ah_y = 0.016

Base Shear Vb_y = 0.016 W

5. LOAD COMBINATIONS

The various loads shall be combined in accordance with the stipulations in IS 875 (Part 5) 1987 and IS 456: 2000. The structural elements shall be designed for the combination that produces most unfavorable effect out of the following combinations.

The results obtained from the computer analysis in the form of member forces and reactions will be used for design the structural members. Following load combinations of the member forces will be considered for arriving at the design forces. The analysis considered load factor is as follows,

Load Combination	LOAD FACTORS								
	D.L.	I.L.	T.L	EQX	EQY	SPECX	SPECY	WX	WY
Limit State Of Serviceability (LSS) Combinations									
LC1	1.0	-	1.0	-	-	-	-	-	-
LC2	1.0	1.0	1.0	-	-	-	-	-	-
LC3	1.0	-	1.0	1.0	-	-	-	-	-
LC4	1.0	-	1.0	-1.0	-	-	-	-	-
LC5	1.0	-	1.0	-	1.0	-	-	-	-
LC6	1.0	-	1.0	-	-1.0	-	-	-	-
LC7	1.0	-	1.0	-	-	-	-	1.0	-
LC8	1.0	-	1.0	-	-	-	-	-1.0	-

LC9	1.0	-	1.0	-	-	-	-	-	1.0
LC10	1.0	-	1.0	-	-	-	-	-	-1.0
LC11	1.0	-	1.0	-	-	1.0	-	-	-
LC12	1.0	-	1.0	-	-	-1.0	-	-	-
LC13	1.0	-	1.0	-	-	-	1.0	-	-
LC14	1.0	-	1.0	-	-	-	-1.0	-	-
LC15	1.0	0.8	1.0	0.8	-	-	-	-	-
LC16	1.0	0.8	1.0	-0.8	-	-	-	-	-
LC17	1.0	0.8	1.0	-	0.8	-	-	-	-
LC18	1.0	0.8	1.0	-	-0.8	-	-	-	-
LC19	1.0	0.8	1.0	-	-	-	-	0.8	-
LC20	1.0	0.8	1.0	-	-	-	-	-0.8	-
LC21	1.0	0.8	1.0	-	-	-	-	-	0.8
LC22	1.0	0.8	1.0	-	-	-	-	-	-0.8
LC23	1.0	0.8	1.0	-	-	0.8	-	-	-
LC24	1.0	0.8	1.0	-	-	-0.8	-	-	-
LC25	1.0	0.8	1.0	-	-	-	0.8	-	-
LC26	1.0	0.8	1.0	-	-	-	-0.8	-	-
Limit State Of Collapse (LSC) Combinations									
COMB1	1.5	-	1.0	-	-	-	-	-	-
COMB2	1.5	1.5	1.0	-	-	-	-	-	-
COMB3	1.2	1.2	1.0	1.2	-	-	-	-	-
COMB4	1.2	1.2	1.0	-1.2	-	-	-	-	-
COMB5	1.2	1.2	1.0	-	1.2	-	-	-	-
COMB6	1.2	1.2	1.0	-	-1.2	-	-	-	-
COMB7	1.2	1.2	1.0	-	-	-	-	1.2	-
COMB8	1.2	1.2	1.0	-	-	-	-	-1.2	-
COMB9	1.2	1.2	1.0	-	-	-	-	-	1.2
COMB10	1.2	1.2	1.0	-	-	-	-	-	-1.2
COMB11	1.2	1.2	1.0	-	-	1.2	-	-	-
COMB12	1.2	1.2	1.0	-	-	-1.2	-	-	-
COMB13	1.2	1.2	1.0	-	-	-	1.2	-	-
COMB14	1.2	1.2	1.0	-	-	-	-1.2	-	-
COMB15	1.5	-	1.0	1.5	-	-	-	-	-
COMB16	1.5	-	1.0	-1.5	-	-	-	-	-
COMB17	1.5	-	1.0	-	1.5	-	-	-	-
COMB18	1.5	-	1.0	-	-1.5	-	-	-	-
COMB19	1.5	-	1.0	-	-	-	-	1.5	-
COMB20	1.5	-	1.0	-	-	-	-	-1.5	-
COMB21	1.5	-	1.0	-	-	-	-	-	1.5
COMB22	1.5	-	1.0	-	-	-	-	-	-1.5
COMB23	1.5	-	1.0	-	-	1.5	-	-	-
COMB24	1.5	-	1.0	-	-	-1.5	-	-	-
COMB25	1.5	-	1.0	-	-	-	1.5	-	-
COMB26	1.5	-	1.0	-	-	-	-1.5	-	-
COMB27	0.9	-	1.0	1.5	-	-	-	-	-
COMB28	0.9	-	1.0	-1.5	-	-	-	-	-

COMB29	0.9	-	1.0	-	1.5	-	-	-	-
COMB30	0.9	-	1.0	-	-1.5	-	-	-	-
COMB31	0.9	-	1.0	-	-	-	-	1.5	-
COMB32	0.9	-	1.0	-	-	-	-	-1.5	-
COMB33	0.9	-	1.0	-	-	-	-	-	1.5
COMB34	0.9	-	1.0	-	-	-	-	-	-1.5
COMB35	0.9	-	1.0	-	-	1.5	-	-	-
COMB36	0.9	-	1.0	-	-	-1.5	-	-	-
COMB37	0.9	-	1.0	-	-	-	1.5	-	-
COMB38	0.9	-	1.0	-	-	-	-1.5	-	-

DL: Dead Load **EQX** : Earthquake Load in X-dir. **WX**: Wind Load in X-dir.

IL: Imposed Load **EQY** : Earthquake Load in Y-dir. **WY**: Wind Load in Y-dir.

6. COVER AND FIRE RATING

Fire rating considered - 2hrs. Cover to reinforcement considered for various elements are as follows.

Raft	60 mm
Columns	40 mm
Shear Wall	40/30 mm
Beams	30 mm
Slabs	25 mm

7. DEFLECTION CRITERIA

7.1 Lateral Deflection (Wind)

Overall Deflection< Height/500

Storey Deflection < Storey height/500

7.2 Lateral Deflection (Seismic)

Overall Drift < H / 250

Storey Drift < 0.004 times storey height

7.3 Vertical Deflection of Beams and Slabs due to Gravity Loads

Total Deflection (DL + LL) < Span/250 up to 20 maximum

Deflection including the effects of Temperature, Creep and Shrinkage Occurring after erection of partitions and the application of finishes < Span/350 or 20mm whichever is less

8. CONSTRUCTION JOINT

Construction joints and shrinkage strips will be planned with the contractor and only be used in locations pre-approved by consultants.

1) No construction joint is allowed in the sunken portion
2) Construction joint shall be provided in slab/beam at l/3 from support.
3) Construction joint shall be placed at accessible location for maintenance purpose.
4) Joints are common source of weakness, therefore it is desirable to avoid or at least minimize them.

9. DESIGN OF STRUCTURAL ELEMENTS

For the design of R.C.C. elements, the Limit State Method will be used as per IS 456-2000. Materials of construction will be predominantly concrete with consideration for strength and durability. The grade of concrete adopted in the Analysis and Design is M35 for Raft, Basement slab, Basement wall etc whereas the vertical elements like shear wall/columns are designed using M40 considering the level of stresses to be borne by the members both in compression as well as flexural.

High Yield Strength Deformed bars conforming to IS: 1786 with F_y = 550 MPa will be used as reinforcement. Structural steel, if any with Fy = 250 Grade shall be used.

Covers to reinforcement shall be in accordance with IS: 456:2000 corresponding to **moderate exposure conditions** for the super-structure or severe exposure conditions for the sub-structure and to satisfy a fire rating of 2 hrs as per National building code of India- SP7 (part IV).

10. FOUNDATION

The proposed Residential building comprises Two Basement+Stilt Floor+1st Floor to 11th Floor+Roof (Residential Use) storey structure located in Thiruvanmaiyur, Chennai. Based on the analysis results, it is noticed that the vertical elements are considerably loaded being a MSB.

As per the column load intensity and the Soil consultant recommendation laid down in the report, the building is designed with Raft (uniform) Foundation. Raft Foundation has been designed using the recommended Safe Bearing Capacity of 400 kN/m^2 with the modulus of subgrade reaction of 40,000 kN/m^2.

11. STABILITY OF STRUCTURES

1. For the purpose of stability of the structure as a whole 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.

2. The factor of safety against sliding shall not be less than 1.40.

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

12.0 OTHER DATA

Specific requirements of floor and wall cutouts for services, sinking (extent & depth) of floors in services, kitchen, utility and toilet areas, external architectural features, and entrance canopies are provided as required by Architects and Service Consultants. The relevant information is obtained from them in the form of drawings. Lift loads and lift machine room equipment and cut out layouts will be obtained from the lift manufacturers. An impact factor of 100% will be considered in the lift supporting structures.

13.0 R.C Design

The structures are analyzed for the various load combinations as per IS: 456-2000. The design of structural elements are carried out by ETABS/RCDC Ver.6.1 for all structural elements for the worst forces extracted from the ETABS analysis output whereas the slab design is being done using in house spread sheet. For the design of R.C.C structural elements carried out, the recommendations stipulated in IS: 456-2000 is followed. Limit State method of design is adopted with appropriate load factors with the various load combinations for the different structural elements appropriately.

13.1. Foundation

Raft Foundation has been designed using Safe Bearing Capacity of 400 kN/m^2 and it is analyzed for the modulus of subgrade reaction of 40,000 kN/m^2. The design has been carried out using SAFE for the exported forces/reactions from the ETABS model.

13.2. Column/Wall

Vertical elements carry both gravity and lateral loads like Columns/RC Walls are designed for the worst combination results using ETABS.

13.3. Beam

Beams are designed for the worst combination results using ETABS/RCDC/in house spread sheet.

13.4. Slab

Flat Plate/irregular slab is designed using SAFE and the conventional Slabs are designed using in house spread sheet as per IS-456 Annexe-D, Table-2

14.0 COMPUTER PROGRAMS USED

The following Software / spreadsheet are used to carry out Structural design.

14.1 PROKON Ver 2.3 - Wall & Beam design

14.2 ETABS Ver 2021 -Three Dimensional FEM analysis and Design Programs

14.3 SAFE 2020 Ver 20 - Used mainly for B Floor Slab Analysis & Design

14.4 In-House Spreadsheet - One way/ Two way slab design

14.5 RCDC V.8.0 - Design Software for all Structural Elements except Raft.

3D MODEL
&
ANALYSIS SUMMARY REPORT

ETABS®

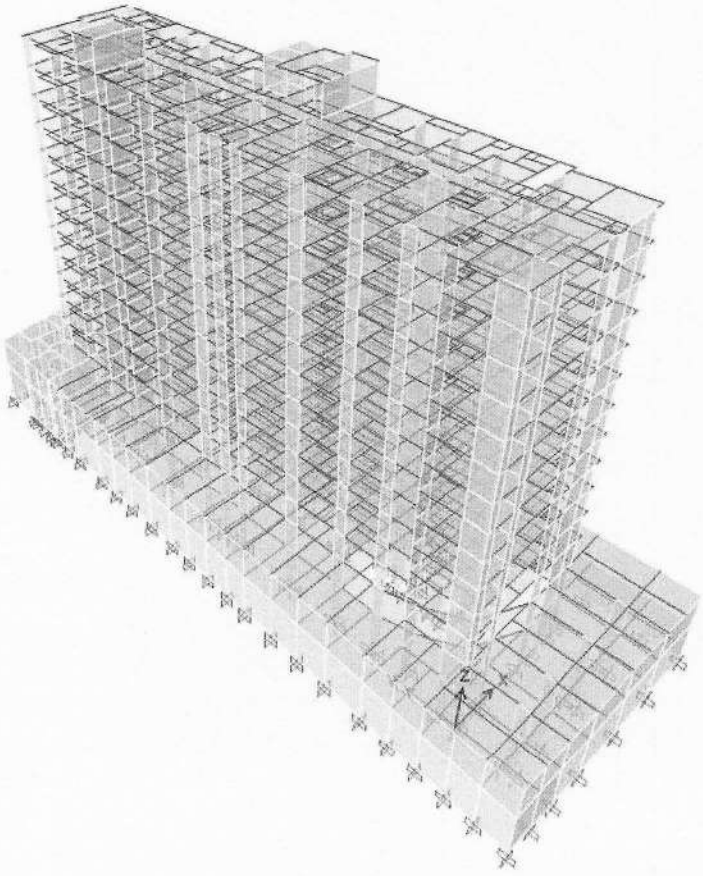


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1 Structure Data

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

1.1 Story Data

Table 1.1 - Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	HEAD ROOM	3	Yes	None	No	Yellow
T1	ROOF	3	Yes	None	No	Yellow
T1	11TH	3	Yes	None	No	Yellow
T1	10TH	3	Yes	None	No	Yellow
T1	9TH	3	Yes	None	No	Yellow
T1	8TH	3	Yes	None	No	Yellow
T1	7TH	3	Yes	None	No	Yellow
T1	6TH	3	Yes	None	No	Yellow
T1	5TH	3	Yes	None	No	Yellow
T1	4TH	3	Yes	None	No	Yellow
T1	3RD	3	Yes	None	No	Yellow
T1	2ND	3	Yes	None	No	Yellow
T1	1ST	3	Yes	None	No	Yellow
T1	STILT	3.6	No	1ST	No	Gray8Dark
T1	BASE-1	4.875	No	1ST	No	Blue

2 Properties

This chapter provides property information for materials, frame sections, shell sections, and links.

2.1 Materials

Table 2.1 - Material Properties - General

Material	Type	SymType	Grade	Color	Notes
DUMMY	Other	Isotropic	Unknown	Green	
HYSD415	Rebar	Uniaxial	HYSD Grade 415	Yellow	
HYSD550	Rebar	Uniaxial	HYSD Grade 550	Gray8Dark	
M35	Concrete	Isotropic	M35	Yellow	
M40	Concrete	Isotropic	M40	Yellow	
Tendon	Tendon	Uniaxial	Unknown	Gray8Dark	

2.2 Frame Sections

Table 2.2 - Frame Section Property Definitions - Summary (Part 1 of 3)

Name	Material	Shape	Color	Area cm2	J cm4	I33 cm4	I22 cm4	I23 cm4	As2 cm2
B 200X380	M35	Concrete Rectangular	Cyan	760	67948.2	91453.3	25333.3	0	633.3
B 200X450	M35	Concrete Rectangular	Cyan	900	86509.3	151875	30000	0	750
B 200X600	M35	Concrete Rectangular	Blue	1200	126434.6	360000	40000	0	1000
B 200X750	M35	Concrete Rectangular	Gray8Dark	1500	166414.2	703125	50000	0	1250
B 300X1050	M35	Concrete Rectangular	Magenta	3150	774994.5	2894062.5	236250	0	2625
B 300X600	M35	Concrete Rectangular	Red	1800	370785.9	540000	135000	0	1500
DUMMY	DUMMY	Concrete Rectangular	Red	100	1408.3	833.3	833.3	0	83.3

Table 2.2 - Frame Section Property Definitions - Summary (Part 2 of 3)

Name	As3 cm2	S33Pos cm3	S33Neg cm3	S22Pos cm3	S22Neg cm3	Z33 cm3	Z22 cm3	R33 mm	R22 mm	Cw cm6	CG Offset 3 mm
B 200X380	633.3	4813.3	4813.3	2533.3	2533.3	7220	3800	109.7	57.7		0
B 200X450	750	6750	6750	3000	3000	10125	4500	129.9	57.7		0
B 200X600	1000	12000	12000	4000	4000	18000	6000	173.2	57.7		0
B 200X750	1250	18750	18750	5000	5000	28125	7500	216.5	57.7		0
B 300X1050	2625	55125	55125	15750	15750	82687.5	23625	303.1	86.6		0
B 300X600	1500	18000	18000	9000	9000	27000	13500	173.2	86.6		0
DUMMY	83.3	166.7	166.7	166.7	166.7	250	250	28.9	28.9		0

Table 2.2 - Frame Section Property Definitions - Summary (Part 3 of 3)

Name	PNA Offset 3 mm	PNA Offset 2 mm	Area Modifier	As2 Modifier	As3 Modifier	J Modifier	I33 Modifier	I22 Modifier	Mass Modifier	Weight Modifier
B 200X380	0	0	1	1	1	1	1	1	1	1
B 200X450	0	0	1	1	1	1	1	1	1	1
B 200X600	0	0	1	1	1	1	1	1	1	1
B 200X750	0	0	1	1	1	1	1	1	1	1
B 300X1050	0	0	1	1	1	1	1	1	1	1
B 300X600	0	0	1	1	1	1	1	1	1	1
DUMMY	0	0	1	1	1	1	1	1	1	1

2.3 Shell Sections

Table 2.3 - Area Section Property Definitions - Summary

Name	Type	Element Type	Material	Total Thickness mm	Deck Material	Deck Depth mm
S 125	Slab	Shell-Thin	M35	125		
S 150	Slab	Shell-Thin	M35	150		
S 175	Slab	Shell-Thin	M35	175		
S 200	Slab	Shell-Thin	M35	200		
W 200	Wall	Shell-Thin	M40	200		
W 300	Wall	Shell-Thin	M40	300		
W 450	Wall	Shell-Thin	M40	450		
W 625	Wall	Shell-Thin	M40	625		

3 Loads

This chapter provides loading information as applied to the model.

3.1 Load Patterns

Table 3.1 - Load Pattern Definitions

Name	Is Auto Load	Type	Self Weight Multiplier	Auto Load
~LLRF	Yes	Other	0	
~SPEC X(D)ECC	Yes	Other	0	
~SPEC X(S)ECC	Yes	Other	0	
~SPEC Y(D)ECC	Yes	Other	0	
~SPEC Y(S)ECC	Yes	Other	0	
~SPEC Z(D)ECC	Yes	Other	0	
Dead	No	Dead	1	
EQ X	No	Seismic	0	IS 1893:2016
EQ Y	No	Seismic	0	IS 1893:2016
LIVE<3	No	Reducible Live	0	
LIVE>3	No	Reducible Live	0	
ROOF	No	Roof Live	0	
SDL	No	Super Dead	0	
TEMP	No	Temperature	0	
WALL	No	Super Dead	0	
WL X	No	Wind	0	Indian IS 875:2015
WL Y	No	Wind	0	Indian IS 875:2015

3.2 Load Sets

Table 3.2 - Shell Uniform Load Sets

Name	Load Pattern	Load Value kN/m2
BALCONY	SDL	3.25
BALCONY	LIVE<3	3
BED/KITCHEN/LIVING	SDL	1.25
BED/KITCHEN/LIVING	LIVE<3	2
BILLIARDS / TT ROOM	SDL	1.25
BILLIARDS / TT ROOM	LIVE>3	5
COMMUNICATION ROOM	SDL	1.25
COMMUNICATION ROOM	LIVE<3	3
CORRIDOR	SDL	1.25
CORRIDOR	LIVE<3	3
DRIVEWAY	SDL	2.4
DRIVEWAY	LIVE<3	3
ELETRICAL ROOM	SDL	1.25
ELETRICAL ROOM	LIVE>3	7.5
FIRE TRACK	SDL	20
FIRE TRACK	LIVE<3	3
GYM/YOGA/INDOOR GAMES	SDL	1.25
GYM/YOGA/INDOOR GAMES	LIVE>3	5
LMR/OHT	SDL	20
LMR/OHT	LIVE<3	3

Table 3.2 - Shell Uniform Load Sets (continued)

Name	Load Pattern	Load Value kN/m2
LOBBY	SDL	1.25
LOBBY	LIVE<3	3
MULTI PURPOSE HALL	SDL	1.25
MULTI PURPOSE HALL	LIVE>3	5
PARKING	SDL	2.4
PARKING	LIVE<3	3
PRE-FUNCTION AREA	SDL	1.25
PRE-FUNCTION AREA	LIVE>3	5
PUMP ROOM	SDL	1.25
PUMP ROOM	LIVE>3	7.5
TERRACE	SDL	3
TERRACE	LIVE<3	3
TOILET	SDL	3.25
TOILET	LIVE<3	2
UTILITY	SDL	3.25
UTILITY	LIVE<3	2

3.3 Auto Wind Loading

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 1 of 3)

Name	Exposure Set	Is Auto Load	Exposure Source	Top Story	Bottom Story	Include Parapet	Parapet Height m	Cp Windward	Cp Leeward	Wind Speed meter/sec
WL X	1	No	Diaphragms	ROOF	STILT	Yes	1.25	0.8	0.5	50
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL X	1	No								
WL Y	1	No	Diaphragms	ROOF	STILT	Yes	1.25	0.8	0.5	50
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								
WL Y	1	No								

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 2 of 3)

Name	Exposure Set	Terrain Category	Importance Factor	Risk Coefficient	Topography	Width Type	Direction Angle deg	Story	Diaphragm
WL X	1	2	1.00	1	1	Auto	0	ROOF	D2
WL X	1							11TH	D1
WL X	1							10TH	D1
WL X	1							9TH	D1
WL X	1							8TH	D1
WL X	1							7TH	D1
WL X	1							6TH	D1
WL X	1							5TH	D1
WL X	1							4TH	D1
WL X	1							3RD	D1
WL X	1							2ND	D1
WL X	1							1ST	D1
WL Y	1	2	1.00	1	1	Auto	90	ROOF	D2
WL Y	1							11TH	D1
WL Y	1							10TH	D1
WL Y	1							9TH	D1
WL Y	1							8TH	D1
WL Y	1							7TH	D1
WL Y	1							6TH	D1
WL Y	1							5TH	D1
WL Y	1							4TH	D1
WL Y	1							3RD	D1
WL Y	1							2ND	D1
WL Y	1							1ST	D1

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 3 of 3)

Name	Exposure Set	Depth m	X m	Y m
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL X	1	16.83	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175

Table 3.3 - Load Pattern Definitions - Auto Wind - Indian IS 875 2015 (Part 3 of 3, continued)

Name	Exposure Set	Depth m	X m	Y m
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175
WL Y	1	61.035	8.415	30.5175

3.4 Auto Seismic Loading

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 1 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	Is Auto Load	X Dir?	X Dir Plus Ecc?	X Dir Minus Ecc?	Y Dir?	Y Dir Plus Ecc?	Y Dir Minus Ecc?
EQ X	0.789	0.041369	133125.6477	5507.2511	No	Yes	No	No	No	No	No
EQ Y	0.412	0.06	133125.6477	7987.5389	No	No	No	No	Yes	No	No

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 2 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	Ecc Ratio	Top Story	Bottom Story	Period Type	User T sec	Z
EQ X	0.789	0.041369	133125.6477	5507.2511	0.05	ROOF	STILT	User Defined	0.789	0.16
EQ Y	0.412	0.06	133125.6477	7987.5389	0.05	ROOF	STILT	User Defined	0.412	0.16

Table 3.4 - Load Pattern Definitions - Auto Seismic - IS 1893 2016 (Part 3 of 3)

Name	Period Used sec	Coeff Used	Weight Used kN	Base Shear kN	I	R
EQ X	0.789	0.041369	133125.6477	5507.2511	1.2	4
EQ Y	0.412	0.06	133125.6477	7987.5389	1.2	4

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQ X according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.789\ sec$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 4$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 1.723701$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{Z I \frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.789	133125.6477	5507.2511

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEAD ROOM	47.475	0	0
ROOF	44.475	1062.0499	0
11TH	41.475	1062.8653	0
10TH	38.475	878.4011	0
9TH	35.475	711.5049	0
8TH	32.475	562.1767	0
7TH	29.475	430.4496	0
6TH	26.475	316.301	0
5TH	23.475	219.6535	0
4TH	20.475	140.5782	0
3RD	17.475	79.0753	0
2ND	14.475	35.1446	0
1ST	11.475	9.0511	0
STILT	8.475	0	0
BASE-1	4.875	0	0

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
Base	0	0	0

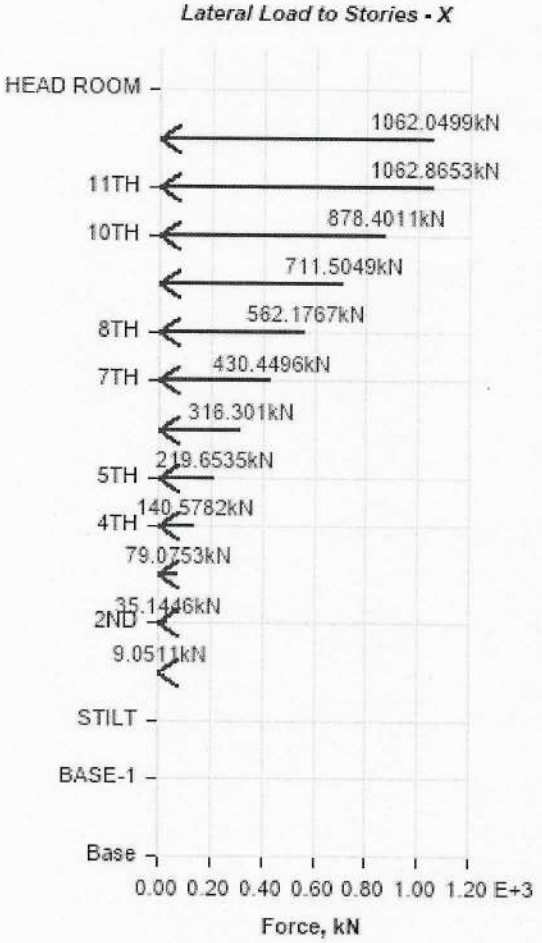


Figure 3-1-Set 1

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQ Y according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.412\ sec$

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 4$

Importance Factor, I [IS Table 8] $I = 1.2$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a/g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

Seismic Coefficient, A_h [IS 6.4.2] $A_h = \frac{Z I \frac{S_a}{g}}{2R}$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.412	133125.6477	7987.5389

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
HEAD ROOM	47.475	0	0
ROOF	44.475	0	1540.3628
11TH	41.475	0	1541.5455
10TH	38.475	0	1274.0045
9TH	35.475	0	1031.9437
8TH	32.475	0	815.3629
7TH	29.475	0	624.3102
6TH	26.475	0	458.7528
5TH	23.475	0	318.5783
4TH	20.475	0	203.8901
3RD	17.475	0	114.6882
2ND	14.475	0	50.9725
1ST	11.475	0	13.1274
STILT	8.475	0	0
BASE-1	4.875	0	0

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
Base	0	0	0

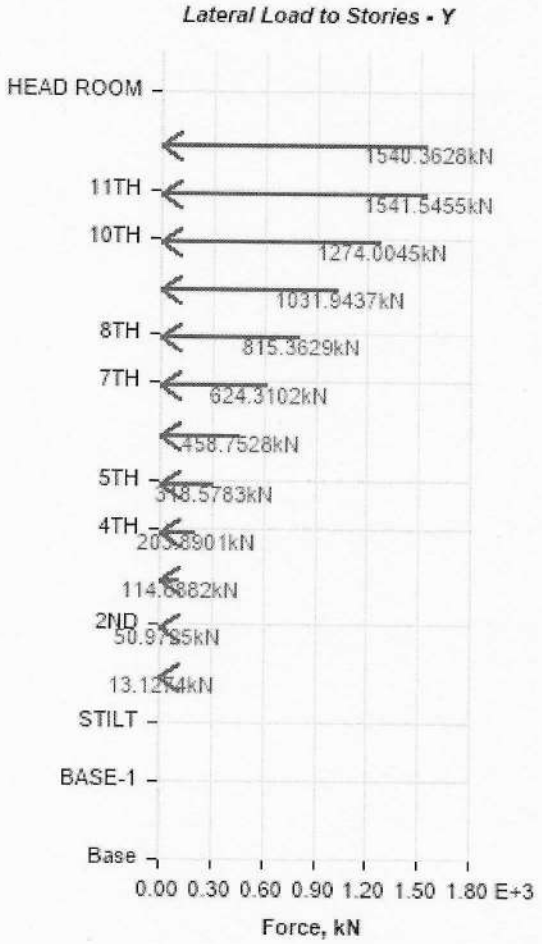


Figure 3-2-Set 1

3.5 Load Cases

Table 3.5 - Load Case Definitions - Summary

Name	Type
Dead	Linear Static
Live>3	Linear Static
Modal	Modal - Ritz
SDL	Linear Static
WALL	Linear Static
LIVE<3	Linear Static
ROOF	Linear Static
TEMP	Linear Static
EQ X	Linear Static
EQ Y	Linear Static
WL X	Linear Static
WL Y	Linear Static
SPEC X(D)	Response Spectrum
SPEC Y(D)	Response Spectrum
SPEC X(S)	Response Spectrum
SPEC Y(S)	Response Spectrum
SPEC Z(D)	Response Spectrum

4 Analysis Results

This chapter provides analysis results.

4.1 Story Results

Table 4.1 - Story Stiffness

Story	Output Case	Case Type	Step Type	Shear X kN	Drift X mm	Stiff X kN/m	Shear Y kN	Drift Y mm	Stiff Y kN/m
HEAD ROOM	EQ X	LinStatic	Step By Step	0	4.975	1.201E-05	0	0.247	0.001
ROOF	EQ X	LinStatic	Step By Step	1062.0498	4.7	225963.381	1.585E-06	0.197	0
11TH	EQ X	LinStatic	Step By Step	2124.9062	5.175	410639.874	2.794E-06	0.16	0
10TH	EQ X	LinStatic	Step By Step	3003.2998	5.329	563542.388	6.869E-06	0.159	0
9TH	EQ X	LinStatic	Step By Step	3714.7976	5.435	683465.832	1.573E-05	0.154	0
8TH	EQ X	LinStatic	Step By Step	4276.9683	5.476	780973.139	2.43E-05	0.151	0
7TH	EQ X	LinStatic	Step By Step	4707.4123	5.432	866624.859	2.385E-05	0.146	0
6TH	EQ X	LinStatic	Step By Step	5023.7079	5.291	949427.315	2.421E-05	0.139	0
5TH	EQ X	LinStatic	Step By Step	5243.3572	5.043	1039719.208	2.445E-05	0.129	0
4TH	EQ X	LinStatic	Step By Step	5383.9339	4.673	1152191.695	2.667E-05	0.113	0
3RD	EQ X	LinStatic	Step By Step	5463.007	4.165	1311604.385	2.679E-05	0.094	0
2ND	EQ X	LinStatic	Step By Step	5498.1511	3.509	1566654.54	2.715E-05	0.083	0
1ST	EQ X	LinStatic	Step By Step	5507.2013	3.297	1670211.444	2.441E-05	0.104	0
STILT	EQ X	LinStatic	Step By Step	5507.2013	0.974	5653969.086	2.43E-05	0.131	0
BASE-1	EQ X	LinStatic	Step By Step	5507.2013	0.504	10919115.236	2.444E-05	0.1	0
HEAD ROOM	EQ Y	LinStatic	Step By Step	0	0.236	0	3.787E-05	4.184	0.009
ROOF	EQ Y	LinStatic	Step By Step	1.239E-06	0.493	0	1540.3629	5.957	258580.624
11TH	EQ Y	LinStatic	Step By Step	0.0004	0.524	0	3081.9083	6.938	444214.565
10TH	EQ Y	LinStatic	Step By Step	0.0007	0.53	0	4355.9128	7.932	549180.571
9TH	EQ Y	LinStatic	Step By Step	0.001	0.533	0	5387.856	8.875	607105.81
8TH	EQ Y	LinStatic	Step By Step	0.0012	0.529	0	6203.2184	9.67	641485.113
7TH	EQ Y	LinStatic	Step By Step	0.0014	0.519	0	6827.5285	10.235	667066.878
6TH	EQ Y	LinStatic	Step By Step	0.0016	0.5	0	7286.2813	10.517	692783.585
5TH	EQ Y	LinStatic	Step By Step	0.0018	0.466	0	7604.8596	10.464	726740.794
4TH	EQ Y	LinStatic	Step By Step	0.0019	0.424	0	7808.7495	9.992	781526.809
3RD	EQ Y	LinStatic	Step By Step	0.002	0.369	0	7923.4377	8.975	882839.631
2ND	EQ Y	LinStatic	Step By Step	0.002	0.321	0	7974.4101	7.192	1108747.164
1ST	EQ Y	LinStatic	Step By Step	0.002	0.302	0	7987.5373	4.66	1714189.378
STILT	EQ Y	LinStatic	Step By Step	0.002	0.23	0	7987.5373	0.89	8974570.814
BASE-1	EQ Y	LinStatic	Step By Step	0.002	0.048	0	7987.5373	0.101	78759937.414

4.2 Modal Results

Table 4.2 - Modal Participating Mass Ratios (Part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY
Modal	1	1.879	0.0068	0.4943	1.446E-06	0.0068	0.4943	1.446E-06	0.1498	0.0053
Modal	2	1.68	0.4977	0.0116	0	0.5044	0.5059	1.609E-06	0.0031	0.4009
Modal	3	1.526	0.0268	0.01	1.004E-05	0.5312	0.5159	1.165E-05	0.0031	0.0249
Modal	4	0.544	0.0002	0.0943	0	0.5314	0.6102	1.171E-05	0.0261	2.405E-05
Modal	5	0.421	0.1522	0.0003	4.173E-05	0.6836	0.6105	0.0001	3.561E-05	0.0997
Modal	6	0.358	0.0366	0.0004	0.0001	0.7202	0.6109	0.0002	1.262E-05	0.02
Modal	7	0.269	0.0001	0.0535	0.0001	0.7202	0.6644	0.0002	0.0085	1.076E-06
Modal	8	0.231	0.0025	0.0002	0.1918	0.7227	0.6646	0.192	0.0304	0.0092
Modal	9	0.187	0.0643	0.0001	0.2095	0.787	0.6647	0.4016	2.94E-05	0.0748

Table 4.2 - Modal Participating Mass Ratios (Part 1 of 2, continued)

Case	Mode	Period sec	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY
Modal	10	0.163	0.1198	1.534E-06	0.1506	0.9068	0.6647	0.5522	0.0024	0.093
Modal	11	0.117	2.836E-05	0.2338	0.0002	0.9069	0.8984	0.5524	0.0706	1.837E-06
Modal	12	0.106	0.0111	0.0001	0.26	0.918	0.8985	0.8124	0.0017	0.0128

Table 4.2 - Modal Participating Mass Ratios (Part 2 of 2)

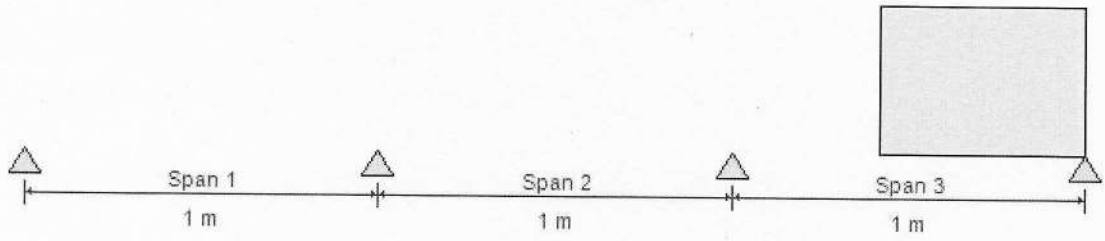
Case	Mode	RZ	SumRX	SumRY	SumRZ
Modal	1	0.0144	0.1498	0.0053	0.0144
Modal	2	0.0174	0.1529	0.4062	0.0317
Modal	3	0.3677	0.156	0.4311	0.3995
Modal	4	0.001	0.1821	0.4311	0.4004
Modal	5	0.0228	0.1821	0.5308	0.4232
Modal	6	0.0674	0.1821	0.5509	0.4906
Modal	7	0.0001	0.1906	0.5509	0.4907
Modal	8	0.0002	0.2211	0.5601	0.4909
Modal	9	0.0132	0.2211	0.6349	0.504
Modal	10	0.0136	0.2235	0.7279	0.5176
Modal	11	0.0001	0.2942	0.7279	0.5177
Modal	12	0.0007	0.2959	0.7407	0.5184

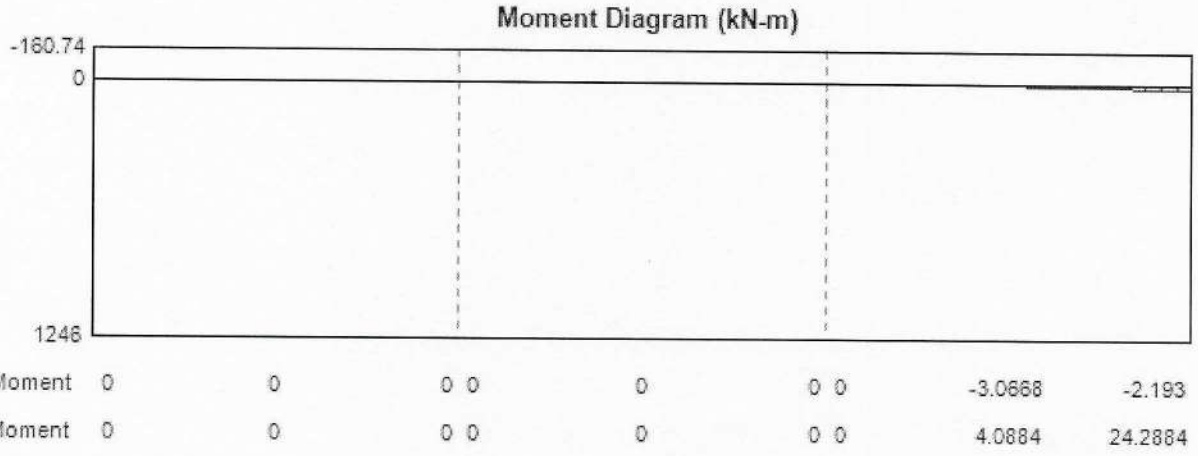
DESIGN OF RAFT FOUNDATION

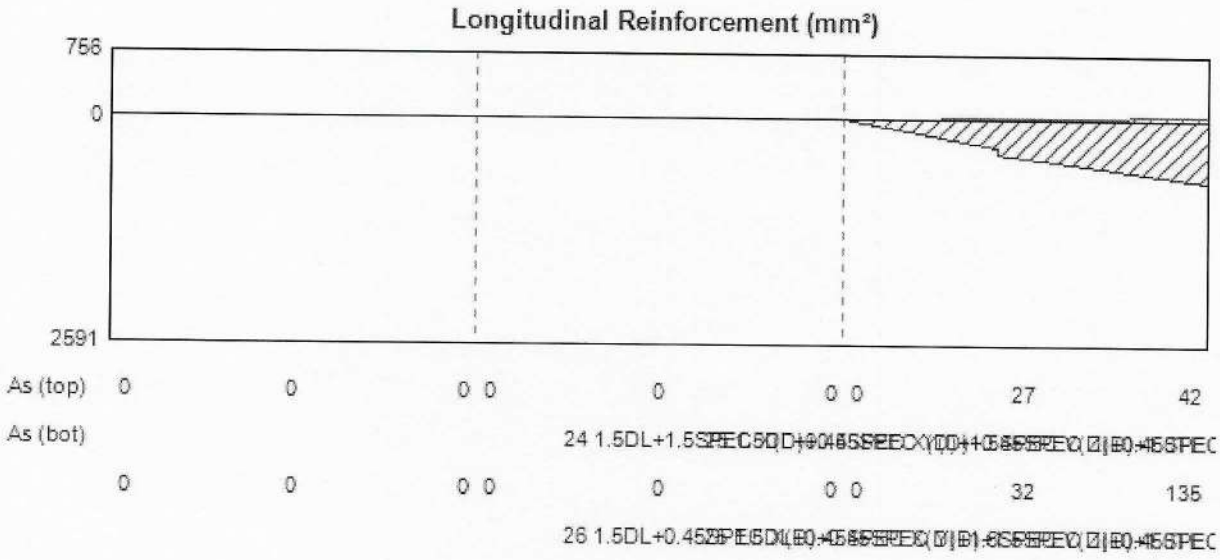
IS 456:2000 Concrete Strip Design

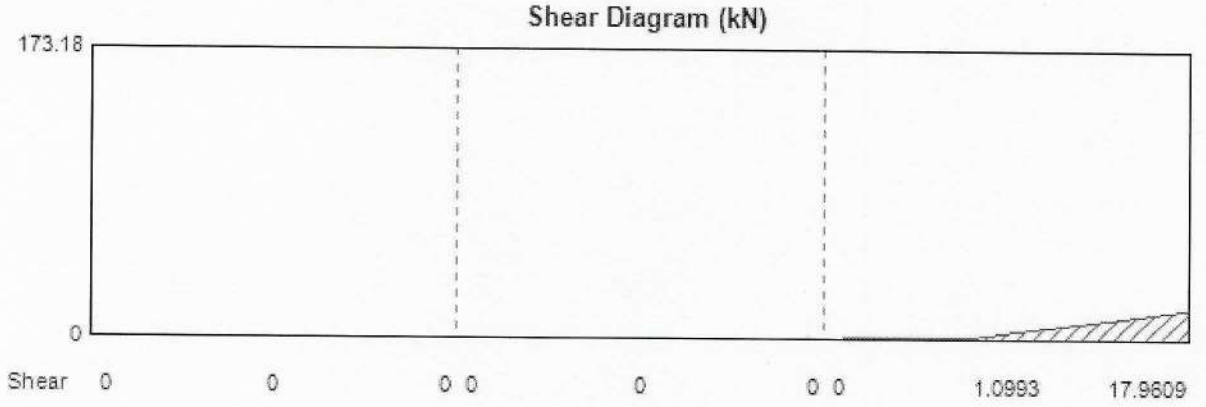
Geometric Properties
Combination = Overall Envelope
Strip Label = SB48
Length = 28.31 m
Distance to Top Rebar Center = 90 mm
Distance to Bot Rebar Center = 90 mm

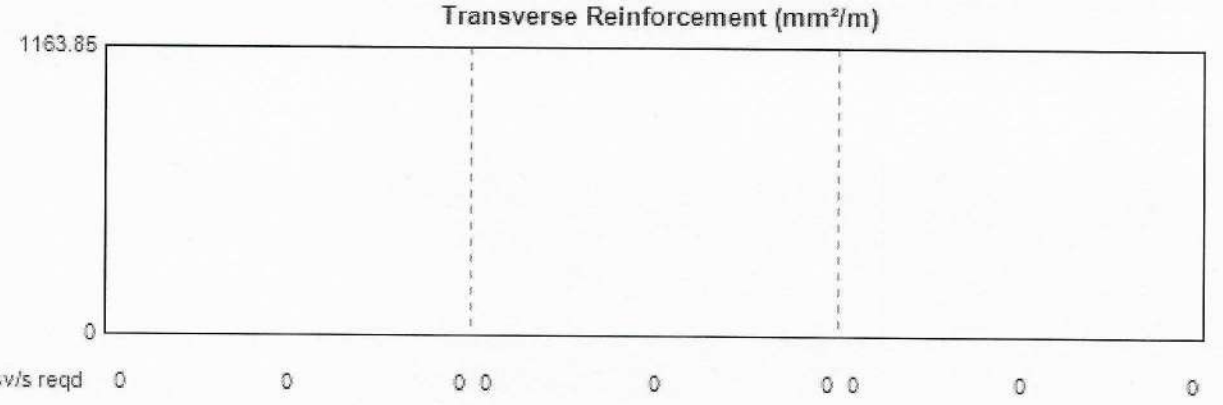
Material Properties
Concrete Comp. Strength = 35 MPa
Concrete Modulus = 29580.4 MPa
Longitudinal Rebar Yield = 550 MPa

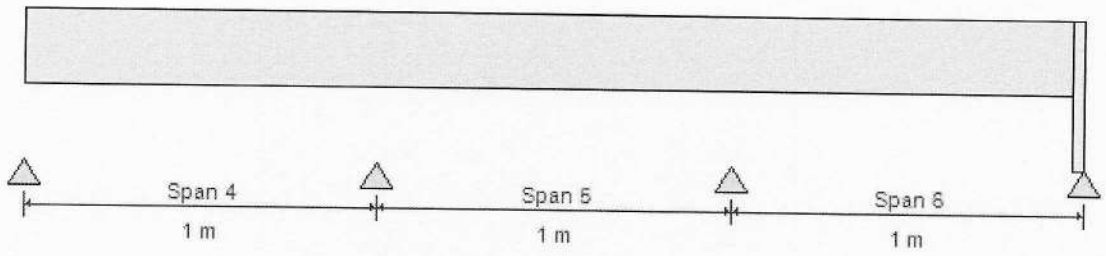




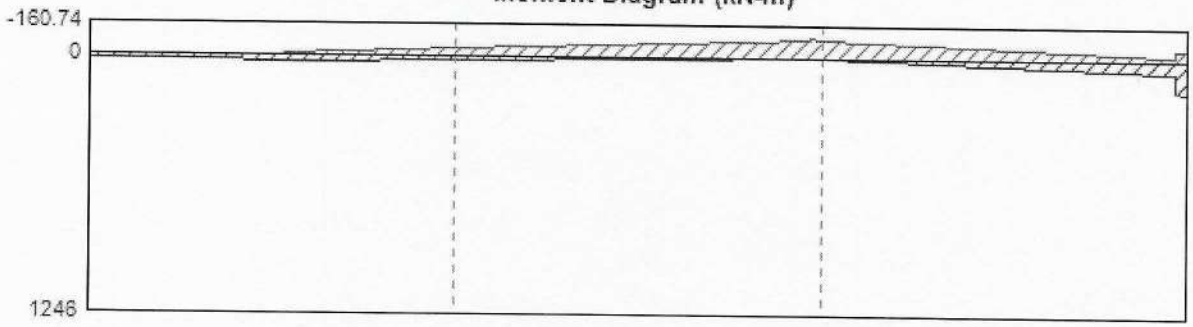

Longitudinal Reinforcement (mm²)
756
0
2591
As (top) 0 0 0 0 0 0 0 27 42
As (bot)
24 1.5DL+1.5
0 0 0 0 0 0 0 32 135
26 1.5DL+0.45


Shear Diagram (kN)
173.18
0
Shear 0 0 0 0 0 0 1.0993 17.9609


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0

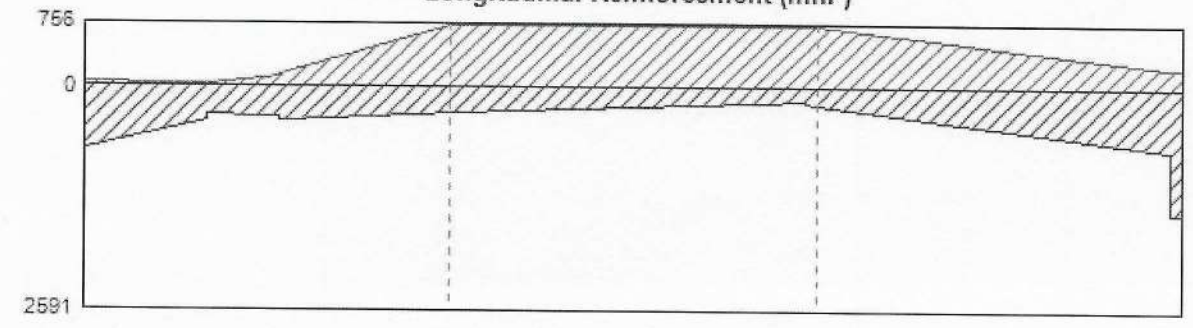


Moment Diagram (kN-m)

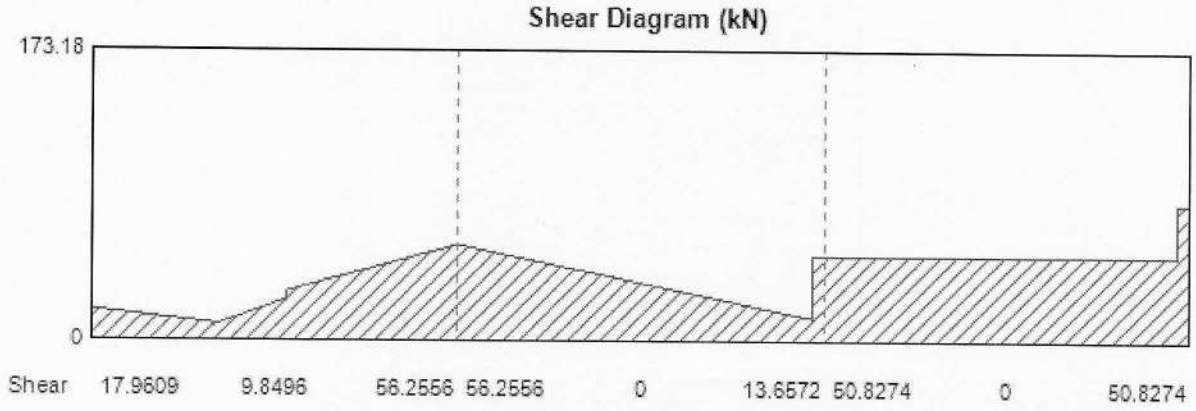


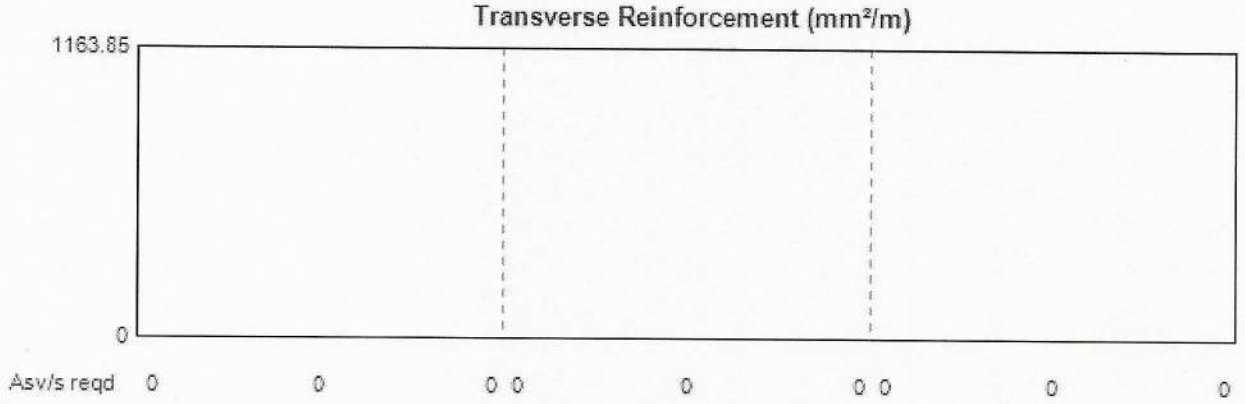
(-)Moment	-2.193	-5.3149	-40.8804	-40.8804	0	-93.5528	-91.5094	0	-22.3645
(+)Moment	24.2884	32.7311	24.0984	24.0984	0	1.737	1.737	0	153.2693

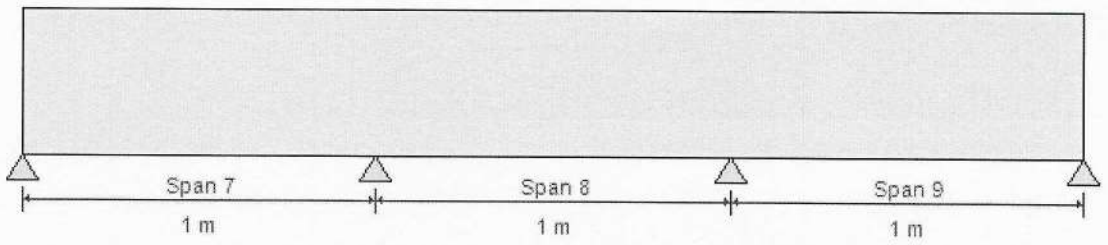
Longitudinal Reinforcement (mm²)



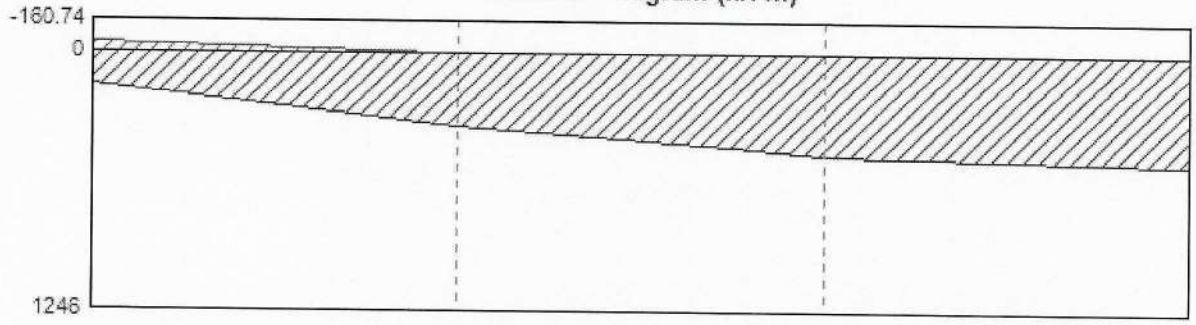
As (top)	42	129	379	379	0	614	604	0	236
	135	256	300	300	0	201	201	0	445


Shear Diagram (kN)
173.18
0
Shear 17.9609 9.8496 56.2556 56.2556 0 13.6572 50.8274 0 50.8274


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0

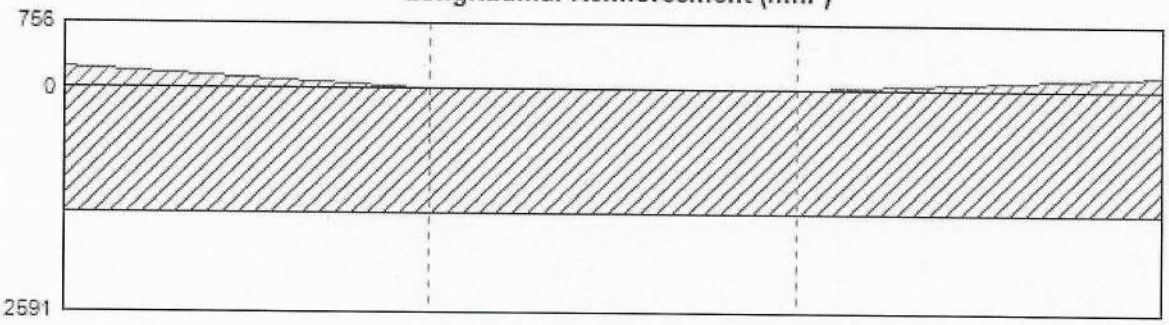

Span 7
1 m
Span 8
1 m
Span 9
1 m

Moment Diagram (kN-m)



(-)Moment	-45.6691	0	0	0	0	0	0	-1.8699
(+)Moment	153.2693	0	365.3292	365.3292	461.4569	500.1107	500.1107	0	539.871

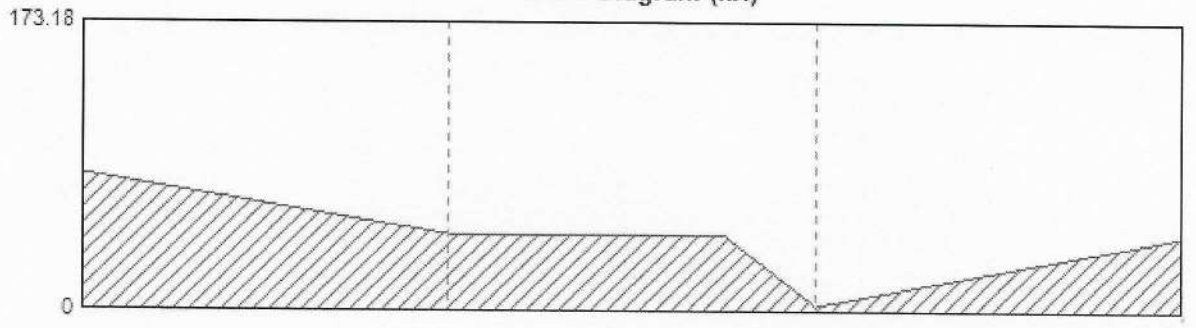
Longitudinal Reinforcement (mm²)



As (top)	233	0	0	0	0	0	0	169
As (bot)	28 0.9DL+0.45SPEC X(D)+1.5SPEC Y(D)+0.45SPEC Z(D)+1.5SPEC X(D)+0.45SPEC Y(D)+0.45SPEC Z(D)+1.0TL							
	445	0	878	878	1053	1125	1125	0	1194

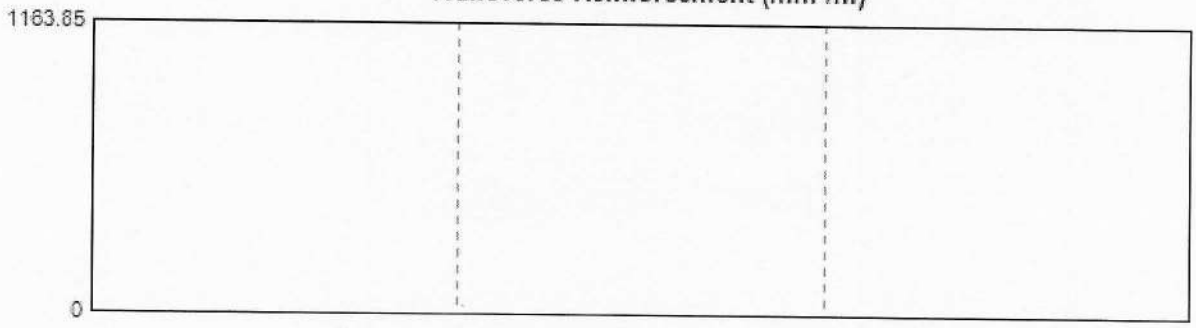
5SPEC X(D)+1.5SPEC Y(D)+0.45SPEC Z(D)+1.5SPEC

Shear Diagram (kN)

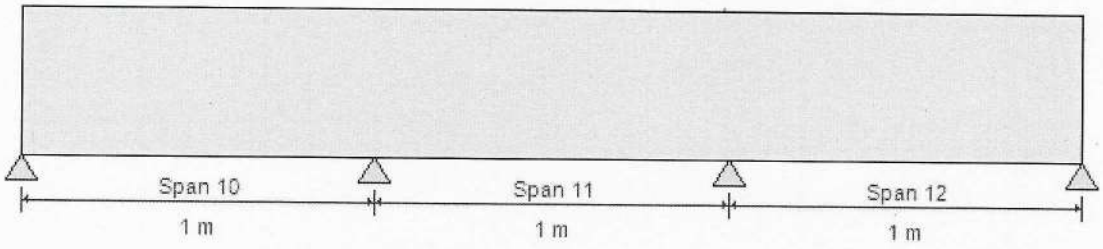


Shear	82.0975	0	45.9778	45.9778	45.9778	45.9778	2.0525	0	44.0286

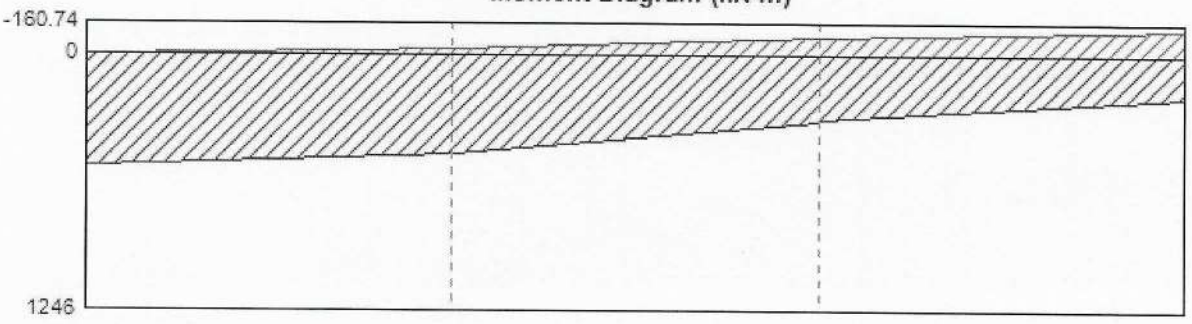
Transverse Reinforcement (mm²/m)



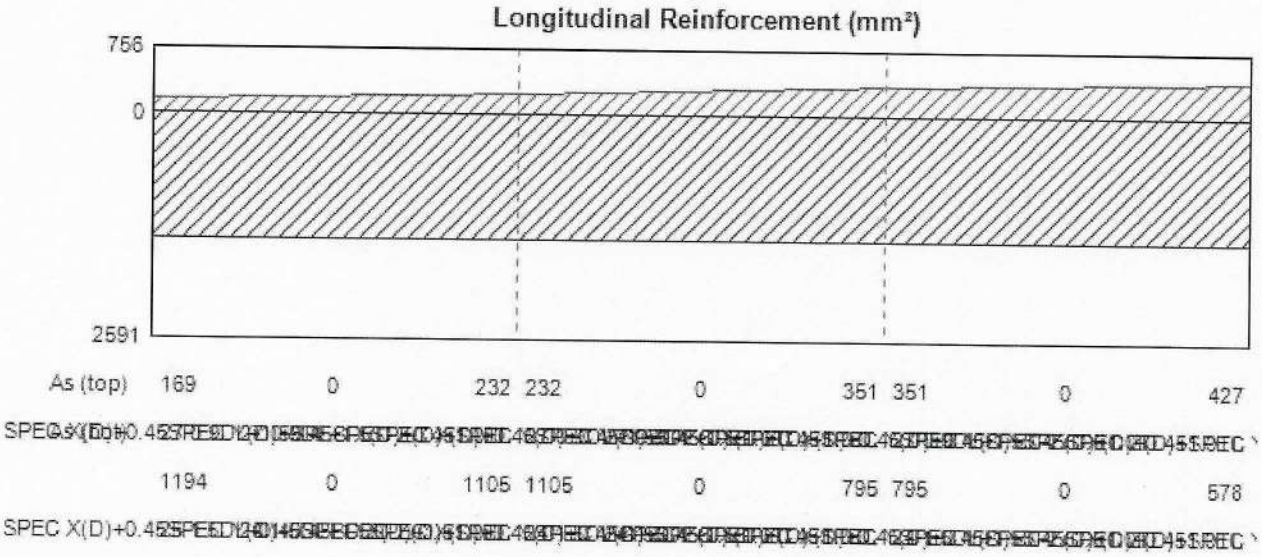
Asv/s reqd	0	0	0	0	0	0	0

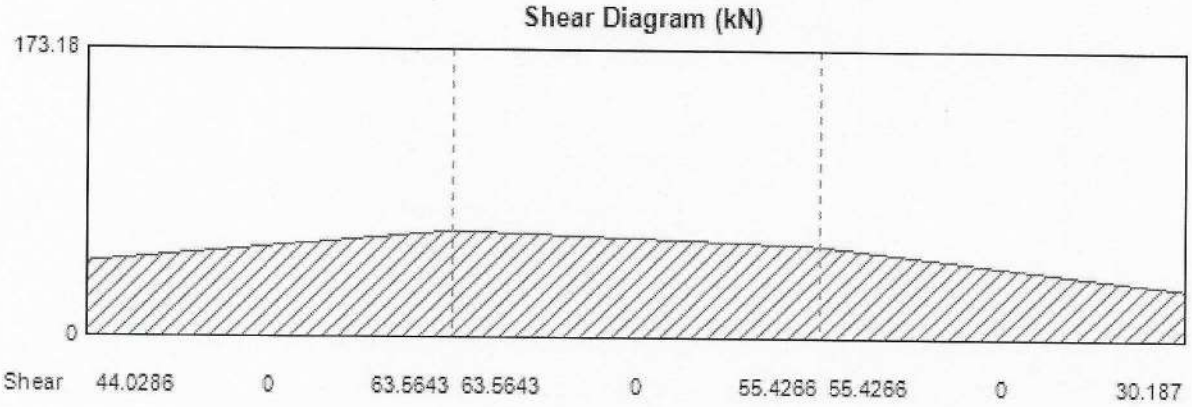


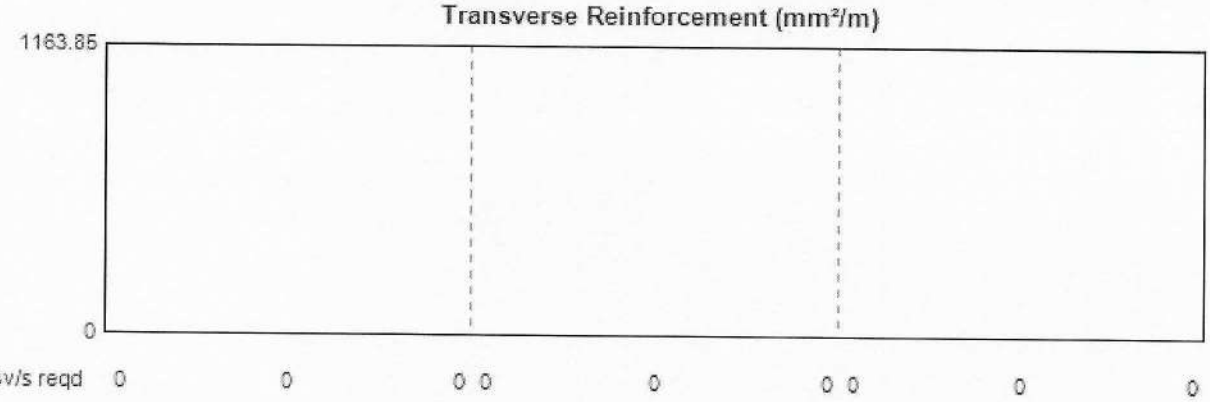
Moment Diagram (kN-m)

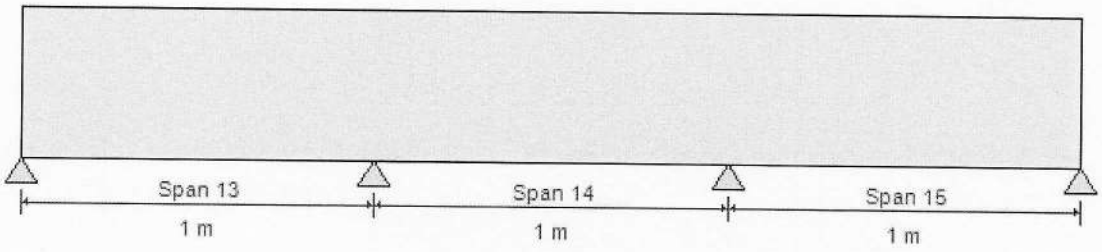


(-)Moment	-1.8699	0	-29.9772	-29.9772	0	-86.3483	-86.3483	0	-128.3792
(+)Moment	539.871	0	481.5036	481.5036	0	317.9939	317.9939	0	205.4116

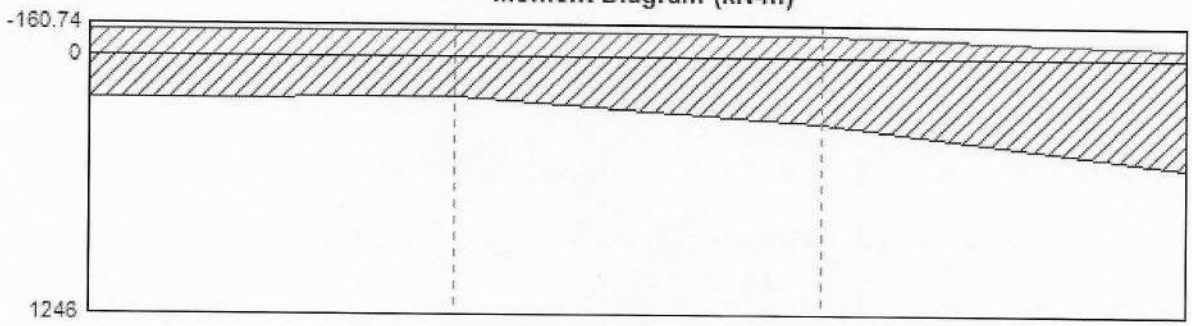

Longitudinal Reinforcement (mm²)
756
0
2591
As (top) 169 0 232 232 0 351 351 0 427
1194 0 1105 1105 0 795 795 0 578


Shear Diagram (kN)
173.18
0
Shear 44.0286 0 63.5643 63.5643 0 55.4266 55.4266 0 30.187


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0 0

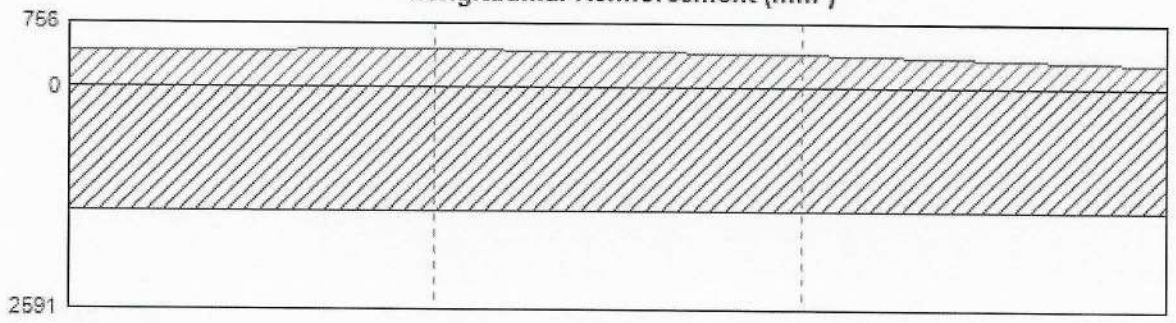


Moment Diagram (kN-m)

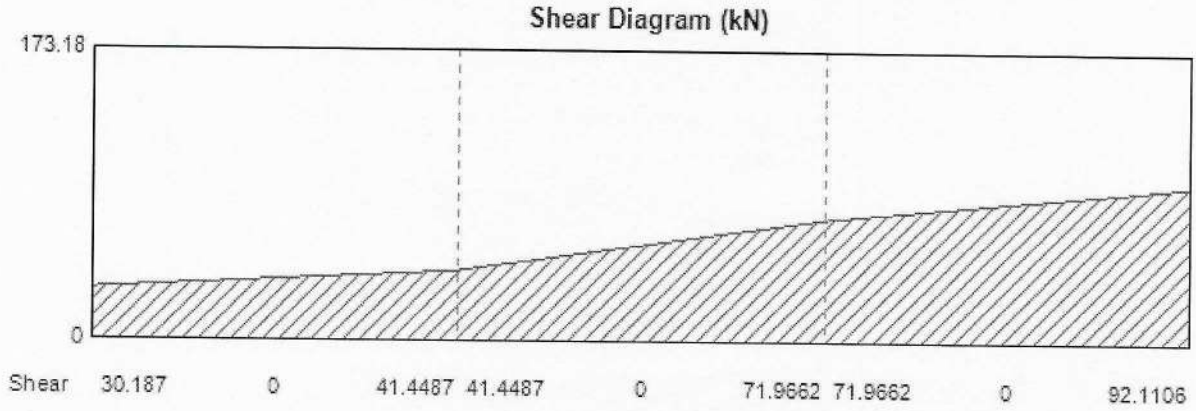


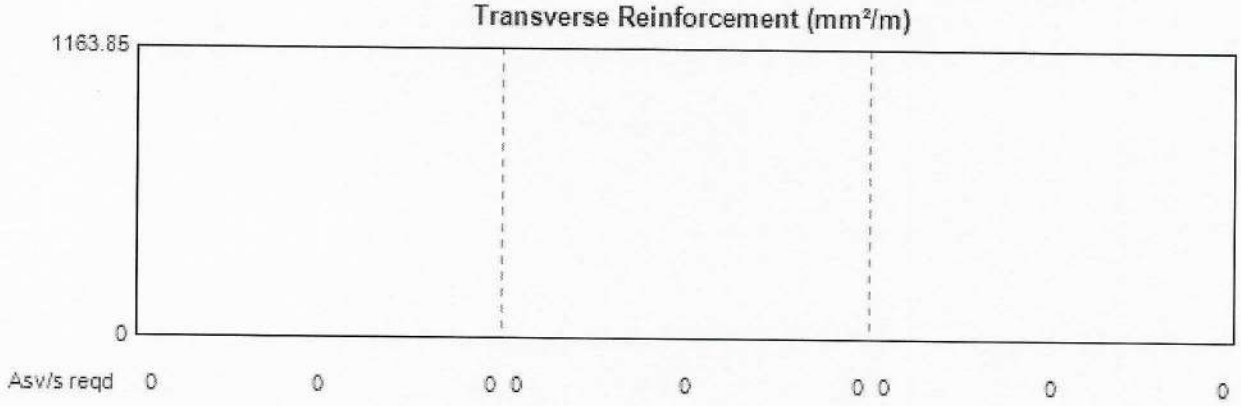
(-)Moment	-128.3792	0	-127.2664	-127.2664	0	-110.3686	-110.3686	0	-49.286
(+)Moment	205.4116	0	199.8672	199.8672	0	322.6977	322.6977	0	537.3632

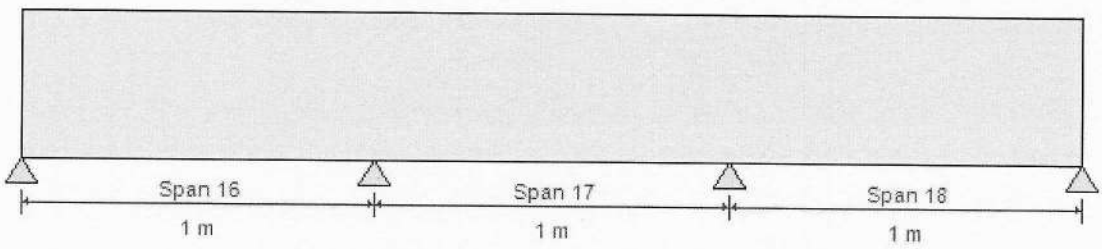
Longitudinal Reinforcement (mm²)



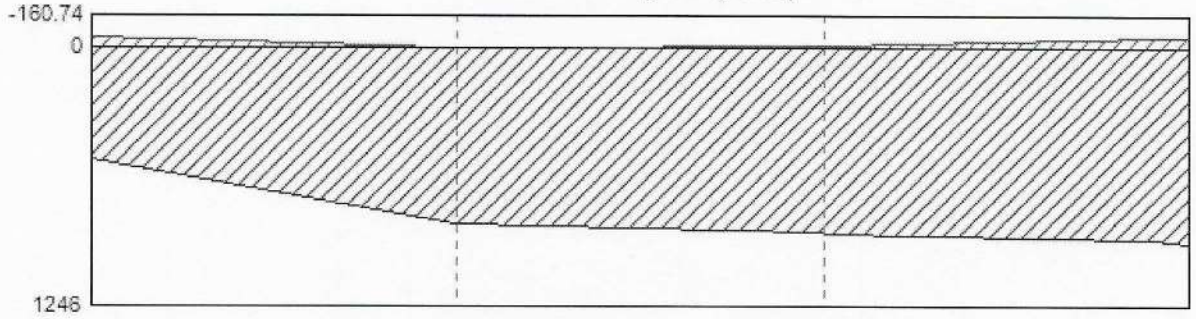
As (top)	427	0	430	430	0	396	396	0	270
SPEC X(D)+0.45									
	578	0	572	572	0	802	802	0	1207
SPEC X(D)+0.45									


Shear Diagram (kN)
173.18
0
Shear 30.187 0 41.4487 41.4487 0 71.9662 71.9662 0 92.1106


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0 0

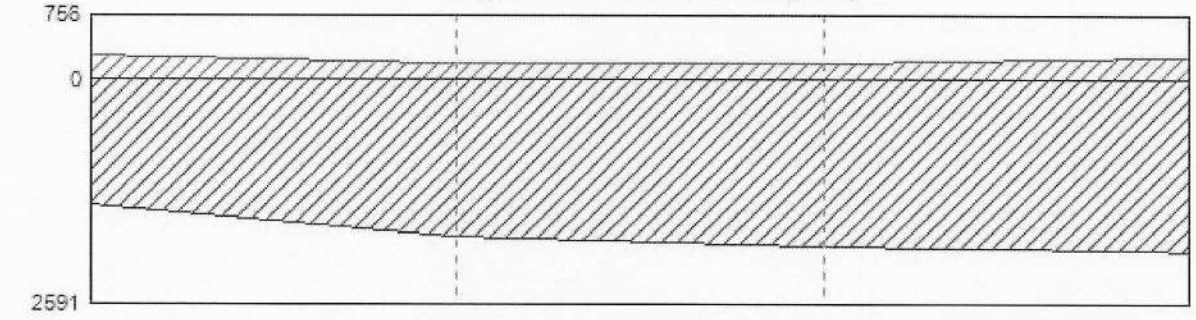

Span 16
1 m
Span 17
1 m
Span 18
1 m

Moment Diagram (kN-m)



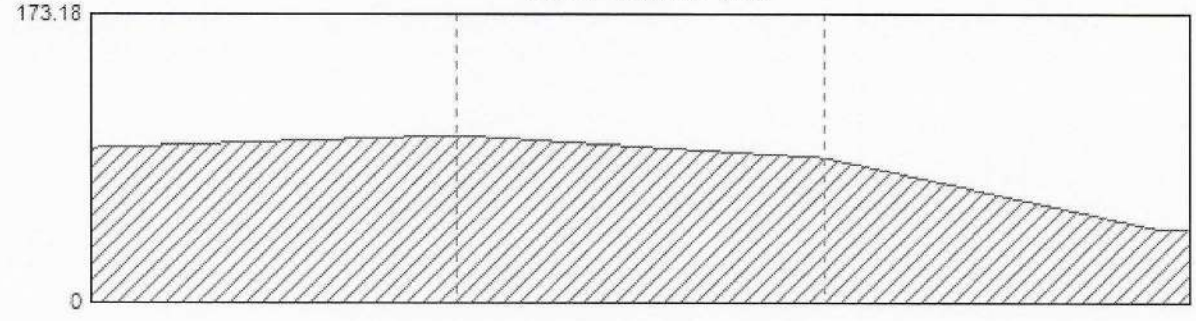
(-)Moment	-49.286	0	-2.7523	-2.7523	0	-6.4857	-6.4857	0	-47.3464
(+)Moment	537.3632	0	848.3557	848.3557	0	894.0685	894.0685	0	946.1814

Longitudinal Reinforcement (mm²)



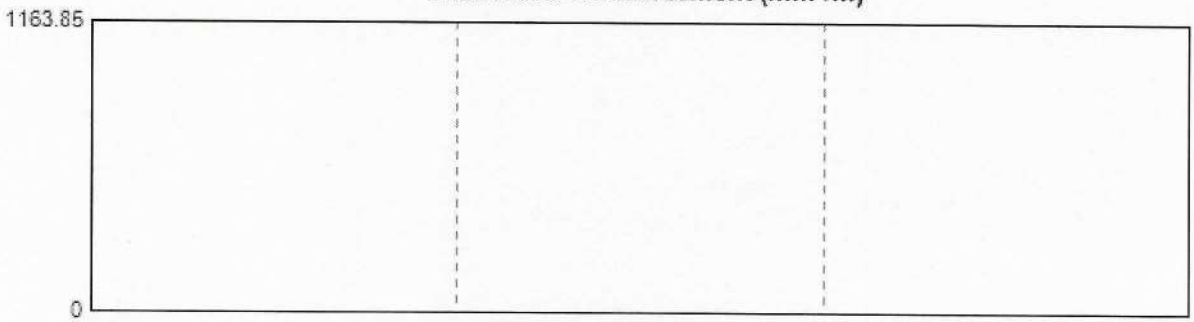
As (top)	270	0	179	179	0	190	190	0	261
SPEC X(D)+0.45	[illegible]								
	1207	0	1823	1823	0	1920	1920	0	2007
SPEC X(D)+0.45	[illegible]								

Shear Diagram (kN)

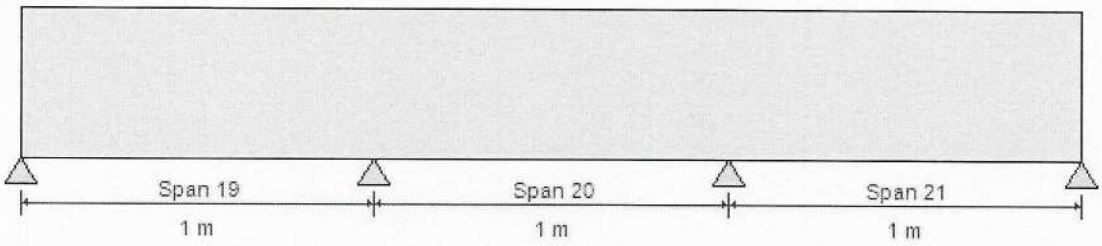


Shear	92.1106	0	99.3838	99.3838	0	86.9509	86.9509	0	44.1452

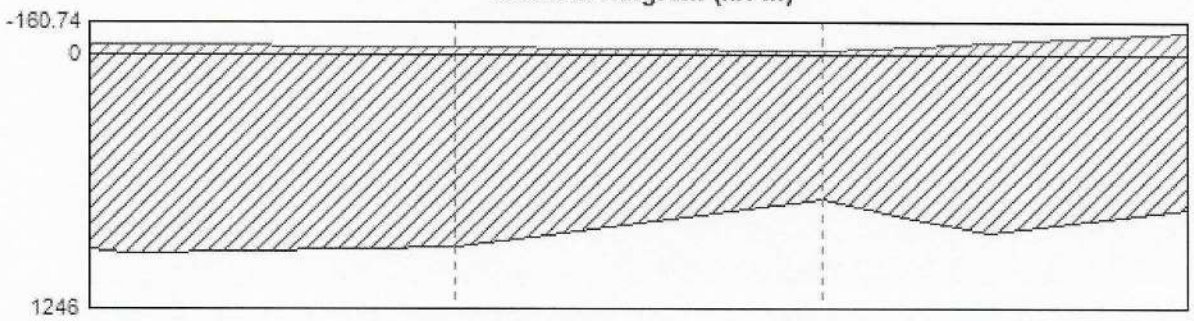
Transverse Reinforcement (mm²/m)



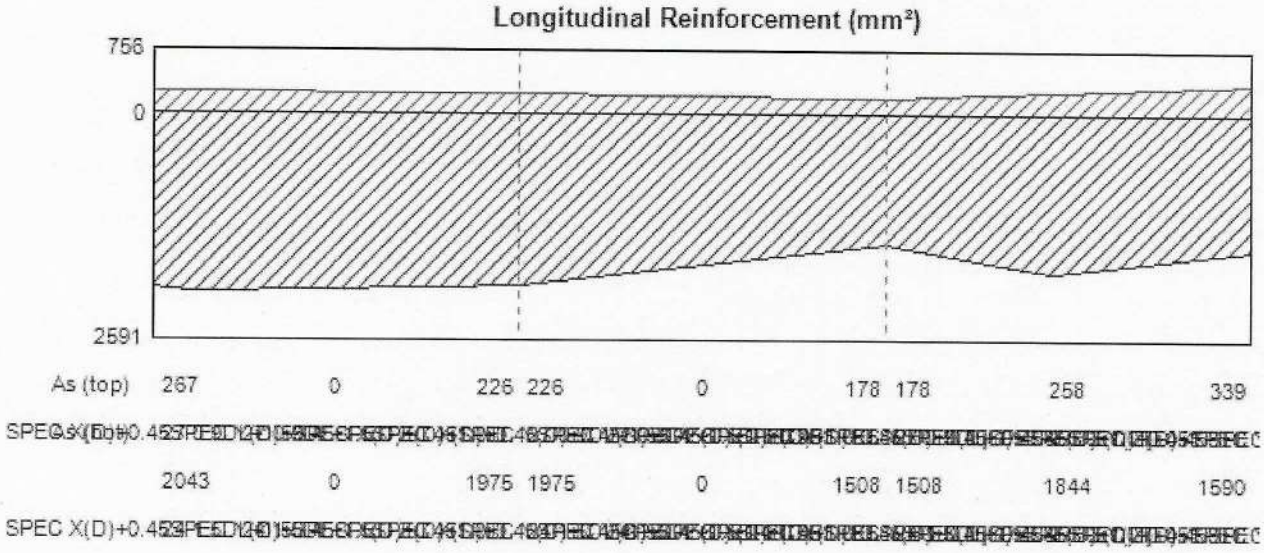
Asv/s reqd	0	0	0	0	0	0	0

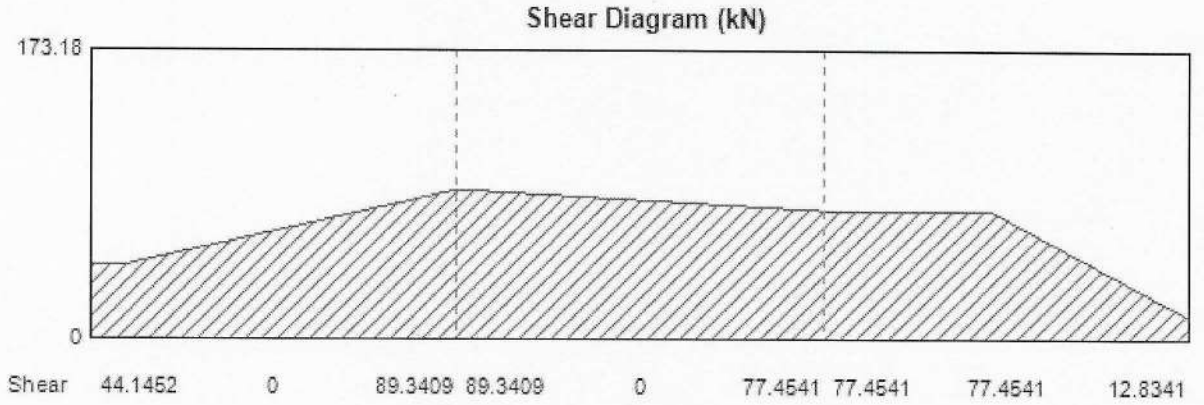


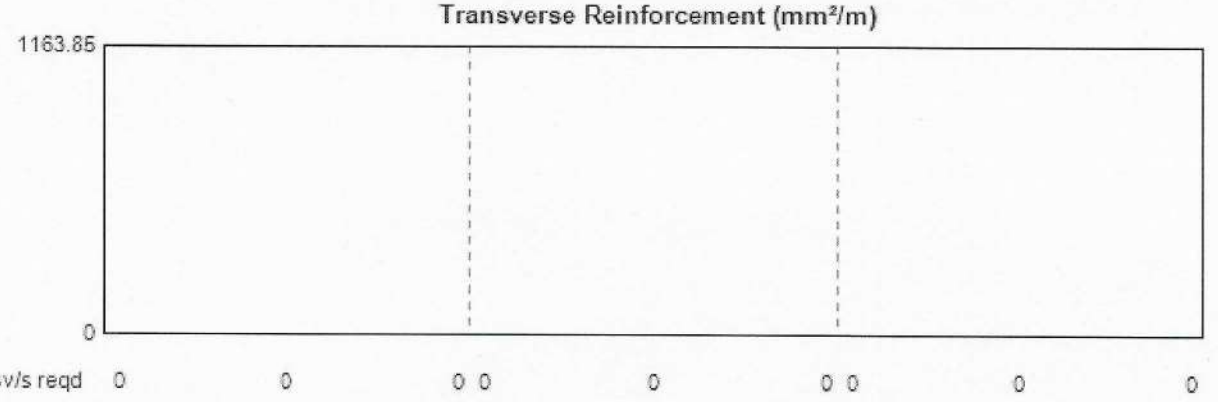
Moment Diagram (kN-m)

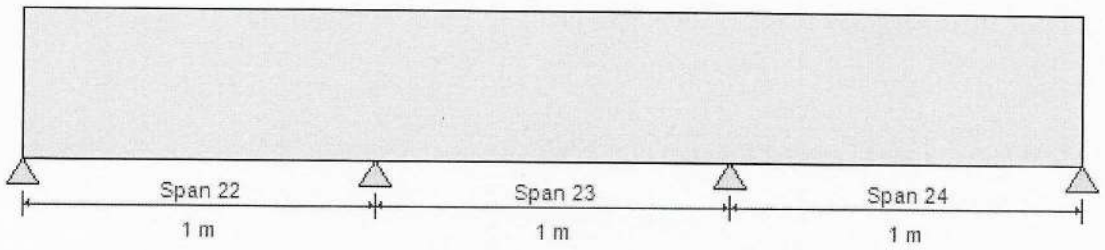


(-)Moment	-50.7301	0	-34.8712	-34.8712	0	-16.9556	-16.9556	-56.5065	-105.5868
(+)Moment	964.9871	0	934.3182	934.3182	0	701.4365	701.4365	873.3375	750.5044

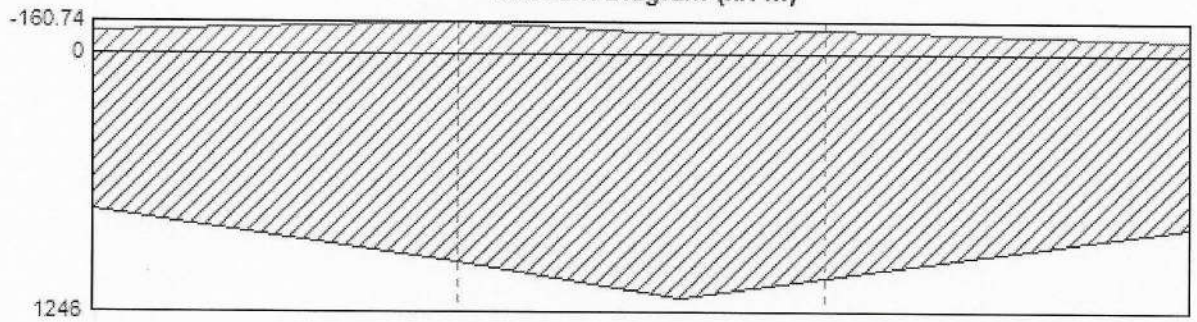

Longitudinal Reinforcement (mm²)
756
0
2591
As (top) 267 0 226 226 0 178 178 258 339
2043 0 1975 1975 0 1508 1508 1844 1590


Shear Diagram (kN)
173.18
0
Shear 44.1452 0 89.3409 89.3409 0 77.4541 77.4541 77.4541 12.8341


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0 0

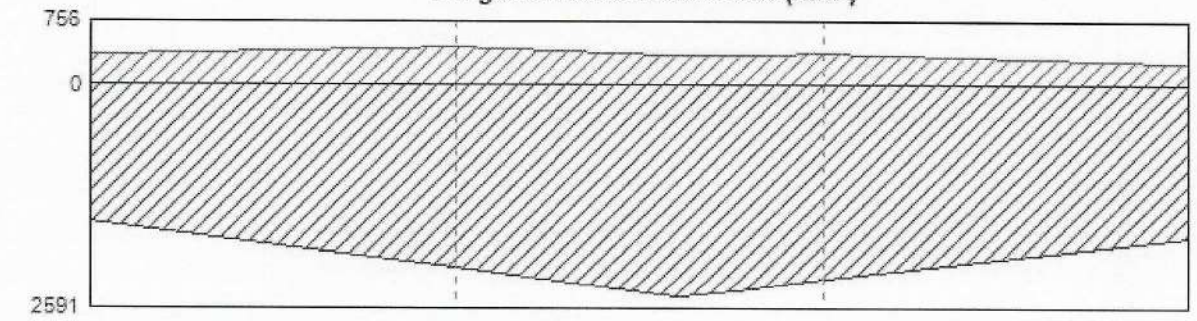


Moment Diagram (kN-m)

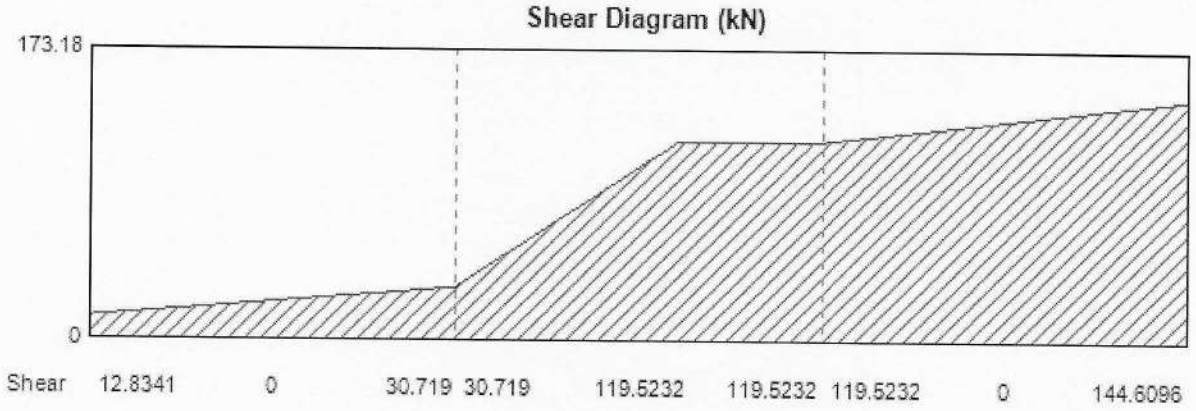


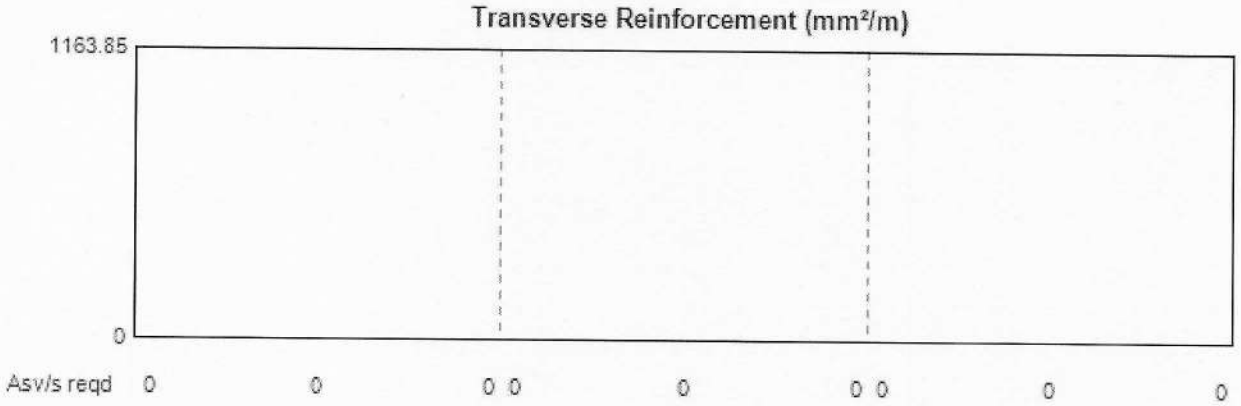
(-)Moment	-105.5868	0	-153.0849	-153.0849	-101.4202	-116.0065	-116.0065	0	-66.3605
(+)Moment	750.5044	0	1006.9207	1006.9207	1186.5199	1134.6403	1084.0575	0	843.8815

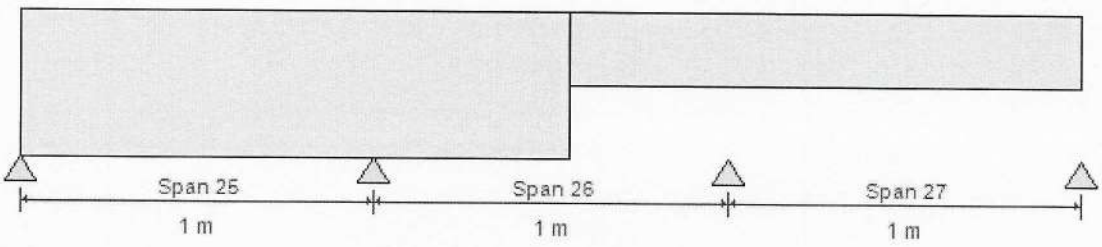
Longitudinal Reinforcement (mm²)



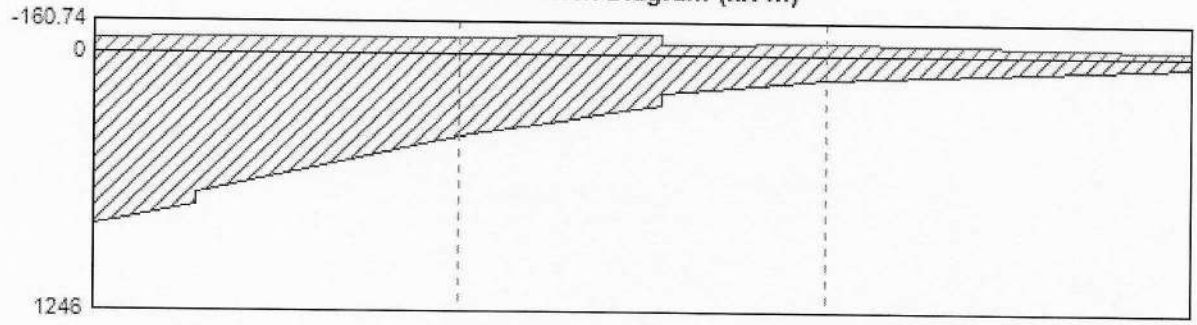
As (top)	339	0	435	435	342	369	369	0	258
SPEC X(D)+0.4	[illegible]								
	1590	0	2105	2105	2467	2363	2261	0	1763
SPEC X(D)+0.4	[illegible]								


Shear Diagram (kN)
173.18
0
Shear 12.8341 0 30.719 30.719 119.5232 119.5232 119.5232 0 144.6096


Transverse Reinforcement (mm²/m)
1163.85
0
Asv/s reqd 0 0 0 0 0 0 0 0

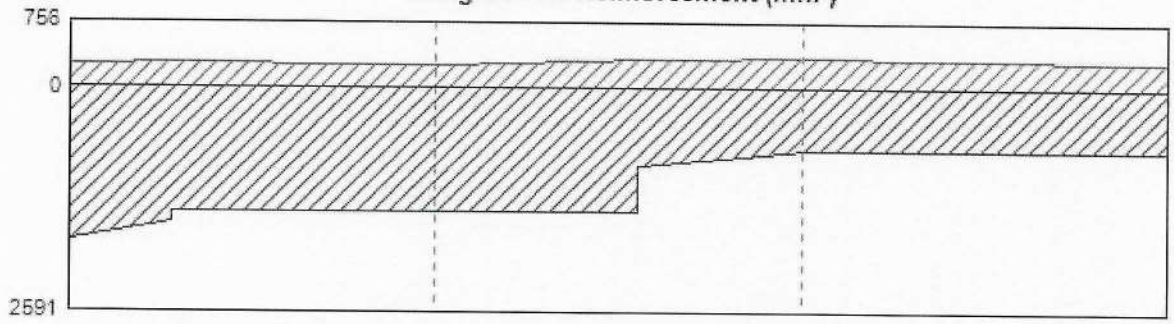

Span 25
1 m
Span 26
1 m
Span 27
1 m

Moment Diagram (kN-m)



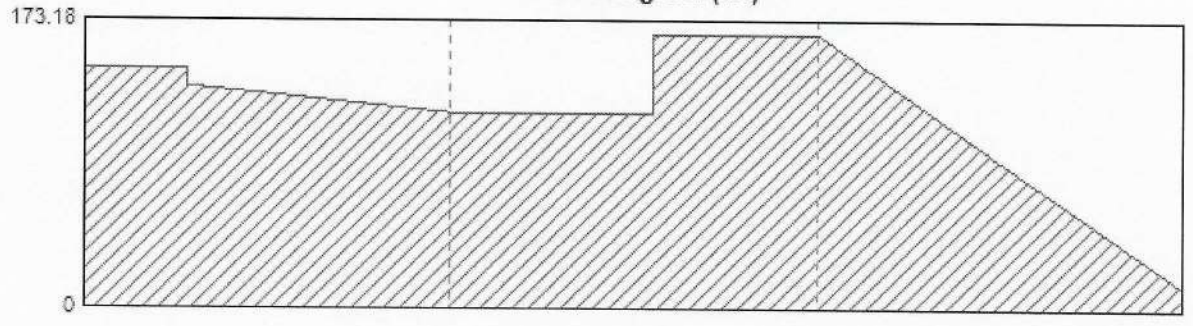
(-)Moment	-66.3605	-76.9618	-75.9175	-75.9175	-48.5816	-54.0971	-54.0971	0	-25.4425
(+)Moment	843.8815	741.3775	398.6692	398.6692	188.2368	119.838	119.838	0	50.5667

Longitudinal Reinforcement (mm²)



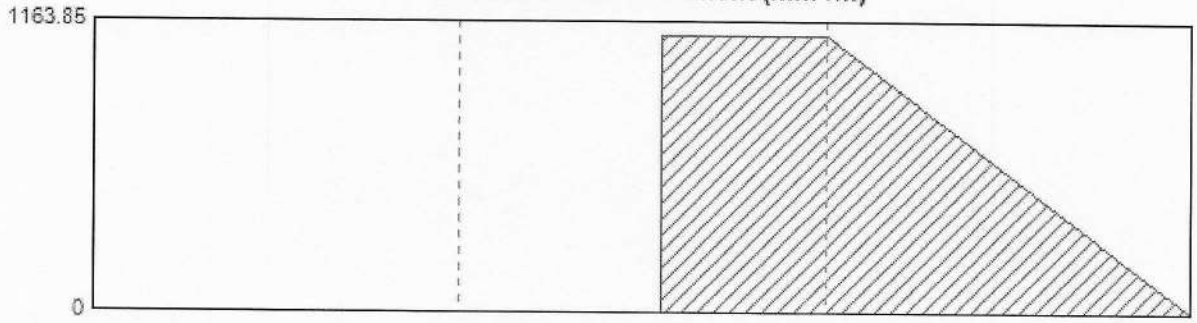
As (top)	258	280	258	258	316	350	350	0	293
	1763	1563	876	876	908	628	628	0	408

Shear Diagram (kN)

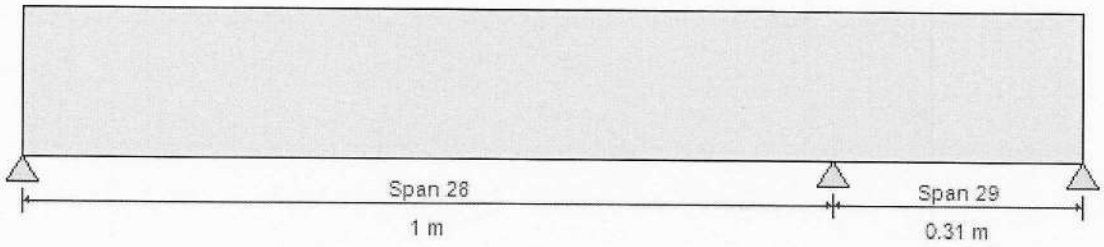


Shear	144.6096	144.6096	117.5532	117.5532	164.9358	164.9369	164.9369	0	13.5561

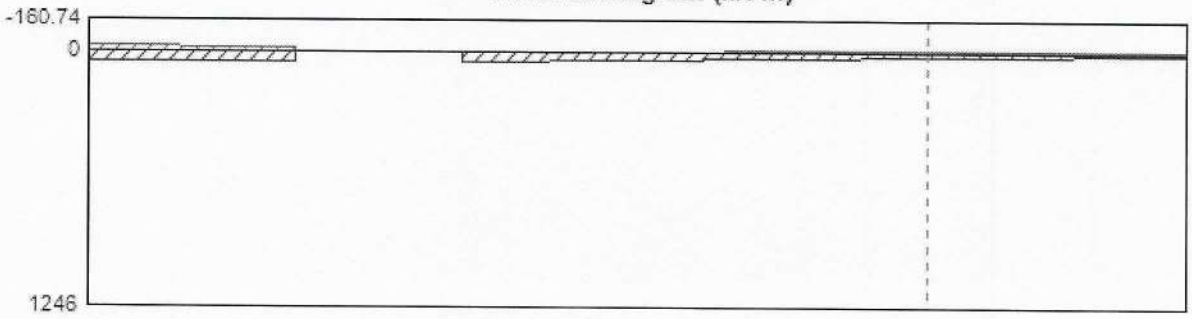
Transverse Reinforcement (mm²/m)



Asv/s reqd	0	0	0	0	1108.43	1108.43	1108.43	0	0

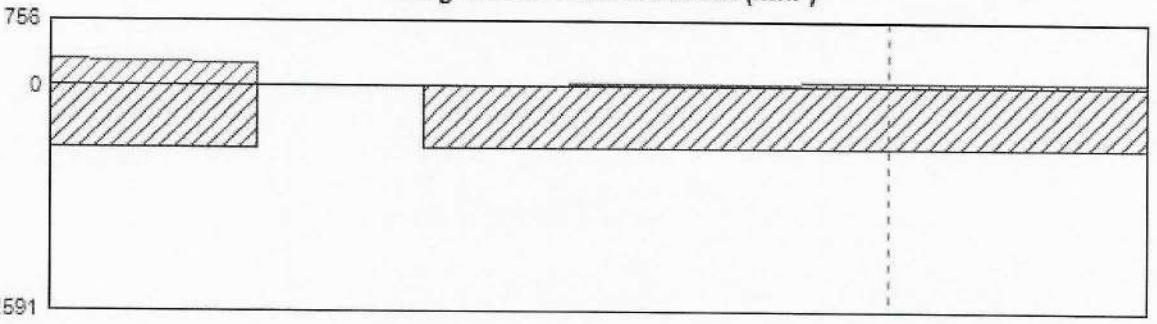


Moment Diagram (kN-m)



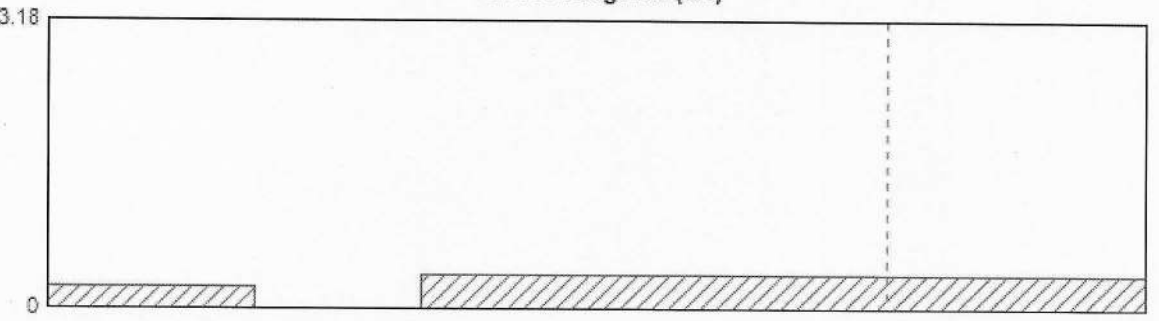
(-)Moment	-25.4425	0	-5.8344	-5.8344	0	-9.0907		
(+)Moment	52.7637	47.5032	24.3985	24.3985	0	11.3657		

Longitudinal Reinforcement (mm²)



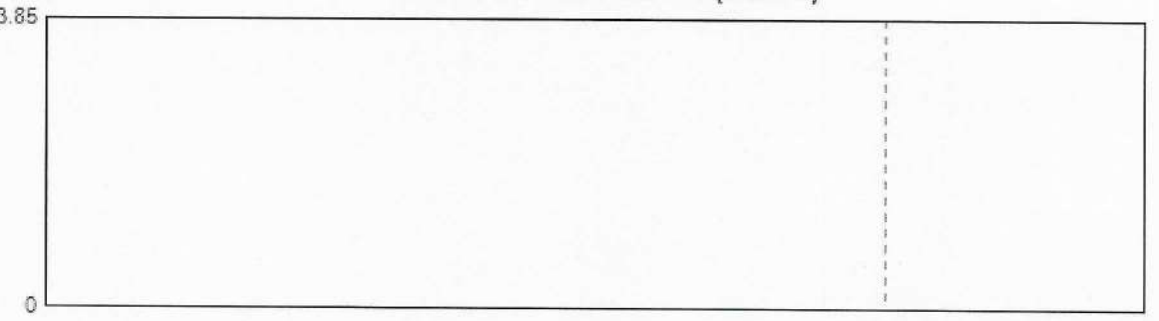
As (top)	293	0	36	36	0	50
As (bot)	28 0.9DL+0.45SPE					
	417	206	112	112	0	60
	25 1.5DL					

Shear Diagram (kN)



Shear	13.5561	0	20.1702	20.1702	0	20.1702

Transverse Reinforcement (mm²/m)



Asv/s reqd	0	0	0	0	0	0

DESIGN OF SHEAR WALL

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
STILT	P42	1160	10275	1200	625	0.5

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	1160	9675	1160	10875	1200	625
Bottom	Leg 1	1160	9675	1160	10875	1200	625

Flexural Design for P_u, M_{u2} and M_{u3} (Part 1 of 2)

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo
Top	1875	0.0025	0.0014	29 0.9DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL
Bottom	1875	0.0025	0.0014	29 0.9DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL

Flexural Design for P_u, M_{u2} and M_{u3} (Part 2 of 2)

P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
3029.1851	84.9182	-316.6341	750000
3096.5034	-146.6714	-115.7855	750000

Shear Design (Part 1 of 2)

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN
Top	Leg 1	1562.5	25 1.5DL+0.45SPEC X(D)+1.5SPEC Y(D)+0.45SPEC Z(D)+1.0TL	4024.79	1143.0399	-286.7417
Bottom	Leg 1	1562.5	25 1.5DL+0.45SPEC X(D)+1.5SPEC Y(D)+0.45SPEC Z(D)+1.0TL	4123.3097	123.0307	-286.7417

Shear Design (Part 2 of 2)

V_c kN	$V_c + V_s$ kN
252.4462	793.7506
254.2196	795.5239

Boundary Element Check (Part 1 of 2)

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m
Top–Left	Leg 1	600	26 1.5DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL	4728.2609	-279.6227
Top–Right	Leg 1	600	26 1.5DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL	4728.2609	464.4081
Bottom–Left	Leg 1	0	26 1.5DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL	4836.0671	-142.1597
Botttom–Right	Leg 1	0	26 1.5DL+0.45SPEC X(D)+0.45SPEC Y(D)+1.5SPEC Z(D)+1.0TL	4836.0671	10.3942

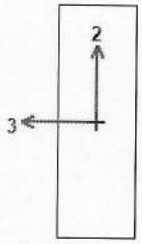
Boundary Element Check (Part 2 of 2)

Stress Comp MPa	Stress Limit MPa
8.17	8
9.4	8
7.4	8
6.52	8

DESIGN OF BEAM

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)



Beam Element Details (Part 1 of 2)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc
5TH	B11	2238	B 200X600	24 1.5DL+1.5SPEC X(D)+0.45SPEC Y(D)+0.45SPEC Z(D)+1.0TL	6775

Beam Element Details (Part 2 of 2)

Length (mm)	LLRF	Type
6775	1	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	600	200	0	30	30

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
-205.0526	0.0035	170.3131	0

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-205.0526	0.0082	0	-205.0609

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)	-205.0609		854	0	854	294
Bottom (-2 Axis)		0	427	0	0	427

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
206.8226	0	206.8505	63.3637	1005.61

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
0.0005	170.3131	160	560	0

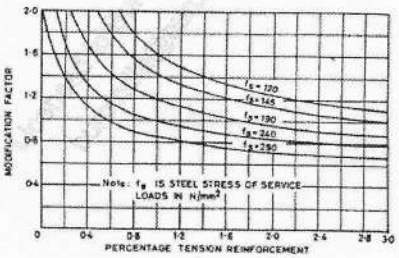
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DESIGN OF SLAB

PROJECT

	DESIGN OF SLAB No:					
1.00	Grade of concrete		=	*35.00*	N/mm^2	Case No: *8*
2.00	Grade of steel		=	*550.00*	N/mm^2	D+(C-D)*(E-A)/(B-A)
3.00	Cover to reinforcement		=	*25.00*	mm	
	Diameter of bar			*8.00*	mm	
4.00	Aspect ratio $\frac{l_y}{l_x}$ =	*5.60* / *3.35*	5.72 / 3.47	1.648	< 2	
5.00	Edge condition: One Short Edge Continuous			Two way slab		
6.00	Modification factor assumed			*1.30*		
		116.09				
7.00	Depth required for deflection:		D =	*150.00*	mm	
				150.00	mm	
			d =	121.00	mm	ok
8.00	Dead Load		=	3.60	kN/m^2	qa
9.00	Live load		=	*2.00*	kN/m^2	
10.00	Partitions & FF		=	*1.25*	kN/m^2	
11.00	Total load		=	6.85	kN/m^2	
12.00	Factored load		=	10.28	kN/m^2	

		Negative	Positive		
A		*1.50000*	*1.50000*		
B		*1.75000*	*1.75000*		
C		*0.00000*	*0.07600*		
D		*0.00000*	*0.08700*		
E		*1.64823*	*1.64823*		
Value		**0.00000**	**0.08252**		



$f_s = 0.58\, f_y \frac{\text{Area of cross-section of steel required}}{\text{Area of cross-section of steel provided}}$

FIG. 4 MODIFICATION FACTOR FOR TENSION REINFORCEMENT

STEP 1	Details	S- SPAN (-ve) support(α_x)	S- SPAN (+ve) span(α_x)	L-SPAN (-ve) support(α_y)	L-SPAN (+ve) span (α_y)
	Co-efficent (IS:456, Table :26	0.000	0.083	0.057	0.043
	M_u=Co-efficient*w* l_x^2	0.00	10.22	7.06	5.32
	K= Mu/bd2	0.00	0.70	0.48	0.36
	Percentage of steel required	0.00	0.15	0.10	0.08
	Ast required(in mm^2)	*0.00*	*180.69*	*123.87*	*93.07*
	Ast min (in mm^2)	180.00	180.00	180.00	180.00
	Ast to be provided (in mm2)	180.00	180.69	180.00	180.00
	Provided bars spacing (c/c)	279.37	278.30	279.37	279.37
	max spacing	250.00	250.00	250.00	250.00
	spacing	250.00	250.00	250.00	250.00
	Reqd bars spacing (c/c)	**250.00**	**250.00**	**250.00**	**250.00**
	Pvd bars spacing (c/c)	*200.00*	*200.00*	*200.00*	*200.00*
	Ast Provided(in mm^2)	**251.43**	**251.43**	**251.43**	**251.43**
	Percentage of steel provided	**0.21**	**0.21**	**0.21**	**0.21**
STEPII	F_s=0.58 *f_y * (Ast required/ Ast provided)				
	F_s			229.25	
	M.F			*1.80*	
	if assumed modification factor is less than or equal to calculated the section is safe for deflection			safe	
	OVERALL DEPTH **D** **150.00** **mm**				
	EFFECTIVE DEPTH **d** **121.00** **mm**				

STEPIII	Crack width calculation			
	m	=	6.8	
	E_s	=	200000.0	
	Ec	=	29580.4	
	Pt	=	0.2	
	k	=	0.2	
	x	=	18.7	
	A_{st}	=	251.4	
	I_{cr}	=	19970343.13	
	M	=	10.2	
	f_{st}	=	354.0	
	ε_m	=	0.0	
	Spacing		200.0	
	a_{cr}	=	103.1	
	ω_{cr}	=	0.16	
			<	
			0.20	mm (safe)

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STRUCTURAL DRAWINGS

THE LANDLENS SUITE

Eight ways to know a piece of land before you pay for it.

This report covers one part of the picture. These cover the rest, drawn from the same government records, for any property in Tamil Nadu.

LandLens One
Ask anything about a property and get an answer grounded in live government records, with the sources shown.
/landlens/one

Verify My Land
Every record check run on one property and returned as a single report.
/landlens/verify-my-land

Legal Opinion
An advocate's written opinion on the title, built on the records we pull for it.
/landlens

One Map
Every layer on one map: the parcel, its boundary, zoning, water bodies and what sits around it.
/landlens/one/map

PriceMap
What land actually changed hands for around this plot, taken from the registered deeds.
/landlens/pricemap

Build Scope
What you are allowed to build here: floor space, height, coverage and setbacks.
/landlens/build-scope

Property Tracker
Watch a property and hear about it when something new is registered against it.
/landlens/property-tracker

Deal Room
Run the transaction in one place: documents, stamping, signatures and the parties.
/landlens/deal-room

FREE TOOLS · NO ACCOUNT NEEDED

Twenty-four checks you can run yourself, at no cost.

Records and verification

The registers themselves, read for you.

- Encumbrance Certificate
- Patta and Chitta
- Field Measurement Sketch
- EC Analyzer
- Bank charge check
- Court case search
- Seller background check
- Approval check by survey

Value and duty

What it is worth and what it costs to register.

- Guideline value by street
- Guideline value by survey
- Stamp duty and registration fees
- Capital gains
- Floor space index
- Area unit converter

Zoning and land use

What the plan says can happen on this land.

- Land use zone finder
- CMDA land use check
- Coastal regulation zone
- Master plan check
- Water bodies finder
- Airport height clearance

Registers and directories

Who holds it, and which office keeps the record.

- Find your registering office
- Temple property check
- Waqf property check
- RERA register

Every free tool
/tools

Services we run for you
/services

The LandLens suite
/landlens/one

Verified RealEstate™

Every claim in this document traces back to a government record.

- Legal opinions, due diligence and title verification
- Building plan, layout and sub-division approvals
- Completion and occupancy certificates, regularisation
- Escrow, negotiation and NRI property management
- Land survey, soil testing, architecture and construction

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Prepared from the registers named on the page each finding sits on. Where a register could not be read, this document says so in its place rather than leaving the gap to be read as a clean result.