PROPOSED MULTIPLEX AND COMMERCIAL BUILDING AT INJAMBAKKAM, CHENNAI. 146,2/169, EAST COAST ROAD, VETUVAKANKANI, INJAMBAKKAM, CHENNAI-115 AT SURVEY NOS 165/176 A1 TO A8 OF INJAMBAKKAM VILLAGE, TAMBARAM TALUK, WITHIN GREATER CHENNAI CORPORATION ZONE-XV DIVISION.

STRUCTURAL DESIGN CALCULATIONS

Structural Consultant

V.SANGAMESWARAN CONSULTING ENGINEERS

"MOUNT VIEW", Third Floor,
New No.64(Old No.111), Mount Road,
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Client

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CONTENTS

Proposed Multiplex and Commercial Building at Injambakkam, Chennai. 146,2/169, East Coast Road, Vetuvakankani, Injambakkam, Chennai-115 at Survey Nos 165/176 A1 To A8 Of Injambakkam Village, Tambaram Taluk, within Greater Chennai Corporation Zone-XV Division.

STRUCTURAL DESIGN BASIS

A. INTRODUCTION

The building referred to above is a framed structure with a commercial office space with ground and Three Upper Floors and a theatre area with stilt and roof enclosing six multiplex screen seating areas. The roof of the commercial area is an ordinary RC beam and slab, while the roof of the multiplex is a PT slab and beam system. The building is analysed and designed conforming to loading standards IS: 875 (Part II) and to seismic forces as per IS 1893: 2002, the revised Indian Code for Earthquake Resistant Design of Structures.

B. STATUTORY REQUIREMENTS:

The design of structural and other building services will comply with the following requirements:

i. National Building Code
ii. The Building Regulations
iii. The Environmental Protection Act in liaison with the Environmental Agency.
iv. Fire prevention and detection in compliance with the local Fire Regulation.

C. DESIGN STANDARDS

Design Method	**LIMIT STATE DESIGN**
Codes & Special Publications used	**IS 456: 2000, IS 1893:2016(Part 1), SP 16,IS 875(Part II),2015** **IS 13920 : 2016**
Concrete Grade	**M 30 for columns, M25 for all other structural elements**
Steel Grade	**Fe 500, Ductile detailing**

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of the Codes and Standards will be used in designs. All design work shall be based on Indian Standards and Codes with latest revision, with amendments if any, as on date.

IS: 432(part 2) – 1982 : Specification for mild steel and medium tensile steel bars and hard-Drawn steel wire for concrete reinforcement

IS: 1786-1985 : Specification for high strength deformed steel bars and wires for Concrete Reinforcements

IS: 12269 : Ordinary Portland cement 43 grade.

IS: 6313 (part II) : Standards for anti-termite treatment.

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 Structure - imposed.

IS: 875 (part 3)-1987 : Code of practice for design loads (other than earthquake) for Buildings and Structure - wind loads

IS: 875 (part 5)-1987 : Code of practice for design loads (other than earthquake) for Buildings / Structures – Special loads and load combinations

IS: 456-2000 : Code of practice for plain and reinforced concrete.

IS: 1343 – 1980 : Code of practice for pre stressed concrete.

IS: 14268 – 1995 : Uncoated stress relieved low relaxation seven-ply strand for pre-Stressed Concrete–Specification

IS: 1893 part 1 – 2002 : Criteria for earthquake resistant design of structures (part-1 general Provisions and buildings)

IS: 4326 -1993 : Code of practice for earthquake resistant design and construction of

IS: 13920-1993 : Ductile detailing of reinforced concrete structures subjected to Seismic forces –code of practice.

IS: 2751 : Code of practice for welding of mild steel bars used for reinforced Concrete construction

IS: SP 34-1987 : Handbook on concrete reinforcement and detailing.

IS: 800 –1984

(reaffirmed 1998) : Code of practice in general construction in Steel.

IS: 1904 - 1986 : Code of practice for structural safety of building foundations.

SP: 16 – 1980 : Design aid for reinforced concrete to IS 456.

Reference : Major Development Plan.

IRC 3- 1983 : Dimensions and Weights of Road Design Vehicles

Wherever appropriate Indian Regulation does not exist for any particular item, appropriate British standards will be used.

IS Standards – Building Materials

IS: 269 - 1989	: Specification for Ordinary, rapid hardening and low heat Portland Cement
IS: 455 - 1989	: Specification for Portland blast furnace slag cement.
IS : 1489 - 1991	: Specification for Portland pozzolana cement
IS: 4031 - 1991	: Method of physical tests for Portland cement.
IS: 383 - 1970	: Specification for coarse and fine aggregates from natural sources for Concrete
IS: 516 -1959	: Method of test for strength of concrete.
IS: 1199 -1959	: Method of sampling and analysis of concrete.
IS: 432 -1982	: Specification for mild steel and medium tensile steel bars and hard drawn Steel wire for concrete reinforcement.
IS: 1139	: Specification for hot rolled mild steel and Medium tensile steel deformed Bars for concrete reinforcement.
IS: 1566 -1982	: Specification for plain hard drawn steel wire fabric for concrete Reinforcement
IS: 1786 -1985	: Specification for high tensile bars for concrete reinforcement.
IS: 4990 -1993	: Specification for plywood for concrete shuttering works.
IS: 2645 -1975	: Specification for integral cement water proofing compounds.
BS: 4449: 1997	: Specification for carbon steel bars for the reinforcement of concrete.

D. DESIGN DATA

Loads considered in the design

1.DEAD LOADS:

Dead load shall include weight of all structural and Architectural components. Self weight of the materials shall be calculated on the basis of unit weights given in IS: 875.

Floor finish of 100mm thickness	: 200 kg/sq.m (2.0 kN/sqm)
False ceiling + ducting + Sprinklers	: 50 kg/sq.m (0.5 kN/sq.m)
Partition walls	: 100 kg/sq.m (1.0 kN/sq.m).
Self-weight of Plain concrete	: 2400 kg/cu.m (24 kN/cu.m)
Self-weight of RCC	: 2500 kg/cu.m (25 kN/cu.m)
Solid block masonry	: 1800 kg/cu.m (18 kN/cu.m)
Brick Wall	: 1900 kg/cu.m (19 kN/cu.m)
Soil (Dry)	: 1800 kg/cu.m (18 kN/cu.m)
Soil (Wet)	: 2000 kg/cu.m (20 kN/cu.m)
Water	: 1000 kg/cu.m (10 kN/cu.m)
Glass	: 2500 kg/cu.m (25 kN/cu.m)
Stainless steel	: 7850 kg/cum
Masonry with plastering	: 2200 kg/cu.m (22 kN/cu.m)
Waterproofing	: 15 kg/sq.m (0.15 kN/sq.m) (membrane).
External finishes	: As per actuals.
Equipment loads	: As per Vendor details.

2. LIVE LOADS:

The superimposed loads shall be calculated in accordance with IS: 875(Part-2) based on Occupancy Classification. For multiple occupancies of use in the building shall be referred with the other appropriate comparable occupancy classification as per Table.1 of IS 875(Part-2)-1987.

Following live loads are considered while designing the structural elements apart from the dead loads as per codes.

Office area	: 400 kg/sq.m (4.0 kN/sq.m)
Stairs/lift lobbies	: 400 kg/sq.m (4.0 kN/sq.m)
Corridors / Balcony	: 400 kg/sq.m (4.0 kN/sq.m)
Public lobbies	: 400 kg/sq.m (4.0 kN/sq.m)
Storage rooms	: 500 kg/sq.m (5.0 kN/sq.m)
AHU Rooms	: 750 kg/sq.m (7.5 kN/sq.m)
Terrace with Access	: 400 kg/sq.m (4.0 kN/sq.m)
Electrical rooms	: 500 kg/sq.m (5.0 kN/sq.m)
UPS & battery rooms	: 1200 kg/sq.m (12.0 kN/sq.m)
Server rooms/MDF rooms/	: 1000 kg/sq.m (10.0 kN/sq.m)
Data center	: 1200 kg/sq.m (12.0 kN/sq.m)
Ramps	: 300 kg/sq.m (3 kN/sq.m) (Without fire truck movement).
Car parking area	: 250 kg/sq.m+ 25% impact (3.125 kN/sq.m)

3. WIND LOADS

Wind loads for design of structures shall be based on the design wind speeds arrived on the basis of IS: 875 (PART III) 2015.

The parameters for calculation of design wind speed as per **IS: 875 (PART III)** are as follows:

Basic wind speed (V_b) : 50 m/sec.

Height : 18.3m

From Table 1, IS 875 (Part 3), for Mean probable design life of Structure as 50 yrs and wind speed of 50m/sec, Risk coefficient, $\mathbf{K_1}$: 1.08

From Table 2, terrain category 3 for a maximum height of 18.3m and plan dimensions 106.588 x 48.88, Terrain, Height, Structure size factor

Topography factor, $\mathbf{K_3}$: 1 , for slopes less than or equal to 3^0

Importance factor for cyclonic region **, K4** : 1.15

Design wind speed (V_z) : V_b x K1 x K2 x K3 x K4

Wind pressure (P_z) : $0.6Vz^2$

Wind directionality factor, K_d : 1

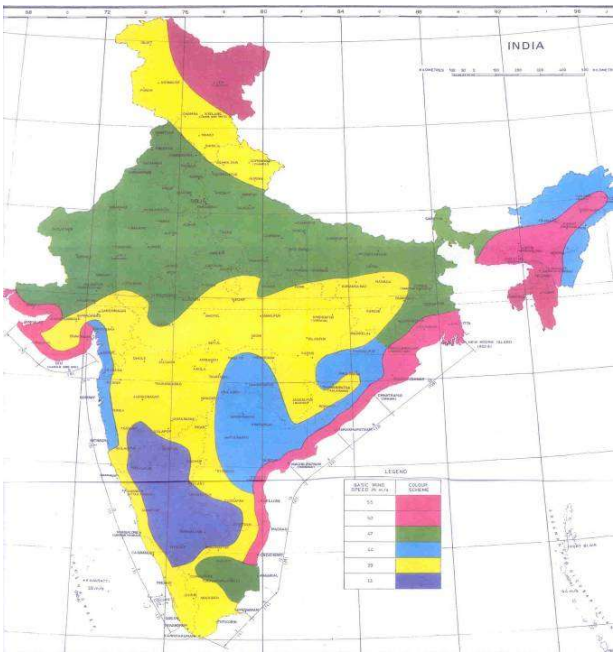
Area Averaging factor , K_a : 1(Table 4, Cl.7.2.2)

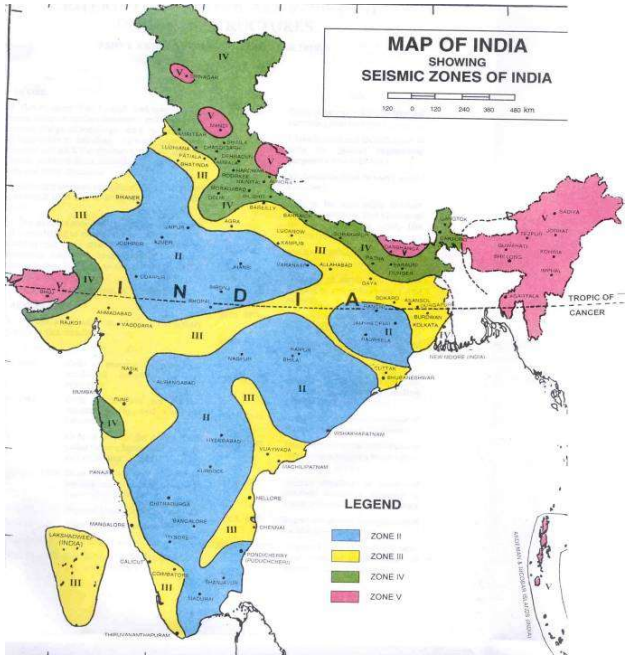
Combination factor, K_c : 1(Cl.7.3.3.13)

***a*. <u>Design wind pressure (P_d)</u> : K_d x K_a x K_c x P_z, kN/m^2**

HEIGHT RANGE,m	K1	K2	K3	K4	Design wind pressure Pz ,kN/m^2
4.575	1.08	0.91	1	1.15	1.916
9.15	1.08	0.91	1	1.15	1.916
13.725	1.08	0.9547	1	1.15	2.108
18.3	1.08	1	1	1.15	2.313

4. Determination of Earthquake Parameters and Loadings





Zone Factor, **Z** for Chennai Seismic **Zone III** : 0.16, (Table 2, Clause 6.4.2)

I, Importance Factor : 1.2, (From Table 8)

R, Response Reduction Factor : 5 for SMRF(Special Moment Resisting Frame, Table 9)

Fundamental Natural Period along X direction, $\mathbf{T_x}$ **: 0.09xh /** $\sqrt{\mathbf{d_x}}$: 0.09 x 18.3/$\sqrt{106.588}$

: 0.1595s(Clause 7.6.2)

The soil at the site is medium $\mathbf{S_a/g}$: 1.36/T as 0.55s ≤ T ≤ 4s : 2.27

Fundamental Natural Period along Z direction, $\mathbf{T_z}$ **: 0.09xh /** $\sqrt{\mathbf{d_z}}$: 0.09 x 18.3 /$\sqrt{48.88}$

: 0.2355s (Clause 7.6.2)

The soil at the site is medium $\mathbf{S_a/g}$: 2.5 as 0s ≤ T ≤ 0.67s : 2.05

Design Horizontal Seismic Coefficient

$$\mathbf{A_h} : \frac{\mathbf{Z\ I\ S_a}}{\mathbf{2Rg}} \quad \text{(Clause 6.4.2)}$$

$$: \frac{0.16 \times 1.2 \times 2.5}{2 \times 5} \quad : \quad 0.048$$

5. Environmental conditions, Corrosion and Fire protection for concrete and structural steel

- Environment : Moderate
- Exposure conditions : Concrete surfaces sheltered from severe rain or freezing wet Environment.
- Fire protection : Thickness of the structural elements as per table 15, 16 & 16A clause 26.4 of IS 456-2000
- Minimum grade of concrete : Moderate exposure – M25
- Nominal cover to reinforcement : For Moderate Exposure Nominal cover should not be less than 30mm
- Nominal covers for 2 hr. fire resistance :-

Nominal Cover						
Beams		**Slabs**		**Ribs**		**Columns**
Simply supported	Continuous	Simply supported	Continuous	Simply supported	Continuous	
mm	mm	Mm	Mm	mm	mm	mm
40	30	35	25	45	35	40

6. TEMPERATURE AND SHRINKAGE EFFECT:

Horizontal floor displacement due to differential temperatures and shrinkage is of importance in long concrete buildings. It can be taken care of by either providing expansion joints at an appropriate spacing or designing structural members for the additional moments caused by the temperature and shrinkage effects. Pour strips at suitable locations shall also be considered where required.

7.TEMPERATURE LOADS:

The effect of temperature will be considered wherever applicable in accordance with relevant Indian Codes. The coefficient for thermal expansion and contraction will be in accordance with IS: 456 and IS: 800 for concrete and steel respectively.

8.EXCEPTIONAL LOADS:

- Loads due to the following catastrophe scenarios are not considered in the design.
- Exceptional loads due to terrorist attacks (Explosions)
- Accidental loads (Falling of aircraft on the building)
- Accidental hitting of vehicle on the façade
- Snow Load

9. MATERIALS:

Materials specified will conform to the latest edition of the relevant Indian Standard or other accepted standard. Specifications for materials will include sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical Specification.

Concrete:

- All structural concrete shall have cube crushing strength of at least M30 to M25 N/sq.mm at 28 days.
- Plain cement concrete shall have cube crushing strength of 10 N/sq.mm (M10) at 28 days.

Concrete Mix

Concrete item	Grade
Foundation & Ramps	M25
Columns	M30
Slabs & beams	M25

Reinforcement steel:

- All reinforcement shall confirm to IS: 1786 – 1985 having minimum yield strength of 500 N/sq.mm.

Structural Steel

All structural steel shall confirm to IS: 2062 with minimum yield strength of 250 N/sq.mm

Water Proofing Material

Waterproofing for Basement including retaining walls shall be done by using self adhesive, self healing SBS Physical membrane with 2 mm thick and 1000N tensile resistance, and 250gsm polyester depending on the water table and site conditions.

Mechanical Splicing Material

Moment Coupler – parallel flange Threaded Type

E. STRUCTURAL CONCEPT

The Structural System comprises of R.C Slab & Beams for all the floors that supported by RCC columns. Floor slabs and beams are considered to act as a rigid diaphragm to transfer the lateral forces to the columns.

F. STRUCTURAL ANALYSIS AND DESIGN:

i. General

- All R.C.C structures shall be designed according to the Limit State Method as specified in IS: 456 – 2000.
- The structure is idealized as 3D space frame and analyzed using ETABS software package for both vertical and lateral loads.
- Forces and moments from the 3D analysis output for the worst combinations are used for the design of structure.
- The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.
- The slab is analyzed as two-way and one way slabs.
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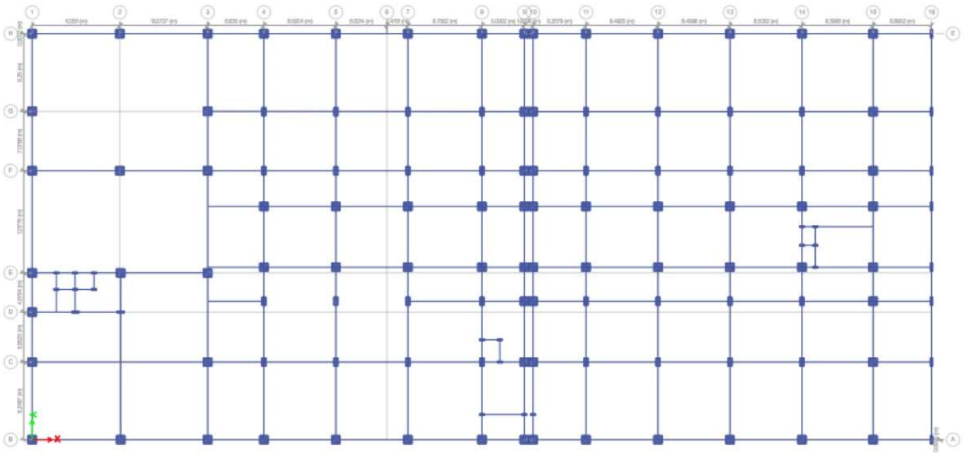

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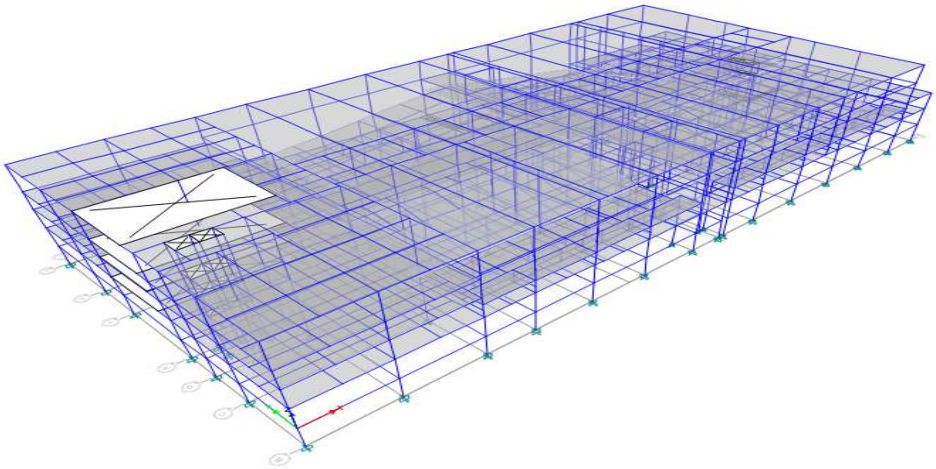
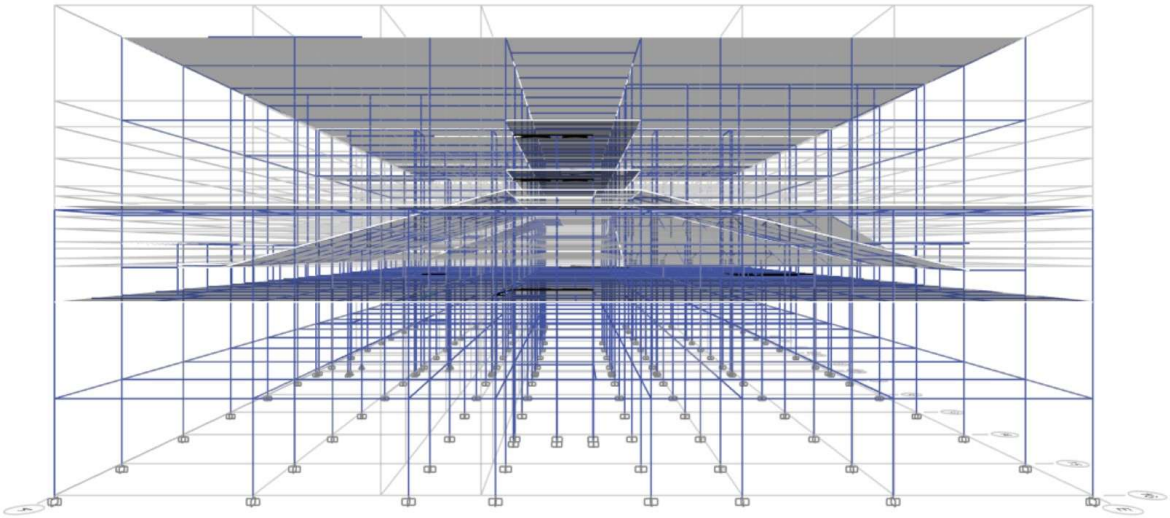
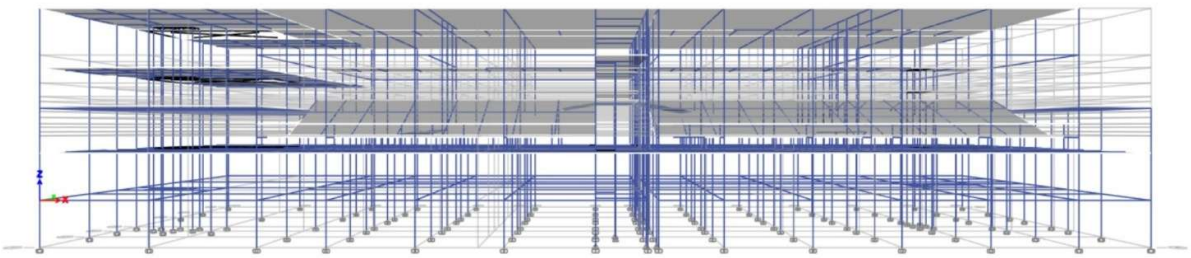






ii. Foundation Details

Type of foundation	**Isolated footings**
Safe bearing capacity of the soil	**320kN/m^2 as per soil test report**
Depth of foundation	**3m below existing ground level**
Diameter of main bars	**10mm,12mm,16mm,20mm**

iii. Slab Details

Type of slab	**Two Way Slab**
Thickness of the slab provided	**125mm, 150mm,175mm**
Steel cover to slab	**25mm**
Diameter of main bars used	**8mm,10mm,12mm**

iv. Beam Details

Size of the beam provided	**1200 x 750mm, 500mm x 750mm,500mm x 600mm,450mm x 600mm,900mm x 600mm 300mmx600mm,500mm x 600mm, 750mm x 600mm**
Bottom steel cover to beam	**25mm**
Diameter of main bars used	**32mm, 25mm, 20mm,16mm, 12mm**
Stirrups used	**2,4 legged stirrups 8mm dia, 10mm dia, 12mm**

v. Column Details

Size of the columns provided	**1000mm x 1000mm, 500mm x 1000mm, 900mm x 200mm 450mm x 200mm, 300mm x 1000mm, 200mm x 600mm**
Steel cover to column	**40mm**
Diameter of main bars used	**32mm,25mm,20mm,16mm**
Binder diameter	**8mm**

vi. DEFLECTION LIMITS:

For Reinforced concrete works:

Limiting values of deflection (Short and Long term) as per clause 35.3 of IS: 456-2000 is followed in the design.

Limiting value for short term deflection is considered as span/250 and for the long term deflection is considered as span/350 or 20mm whichever less as per IS 456 – 2000.

As per IS1893 (Part1) :2002, Story drift in any storey due to minimum specified design seismic lateral force shall not exceed 0.004 times the storey height design.

Lateral sway due to wind load should not exceed H/500 (H is the total height of structure).

vii. CRACKING LIMITS:

Limiting values of crack width as per clause 35.3 of IS: 456-2000 is followed in the design.

In general for slabs and beams, the crack width is limited to 0.3mm.

For basement retaining wall and water retaining structures, crack width is limited to 0.2mm.

viii. LOAD COMBINATIONS:

The various loads are combined in accordance with the stipulations in IS: 875 (Part 5)-1987; whichever combination produces the most unfavorable effect in the building foundation or structural member concerned may be adopted.Wind load and earthquake loads are considered for both x & y directions. Whenever imposed load is combined with earthquake load, the appropriate part of imposed load as specified in IS: 1893-2002 / Clause 7.3.1 of seismic code will be used both for evaluating earthquake effect and for combined load effects used in such combination.

1.Load Cases

Load Case Definitions - Summary

Name	Type
Modal	Modal - Eigen
Dead	Linear Static
Live	Linear Static
EQ +X	Linear Static

Name	Type
EQ +Y	Linear Static
WIND +X	Linear Static
WIND +Y	Linear Static
RSA-X	Response Spectrum
RSA-Y	Response Spectrum

1.1 Load Combinations

Load Combination Definitions

Name	Type	Is Auto	Load Name	SF	Notes
101 1.5 DL+1.5 LL	Linear Add	No	Dead	1.5	
101 1.5 DL+1.5 LL			Live	1.5	
102 1.2 SL X+0.36 SL Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
102 1.2 SL X+0.36 SL Y+1.2 DL+1.2 LL			Live	1.2	
102 1.2 SL X+0.36 SL Y+1.2 DL+1.2 LL			EQ +X	1.2	
102 1.2 SL X+0.36 SL Y+1.2 DL+1.2 LL			EQ +Y	0.36	
103 1.2 SL X+-0.36 SL Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
103 1.2 SL X+-0.36 SL Y+1.2 DL+1.2 LL			Live	1.2	
103 1.2 SL X+-0.36 SL Y+1.2 DL+1.2 LL			EQ +X	1.2	
103 1.2 SL X+-0.36 SL Y+1.2 DL+1.2 LL			EQ +Y	-0.36	
104 0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
104 0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			Live	1.2	
104 0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			EQ +X	0.36	
104 0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			EQ +Y	1.2	
105 -0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
105 -0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			Live	1.2	
105 -0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			EQ +X	-0.36	
105 -0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL			EQ +Y	1.2	
106 1.2 RSA X+0.36 RSA Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
106 1.2 RSA X+0.36 RSA Y+1.2 DL+1.2 LL			Live	1.2	
106 1.2 RSA X+0.36 RSA Y+1.2 DL+1.2 LL			RSA-Y	0.36	
106 1.2 RSA X+0.36 RSA Y+1.2 DL+1.2 LL			RSA-X	1.2	
107 1.2 RSA X+-0.36 RSA Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
107 1.2 RSA X+-0.36 RSA Y+1.2 DL+1.2 LL			Live	1.2	
107 1.2 RSA X+-0.36 RSA Y+1.2 DL+1.2 LL			RSA-Y	-0.36	
107 1.2 RSA X+-0.36 RSA Y+1.2 DL+1.2 LL			RSA-X	1.2	
108 0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
108 0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			Live	1.2	
108 0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			RSA-Y	1.2	
108 0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			RSA-X	0.36	
109 -0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL	Linear Add	No	Dead	1.2	
109 -0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			Live	1.2	
109 -0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			RSA-Y	1.2	
109 -0.36 RSA X+1.2 RSA Y+1.2 DL+1.2 LL			RSA-X	-0.36	
110 1.5 SL X+0.45 SL Y+1.5 DL	Linear Add	No	Dead	1.5	
110 1.5 SL X+0.45 SL Y+1.5 DL			EQ +X	1.5	
110 1.5 SL X+0.45 SL Y+1.5 DL			EQ +Y	0.45	
111 1.5 SL X+-0.45 SL Y+1.5 DL	Linear Add	No	Dead	1.5	
111 1.5 SL X+-0.45 SL Y+1.5 DL			EQ +X	1.5	
111 1.5 SL X+-0.45 SL Y+1.5 DL			EQ +Y	-0.45	
112 0.45 SL X+1.5 SL Y+1.5 DL	Linear Add	No	Dead	1.5	
112 0.45 SL X+1.5 SL Y+1.5 DL			EQ +X	0.45	
112 0.45 SL X+1.5 SL Y+1.5 DL			EQ +Y	1.5	
113 -0.45 SL X+1.5 SL Y+1.5 DL	Linear Add	No	Dead	1.5	
113 -0.45 SL X+1.5 SL Y+1.5 DL			EQ +X	-0.45	
113 -0.45 SL X+1.5 SL Y+1.5 DL			EQ +Y	1.5	
114 1.5 RSA X+0.45 RSA Y+1.5 DL	Linear Add	No	Dead	1.5	
114 1.5 RSA X+0.45 RSA Y+1.5 DL			RSA-Y	0.45	

Name	Type	Is Auto	Load Name	SF	Notes
114 1.5 RSA X+0.45 RSA Y+1.5 DL			RSA-X	1.5	
115 1.5 RSA X+-0.45 RSA Y+1.5 DL	Linear Add	No	Dead	1.5	
115 1.5 RSA X+-0.45 RSA Y+1.5 DL			RSA-Y	-0.45	
115 1.5 RSA X+-0.45 RSA Y+1.5 DL			RSA-X	1.5	
116 0.45 RSA X+1.5 RSA Y+1.5 DL	Linear Add	No	Dead	1.5	
116 0.45 RSA X+1.5 RSA Y+1.5 DL			RSA-Y	1.5	
116 0.45 RSA X+1.5 RSA Y+1.5 DL			RSA-X	0.45	
117 -0.45 RSA X+1.5 RSA Y+1.5 DL	Linear Add	No	Dead	1.5	
117 -0.45 RSA X+1.5 RSA Y+1.5 DL			RSA-Y	1.5	
117 -0.45 RSA X+1.5 RSA Y+1.5 DL			RSA-X	-0.45	
118 1.5 SL X+0.45 SL Y+0.9 DL	Linear Add	No	Dead	0.9	
118 1.5 SL X+0.45 SL Y+0.9 DL			EQ +X	1.5	
118 1.5 SL X+0.45 SL Y+0.9 DL			EQ +Y	0.45	
119 1.5 SL X+-0.45 SL Y+0.9 DL	Linear Add	No	Dead	0.9	
119 1.5 SL X+-0.45 SL Y+0.9 DL			EQ +X	1.5	
119 1.5 SL X+-0.45 SL Y+0.9 DL			EQ +Y	-0.45	
120 0.45 SL X+1.5 SL Y+0.9 DL	Linear Add	No	Dead	0.9	
120 0.45 SL X+1.5 SL Y+0.9 DL			EQ +X	0.45	
120 0.45 SL X+1.5 SL Y+0.9 DL			EQ +Y	1.5	
121 -0.45 SL X+1.5 SL Y+0.9 DL	Linear Add	No	Dead	0.9	
121 -0.45 SL X+1.5 SL Y+0.9 DL			EQ +X	-0.45	
121 -0.45 SL X+1.5 SL Y+0.9 DL			EQ +Y	1.5	
122 1.5 RSA X+0.45 RSA Y+0.9 DL	Linear Add	No	Dead	0.9	
122 1.5 RSA X+0.45 RSA Y+0.9 DL			RSA-Y	0.45	
122 1.5 RSA X+0.45 RSA Y+0.9 DL			RSA-X	1.5	
123 1.5 RSA X+-0.45 RSA Y+0.9 DL	Linear Add	No	Dead	0.9	
123 1.5 RSA X+-0.45 RSA Y+0.9 DL			RSA-Y	-0.45	
123 1.5 RSA X+-0.45 RSA Y+0.9 DL			RSA-X	1.5	
124 0.45 RSA X+1.5 RSA Y+0.9 DL	Linear Add	No	Dead	0.9	
124 0.45 RSA X+1.5 RSA Y+0.9 DL			RSA-Y	1.5	
124 0.45 RSA X+1.5 RSA Y+0.9 DL			RSA-X	0.45	
125 -0.45 RSA X+1.5 RSA Y+0.9 DL	Linear Add	No	Dead	0.9	
125 -0.45 RSA X+1.5 RSA Y+0.9 DL			RSA-Y	1.5	
125 -0.45 RSA X+1.5 RSA Y+0.9 DL			RSA-X	-0.45	
126 1.2 DL+1.2 LL+1.2 WL +X	Linear Add	No	Dead	1.2	
126 1.2 DL+1.2 LL+1.2 WL +X			Live	1.2	
126 1.2 DL+1.2 LL+1.2 WL +X			WIND +X	1.2	
127 1.2 DL+1.2 LL+1.2 WL +Y	Linear Add	No	Dead	1.2	
127 1.2 DL+1.2 LL+1.2 WL +Y			Live	1.2	
127 1.2 DL+1.2 LL+1.2 WL +Y			WIND +Y	1.2	
128 1.5 DL+1.5 WL +X	Linear Add	No	Dead	1.5	
128 1.5 DL+1.5 WL +X			WIND +X	1.5	
129 1.5 DL+1.5 WL +Y	Linear Add	No	Dead	1.5	
129 1.5 DL+1.5 WL +Y			WIND +Y	1.5	
130 0.9 DL+1.5 WL +X	Linear Add	No	Dead	0.9	
130 0.9 DL+1.5 WL +X			WIND +X	1.5	
131 0.9 DL+1.5 WL +Y	Linear Add	No	Dead	0.9	
131 0.9 DL+1.5 WL +Y			WIND +Y	1.5	
201 1 DL+1 LL	Linear Add	No	Dead	1	
201 1 DL+1 LL			Live	1	
202 0.8 SL X+0.24 SL Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
202 0.8 SL X+0.24 SL Y+1 DL+0.8 LL			Live	0.8	
202 0.8 SL X+0.24 SL Y+1 DL+0.8 LL			EQ +X	0.8	
202 0.8 SL X+0.24 SL Y+1 DL+0.8 LL			EQ +Y	0.24	
203 0.8 SL X+-0.24 SL Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
203 0.8 SL X+-0.24 SL Y+1 DL+0.8 LL			Live	0.8	
203 0.8 SL X+-0.24 SL Y+1 DL+0.8 LL			EQ +X	0.8	
203 0.8 SL X+-0.24 SL Y+1 DL+0.8 LL			EQ +Y	-0.24	
204 0.24 SL X+0.8 SL Y+1 DL+0.8 LL	Linear Add	No	Dead	1	

Name	Type	Is Auto	Load Name	SF	Notes
204 0.24 SL X+0.8 SL Y+1 DL+0.8 LL			Live	0.8	
204 0.24 SL X+0.8 SL Y+1 DL+0.8 LL			EQ +X	0.24	
204 0.24 SL X+0.8 SL Y+1 DL+0.8 LL			EQ +Y	0.8	
205 -0.24 SL X+0.8 SL Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
205 -0.24 SL X+0.8 SL Y+1 DL+0.8 LL			Live	0.8	
205 -0.24 SL X+0.8 SL Y+1 DL+0.8 LL			EQ +X	-0.24	
205 -0.24 SL X+0.8 SL Y+1 DL+0.8 LL			EQ +Y	0.8	
206 0.8 RSA X+0.24 RSA Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
206 0.8 RSA X+0.24 RSA Y+1 DL+0.8 LL			Live	0.8	
206 0.8 RSA X+0.24 RSA Y+1 DL+0.8 LL			RSA-Y	0.24	
206 0.8 RSA X+0.24 RSA Y+1 DL+0.8 LL			RSA-X	0.8	
207 0.8 RSA X+-0.24 RSA Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
207 0.8 RSA X+-0.24 RSA Y+1 DL+0.8 LL			Live	0.8	
207 0.8 RSA X+-0.24 RSA Y+1 DL+0.8 LL			RSA-Y	-0.24	
207 0.8 RSA X+-0.24 RSA Y+1 DL+0.8 LL			RSA-X	0.8	
208 0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
208 0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			Live	0.8	
208 0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			RSA-Y	0.8	
208 0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			RSA-X	0.24	
209 -0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL	Linear Add	No	Dead	1	
209 -0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			Live	0.8	
209 -0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			RSA-Y	0.8	
209 -0.24 RSA X+0.8 RSA Y+1 DL+0.8 LL			RSA-X	-0.24	
210 1 SL X+0.3 SL Y+1 DL	Linear Add	No	Dead	1	
210 1 SL X+0.3 SL Y+1 DL			EQ +X	1	
210 1 SL X+0.3 SL Y+1 DL			EQ +Y	0.3	
211 1 SL X+-0.3 SL Y+1 DL	Linear Add	No	Dead	1	
211 1 SL X+-0.3 SL Y+1 DL			EQ +X	1	
211 1 SL X+-0.3 SL Y+1 DL			EQ +Y	-0.3	
212 0.3 SL X+1 SL Y+1 DL	Linear Add	No	Dead	1	
212 0.3 SL X+1 SL Y+1 DL			EQ +X	0.3	
212 0.3 SL X+1 SL Y+1 DL			EQ +Y	1	
213 -0.3 SL X+1 SL Y+1 DL	Linear Add	No	Dead	1	
213 -0.3 SL X+1 SL Y+1 DL			EQ +X	-0.3	
213 -0.3 SL X+1 SL Y+1 DL			EQ +Y	1	
214 1 RSA X+0.3 RSA Y+1 DL	Linear Add	No	Dead	1	
214 1 RSA X+0.3 RSA Y+1 DL			RSA-Y	0.3	
214 1 RSA X+0.3 RSA Y+1 DL			RSA-X	1	
215 1 RSA X+-0.3 RSA Y+1 DL	Linear Add	No	Dead	1	
215 1 RSA X+-0.3 RSA Y+1 DL			RSA-Y	-0.3	
215 1 RSA X+-0.3 RSA Y+1 DL			RSA-X	1	
216 0.3 RSA X+1 RSA Y+1 DL	Linear Add	No	Dead	1	
216 0.3 RSA X+1 RSA Y+1 DL			RSA-Y	1	
216 0.3 RSA X+1 RSA Y+1 DL			RSA-X	0.3	
217 -0.3 RSA X+1 RSA Y+1 DL	Linear Add	No	Dead	1	
217 -0.3 RSA X+1 RSA Y+1 DL			RSA-Y	1	
217 -0.3 RSA X+1 RSA Y+1 DL			RSA-X	-0.3	
218 1 DL+0.8 LL+0.8 WL +X	Linear Add	No	Dead	1	
218 1 DL+0.8 LL+0.8 WL +X			Live	0.8	
218 1 DL+0.8 LL+0.8 WL +X			WIND +X	0.8	
219 1 DL+0.8 LL+0.8 WL +Y	Linear Add	No	Dead	1	
219 1 DL+0.8 LL+0.8 WL +Y			Live	0.8	
219 1 DL+0.8 LL+0.8 WL +Y			WIND +Y	0.8	
220 1 DL+1 WL +X	Linear Add	No	Dead	1	
220 1 DL+1 WL +X			WIND +X	1	
221 1 DL+1 WL +Y	Linear Add	No	Dead	1	
221 1 DL+1 WL +Y			WIND +Y	1	

F.STRUCTURAL DESIGN

A.COLUMN DESIGN

GOVERNING CASE FOR DESIGN 105 -0.36 SL X+1.2 SL Y+1.2 DL+1.2 LL

LOAD COMBINATION 11 : 1.2 (D.L+L.L+WLZ)

				10786.				
F_X :	54.8817	kN	F_z :	9	kN	F_y :	-53.3934	kN
	374.949						165.653	
M_X :	6	kNm	M_z :	3.0235	kNm	M_y :	3	kNm

Column Size

b	1000	mm	fck	30	
D	1000	mm	fy	500	
Cover	40	mm	Effective Length ratio	0.65	IS 456:2000pg.94

Ground Floor Height,L	4575	mm	L_{eff1}	0.65 x L	2973.75
First Floor Height,L	4575	mm	L_{eff2}	0.65 x L	2973.75
Second Floor Height,L	4575	mm	L_{eff3}	0.65 x L	2973.75
Third Floor Height,L	4575	mm	L_{eff4}	0.65 x L	2973.75

Check for slenderness

L_{eff1}/D	2.97	L_{eff1}/b	2.97
L_{eff2}/D	2.97	L_{eff2}/b	2.97
L_{eff3}/D	2.97	L_{eff3}/b	2.97
L_{eff4}/D	2.97	L_{eff4}/b	2.97

All columns are short about both axis

		10786.9	
Axial Load, P_u	:	1	kN
		374.949	
Moment,M_x	:	6	kNm
		165.653	
Moment,M_z	:	3	kNm

Check for Accidental Eccentricity

Equivalent Eccentricity of Loads is given by

M_x / P_u :	34.76	mm
M_z / P_u :	15.36	mm

Only Mx / Pu is greater than 20mm minimum. Hence only Uniaxial Bending.

Size of column and check e_{min}

e_{min} : Leff/500 + D/30 :	39.2808	3	>20			

Hence adopt 39.28mm eccentricity.

Design Axial Load, P_u :	10786.9	1	kN			
Design Moment,M_x :	P_u x e_{min}	423.70983	7	kNm	greater than	374.9496
Hence design moment :		423.71		kNm		

Designing the column as an axially loaded column with uniaxial moment

Calculation of Area of Steel

Cover	40	mm				
Design Axial Load, P_u :	10786.9	1	kN			
Design Moment,M_x :	P_u x e_{min}	423.71	kNm			
b	1000	mm		fck	30	
D	1000	mm		fy	500	
Cover	40	mm				

Diameter of rod assumed		32	mm
d' :	40 + 32/2:	56	mm
d'/D :	56/ 1000 :	0.0560	

$M_z/f_{ck}bD^2$: 423.71 x 10^6 /30 x 1000 x1000 x 1000: 0.0141

P_u/f_{ck} bD : 13052.99x 10^3 /40 x 900 x900 : 0.35956

From SP16 Chart 44 4

p/f_{ck} : 0.02

p : 0.02 x 30 :	0.6	%	
A_s : 0.6 x 1000 x1000/100 :	6000	mm^2	
Load carrying capacity of column under direct bending:		10000	kN
Load to be carried by steel : (13052.99-8100/190):		4141.633	mm^2

Provide 20NosY32, A_s provided : 16080mm^2

Check for Horizontal Shear

Shear force : 54.8817 kN

The horizontal shear the column is subjected to :54.8817 x 10^3 / 1000 x 1000

0.055 : N/mm^2

less than 0.5N/mm^2

From IS : 456, Table 19 and Clause 40.2.2 design shear strength of members under axial compression is not to exceed 0.5/mm^2

*B. **DESIGN OF FOUNDATION*-COMBINED FOOTING**

Load from columns J9 and K9 : 8310 + 2969 : 11279kN

10% self weight : 1127.9kN

Total load : 12406.9kN

Safe bearing capacity of the soil : 320kN/m^2

Area of footing required : 12406.9/320 : 38.77m^2.

Provide a footing of size 5m x 8m.

Design soil bearing pressure : 11279 / 5 x 8 : 281.975kN/m^2<320kN/m^2.Ok.

Factored design soil pressure : 1.5 x 281.975 : 423kN/m^2.

Designing as a combined footing with raft beam and slab.

1. Design of the slab 650 depth

Effective depth of the slab, d : 650-50-10 : 590mm

Moment on the cantilever slab : 423 x $1.6^2/2$: 541.44kNm.

M_u/bd^2 : 521.44 x 10^6 / 1000 x 590^2 : 1.5 *From Table 55 of SP16* p_t : 0.373

A_{st} :0.373 x 1000 x 590/100 : 2200.7mm^2 , *A_{st} provided : Y 20 at 100(3142mm^2).*

2. Design of the raft beam 2100 x 1300

Effective depth of the beam, d : 1300-50-12.5 : 1237.5mm

STAAD.Pro Report

Included in this printout are results for load cases:

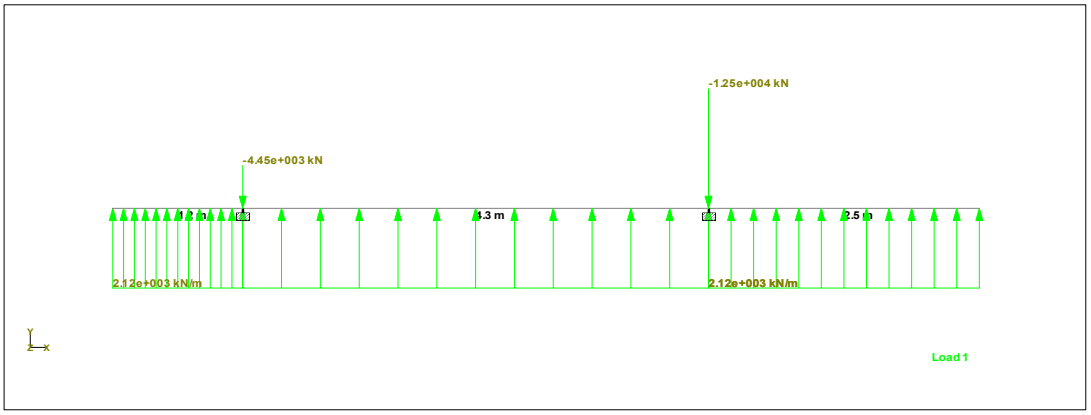
Type	L/C	Name
Primary	1	1.5(D.L+L.L)

Node Loads : 1 1.5(D.L+L.L)

Node	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
48	-	-12.5E 3	-	-	-	-
55	-	-4.45E 3	-	-	-	-

Beam Loads : 1 1.5(D.L+L.L)

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
33	UNI kN/m	GY	2.12E 3	-	-	-	-
50	UNI kN/m	GY	2.12E 3	-	-	-	-
51	UNI kN/m	GY	2.12E 3	-	-	-	-

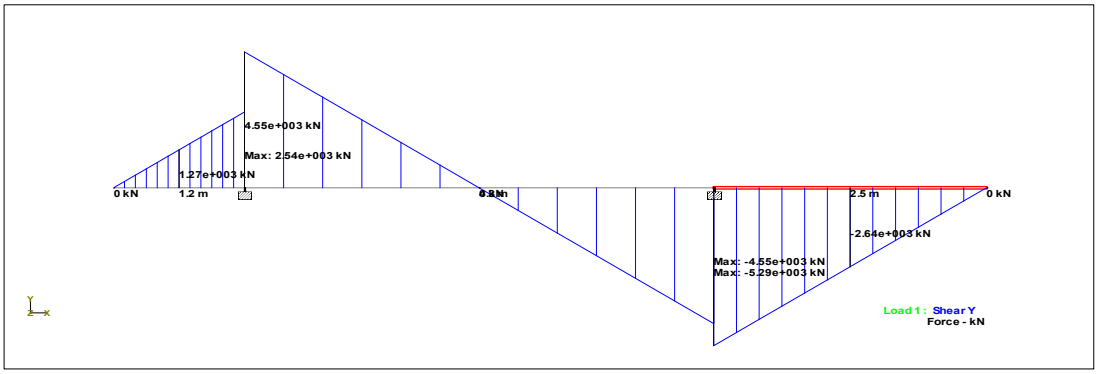


Whole Structure Loads 10387.5kN:1m 1 1.5(D.L+L.L)

Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
33	10	1.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	1.200	2.54E 3
				Max +ve	0.000	0.000	0.000	-0.000
50	48	4.300	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	4.300	4.55E 3
				Max +ve	0.000	0.000	0.000	-4.55E 3
51	48	2.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	2.500	-0.000
				Max +ve	0.000	0.000	0.000	-5.29E 3

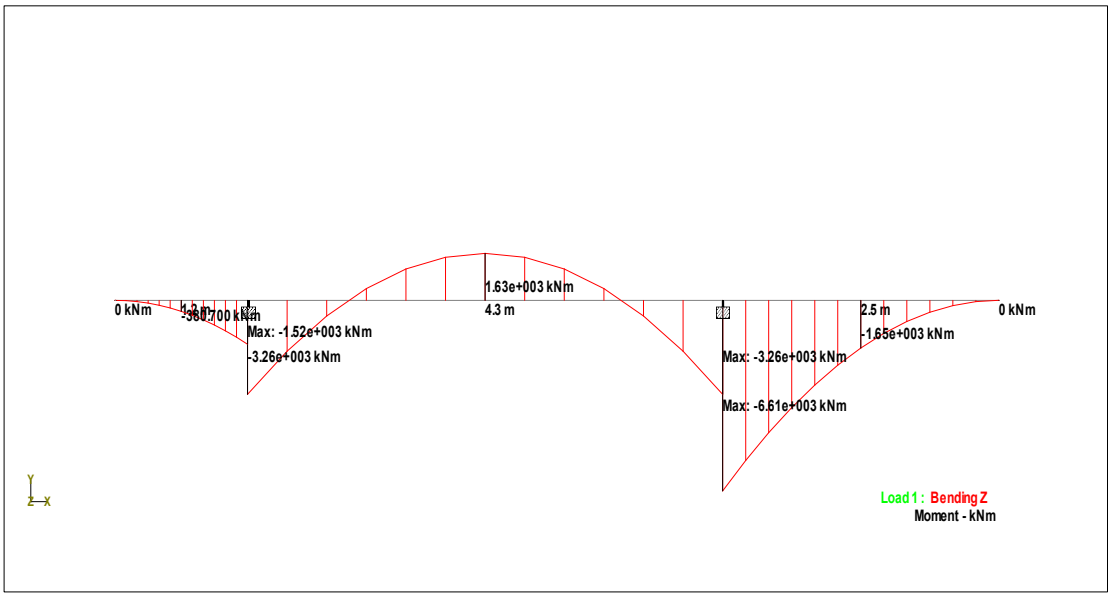


Whole Structure Fy 3000kN:1m 1 1.5(D.L+L.L)

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kNm)	d (m)	Max Mz (kNm)
33	10	1.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.200	-1.52E 3
50	48	4.300	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	2.150	1.63E 3
				Max +ve	0.000	0.000	0.000	-3.26E 3
51	48	2.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	2.500	0.000
				Max +ve	0.000	0.000	0.000	-6.61E 3



Whole Structure Mz 5000kNm:1m 1 1.5(D.L+L.L)

Cantilever moment at support : 6610kNm

M_u/bd^2 : 6610 x 10^6 / 2100 x 1237.5^2 : 2.1 *From Table 3 of SP16* p_t : 0.542

A_{st} : 0.542 x 2100 x 1237.5/100 : 14085.225mm^2 , *A_{st} provided : 36Y25(17676mm^2).*

Maximum moment at midspan : 1630kNm

M_u/bd^2 : 3919 x 10^6 / 2100 x 1237.5^2 : 1.25, *From Table 55 of SP16* p_t : 0.306

A_{st} : 0.306 x 2100 x 1237.5/100 : 7952mm^2 , *A_{st} provided : 20Y25+16Y16 (13036mm^2).*

Maximum Shear Force : 4230kN. For p_t : 0.7

Shear capacity of the section : $\tau_c'bd$: 0.56 x 2100 x 1237.5 : 1455.33 kN

Shear to be carried by the stirrups, V_{us} : 4230 – 1455.33 : 2774.7kN

V_{us} /d : 2774.7/123.75 : 22.42/3 : 7.47. **Provide stirrups of Y12ST6@100mm in the cantilever and 1m from the supports.**

D. DESIGN OF PLINTH BEAM

Assuming a plinth beam of size 200mm x 600mm.

Self weight of the plinth beam : 0.20 x 0.600 x 25 : 3 kN/m

Slab reaction on the plinth beam : 7 x 8/3 : 18.67kN/m

Total load on the plinth beam : 18.67+3 : 21.67kN/m

Maximum Moment for a span of 7m : 21.67 x 1.5 x 7^2 /16 : 99.54kNm

Mu/bd^2 : 99.54 x 10^6 / 200 x 567^2 : 1.55*From Table 3 of SP16* p_t = 0.387,

A_{st} : 0.387x 200 x 567/100 : 438.85mm^2

Top and bottom steel of 3 Nos. of Y16 is provided. Area of steel provided : 603mm^2

E.DESIGN OF FLOOR BEAMS

a.DESIGN OF FIRST FLOOR BEAM A6-H6-1200mm x 750mm

The flexural members shall fulfill the following general requirements.

IS 13920; Clause 6.1.2:

Effective Depth : d : 750-25-16.5:709mm

b / D ≥ 0.3 ; 750 / 1200 : 0.6 , O.K

IS 13920; Clause 6.1.3:

b ≥ 200mm , b : 1200mm, hence O.K

IS 13920; Clause 6.1.4 :

D ≤ L_c / 4 , 19223/ 750 : 25.6 > 4, hence O.K.

Limiting Longitudinal Steel %

Minimum reinforcement : 0.24%(Clause 6.2.1(b) of IS 13920: 1993): 2041.92mm^2.
Maximum reinforcement: 2.5 % (Clause 6.2.2 of IS 13920: 1993): 21270mm^2

Self weight of the beam : 0.450x0.370x25 : 4.1625kN/m

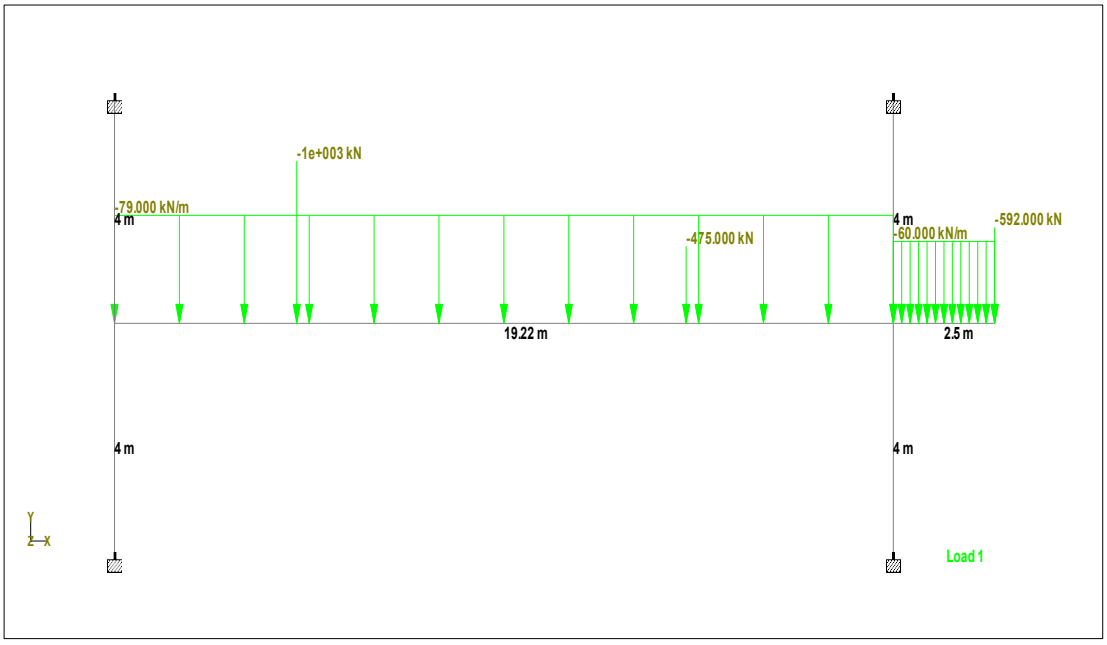
STAAD.Pro Report

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	1.5(D.L+L.L)

Beam Loads : 1 1.5(D.L+L.L)

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
11	UNI kN/m	GY	-79.000	-	-	-	-
	CON kN	GY	-1E 3	4.500	-	-	-
	CON kN	GY	-475.000	14.110	-	-	-
29	UNI kN/m	GY	-60.000	-	-	-	-
	CON kN	GY	-592.000	2.500	-	-	-

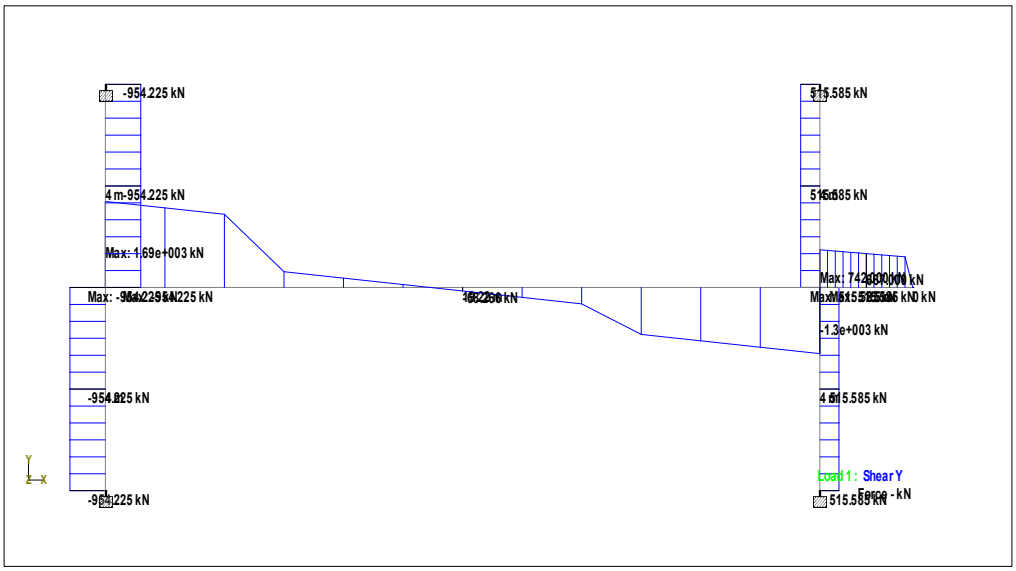


Whole Structure Loads 355.434kN:1m 1 1.5(D.L+L.L)

Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
11	10	19.223	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	1.69E 3
				Max +ve	0.000	0.000	19.223	-1.3E 3
27	20	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	515.585
				Max +ve	0.000	0.000		
28	20	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	515.585
				Max +ve	0.000	0.000		
29	20	2.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	742.000
				Max +ve	0.000	0.000	2.500	-0.000
30	10	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-954.225
31	10	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-954.225

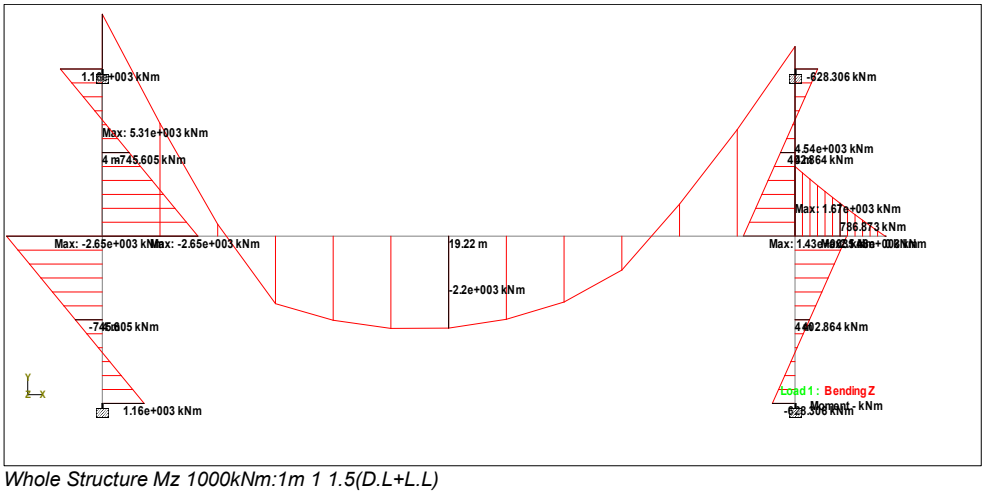


Whole Structure Fy 1000kN:1m 1 1.5(D.L+L.L)

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kNm)	d (m)	Max Mz (kNm)
11	10	19.223	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	5.31E 3
				Max +ve	0.000	0.000	8.010	-2.21E 3
27	20	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	1.43E 3
				Max +ve	0.000	0.000	4.000	-628.306
28	20	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	1.43E 3
				Max +ve	0.000	0.000	4.000	-628.306
29	20	2.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	1.67E 3
				Max +ve	0.000	0.000	2.500	-0.000
30	10	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	4.000	1.16E 3
				Max +ve	0.000	0.000	0.000	-2.65E 3
31	10	4.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	4.000	1.16E 3
				Max +ve	0.000	0.000	0.000	-2.65E 3



Whole Structure Mz 1000kNm:1m 1 1.5(D.L+L.L)

Beam Size: 1200mm x 750mm

Maximum moment at support : 4471kNm

M_u/bd^2 : 4471 x 10^6 / 1200 x 709^2 : 7.4 *From Table 55 of SP16* p_t : 1.93

A_{st} :1.93 x 1200 x 709/100 : 16420.44mm^2 , *A_{st} provided : 8Y32+8Y32+ 8Y32(19296mm^2).*

Maximum moment at midspan : 2210kNm

M_u/bd^2 : 2210 x 10^6 / 1200 x 709^2 : 3.7, *From Table 55 of SP16* p_t : 1.035

A_{st} : 1.035 x 1200 x 709/100 : 8805.78mm^2 , *A_{st} provided : 8Y32+8Y32+ 8Y32(19296mm^2).*

Maximum Shear Force : 1655kN. For p_t : 2.2

Shear capacity of the section : $\tau_c'bd$: 0.84 x 1200 x 709 : 714.672 kN

Shear to be carried by the stirrups, V_{us} : 1655 – 714.672 : 940.328kN

V_{us} /d : 940.328/70.9 : 13.26/3;4.42. **Provide stirrups of Y10ST6@100mm for 3m near the supports and Y10ST6@125mm for the next 3m and Y10ST6@150mm for the remaining span.**

All the other beams are designed in a similar way.

b.DESIGN OF SLOPED BEAM Q7-Q13 375mm X 750mm

The flexural members shall fulfill the following general requirements.

IS 13920; Clause 6.1.2:

Effective Depth : d : 750-25-12.5:712.5mm

b / D ≥ 0.3 ; 375 / 750 : 0.5 , O.K

IS 13920; Clause 6.1.3:

b ≥ 200mm , b : 375mm, hence O.K

IS 13920; Clause 6.1.4 :

D ≤ L_c / 4 , 9310/ 750 : 12.41 > 4, hence O.K.

Limiting Longitudinal Steel %

Minimum reinforcement : 0.24%(Clause 6.2.1(b) of IS 13920: 1993): 675mm^2.
Maximum reinforcement: 2.5 % (Clause 6.2.2 of IS 13920: 1993): 7031.25mm^2

Self weight of the beam	: 0.375x0.600x25	: 5.625kN/m
Weight of 200mm wall	: 0.2 x 2.55 x 20	: 10.2kN/m^2

STAAD.Pro Report

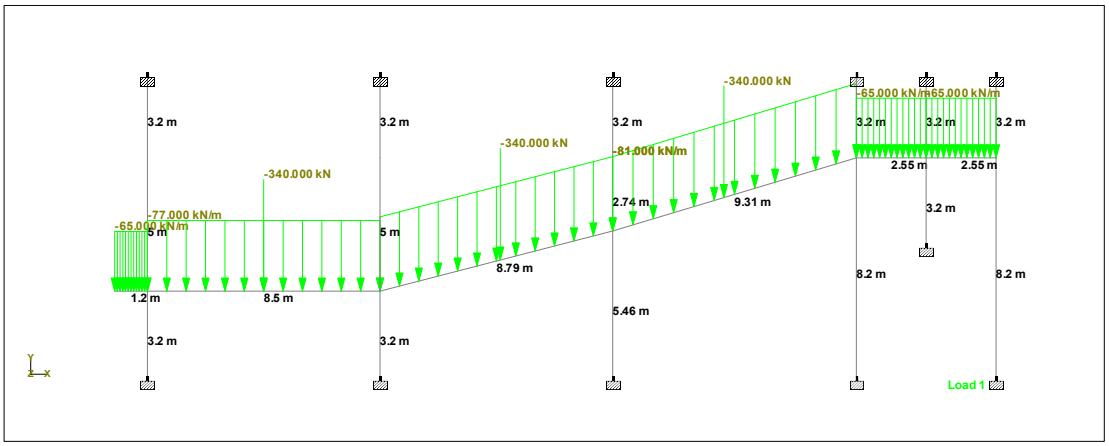
Included in this printout are data for:
All The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	1.5(D.L+L.L)

Beam Loads : 1 1.5(D.L+L.L)

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
29	UNI kN/m	GY	-65.000	-	-	-	-
42	UNI kN/m	GY	-77.000	-	-	-	-
	CON kN	GY	-340.000	4.250	-	-	-
45	UNI kN/m	GY	-81.000	-	-	-	-
	CON kN	GY	-340.000	4.250	-	-	-
46	UNI kN/m	GY	-81.000	-	-	-	-
	CON kN	GY	-340.000	4.250	-	-	-
63	UNI kN/m	GY	-65.000	-	-	-	-
64	UNI kN/m	GY	-65.000	-	-	-	-



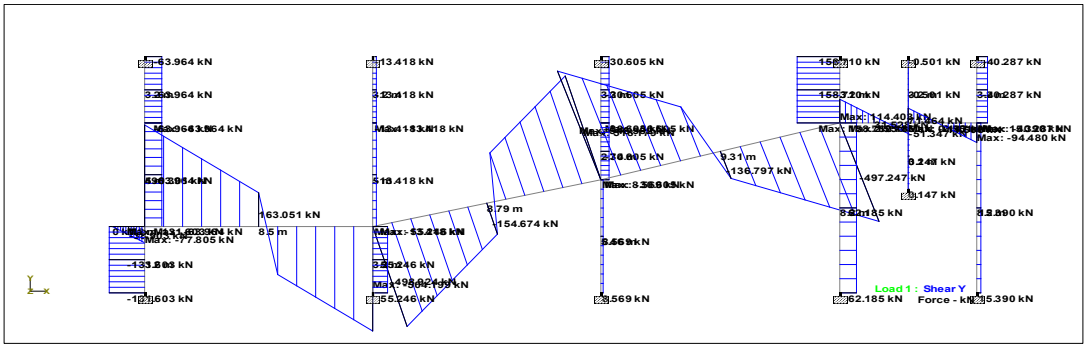
Whole Structure Loads 81.2833kN:1m 1 1.5(D.L+L.L)

Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
29	20	1.197	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	1.197	-77.805
42	23	8.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	490.301
				Max +ve	0.000	0.000	8.500	-504.199
45	37	9.313	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	548.582
				Max +ve	0.000	0.000	9.313	-497.247
46	37	8.795	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	518.179
				Max +ve	0.000	0.000	8.795	-498.924
47	23	5.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-63.964
48	32	5.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-13.418
49	36	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	158.710
				Max +ve	0.000	0.000		
50	37	2.742	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-30.605
51	23	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		

				Max +ve	0.000	0.000	0.000	-131.603
52	32	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	55.246
				Max +ve	0.000	0.000		
53	36	8.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	62.185
				Max +ve	0.000	0.000		
54	37	5.458	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	8.569
				Max +ve	0.000	0.000		
55	46	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-30.605
57	47	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-13.418
59	48	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-63.964
61	49	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	0.147
				Max +ve	0.000	0.000		
62	49	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-0.501
63	36	2.550	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	114.403
				Max +ve	0.000	0.000	2.550	-51.347
64	49	2.553	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	71.464
				Max +ve	0.000	0.000	2.553	-94.480
65	50	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-40.287
66	50	8.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	15.390
				Max +ve	0.000	0.000		



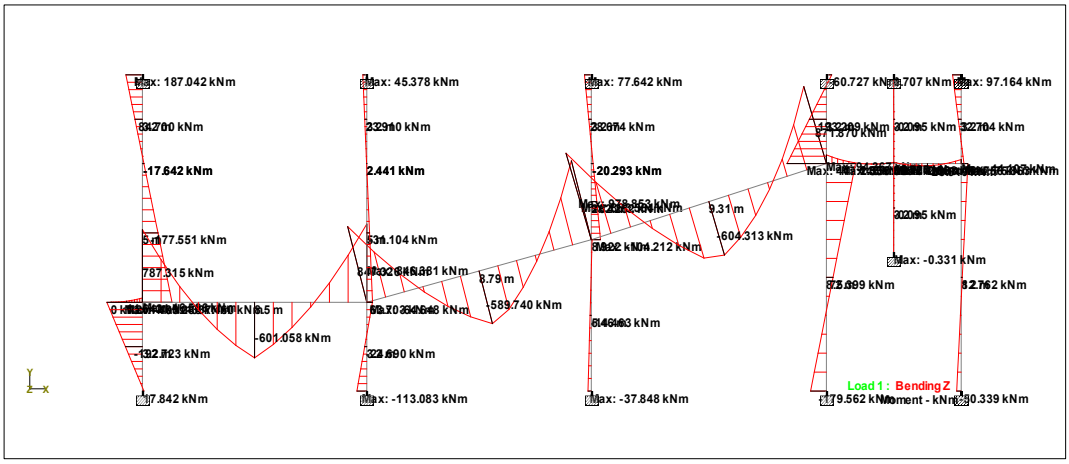
Whole Structure Fy 100kN:1m 1 1.5(D.L+L.L)

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kNm)	d (m)	Max Mz (kNm)
29	20	1.197	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	1.197	46.566
				Max +ve	0.000	0.000	0.000	-0.000
42	23	8.500	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	8.500	846.381
				Max +ve	0.000	0.000	4.250	-601.058
45	37	9.313	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	978.853
				Max +ve	0.000	0.000	4.656	-604.313
46	37	8.795	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	883.564
				Max +ve	0.000	0.000	4.397	-589.740
47	23	5.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-337.460
48	32	5.000	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	5.000	2.441
				Max +ve	0.000	0.000	0.000	-64.648
49	36	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	447.145
				Max +ve	0.000	0.000	3.200	-60.727
50	37	2.742	1:1.5(D.L+L.L)	Max -ve	0.000	0.000		
				Max +ve	0.000	0.000	0.000	-104.212
51	23	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	17.842
				Max +ve	0.000	0.000	0.000	-403.288
52	32	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	63.703
				Max +ve	0.000	0.000	3.200	-113.083
53	36	8.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	330.359
				Max +ve	0.000	0.000	8.200	-179.562
54	37	5.458	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	8.922

				Max +ve	0.000	0.000	5.458	-37.848
55	46	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	77.642
				Max +ve	0.000	0.000	0.000	-20.293
57	47	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	45.378
				Max +ve	0.000	0.000		
59	48	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	187.042
				Max +ve	0.000	0.000	0.000	-17.642
61	49	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	0.140
				Max +ve	0.000	0.000	3.200	-0.331
62	49	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	0.707
				Max +ve	0.000	0.000	0.000	-0.898
63	36	2.550	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	94.367
				Max +ve	0.000	0.000	1.700	-6.194
64	49	2.553	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	2.553	44.107
				Max +ve	0.000	0.000	1.064	-24.517
65	50	3.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	3.200	97.164
				Max +ve	0.000	0.000	0.000	-31.756
66	50	8.200	1:1.5(D.L+L.L)	Max -ve	0.000	0.000	0.000	75.863
				Max +ve	0.000	0.000	8.200	-50.339



Whole Structure Mz 300kNm:1m 1 1.5(D.L+L.L)

Beam Size: 375mm x 750mm

Maximum moment at support : 978.853kNm

M_u/bd^2 : 978.853 x 10^6 / 375 x 712.5^2 : 5.15 *From Table 55 of SP16* p_t : 1.344

A_{st} : 1.374 x 375 x 712.5/100 : 3671.156mm^2 , *A_{st} provided : 4Y25+4Y25 (3928mm^2).*

Maximum moment at midspan : 604.313kNm

M_u/bd^2 : 604.313 x 10^6 / 375 x 712.5^2 : 3.2, *From Table 3 of SP16* p_t : 0.898

A_{st} : 0.898 x 375 x 712.5/100 : 2399.34mm^2 , *A_{st} provided : 4Y25+4Y20(3220mm^2).*

Maximum Shear Force : 548kN. For p_t : 1.2

Shear capacity of the section : $\tau_c'bd$: 0.69 x 375 x 712.5 : 184.35 kN

Shear to be carried by the stirrups, V_{us} : 548 – 184.35 : 363.65kN

V_{us} /d : 363.65/71.25 : 5.1. **Provide stirrups of Y10ST2@100mm for 1m near the supports and Y10ST2@125mm for the next 1m and Y10ST2@150mm for the next 1m and Y10ST2@200mm for the remaining span.**

All the other beams are designed in a similar way.

F.DESIGN OF FLOOR SLABS

1.TWO WAY SLAB

Self Weight of the slab 150mm thick	: 3.75kN/m^2
Floor Finish	: 1 kN/m^2
Live Load	: 5kN/m^2
Total Load	: 9.75 kN/m^2

The slab has one long edge discontinuous

l_y / l_x : 5.111/4.688 : 1.1 < 2. The slab is designed as a two-way slab.

From Table 26 of IS 456: 2000 for l_y / l_x : 1.1; α_{x-} : 0.044 , α_{y-} : 0.037

Negative moment at continuous edge for shorter side M_x : $\alpha_x w l^2_x$

: 0.044 x 9.75 x 4.688^2 x 1.5 : 14.14 kNm

Effective depth required : $\sqrt{14.14 \times 10^6 / 0.138 \times 25 \times 1000}$

: 64mm.

A slab depth of 150mm is provided.

M_u/bd^2 : 14.14 x 10^6 /1000 x 125^2 : 0.9

From Table 3 of SP16 p_t : 0.216

A_{st} required : 0.216 x 1000 x125/100 : 270mm^2.

However Y12@ 125mm c/c (906mm^2) is provided along the shorter span.

Positive moment at midspan for the longer side M_y : $\alpha_y w l^2_x$

: 0.037 x 9.75 x 4.688^2 x 1.5 : 11.89kNm

M_u/bd^2 : 11.89x 10^6 /1000 x 125^2 : 0.8 p_t : 0.231

A_{st} required : 0.231x 1000 x125/100 : 288.75mm^2.

However Y12@ 125mm c/c (906mm^2) is provided along the shorter span.

All other slabs are designed in a similar way.

APPENDIX