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Analysis and design of a Multi Storey Building with Flat Slab under Seismic Zones using Etabs

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Abstract:-
With the expansion in populace and improvement of human advancement, the interest for HOUSING is expanding at a pinnacle rate. Particularly in towns because of quick industrialization, the interest is high. Adjusting the development of Multistoried Building matches with interest as well as decreases the price of the single house. Thus an Engineer to be educated about the arranging and planning of such Multistoried Buildings. Headways of computer packages have given numerous instruments to the fashioner towards accomplishing the best and precision in their work. An endeavor is made in this venture to use the computer packages and contrasting the outcomes and manual methodology. In our task, a G+11 Structure with flat slab is broke down and intended for live loads, dead burden, seismic loads and wind loads. The total procedure of Modeling, Analysis of entire structure is conveyed by utilizing ETABS Packages and the designs of typical auxiliary elements (shaft, segment, and slab) are finished by physically. The typical flat slab is structure in SAFE by utilizing finite element strategy. The basic reactions are contrasting and seismic zone II and III, arranged data base for reactions. Punching shear fortification is a proficient technique to increment the quality as well as the twisting limit of flat slabs upheld by sections. Particularly, the expansion in misshapening limit is wanted with the goal that the heap can be dispersed to different backings forestalling a complete breakdown of the structure on account of the event of a neighborhood failure.

Key words: Flat slab, ETABS, SAFE, punching shear

Introduction

Presently days, there is an expansion in lodging necessity with expanded populace and urbanization. In this way, building area has increased expanding noticeable quality. In any case, the way that the reasonable terrains for structure/development particularly in the territories in which individuals live seriously are constrained and costly demonstrates that there is a need for ideal assessment of these grounds. Furthermore, persistently expanding prices prompts increment in structure costs; in this way, both dimensional and cost advancement ends up essential and even irreplaceable. At the point when a structure is anticipated, geometrical components of elements having a place with transporter arrangement of the structure are generally controlled by utilizing building ability and encounters increased after some time. In estimating, the ductile powers to which the material to be exposed to ought to consent to the determinations. In the structure plan, the pre-estimating subtleties gave are commonly not changed much; sizes got in second or – at most third arrangement are taken as transporter framework sizes. Actually, transporter framework can be measured in infinite potential outcomes in a way to guarantee all the vital conditions; and the expense of every bearer framework option can be not the same as one another.

The fundamental point in the building is to discover a structure having most minimal expense, and guaranteeing anticipated restrictions.

LITERATURE REVIEW

BASKARAN (2007) has taken a shot at unpredictable flat slabs planned by auxiliary layer approach. Flat slabs are less work serious, rearrange the establishment of administrations and can suit more floors inside confined statures. In any case, the range affecting their plan is the longest and they require more steel contrasted with two-way slabs. Different disadvantages of flat slabs are powerlessness to punching shear failure and higher redirections. To abstain from punching shear failure drop boards, segment heads or shear support are utilized. In the event that length in flat slabs is diminished, at that point both diversion and punching shear issues can be evaded. Nonetheless, draftsmen want to have few uncovered sections in usable regions. This definitely prompts segments in an unpredictable design, covered up inside parcels or dividers. Flat slab development with sections in a sporadic format is a reasonable arrangement in developing buildings that fulfill their useful necessities in urban conditions.

HISABE has taken a shot at Fatigue Life Extension of Damaged RC Slabs by Strengthening with Carbon Fiber Sheets Attaching Method. A progression of wheel trucking exhaustion tests were led on the purposefully harmed fortified solid slabs of thruway spans reinforced with carbon fiber sheets appended by the matrix holding strategy. Because of this investigation, it was discovered that framework holding strategy where carbon fiber sheets were reinforced with interims on the base surface of solid decks was approximately multiple times higher than that of a non-fortified RC slab, and there was no issue in adhesiveness in lattice holding parts.

GRAF(1992) has chipped away at analysis and testing of a flat slab solid structure. A 14-story fortified solid flat slab solid structure in southern California was surveyed for seismic tremor chance. The mid-1960's structure utilizes outline activity between the slab and segments for sidelong obstruction. Dissimilar to other flat slab buildings harmed in past quakes, this structure has expansive, profound, pyramid-molded drop board to strengthen the basic slab-section joint. Fundamental direct analysis distinguished plausible basic shortcoming and seismic requests on structure, however the tremor execution of the drop board couldn't surveyed. Testicles at the University of California, Gerkelty grounds explored the flexibility of the slab-segment association, and gave data to explanatory model refinement. Results indicated solidness debasement as excepted, yet loss of solidarity with in foreseen most extreme floats was insignificant.

George has chipped away at uses of flat-slab r/c structures in seismic locales. It is realized that the Greek codes permit flat-slab auxiliary frameworks, anyway they give explicit consistence criteria. In the present examination an all-inclusive parametric examination was done so as to distinguish the seismic reaction of basic frameworks comprising of a) slabs-segments b) segments parametric shafts c) segments shear dividers slabs d) sections shear dividers slabs and parametric pillars. The previously mentioned frameworks were examined for all conceivable story statures in Greece by methods for F.E.M. Code SAP2000 ver.9. The consistence criteria given by the Greek Code to tremor obstruction are identified with second request impacts, torsion adaptability, limit plan and the affectability of brick work infill. Ends were extricated concerning the quantity of story which can be connected to each case.

ALTUG(2004) has chipped away at Fragilityanaly sister of flat-slab structures. Flat-slab RC buildings show a few focal points over customary minute opposing casings. In any case, the auxiliary adequacy of flat-slab development is thwarted by its supposed sub-par execution under tremor stacking. Albeit flat-slab frameworks are broadly utilized in quake inclined areas of the world, delicacy bends for this sort of development are not accessible in the writing. This investigation centers around the inference of such delicacy bends utilizing medium-ascent flat-slab buildings with brick work infill dividers. The examination utilize ed a lot of tremor records good with the structure range chose to speak to the changeability in ground movement. Inelastic reaction history analysis was utilized to break down the irregular example of structures exposed to the suite of records scaled regarding uprooting otherworldly ordinates, while checking four execution limit states. The delicacy bends created from this investigation were contrasted and the delicacy bends inferred for minute opposing RC outlines. The examination inferred that seismic tremor misfortunes for flat-slab structures are in a similar range with respect to minute opposing casings. Contrasts, be that as it may, exist. The examination additionally demonstrated that the distinctions were legitimate regarding auxiliary reaction attributes of the two basic structures.

PORCO(2013) has dealt with About the Reliability of Punching Verifications in Reinforced Concrete Flat Slabs. Dynamic: Reinforced solid slabs are a broadly diffused basic arrangement either in Italy, or abroad; this for a progression of focal points associated with their basic origination and their exhibitions. Be that as it may, this arrangement of points of interest is gotten because of legitimate plan, particularly situated to fittingly measuring the thickness of the plate itself. In addition, for flat structures with concentrated burdens, as the instance of flat slabs on prompt backings, wonder of punching can't be ignored, as it unavoidably influences the structure thus it must be considered even in the beginning times of the undertaking. In this paper an endeavor to assess the unwavering quality of punching confirmations has been made, alluding to some in power guidelines; this has been conceivable making a correlation between the mean opposing benefits of punching, got applying law solution and the genuine breakdown load for certain segments having a place with a structure that crumbled amid the beginning periods of its development. For the particular contextual analysis dissected, there has been the chance to play out an on location examination, gathering a lot of data with respect to the mechanical properties of the utilized materials, the genuine situating of the rebar in the basic elements, the genuine measure of solid spread, etc. Since in a punching failure component a critical element is the opposition of the solid, the exact meaning of its properties accomplishes extraordinary significance, particularly while existing buildings are included.

FAYAZUDDIN(2012) has taken a shot at Comparative Analysis of Flat Plate Multistoried Frames With and Without Shear Walls under Wind Loads. Unique— Flat plate is the term utilized for a slab framework with no section flares or drop boards. In spite of the fact that segment designs are ordinarily on a rectangular framework, flat plates can be utilized with sporadically divided section formats. In flat plate stacks legitimately to supporting segments, which is unique in relation to other two path frameworks by the absence of pillars, segment capitals, and drop boards? In tall multistoried structures the flat plate floor framework has week protection from horizontal burdens like breeze, consequently uncommon highlights like shear dividers, basic Walls are to be given in the event that they are to be utilized in High ascent developments. In the present examination numerical investigations for 20,40,60,80 storied for edges with typical ordinary pillar bolstered slab framework, flat plate floor framework, flat plate floor framework with Shear dividers has been led. A Comparison the Critical Column Axial Forces, Column minutes, Lateral Drift (in mm) because of static and wind stacks on the structures situated at Hyderabad at an essential breeze speed of 44 m/s has been seen amid analysis.

ETABS is a worldwide utilized most dominant auxiliary analysis and plan programming which is created and kept up by CSI (Computers and Structures Inc., USA). Architects are utilizing this marvelous programming to investigate and plan of basic frameworks. For instance, the tallest structure on the planet Burj Khalifa were broke down and planned utilizing ETBS programming.

There are a few adaptation of ETABS and the most extreme refreshed form is ETABS 2016. In spite of the fact that you will get a few split forms of ETBS to download on the different mechanism of the web yet to get best outcomes I would propose you to purchase an authorized duplicate of ETABS 2016.

ETABS is actually simple to utilize and the 2016 variant involves the accompanying highlights

- New UI to facilitate the assignment
- Hardware Accelerated Graphics included
- New layouts are incorporated
- Model sees are modernized
- Intelligent snaps and engineering following has been included
- Automatically produces plans and heights
- Interactive table data altering highlights included
- Tower highlights are incorporated
- A layered shell element has been included
- You can configuration shear dividers and connection between elements
- Updated with the most recent structure innovation and codes

Points of interest of ETABS

ETABS is a 3D displaying programming for any sort of basic analysis and structure. Utilizing this program you can perform both steel structure and RC Structure. Here are some significant focal points of ETABS programming for 3D demonstrating

1. ETABS permits client for Graphic information and change for simple and speedy model creation for a structure.
2. Creation of 3D model with the usage of plan perspectives and heights, 3D model of any sort of complex structure can be made effectively.
3. With the assistance of comparable story idea production of 3D model is simple and speedier. On the off chance that the story's are comparable, at that point the model age time can be diminished different time through comparable story idea.
4. Editing of model is simple. Moving any item from one position to other, joining at least two articles utilizing blend direction, making the comparative item utilizing Mirror order and make duplicate

of any item in a similar dimension of various story level.
5. Drawing of item with most exactness utilizing snap direction comprising of end, opposite and center or some different alternatives.
6. Creation of item is extremely brisk for an article like shaft, segment, slab, divider and so on with a single tick of mouse.
7. Easy route through different survey of windows. This component enables you to make or alter your model in all respects effectively with continuous view.
8. Create your model and altering has been simple through 3D see with various kind of zoom alternative just as panning direction for moving the entire model effectively with no revolution.
9. Different view choice of the 3D model including plan see, any side rise see, and furthermore customization see made by the modeler.
10. Graphical inclusion of sectional element of any sort of shape and material through segment creator. Practically a wide range of state of different individuals are accessible in this program.
11. Geometry of model reordering highlight from and to spreadsheets
12. Exporting ability of the model geometry to .dxf records can be utilized in various working viewpoints.
13. Connection with EC-Praxix 3J which permits to analysis and plan for the steel structure associations.
14. Automatic thought of self load of material has made it simple to view self as weight of different individuals even the size is changed.
15. Automatic making of Earthquake and Wind load spares bunches of time to figure them physically and dole out them in the 3D Model.
16. Load blend according to your characterized construction standard is likewise mechanized; you don't have to characterize them exclusively which spare bunches of time.
17. Very simple bringing in of model geometry just as plan of Reinforced Concrete structures according to Greek code with the mix of STEREOSTATIKA.
18. For the plan of Reinforced Concrete structures according to Greek and stone work structure according to Eurocode 6 likewise Reinforced Concrete coats according to Greek Code and sucker analysis has been made simple to perform via naturally making plastic pivots.
19. For the 3D plan of auxiliary segments like extensions, dams, tanks and building structures this program has combination with SAP2000.
20. To dissect and structure slab with any shape and tangle establishments Etabs is incorporated with SAFE enabling you to finish analysis and plan of a slab.

1. ANALYSIS AND DESIGN

2. 3.1 General

Flat slab structure having G+11 storey is analysed for garvity and latral loads. 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.

3. 3.2 Geometry Data

Table 3.1 Geometry data

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S.NO	ITEM	DIMENSSION
1	Plan dimensions	40 m x 40 m
2	Length in X-direction	40 m
3	Length in Y-direction	40 m
4	Floor to floor height	3.6 m
5	No. of Stories	11
6	Total Height of the building	39.6 m
7	Thickness of the slab	250 mm
8	Thickness of the drop	100 mm
9	Width of the drop	3000 mm
10	Edge beam	400 x 900 mm
11	Size of the column	1-3 storey 850 mm x 850 mm 4-6 storey 750 mm x 750 mm 7-9 storey 600 mm x 600 mm 10- 11 storey450 mm x 450
12	Grade of the concrete	M25
13	Grade of the steel	Fe 415
14	Panel dimension	8 m x 8 m

PLAN VIEW OF THE STRUCTURE

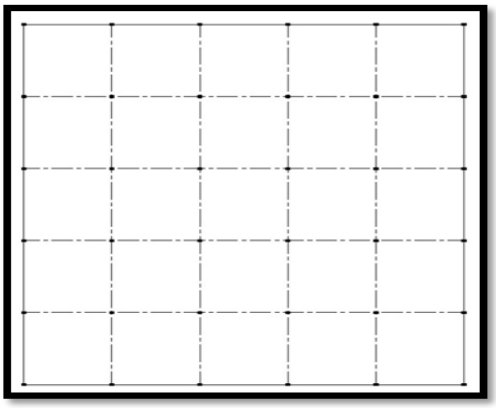

Fig: 3.1 Plan of the structure

3D VIEW OF THE STRUCTURE

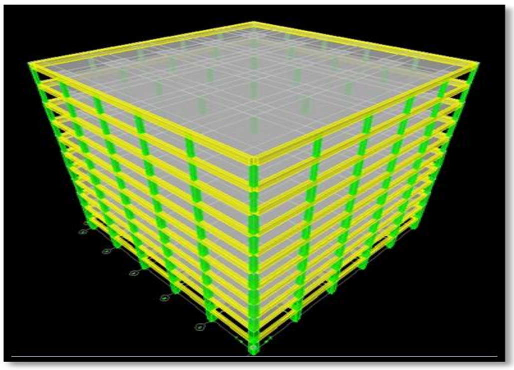

Fig: 3.2 3D view of the structure

ELEVATION OF THE STRUCTURE

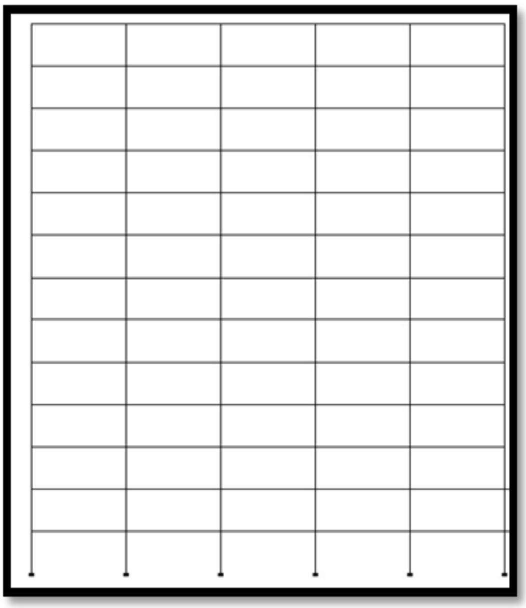

Fig: 3.3 Elevation of the structure

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4. MESHING

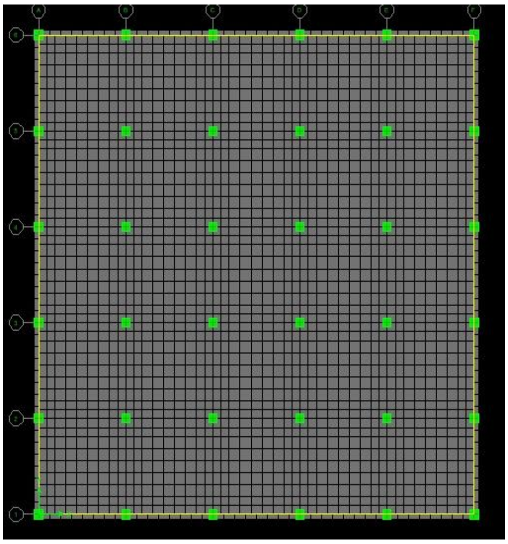

Fig: 3.4 FEM meshing of the slab

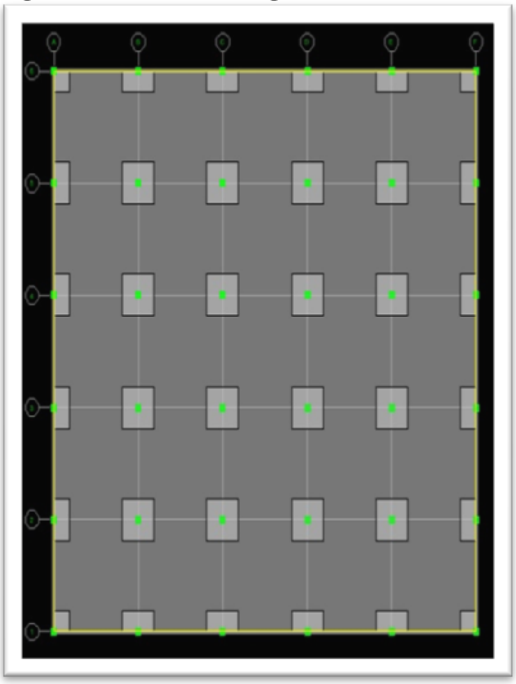

Fig:3.5 Column drop

5. 3.3 LOAD CASES AND LOAD COMBINATIONS

In this present work consider both gravity and lateral load cases. The load combinations as per the Indian standards are considered. The primary load cases and the load combinations are shown in table 3.2 and 3.3 respectively.

Table: 3.2 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

Table: 3.3Load 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	COMB39	1.5(D.L+L.L+WX)
COMB15	D.L+L.L+EQX	COMB40	1.5(D.L+L.L+WY)
COMB16	D.L+L.L+EQY	COMB41	1.5(D.L+L.L+WNX)
COMB17	D.L+L.L+EQNX	COMB42	1.5(D.L+L.L+WNY)
COMBINATION NUMBER	LOAD COMBINATION	COMBINATION NUMBER	LOAD COMBINATION
COMB18	D.L+L.L+EQNY	COMB43	0.9(D.L+L.L)+1.5WX
COMB19	D.L+L.L+WX	COMB44	0.9(D.L+L.L)+1.5WY
COMB20	D.L+L.L+WY	COMB45	0.9(D.L+L.L)+1.5WNX
COMB21	D.L+L.L+WNX	COMB46	0.9(D.L+L.L)+1.5WNY
COMB22	D.L+L.L+WNY	COMB47	D.L+0.8(L.L+WX)
COMB23	D.L+WX	COMB48	D.L+0.8(L.L+WY)
COMB24	D.L+WY	COMB49	D.L+0.8(L.L+WNX)
COMB25	D.L+WNX	COMB50	D.L+0.8(L.L+WNY)

The lateral load is transformed to the structural elements through the diaphragm action. The diaphragm is created while modeling the structure. The diaphragm action in the structure denoted by id D1 in each storey. By comparing purpose name id is used for entire structure. For action of diaphragm in each floor the modes are formed in both X and Y direction. The deflection in X and Y direction corresponding mode number is shown in Table x and the time taken by each mode in each floor is shown in Table x.

Table: 3.4 MODAL PERIODS AND FREQUENCIES

MODE NUMBER	PERIODS (Time)	Frequency (CYCLES/TIME)	CIRCULAR FREQ (RADIANS/TIME)
MODE1	2.03109	0.49235	3.09350
MODE2	2.03109	0.49235	3.09350
MODE3	1.47961	0.67585	4.24651
MODE4	0.75288	1.32823	8.34551
MODE5	0.75288	1.32823	8.34551
MODE6	0.56306	1.77601	11.15899
MODE7	0.43695	2.28859	14.37964
MODE8	0.43695	2.28859	14.37964
MODE9	0.33535	2.98196	18.73618
MODE10	0.28672	3.48769	21.91379
MODE11	0.28672	3.48769	21.91379
MODE12	0.22522	4.44014	27.89823

6. 3.4 ANALYSIS AND RESULTS

The present structure is modeled and analyzed and analysis using ETABS. For the analysis of gravity loads live load of the structure is considered 2 kN/m^2. For the lateral load analysis (wind and earthquake) parameter are considered as per Indian code basis. The lateral load is transferred to the structural members through diaphragm action is considered. The seismic and wind parameters are shown in Table .

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,

Z = 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 soas to reduce the Maximum Considered Earthquake (MCE) zone factor to the factor for Design Basis Earthquake (DBE).

I= Importance factor, depending upon the functional use of the structures, characterized by. Hazardous consequences of its failure, post-earthquake functional needs, historical value.

R=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.

Sa /g =Average response acceleration coefficient.

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

$$\boxed{F = \left(C_{pe} - C_{pi}\right) A P_a}$$

{NOTE: Design wind speed up to 10m 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.

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

Where

- P_z = Design wind pressure in N/m^{2}atheight 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

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Volume 06 Issue 06
May 2019

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: 3.5 Seismic and Wind parameters

Seismic coefficients AS PER IS: 1893-2001			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 are shown in Table

SUPPORT REACTIONS

If a support prevents translation of a body in a given direction, a force is developed on the body in that direction.Fixed support the support prevents translation in vertical and horizontal directions and also rotation, Hence a couple moments is developed on the body in that direction as well.

Table: 3.6 SUPPORT REACTIONS

STOREY	POINT	REACTION	
		ZONE-2	ZONE-3
BASE	279	5362.67	5362.67
BASE	280	7820.67	7820.67
BASE	281	7954.31	7954.31
BASE	282	7954.31	7954.31
BASE	283	7820.67	7820.67
BASE	284	5362.67	5362.67
BASE	285	7849.89	7849.89
BASE	286	8712.88	8712.88
BASE	287	9331.40	9331.40
BASE	288	9331.40	9331.40
BASE	289	8712.88	8712.88
BASE	290	7849.89	7849.89
BASE	291	7956.67	7956.67
BASE	292	9247.39	9274.39
BASE	293	10004.1	10004.10
BASE	294	10004.10	1004.10
BASE	295	9274.39	9274.39
BASE	296	7956.67	7956.31
BASE	297	7954.31	7954.31
BASE	298	9275.41	9275.41
BASE	299	10006.42	10006.42
BASE	300	9275.41	9275.41
BASE	301	7954.31	7954.31
BASE	302	7820.67	7820.67
BASE	303	8663.15	8663.15
BASE	304	9274.39	9274.39
BASE	305	9274.39	9274.39
BASE	306	8663.15	8663.15
BASE	307	7820.67	7820.67
BASE	308	5865.25	5865.25

STRUCTURAL RESPONSES

1. **MAXIMUM STOREY DRIFT**

Inter-story drift is one of the particularly useful engineering response quantity and indicator of structural performance, especially for high-rise buildings. However, many researchers and engineers do not notice the difference between inter-story drift and harmful inter-story drift. Also, few programmers have considered the harmful inter-story drift in their structural analysis procedure. So they may unreasonably use the inter-story drift as unique standard for structural behavior judgment, which may eventually lead to unacceptable results and relatively conservative conclusions

Table: 3.7 Maximum Storey drifts

STOREY	DIRECTION	MAXIMUM DRIFT	
		ZONE-2	ZONE-3
STOREY11	X	0.001097	0.001754
	Y	0.001124	0.001124
STOREY10	X	0.001618	0.002589
	Y	0.001664	0.001664
STOREY9	X	0.001457	0.002332
	Y	0.001493	0.001493
STOREY8	X	0.001639	0.002623
	Y	0.001682	0.001682
STOREY7	X	0.001752	0.002804
	Y	0.001799	0.001799
STOREY6	X	0.001558	0.002494
	Y	0.001587	0.001597
STOREY5	X	0.001565	0.002505
	Y	0.001606	0.001606
STOREY4	X	0.001532	0.002451
	Y	0.001573	0.001573
STOREY3	X	0.001371	0.002193
	Y	0.001410	0.001410
STOREY2	X	0.001206	0.001911
	Y	0.001214	0.001214
STOREY1	X	0.001379	0.002181
	Y	0.001418	0.001418

2. SHEAR FORCE

Shearing forces are unaligned forces pushing one part of a body in one direction, and another part the body in the opposite direction. When the forces are aligned into each other, they are called compression forces. An example is a deck of cards being pushed one way on the top, and the other at the bottom, causing the cards to slide. Another example is when wind blows at the side of a peaked roof of a home - the side walls experience a force at their top pushing in the direction of the wind, and their bottom in the opposite direction, from the ground or foundation. William A. Nash defines shear force thus: "If a plane is passed through a body, a force acting along this plane is called shear force or shearing force.

Table: 3.8 Shear force

STOREY	LOAD	SHEARFORCE	
		ZONE-2	ZONE-3
11	20368.9	738.19	1181.1
10	47614.1	1366.2	2185.9
9	48598.2	1366.2	3023.0
8	76795.7	1889.4	3698.7
7	104993.2	2635.0	4216.1
6	159826.3	2880.5	4608.8
5	189195.5	3055.4	4888.7
4	218564.8	3167.3	5007.8
3	248059.6	3231.8	5171.0
2	278331.9	3519.0	5217.7
1	293003.2	3519.0	5223.5

3. MOMENTS

Moment is a measure of the average internal stress induced in a structural element when an external force or moment is applied to the element causing the element to bend. The internal stresses in a cross-section of a structural element can be resolved into a resultant force and a resultant couple. For equilibrium, the moment created by external forces (and external moments) must be balanced by the couple induced by the internal stresses. The resultant internal couple is called the bending moment while the resultant internal force is called the shear force (if it is transverse to the plane of element) or the normal force (if it is along the plane of the element).

Table: 3.9 Moments

STOREY	MOMENT	
	ZONE-2	ZONE-3
11	427062.5	407379.5
10	952282.3	952282.35
9	1500923.5	1540347.9
8	2099865.7	2107701.8
7	2663815.9	2675975.6
6	3251201.4	3268577.3
5	3838586.8	3838586.8
4	4425972.3	4394748.7
3	4961192.0	4991539.7
2	5636865.6	5566638.6
1	5930292.6	5985209.7

3. TENSILE FORCES

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing.

Table: 3.10 Tensile force

STOREY	TENSIL FORCE	
	ZONE-2	ZONE-3
11	16219.1	24718.3
10	30019.19	45875.2
9	41519.46	63446.2
8	50803.20	77630.4
7	57911.06	88490.1
6	63308.31	96734.7
5	67155.43	102611.3
4	69617.58	106372.2
3	71036.18	108538.9
2	71679.19	109521
1	71751.18	109636.1

4. STOREY SHEAR

Capacity design philosophy is a powerful tool used to prevent the mechanism responsible for story-collapse. One of the key elements of the philosophy is a dynamic magnification factor that is multiplied to the column moments provided by static analysis to obtain the column design moments. However, when considering various specific structures a number of questions arise regarding the validity of a dynamic multiplication factor.

Table: 3.11 Storey shear

STOREY SHEAR		
STOREY	ZONE-2	ZONE-3
Base	1360.60	2176.47
1	1356.8	2170.57
2	1341.84	2146.96
3	1323.4	2099.76
4	1271.75	2017.14
5	1201.66	1916.83
6	1094.67	1763.40
7	958.17	1533.26
8	784.79	1255.91
9	567.13	943.16
10	312.58	506.49
11	238.79	400.27

ANALYSIS RESULTS AND DISCUSSION

In this present study the data base is prepared for the seismic zones in India for different major cities having zone factor 0.1 and 0.16 are consider for the study.

1. Effect of axial force on structure

For the worst load combination, axial forces in the structure are plotted on y-axis against at each storey level. The maximum axial force is 293003.2 kN. It indicates that the variation in axial force of structure with storey level is non-linear for worst load combination

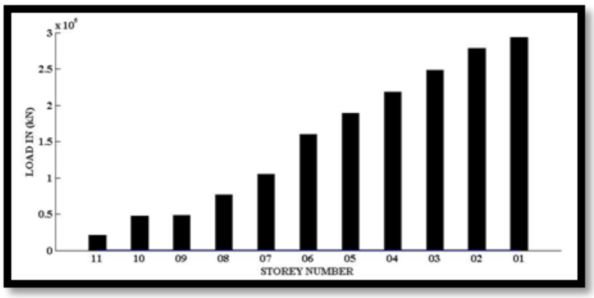

Fig: 3.6 Effect of axial force on structure

2. Effect of storey drift on structure

For the worst load combination storey drift in the structure is plotted on y-axis against at each storey level. From the Fig.3.7, it is observed that maximum storey drift in between zone II and III is 37%. It indicates that the variation in maximum storey drift with storey level is nonlinear for worst load combination.

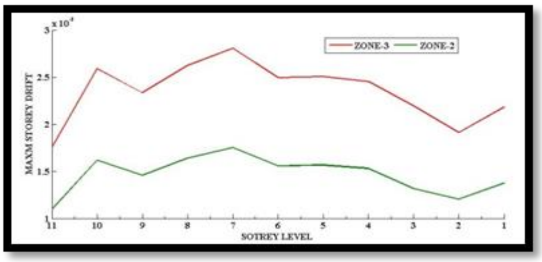

Fig: 3.7 Effect of storey drift on structure

3. Effect of shear force on structure

For the worst load combination shear force in the structure is plotted against at each storey level. From the Fig.3.8, The difference in maximum shear force between seismic zone II and zone III is 37 %. It indicates that the variation in maximum shear force with storey level is non-linear for worst load combination.

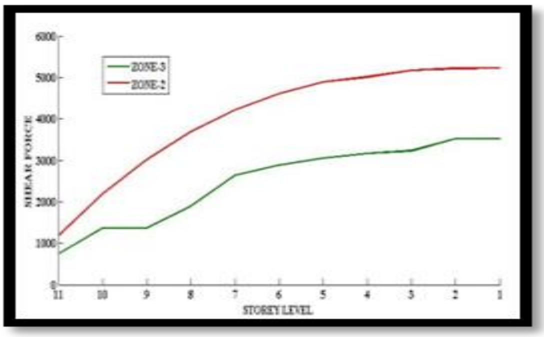

Fig: 3.8 Effect of shear force on structure

4. *Effect of storey shear on structure*

For the worst load combination storey shear in the structure is plotted on y-axis against at each storey level. From the Fig.3.9. The difference in maximum storey shear between seismic zone II and zone III is 38%. It indicates that the variation in maximum storey shear with storey level is non- linear for worst load combination.

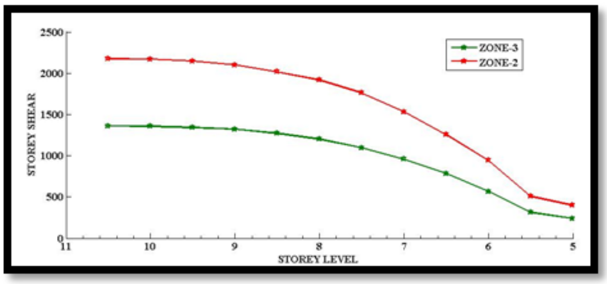

Fig: 3.9 Effect of storey shear on structure

5. *Effect of Maximum moments on structure*

For the worst load combination, maximum moments in the wall are plotted on y-axis against at each storey level. It is concluded from Fig.3.10. The difference in maximum storey shear between seismic zone II and zone III is 5%.It indicates that the variation in maximum moments with zone is non-linear for worst load combination.

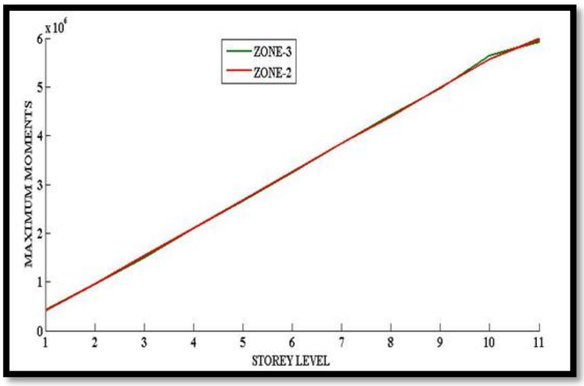

Fig: 3.10 Effect of Maximum moments on structure

6. *Effect of tensile forces on structure*

For the worst load combination tensile force in the structure is plotted against at each storey level. From the Fig.3.11. The difference in maximum storey shear between seismic zone II and zone III is 34%.It indicates that the variation in maximum tensile force with storey level is non-linear for worst load combination.

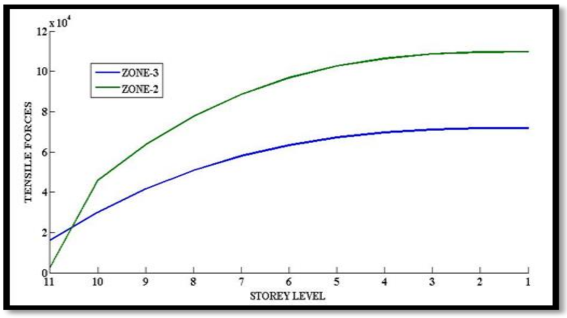

Fig: 3.11 Effect of tensile forces on structure

7. *Effect of time period on structure*

Time period in the structure is plotted in the Y-axis against mode number. From the fig: 3.12. The period for mode-I in the structure is 2.031 sec. the graph is plotted for time periods against the mode shapes in the structure.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 06
May 2019

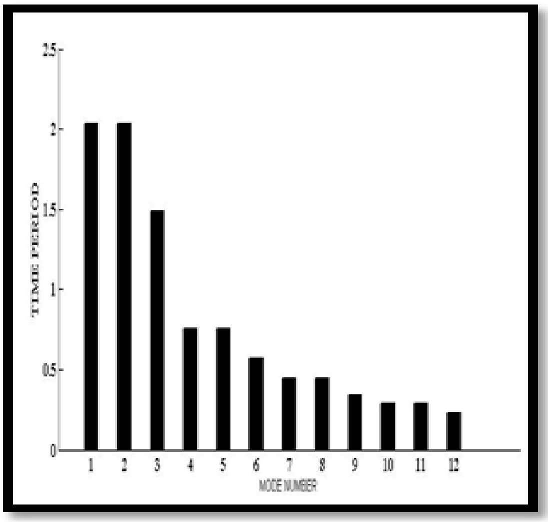

Fig: 3.12 Effect of time period on structure

The distribution of maximal moments under loads over the plate of the model M1 and M2 in presented in Fig:

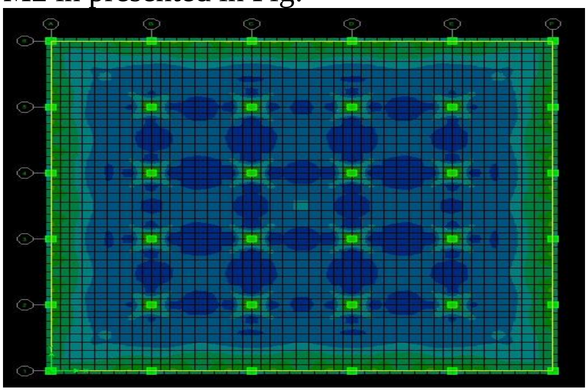

Fig: 3.13 Shell Stress due to Mmax

The distribution of maximum shear force under loads over the plate of the model M1 and M2 is presented in Fig:

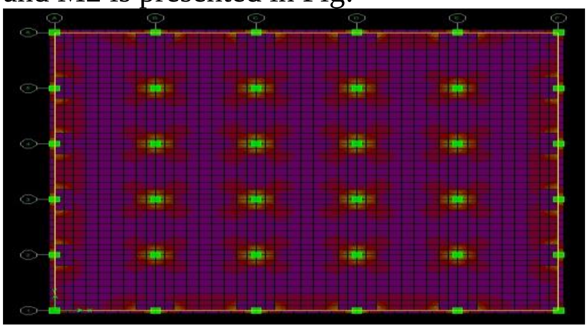

Fig:3.14 Shell Stress due to Vmax

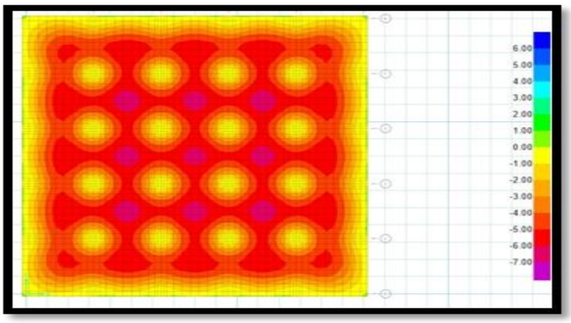

Fig: 3.15 Maximum shell stresses in SAFE

DESIGN AND RESULTS

Flat-slab building structures possesses major advantages over traditional slab-beam column structures because of the free design of space, shorter construction time, architectural –functional and economical aspects. Because of the absence of deep beams and shear walls, flat-slab structural system is significantly more flexible for lateral loads then traditional RC frame system and that make the system more vulnerable under seismic events.

In design and engineering practice, the selectively defined design of space, design of structure, speed and efficiency of realization represent an extraordinarily important factor for the Investor. This assertion is supported by the fact that the flat-slab RC system has lately been increasingly imposed as a more acceptable and more attractive structural system in the world and in Macedonia as well. What is rational and optimal for these flat-slab structures is that they enable simple design, pure and clear space with absence of beams (the role of the beams is transferred to the RC floor slab), faster construction and time saving. The system consists of columns resting directly on floor slabs for which sufficient strength and ductility should be provided to enable sustaining of large inelastic deformations without failure. The absence of beams, i.e., the transferring of their role to the floor RC structure which gains in height and density of reinforcement in the parts of the hidden beams, the bearing capacity of the structural system, the plate-column and plate-wall connection, all the advantages and disadvantages of the system have been tested through long years of analytical and experimental investigations. For the last 20 to 30 years, the investigations have been directed toward definition of the actual bearing capacity, deformability and stability of these structural systems designed and constructed in seismically active regions.

PUNCHING SHEAR DATA

Flat slab exhibits higher stress at the column connection .They are most likely to fail due to punching shear which will occur due to the concentration of shear forces and the unbalanced bending and twisting moments . It has to be noted that the punching shear failure is rather more critical than the flexural failure. Such a concentration of shear force and moments leads to unsymmetrical stress distribution around the slab-column connections. The local and brittle nature of the punching shear failure is in the form of crushing of concrete in the column periphery before the steel reinforcement reaches the yield strain. The observed angle of failure surface is found to vary between 26° and 36°. Thus the punching shear capacity of a slab (in absence of shear reinforcement) depends on the strength of concrete, the area of tension reinforcement, the depth of the slab and the column size. The sudden disaster effect of the punching shear is a critical problem for any designer. Punching shear is a type of failure of reinforced concrete slabs subjected to high localized forces. In flat slab structures this occurs at column support points. The failure is due to shear:

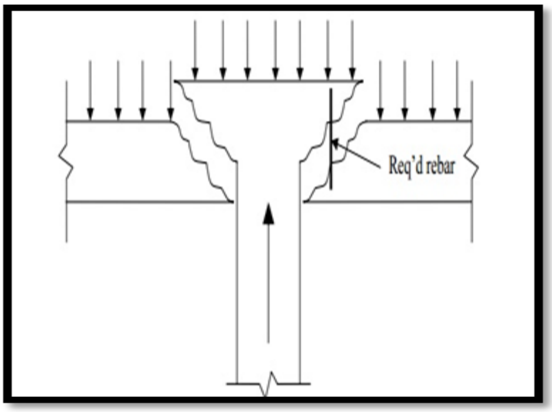

Fig:4.1 Punching Shear failure

Fig: 4.2 Global collapse of the structure due to punching shear

When the flat slab is exposed to a concentrated load larger than the capacity, the effect on the slab is referred to punching shear. In these slabs, the sheer force per unit length can become high close to the area of loading. If the capacity for punching in the slab is exceeded, a punching shear failure may occur within the discontinuity regions (D-region) of the flat slab. This type of failure is a brittle failure mechanism, and may cause a global failure of the structure. Punching shear failure is a typical failure for slab-column connection. The above figure shows an example of a global failure of a structure due to punching shear.

Table: 4.1 punching shear DATA.

Point	Shrst Max	Shrstr cap	Status	Vu	MU2	Mu3
286	0.09612	1.3063	Ok	918.353	0.7162	-0.716
287	0.09549	1.3063	Ok	911.712	-0.5635	1.3348
288	0.09549	1.3063	Ok	911.712	0.5635	1.3348
289	0.09612	1.3063	Ok	918.353	-0.7162	-0.716
292	0.09545	1.3063	Ok	911.519	-0.357	1.4184
293	0.09405	1.3063	Ok	897.33	-0.6725	1.6342
294	0.09545	1.3063	Ok	897.33	0.6725	1.6342
295	0.09533	1.3063	Ok	911.519	0.357	1.4184
298	0.09391	1.3063	Ok	911.54	-0.3416	-0.549
299	0.09391	1.3063	Ok	897.357	-0.6534	-0.653
300	0.09533	1.3063	Ok	897.357	0.6534	-0.653
301	0.09624	1.3063	Ok	911.54	0.3416	-0.549
304	0.09535	1.3063	Ok	918.189	0.7464	1.6341
305	0.09535	1.3063	Ok	911.368	-0.5336	0.6517
306	0.09535	1.3063	Ok	911.368	0.5336	0.6517
307	0.09624	1.3063	Ok	918.189	-0.7464	1.6341

Column Design

Given Inputs:

Lendth of Column (D)	=	450	mm
Breadth of Column (B)	=	450	mm
Unsupported length (longer direction)	=	3000	mm
Unsupported length (shorter direction)	=	3000	mm
Effective length factor(longer direction)	=	1	
Effective length factor (longer direction)	=	1	
Factored axial load p_u	=	324.4	kN
Factored moment M_{ix}	=	177.5	kNm
Factored moment M_{iz}	=	177.5	kNm
Grade of concrete f_{ck}	=	25	N/mm^2
Grade of steel f_y	=	415	N/mm^2
Clear cover	=	40	mm
Max dia for reinforcement used	=	16	

Solutions:

Check for slenderness

Effective legth in longer direction	=	3000 mm
Effective length in shorter direction	=	3000 mm
Effective cover d'	=	48 mm
Slenderness Ratio(L_{ex}/D)(Longer direction)	=	6.7
Slenderness Ratio(L_{ex}/D)(Shorter direction)	=	6.7
Additional Moment due to slender(Longer Direction)	=	0
Additional Moment due to slender(Shorter Direction)	=	0

Calculation of p_{uz}

Assume percentage of reinforcement	=	1 %
Gross Area (Ag)	=	202500 mm^2
Area of Concerte (Ac)	=	200475 mm^2
Area of steel reinforcement (Asc)	=	2025 mm^2
Utimate Axial load (Puz)	=	2885.63 kN

Calculation of p_{bx}

d'/D (Longer direction)	=	0.107
Co-efficent of k1(from sp16 table 60)	=	0.219
Co-efficent of k2(from sp16 table 60)	=	0.096
Pbx	=	1128
Reduction factor Kx	=	1.46

Calculation of p_{bz}

d'/D (Longer direction)	=	0.107
Co-efficent of k1(from sp16 table 60)	=	0.219
Co-efficent of k2(from sp16 table 60)	=	0.096
Pbx	=	1128
Reduction factor Kx	=	1.46

Check for moment due to min eccentricity

Minimum eccentricity e_x	=	21
Moment due to minimum eccentricity	=	6.813
Maximum moment	=	177.5
Minimum eccentricity ey	=	21
Moment due to minimum eccentricity	=	6.813
Maximum moment	=	177.5
Final Design Moment in longer direction	=	177.5
Final Design Moment in Shorter direction	=	177.5

Check for interaction

p_t/f_{ck}	=	0.04
$p_u/(f_{ck}bD)$	=	0.064
$M_{ux1}/(f_{ck}bD^2)$ From sp16	=	0.325
Uni axial moment capacity M_{ux1}	=	740.4
$M_{uy1}/(f_{ck}bD^2)$ From sp16	=	0.325
Uni axial moment capacity Muy1	=	740.4
P_u/P_{uz}	=	0.112
α_n	=	1
Interaction	=	0.48
Desin check	=	Design ok

Design of Flat Slab
(Using Direct design Method)
Data

Size of panel = 8000 x 8000 mm
c/c distance between columns
Grade of concrete = M25
Grade of Steel = Fe415
Clear cover = 30 mm
Method of design = limit state of design
Column size = 850 x 850 mm

Proportioning:

l/d ratio = 26
Assuming min steel & fs = 240
Modification factor = 1.7 Assume
Effective depth required = 181.0
Over all depth = 219.0
Provided slab thickness = 250> 125
Drop thickness = 400 mm

LOADS

Dead load of slab = 6.25 kN/m^2
Live load = 4 kN/m^2
Floor finishes and partitions = 3 kN/m^2
Dead load due to extra = 0.421
Depth of slab at drops = 0.527

Total = 13.671 kN/m^2
Factored load = 20.507 kN/m^2
Say = 22 kN/m^2

DROPS

Length of drop = 2666.7 mm
provide 3000 mm
Width of drop = 2666.7 mm
provide 3000 mm

Bending moment in longer direction:

L1 = 8m; L2 = 8m
Size of the column = 850 x 850 mm
Ln = 5m as per IS 456-2000 clause:31.4.2.2
= 0.65x8 Ln>0.6511
= 5.20 m
Total load = 880 kN
Mo = 572 kN-m
Total negative moment M1 = 372 kN-m
Total positive moment M1 =200 kN-m

Width of column strip, on one side of the column

As per clause 31.1.1 of IS: 456-2000
= 0.25x8 = 2.00
= 0.25x8 = 2.0
Therefore width of column strip, on each side = 2
Provide 2.5 m size on one side of the column
Width of middle strip = 3 m
Bending moment for column strip:
Negative moment = 75% of total negative moment
= 279 kN-m
Positive moment = 60% of Total positive moment
= 120 kN-m

Bending moment for middle strip

Negative moment = 25% of total NEGATIVE moment
= 93 kN-m
Positive moment = 40% of total positive moment
= 80 kN-m

Bending moment of shorter span

Let L1 = 8 m , L2 = 8 m
Ln = 5 as per IS 456-2000 clause: 31.1.2.2
= 0.65x8 = 5.20 m
Total load = 915 kN-m
Mo = 595 kN-m
Total negative moment M1 = 386.67 kN-m
Total positive moment M2 = 208.21 kN-m

Width of column strip, on one side of column = 2.5 calculated above
Width of middle strip = 3m
Bending moment for column strip
Negative moment = 75% of Total Negative moment
= 290 kN-m
Positive moment = 60% of total positive moment
= 125 kN-m

Bending moment for middle strip

Negative moment = 25% of Total negative moment
= 97 kN-m
Positive moment = 40% of Total positive moment
= 83 kN-m

Design section:

Drops:

Effective depth required = 205.01 mm
Provide effective depth = 362 mm **hence Ok**

Slab:

Effective depth required = 104 mm
Provide effective depth = 212 mm **hence Ok**

Reinforcement:

Longer span:

Column strip:

Maximum –ve bending moment = 279 kN-m
Width of column strip = 2.00 m
Since there are two column strips, moment resisted by
Each column strip =139 kN-m
M/bd^2 =0.8
Negative Ast = 832.23 mm^2 per 1m width
Min Ast = 480 mm^2
(0.12%)
Negative Ast = 832.23 mm^2
Obtained 20@377 c/c
Provide 20@125 c/c spacing should not > 2*slab thick
Maximum +ve bending moment = 93 kN-m

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 06
May 2019

Width of the middle strip = 3m
M/db^2 = 1.03
For table -4, of sp-16 for M25 and Fe 415
Negative Ast = 639.5 mm^2
Min Ast = 300 mm2 (0.12%)
Negative Ast = 639.5 mm^2
Obtained 20 @ 491 c/c
Provide 20 @ 225 c/c
Maximum +ve bending moment = 80 kN-m
Width of the middle strip = 3 m
M/bd^2 = 0.89
Provided Ast= 546.78mm^2
Min Ast = 300 mm2 (0.12%)
Positive Ast = 546.78 mm^2
Obtained 16 @ 368 c/c
Provide 16 @ 200 c/c

7. Shorter span:

8. Column strip:

Maximum –ve bending moment = 290 kN-m
Width of column strip = 2.0 m
Since there are two column strips, moment resisted by
Each column strip = 145 kN-m
M/bd^2 = 0.83
Negative Ast = 866.95 mm^2
Min Ast= 480mm^2 (0.12%)
Negative Ast = 866.95 mm^2
Obtained 20@ 362 c/c
Provide 20@ 125 c/c
Maximum –ve bending moment = 125 kN-m
Width of column strip = 2.0 m
Since there are two column strips, moment resisted by
Each column strip = 62.462 kN-m
M/bd^2 = 1.0
Negative Ast = 644.91 mm^2
Min Ast= 300 mm^2 (0.12%)
Negative Ast = 644.91 mm^2
Obtained 20@ 487 c/c
Provide 20@ 200 c/c
Provide 8 @ 167 c/c distribution reinforcement

Middle Strip:
Maximum –ve bending moment = 97 kN-m
Width of Middle strip = 3.0 m
M/bd^2 = 1.08
Negative Ast = 666.57 mm^2
Min Ast= 300 mm^2 (0.12%)
Negative Ast = 666.57 mm^2
Obtained 16 @ 301 c/c
Provide 16 @ 225 c/c
Maximum + ve bending moment = 83.283 kN-m
Width of Middle strip = 3.0 m
M/bd^2 = 0.93
Positive Ast = 569.72 mm^2
Min Ast= 300 mm^2 (0.12%)
Positive Ast = 569.72 mm^2
Obtained 12 @ 198 c/c
Provide 12 @ 200 c/c
Check for shear

9. Drop:

Considering section at a distance of hale the effective depth of drop from face to column
Effective depth = 362 mm
Perimeter =4.848 m
Shear in drop = 1375.7 kN
Nominal shear stress = 1.18 N/mm^2
Permissible shear stress = 1.25 N/mm^2
Hence safe
Slab:
Considering section at a distance of hale the effective depth of slab from face to drop.
Effective depth = 212 mm
Perimeter = 12.85 m
Shear in slab = 734 kN
Nominal shear stress = 0.40 $N/mm2^2$
Permissible shear stress = 1.25 N/mm^2
Hence safe

e-ISSN: 2348-6848
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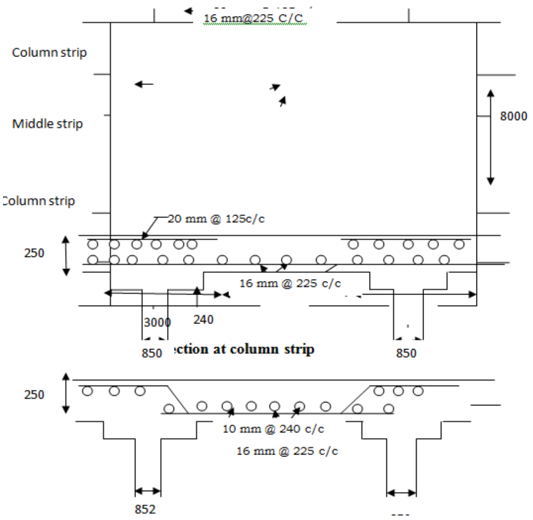
Volume 06 Issue 06
May 2019



Section at middle strip

10. CONCLUSIONS

1. For improving drift conditions of flat slab in higher seismic zones lateral load resisting system should be coupled with slab column frame and or stiffness of column should be increases.
2. The negative moment's section shall be designed to resist the larger of two interior negative design moments for the span framing into common supports.
3. Drops are important criteria in increasing the shear strength of the slab.
4. The negative moment is highly concentrated within the critical perimeter of the column; positive moment is much more uniform with maximum at column center line.
5. The maximum axial force is 293003.2 KN
6. The maximum storey drift in between zone II and III is 37%.
7. The difference in maximum shear force between seismic zone II and zone III is 37 %.
8. The difference in maximum storey shear between seismic zone II and zone III is 38%.
9. The difference in maximum moments between seismic zone II and zone III is 5%
10. The difference in maximum tensile force between seismic zone II and zone III is 34%.
11. The time period for mode-I in the structure is 2.031 sec for zone-II.

REFERENCES

1. K. Baskaran (2007) irregular flat slabs designed according to structural membrane approach" morley symposium on concrete plasticity and its application, *pp. 27-42*
2. Nobuhiro hisabe1, masasumi okada2, daisuke miyama2, shigeyuki matsui3,hiroshi onishi3, akirakobayashi, hideakifukagawa, and yousukemimoto "fatigue life extension of damaged rc slabs by strengthening with carbon fiber sheets attaching method" earthquake engineering research vol.2, pp b3-45.

3. W.p.graf&mehrdedmehrain(1992) Anlysis and testingof flat slabconcretbulinggeorgee.lelekakis, athinat.birda, stergiosa.mitoulis, theodorosa.Chrysanidis, ioannisa.tegosApplications of flat-slab r/c structures in seismic regions.
4. M. Altugerberik, amr s. Elnashai (2004) fragilityanalysis of flat-slab structures. F. Porco, g. Uva, m. Sangirardi and s. Casolo.(2013) about the reliability of punching verifications in reinforced concretflat slabs

5.Fayazuddin ahmedsyed, b. Dean Kumar, y. Chandrasekhar, b.l.p. swami(2012 comparative analysis of flat plate multistoried frames with and without shear walls under wind loads.

6.Sandesh d. Bothara*, Dr.valssonvarghese(2012)"dynamic analysis of special moment resisting

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 06 Issue 06
May 2019

frame building with flat slab and grid slab"
7.Kiran s. Patil, n.g.gore, p.j.salunke(2013) optimum design of reinforced concrete flat slab with drop panel.
8.Viswanathant.s, mohanganesh g., santhia.s(2012) shear stress distribution of flat-plate using finite element analysis.
9.Prof. K s sable, er. V a ghodechor, prof. S b kandekar(2012) comparative study of seismic behavior of multistory flat slab and conventional Reinforced concrete framed structures.
10.A.k.kandales.s.patil (2013) comparative study of rectangular prestressed concrete flat slab and rcc flat slab.
11.Dr.Uttamashagupta,shrutiratnaparkhe, padmagome(2012) Seismic behavior of buildings having flat slabs with drops.
12.Amit a. Sathawane&r.s. deotaleAnalysis and design of flat slab and grid slab and their cost comparison.
13. L. Nguyen-minh, m. Rovnák, t. Tran-quoc, and k. Nguyen-kim Punching shear resistance of steel fiber reinforced concrete flat slabs

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