ANALYSIS AND DESIGN OF RESIDENTIAL BUILDING C+G+7 USING E-TABS

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ABSTRACT: The main steps of any building construction and planning is drafting, analysing and designing the building. In the present days of improving science and technology, analysing and designing of a building has been made easy by using ETABS software. ETABS software helps civil engineers to make their work easy and decreases time necessary for planning. The project going to be done is design of a multi-storey building which is going to be used as a residential. The building plan has been drafted using the AutoCAD software by the requirement and available area. The super structure i.e. the building frame has been analysed and designed using the ETABS software. In the present project C+G+7 building consider to analysis and design for both gravity and lateral (wind and earth quake) loads as per Indian standards. By using the software building can be analysed and we can check for any failures in the analysis and redesign them, so that we can prevent failures after construction. By using the output building can be constructed according to the design.

Keywords: Building, Wind and Earth quake, ETABS.

INTRODUCTION

GENERAL

A building is a man-made structure with a roof and walls standing more or less permanently in one place. Buildings come in a variety of shapes, sizes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. To better understand the term building compares the list of structures. Buildings serve several needs of society – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful). Ever since the first cave paintings, buildings have also become objects or canvases of artistic expression. In recent years, interest in sustainable planning and building practices has also become an intentional part of the design process of many new buildings. A slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of a structure can take many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs may be supported on monolithic concrete beam, steel beams, walls or directly over the columns. Concrete slab behave primarily as flexural members and the design is similar to that of beams.

CONVENTIONAL SYSTEM

The structural components in a typical multi-storey building, consists of a floor system which transfers the floor loads to a set of plane frames in one or both directions. The floor system also acts as a diaphragm to transfer lateral loads from wind or earthquakes. The frames consist of beams and columns and in some cases braces or even reinforced concrete shear walls. As the height of the building increases beyond ten stories (tall building), it becomes necessary to reduce the weight of the structure for both functionality and economy

Since concrete floors are functionally more suitable, have less vibration and more abrasion and fire resistance, the usual tendency is to make them act either with profiled steel decks and/or with steel beams to give a light weight floor system. Similarly masonry walls may be replaced with glazing and curtains or blinds to reduce the weight. The different types of floors used in steel-framed buildings are as follows:

- Concrete slabs supported by open-web joists
- One-way and two-way reinforced concrete slabs supported on steel beams
- Concrete slab and steel beam composite floors
- Profiled decking floors
- Precast concrete slab floors.

Steel forms or decks are usually attached to the joists by welding and concrete slabs are poured on top. This is one of the lightest types of concrete floors. For structures with light loading.

These are much heavier than most of the newer light weight floor systems and they take more time to construct, thus negating the advantage of speed inherent in steel construction. This floor system is adopted for heavy loads. One way slabs are used when the longitudinal span is two or more times the short span. In one-way slabs, the short span direction is the direction in which loads get transferred from slab to the beams. Hence the main reinforcing bars are provided along this direction. However, temperature, shrinkage and distribution steel is provided along the longer direction.

The two-way concrete slab is used when aspect ratio of the slab i.e. longitudinal span/transverse span is less than 2 and the slab is supported along all four edges. The main reinforcement runs in both the directions. A typical cross-section of a one-way slab floor with supporting steel beams. Also shown is the case when the steel beam is encased in concrete for fire protection.

LITERATURE SURVEY

Youssef (2001) has worked on Seismic design and analysis of underground structures. Underground facilities are an integral part of the infrastructure of modern society and are used for a wide range of applications, including subways and railways, highways, material storage, and sewage and water transport. Underground facilities built in areas subject to earthquake activity must withstand both seismic and static loading. Historically, underground facilities have experienced a lower rate of damage than surface structures. Nevertheless, some underground structures have experienced significant damage in recent large earthquakes, including the 1995 Kobe, Japan earthquake, the 1999 Chi-Chi, Taiwan earthquake and the 1999 Kocaeli, Turkey earthquake. This report presents a summary of the current state of seismic analysis and design for underground structures. This report describes approaches used by engineers in quantifying the seismic effect on an underground structure. Deterministic and probabilistic seismic hazard analysis approaches are reviewed. The development of appropriate ground motion parameters, including peak accelerations and velocities, target response spectra, and ground motion time histories, is briefly described.

Iunio Iervolino (2005) Record Selection for Nonlinear Seismic Analysis of Structures. This study addresses the question of selection and amplitude scaling of accelerograms for predicting the nonlinear seismic response of structures. Despite the current practices of record selection according to a septic magnitude-distance scenario and scaling to a common level, neither aspect of this process has received significant research attention to ascertain the benefits or effects of these practices on the conclusions. This paper hypothesizes that neither these usual principal seismological characteristics nor scaling of records matters to the nonlinear response of structures. It then investigates under what conditions this hypothesis may not be sustainable. Two classes of records sets are compared in several case studies: one class is carefully chosen to represent a specific magnitude and distance scenario, the other is chosen randomly from a large catalog. Results of time-history analyses are formally compared by a simple statistical hypothesis test to assess the difference, if any, between nonlinear demands of the two classes of records. The effect of the degree of scaling _by first-mode spectral acceleration level_ is investigated in the same way. Results here show _1_ little evidence to support the need for a careful site-specific process of record selection by magnitude and distance, and _2_ that concern over scenario-to-scenario record scaling, at least within the limits tested, may not be justified.

M. Kutanis (2002) has worked on earthquake analysis of building structures with foundation uplift in downtown adapazari. The primary objective of this study is to investigate the effect of foundation flexibility and uplift on the seismic response of building structures located in downtown Adapazari, where substantial geotechnical effects occurred during the earthquake. To perform the analysis, the basic data about the soil conditions at the site was collected from subsoil investigation reports that were compiled by various government agencies, local public body and private consultants. The geotechnical model included a nonlinear representation of the soil material below the mat foundation. This foundation model could accommodate both uplift and plastic yielding of the soil material. The superstructure was idealized as a typical R/C frame structure subjected to the E-W component of 17 August 1999 Marmara earthquake recorded at SKR station in Adapazari. The authors performed the analysis using the nonlinear computer program Drain-2DX.

Kiyoshi has worked on seismic analysis of reinforced concrete building. Open rectangular continuous frames are the most convenient construction element insofar as usable space is concerned. However, because of the pratical limitation of dimensions, an effective resistance against lateral force cannot be expected integrally especially in multi-storied buildings. The basic principle of the stress analysis is to distribute the lateral shear at any one storey to the resisting elements of the storey. This distribution is made in proportion to the D-values, distribution coefficients, of the elements.

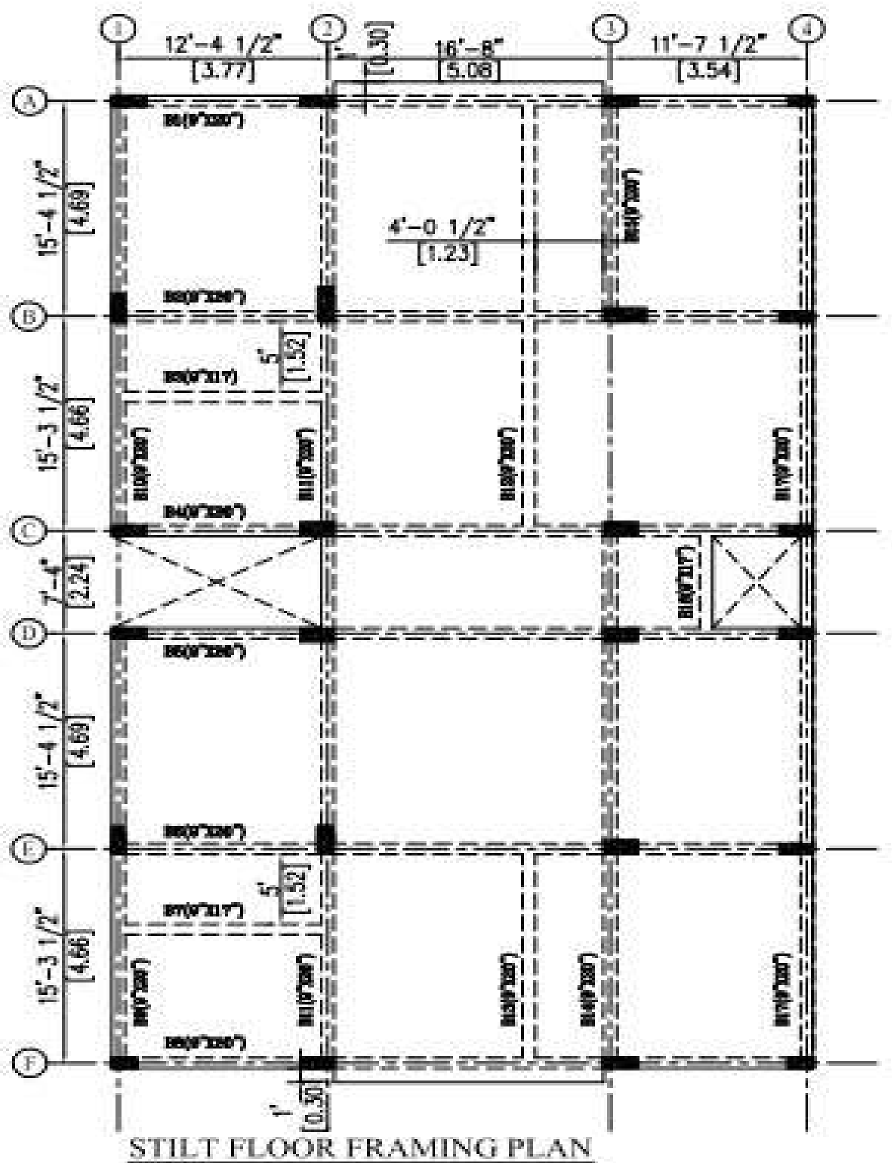


Fig: Plan of the structure

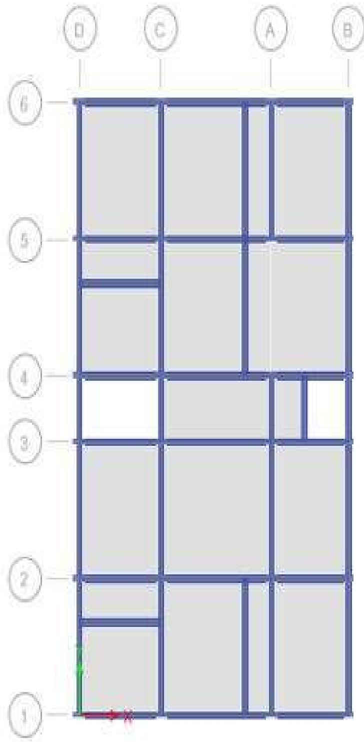


Fig: plan of the structure from ETABS

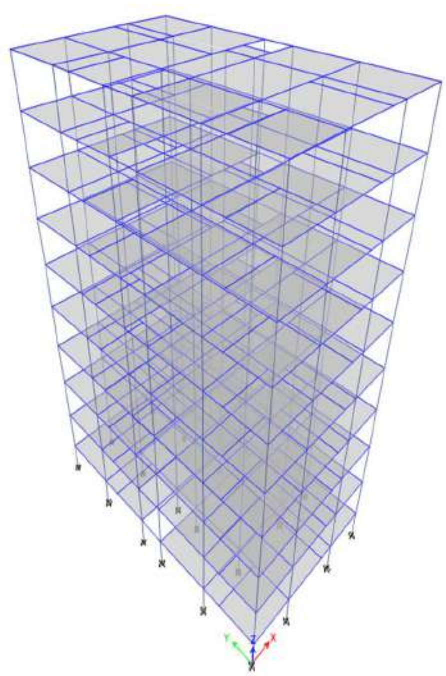


Fig: 3D view of the structure

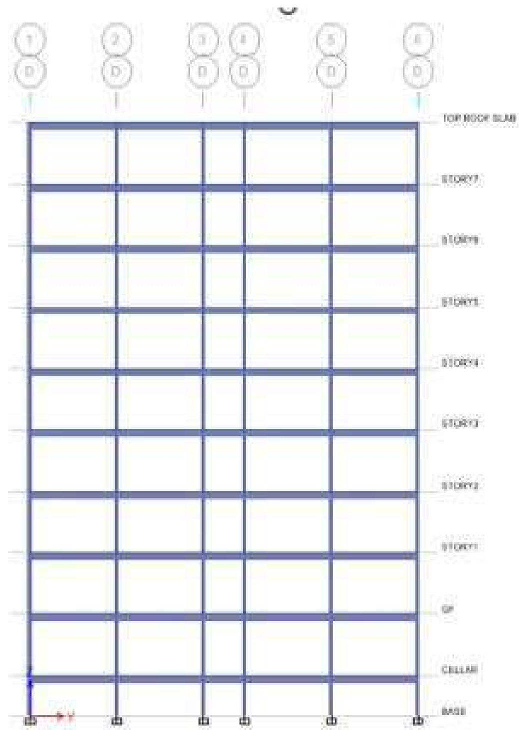


Fig: Elevation of the structure

ANALYSIS AND RESULT

GENERAL

Structure having C+G+7 storey is analysed for garvity and latral loads (sesimic and wind load). The effect of axial force, out of plane moments, lateral loads, shear force, storey drift, storey shear and tensile force are observed for different stories. The analysis is carried out using ETABS and data base is prepared for different storey levels as follows.

LOAD CASES AND LOAD COMBINATIONS

In this present work consider both gravity and lateral load case (SESIMIC AND WIND). The load combinations as per the Indian standards are considered. The primary load cases and the load combinations are shown following tables respectively.

Table: Load combinations

COMBINATION NUMBER	LOAD COMBINATION	COMBINATION NUMBER	LOAD COMBINATION
COMB1	D.L+L.L	COMB26	D.L+WNY
COMB2	1.5(D. L+L.L)	COMB27	1.5(D. L+WX)
COMB3	1.5(D. L+EQX)	COMB28	1.5(D. L+WY)
COMB4	1.5(D. L+EQY)	COMB29	1.5(D. L+WNX)
COMB5	1.5(D. L+EQNX)	COMB30	1.5(D. L+WNY)
COMB6	1.5(D. L+EQNY)	COMB31	1.2(D. L+L.L+WX)
COMB7	1.2(D.L.+L.L+EQX)	COMB32	1.2(D. L+L.L+WY)
COMB8	1.2(D.L.+L.L+EQY)	COMB33	1.2(D. L+L.L+WNX)
COMB9	1.2(D.L.+L.L+EQNX)	COMB34	1.2(D. L+L.L+WNY)
COMB10	1.2(D.L.+L.L+EQNY)	COMB35	1.5(D. L+L.L) +WX
COMB11	0.9D. L+1.5EQX	COMB36	1.5(D. L+L.L) +WY
COMB12	0.9D. L+1.5EQY	COMB37	1.5(D. L+L.L) +WNX
COMB13	0.9D. L+1.EQNX	COMB38	1.5(D. L+L.L) +WNY
COMB14	0.9D. L+1.5EQNY	COMB22	D.L+L.L+WNY
COMB15	D.L+L.L+EQX	COMB23	D.L+WX
COMB16	D.L+L.L+EQY	COMB24	D.L+WY
COMB17	D.L+L.L+EQNX	COMB25	D.L+WNX
COMB18	D.L+L.L+EQNY	COMB39	1.5(D. L+L.L+WX)
COMB19	D.L+L.L+WX	COMB40	1.5(D. L+L.L+WY)
COMB20	D.L+L.L+WY	COMB41	1.5(D. L+L.L+WNX)
COMB21	D.L+L.L+WNX	COMB42	1.5(D. L+L.L+WNY)

Table: Primary load cases

LOAD CASE NUMBER	LOAD TYPE	LOAD CASE NUMBER	LOAD TYPE
1	Dead load	6	EQ in Negative Y
2	Live load	7	WIND in X
3	EQ in X	8	WIND in Y
4	EQ in Y	9	WIND in Negative X
5	EQ Negative X	10	WIND in Negative Y

Design spectrum calculations

The design horizontal seismic coefficient Ah for a structure shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

Where

Zone Factor (Z) = It is a factor to obtain the design spectrum depending on the perceived maximum seismic risk characterized by Maximum Considered Earthquake (MCE) in the zone in which the structure is located. The basic zone factor included in this standard is reasonable estimate of effective peak ground acceleration's .Zone factor is for the Maximum Considered Earthquake (MCE) and service life of structure in a zone. The factor 2 in the denominator of Z is used so as to reduce the Maximum Considered Earthquake (MCE) zone factor to the factor for Design Basis Earthquake (DBE).

Importance factor (I) = It is a factor used to obtain the design seismic force depending on the functional use of the structure, characterized by hazardous consequences of its failure, its post-earthquake functional need, historic value, or economic importance. Importance factor, depending upon the functional use of the structures, characterized by. Hazardous consequences of its failure, post-earthquake functional needs, historical value.

Response Reduction Factor (R) it is the factor by which the actual base shear force, that would be generated if the structure were to remain elastic during its response to the Design Basis Earthquake (DBE) shaking, shall be reduced to obtain the design lateral force. Response reduction factor, depending on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations. However, the ratio (I/R) shall not be greater than 1.0.

Structural response factor (Sa /g) = It is a factor denoting the acceleration response spectrum of the structure subjected to earthquake ground vibrations, and depends on natural period of vibration and damping of the structure. Average response acceleration coefficient.

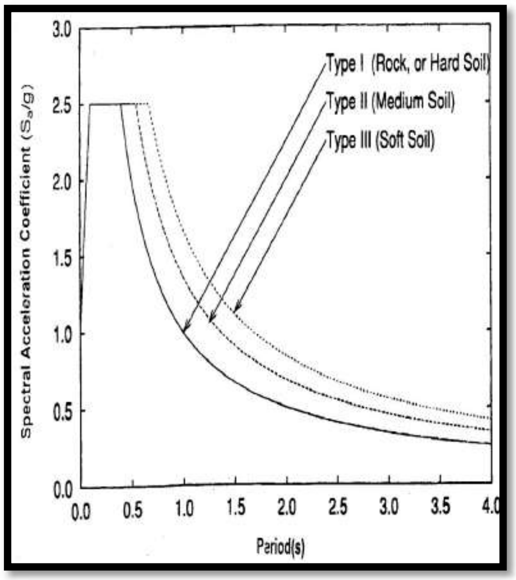


Fig: Response spectrum for rock and soil for 5 percent damping

DESIGN WIND SPEED (Vz)

The basic wind speed (V_b) shall be modified to include the following effects to get design wind velocity at any height (V_z) for the chosen structure

- Risk level
- Terrain roughness, height and size of structure and
- Local topography.

It can be mathematically expressed as follows:

$$V_z = V_b K_1 K_2 K_3$$

Where

V_Z = design wind speed at any height z in m/s;

K_1 = probability factor (risk coefficient)

K_2 = terrain, height and structure size factor and

K_3 = topography factor

BASIC WIND SPEED AT 10 m HEIGHT FOR SOME IMPORTANT CITIES/TOWNS

City/Town	Basic Wind Speed (m/s)
Agra	47
Ahmadabad	39
Ajmer	47
Almora	47
Amritsar	47
Asansol	47
Aurangabad	39
Bahraich	47
Bangalore	33
Barauni	47
Bareilly	47
Bhatinda	47
Bhilai	39
Bhopal	39
Bhubaneshwar	50
Bhuj	50
Bikaner	47
Bokaro	47
Bombay	44
Calcutta	50
Calicut	39
Chandigarh	47
Coimbatore	39
Cuttack	50
Darbhanga	55
Darjeeling	47
Dehra Dun	47
Delhi	47
Durgapur	47
Gangtok	47
Gauhati	50
Gaya	39
Gorakhpur	47
Hyderabad	44
Imphal	47
Jabalpur	47
Jaipur	47
Ja.mshedpur	47
Jhansi	47

City/Town	Basic Wind Speed (m/s)
Jodhpur	47
Kanpur	47
Kohima	44
Kurnool	39
Lakshadweep	39
Lucknow	47
Ludhiana	47
Madras	50
Madurai	39
Mandi	39
Mangalore	39
Moradabad	47
Mysore	33
Nagpur	44
Nainital	47
Nasik	39
Nellore	50
Panjim	39
Patiala	47
Patna	47
Pondicherry	50
Port Blair	44
Pune	39
Raipur	39
Rajkot	39
Ranchi	39
Roorkee	39
Rourkela	39
Simla	39
Srinagar	39
Surat	44
Tiruchchirappalli	47
Trivandrum	39
Udaipur	47
Vadodara	44
Varanasi	47
Vijaywada	50
Visakhapatnam	50

TABLE 1 RISK COEFFICIENTS FOR DIFFERENT CLASSES OF STRUCTURES IN DIFFERENT WIND SPEED ZONES

(*Clause* 5.3.1)

Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed (m/s) of					
		33	39	44	47	50	55
All general buildings and structures	50	1·0	1·0	1·0	1·0	1·0	1·0
Temporary sheds, structures such as those used during construction operations (for example, formwork and falsework), structures during construction stages and boundary walls	5	0·82	0·76	0·73	0·71	0·70	0·67
Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0·94	0·92	0·91	0·90	0·90	0·89
Important buildings and structures such as hospitals communication buildings / towers, power plant structures	100	1·05	1·06	1·07	1·07	1·08	1·08

NOTE: Design wind speed up to 10.0 m height from mean ground level shall be considered constant.

DESIGN WIND PRESSURE

The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity.

$$p_z = 0.6\, V_z^{\,2}$$

Where

- P_z = Design wind pressure in N/m^2 at height z, and
- V_z=design wind velocity in m/s at height 2.

NOTE - The coefficient 0’6 (in SI units) in the above formula depends on a number of factors and mainly on the atmospheric pressure and air temperature. The value chosen corresponds to the average appropriate Indian atmospheric conditions.

Wind Load on Individual Members

When calculating the wind load on individual structural elements such as roofs and walls, and individual cladding units and their fittings, it is essential to take account of the pressure difference between opposite faces of such elements or units. For clad structures, it is, therefore, necessary to know the internal pressure as well as the external pressure. Then the wind load, **F,** acting in a direction normal to the individual structural element or cladding unit is

$$F = (C_{pe} - C_{pi})\, AP_a$$

Where

C_e = external pressure coefficient,

C_i = internal pressure- coefficient,

A = surface area of structural or cladding unit, and

P_d = design wind pressure element

Table: Seismic and Wind parameters

Seismic coefficients AS PER IS: 1893-2002			Wind Coefficients AS PER IS: 875-1987	
Seismic Zone Factor	0.1		Wind speed (V_b)	44m/s
Soil Type	III		Terrain Category	II
Importance Factor (I)	1		Structure Class	B
Response Reduction (R)	3		Risk Coefficient k_1 factor	1
			Topography k_3 factor	1
			Windward coefficient	0.8
			Leeward coefficient	0.5

After the gravity and lateral load analysis the parametric study is carried out for the responses the structural responses are tabulated.

ANALYSIS AND RESULTS

- All moving loads come under live loads.

Live load (on floors): 2kN/m^2, (IS 875:1987 – Part -2)

Live load (on roof): 1kN/m^2, (IS 875:1987 – Part -2)

- Floor finishes are the super imposed dead loads.

Floor Finishes (on floors): 1.5kN/m^2

Floor Finishes (on roof): 2kN/m^2

- Wall loads are the loads of bricks used in construction.

For 9” wall (outer wall): 12.45kN/m^2 (wall thickness*height of the floor*density of brick = 0.23*3*18)

For 4.5” wall (inner wall): 6.21kN/m^2 (wall thickness*height of the floor*density of brick = 0.115*3*18)

- Earthquake loads are given so that the building shall be earthquake resistant.

Zone: IV (According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.)

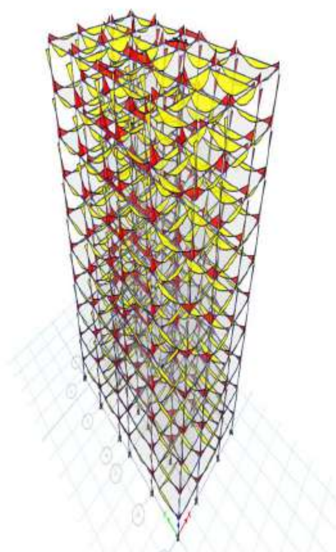
Zone factor: 0.24

Soil type: II (medium stiff soil)

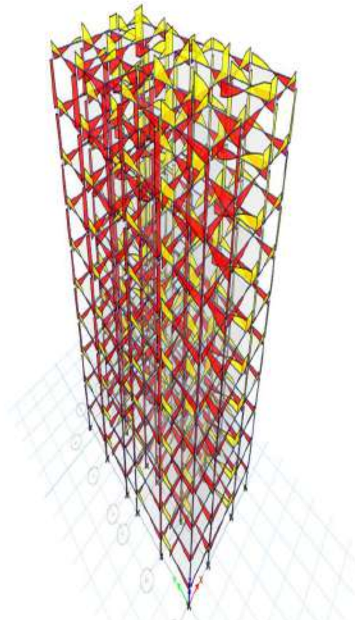
Importance factor, I: 1.0 (as residential building)

The building is proposed to have ordinary moment resisting frame.

RESULTS AND DISCUSIONS



Bending Moment for whole structure



Shear force for whole structure

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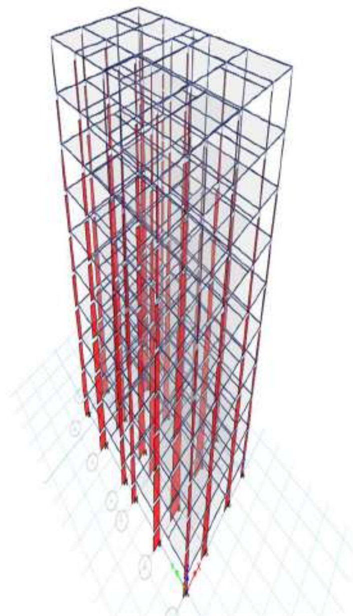

Axial force for whole structure

This calculation presents the automatically generated lateral wind loads for load pattern WLX according to Indian IS875:1987, as calculated by ETABS.

Exposure Parameters

Exposure From = Diaphragms

Structure Class = Class B

Terrain Category = Category 2

Wind Direction = 0;90 degrees

Basic Wind Speed, V_b [IS Fig. 1] $V_b = 44 \frac{meter}{sec}$

Windward Coefficient, $C_{p,wind}$ $C_{p,wind} = 0.8$

Leeward Coefficient, $C_{p,lee}$ $C_{p,lee} = 0.5$

Top Story = TERRACE

Bottom Story = BASE

Include Parapet = No

Factors and Coefficients

Risk Coefficient, k_1 [IS 5.3.1] $k_1 = 1$

Topography Factor, k_3 [IS 5.3.3] $k_3 = 1$

Lateral Loading

Design Wind Speed, V_z [IS 5.3]	$V_z = V_b k_1 k_2 k_3$	$V_z = 44$
Design Wind Pressure, p_z [IS 5.4]	$p_z = 0.6{V_z}^2$	

Applied Story Forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
TERRACE	29	56.3534	0
STORY7	26	110.652	0
STORY6	23	107.5998	0
STORY5	20	104.4913	0
STORY4	17	101.0296	0
STORY3	14	97.1049	0
STORY2	11	92.8289	0
STORY1	8	91.1344	0
GF	5	91.1066	0
CELLAR	2	75.9222	0
BASE	0	0	0

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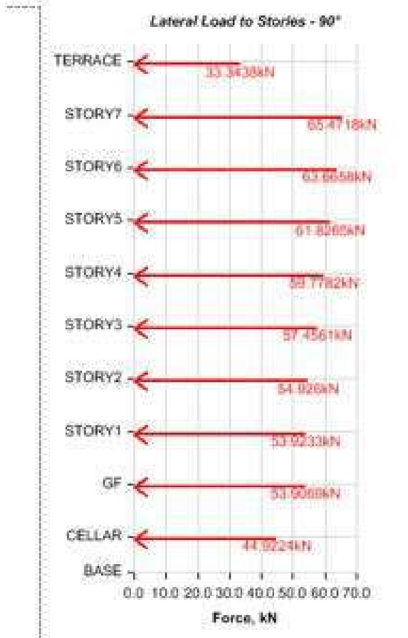

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
TERRACE	29	0	33.3438
STORY7	26	0	65.4718
STORY6	23	0	63.6658
STORY5	20	0	61.8265
STORY4	17	0	59.7782
STORY3	14	0	57.4561
STORY2	11	0	54.926
STORY1	8	0	53.9233
GF	5	0	53.9069
CELLAR	2	0	44.9224
BASE	0	0	0

STRUCTURAL ELEMENTS DESIGN

Load calculations

1. 9" or 230mm WALL LOAD :

unit weight of brick = 19.0 kN/m3

floor height = 3.0 m

Beam depth = 0.450 m

9" Or (230MM) Brick wall = (3.0-0.450) x 0.230 x 19

= 11.14 kN/m

say 11.15 kN/m

2. **Railing Load :**

Railing load or Parapet wall looad = 1.0 X .115 X19

= 2.18

say 2.2 kN/m

FLOOR LOADS

1. 180mm thick slab load :

Unit weight of concrete = 25 kN/m3

Slab Self weight = 0.180 x 25 = 4.5 kN/m2

Floor finishes = 1.0 kN/m2

Partion load on slab panel = 1.0 kN/m2

Total Load = 6.5 kN/m2

2. 150mm thick slab load : (water tank)

Unit weight of concrete = 25 kN/m3

Slab Self weight = 0.150 x 25 = 3.75 kN/m2

Floor finishes = 1.5 kN/m2

Total Load = 5.25 kN/m2

Water Load on oht Bottom slab (1.0 mt. Height water level)

= 1.0 X10 = 10 kN/m2

B. Imposed loads:- Asper IS875 part-II

All rooms and kitchens – 2.0 kN/m2

Toilets and bath rooms – 2.0 kN/m2

Corridors, passages, staircases

Including fire escapes and store rooms – 3.0kN/m2

Balconies – 3.0kN/m2

Commercials , Retail Merchantiles

Cafeterias and restaurants & Public lounges – 4.0kN/m2

Distribution of slab load into equivalent uniform load per unit length of the beam (per meter)

(As per SP-24, clause 23.5) of the following equations:

On the short span = $\frac{Wl_x}{3}$

On the long span = $\frac{Wl_x}{6}\left[3-\left(\frac{l_x}{l_y}\right)^2\right]$

DESIGN OF SLABS

Slabs are plane structural members whose thickness is small compared to its length and breadth. Slabs are mostly used as a roof covering and carry the distributed load primary by flexure. A slab may be supported by beams or walls and may be used as the flange of a T-Beam or L-Beam.

Slabs are in general, divided into two categories depending upon the ratio long span to short span. When this ratio is greater than or equal to 2, the slab is to be designed as slab spanning in one direction (i.e., one way slab) but if the ratio is less than 2, the slab is to be designed as slab spanning in 2 directions (i.e., 2 way slab).

The slabs are designed by using the theories of bending and shear. The Following methods of analysis are commonly used for the design of slabs

Yield line theory

Semi empirical coefficient

DESIGN REQUIREMENTS OF SLABS:

Effective span:

As per Clause 22.2 of IS 456-2000,

The effective span is taken as clear span plus the effective depth of slab or center to center of supports, whichever is less.

Control of deflection:

As per clause 23.2.1 of IS 456 - 2000

(a) The basic values of span to effective depth ratios for spans up to 10M.

Cantilever : 7

Simply supported : 20

Continuous : 26

(b) For spans above 10 M the values in (a) may be multiplied by 10/ span in meters, except for cantilevers.

(c) Depending on the area and the type of steel for tension reinforcement the values in (a) and (b) should be modified.

Minimum Reinforcement:

The reinforcement in either direction in slabs shall not be less than 0.15 percent of the total cross – sectional area. However, this value can be reduced to 0.12 percent when high strength deformed bars are used (As per Clause 26.5.2.1 of IS 456 – 2000).

Maximum Diameter:

The diameter of reinforcing bars shall not exceed one eighth of the total thickness of the slab (As per Clause 26.5.2.2 of IS 456 – 2000).

Spacing of Bars:

The horizontal distance between parallel main reinforcement bars shall not be more than 3 times the effective depth of solid slab or 450 mm whichever is smaller.

The horizontal distance between parallel reinforcement bars provided against shrinkage and temperature shall not be than 5 times the effective depth of a solid slab or 450 mm whichever is smaller.

Cover to Reinforcement:

At the end of reinforcement bar not less than 25 mm, nor less than twice the diameter of such bar.

For tensile, compressive, shear, or other reinforcement in a slab, not less than 15 mm, less than the diameter of such bar.

For any other reinforcement, not less than 15 mm, nor less than diameter of such bar.

Check for Development Length:

At simple supports and at points of inflection, positive moment tension reinforcement shall be limited to a diameter such that Ld completed for fd does not exceed M1/ v + Lo.

Where,

M1 = moment or resistance of the section assuming all reinforcement at the section to be stressed to fd.

fd. = 0.87 fy

V = Shear force at the section due to design loads.

Lo = Sum of the anchorage anchorage beyond the center of the support.

Ld = st/ 4 τbd

st is stress in bar at section

τbd is design bond stress.

DESIGN OF FOOTINGS

THEORY OF FOOTINGS

Footing or foundation is defined as the part of substructure, which transmits the loads from the super-structure to surrounding soil stratum safely. Foundation are classified as two types,

1. Shallow foundation
2. Deep foundation

The depth of the foundation is less than or equal to the width of the foundation then the foundation is said to be shallow foundation. If the depth of the foundation is greater than width of the foundation then the foundation is said to be Deep foundation.

Design of footing mainly depends on the safe bearing capacity of the soil on which the footing rests and the load coming from the superstructure. Footings may be isolated, combined.

Isolated or independent footings are the footings that support the individual columns. They distribute and spread the load over a sufficiently large of the soil stratum to minimize the bearing pressure. Isolated footings may be square, rectangular or circular.

In general, it is assumed that the soil behaves elastically that is the strain in the soil is proportional to applied stress and strain distribution in the soil immediately under the base of the footing is linear. Stress distribution is different soils.

For analysis purpose, a footing can be compared with a rigid body in equilibrium subjected to loads. Like other structural members, a footing is designed to resist shear forces and bending moments.

In design, for any soil the pressure distribution is assumed to uniform.

In design, the critical section for one way shear (beam shear) is at a distance equal to the effective depth, d from the face of column footing. The critical section for two way shear or slab type shear shall be at a distance d/2 from the periphery of column, perpendicular to the plane of the slab. The critical section for bending moment is at the face of the column. Generally the footing is sensitive to punching shear.

IS-CODE PROVISIONS FOR DESIGN OF FOOTINGS:

1. Footings shall be designed to sustain the applied loads, moment and forces. And safe bearing capacity is not exceeded.

2. In R.C.C. footing, the thickness at the edge shall not be less than 15cm for footing on soil.

3. The greatest bending moment to be used in the design of an isolated concrete at the face of the column.

4. The critical section for diagonal cracking is taken at a distance equal to the effective depth from the face of the column in hard soils and shall not exceed nominal shear stress.

Conclusion:

case-1

as our project deals with the most economical column method in this project we have design the structure in an economical way by reducing the sizes in the sections. As the load is more at the bottom when compared to the top floors, there is no need of providing large sizes at the top.

Case-2

economizing the column by means of area of steel as per code, the min percentage of
steel is 0.8%gross cross-sectional area and max: 6% as per code.

Case-3

economizing the column by means of column orientation is longer span longer direction will reduce the amount of bending as a result the area of steel is also reduced

case -4 (scope for futher study)

if the height of the structure is increased, the stiffness phenomenon (slenderness effect) i.e., long column effect will come in to the picture. As a result, the number of deflections is far greater than the codal provisions (is - 456).

BIBLIOGRAPHY

We have used a number of books and code as a reference for carrying out this project work. Some of the books (s) that we refer are mentioned below. INDIAN STANDARD CODE

- IS CODE 456-2000
- IS CODE 875-1987 PART I
- IS CODE 875-1987 PART II
- IS CODE 875-1987 PART III
- DESIGN AIDS TO IS -456-2000 (SP 16)
- ARRANGEMENT OF REINFORCEMENT USING SP 34

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