International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

Flat Slab And Shear Wall Interaction Of Multi-Storey Rcc Buildings

Krapanshu Khandelwal[1], Harsh kataria[2], Prateek Kanojiya[3] ; Mrs. Nikita Thora[4]

Undergraduate Student, Dept. of Civil Engineering, Medicaps Institute of Science and Technology, Indore, India
Assistant Profesor, Dept. of Civil Engineering, Medicaps Institute of Science and Technology, Indore, India

krupanshukhandelwal@gmail.com[1], harsh12kataria@gmail.com[2], prateekkanojiya@gmail.com[3]
Nikitathora2529@gmail.com[4]

Abstract*— *The world is progressing towards modernization and urbanization. The basic step towards it is to improve the design of tall building which is the only alternative to provide shelter to many on a single land. Tall structures are suitable for commercial as well as residential living. The design of multi-storied structures should be such that it possesses adequate strength, stability, rigidity and durability in a longer run. Apart from these factors, modern trend is also towards aesthetic view which should also be considered while designing structures. The reinforced concrete flat slab is a slab which is generally used in multi-storied structures due to its easy installation and it also reduces the cost of formwork and construction time. A reinforced concrete flat slab is directly supported on columns without any beam member. As the lateral load increases with the height it is very crucial to consider it while designing a multi-storied building. The flat slab floor system has very weak resistance to lateral loads (wind and earthquake loads). Now to resist these lateral loads shear walls are to be introduced which resist lateral loads from wind and earthquake. The shear wall is a relatively thin wall which has resistance to sway movements caused due to lateral loadings. The aim of the research work presented in this paper is to examine the effect of shear wall on the flat slab structure system. The static analysis of the structure is carried out on the software STAAD PRO 2007. The case study is also presented for the design and analysis of 10, 20 and 30 storied frames with flat slab supported system and flat slab floor system with shear wall. The comparison is made between the Principal, Von Mises, Tresca stresses due to static and earthquake loads on structure for 10, 20 and 30 storied flat slab floor systems with and without shear wall of varying thickness.

Keywords— Tall building, Flat slab, Shear wall, Principal stress, Von Mises stress, Tresca stress.

I. INTRODUCTION

(i) FLAT SLAB

The conventional RCC flat slab is directly supported on column without the beam member (beamless). The part of the slab bound on the four sides by centre lines of columns is called a panel. The flat slab is comparatively thick at the supporting columns to provide proper strength in shear and to reduce the negative reinforcement at the support regions. The thickened portion meets the drop panel is enlarged so as to increase the perimeter of the critical section for shear and hence increasing the capacity of the slab for resisting two-way shear and to reduce negative bending moment at the support.

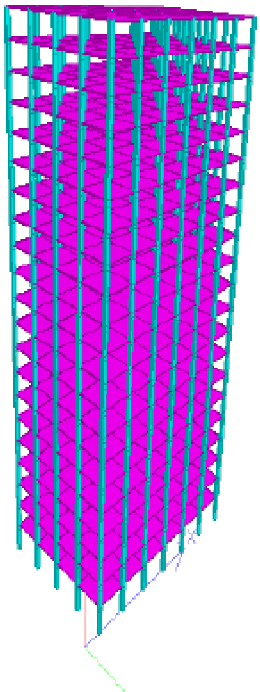
(ii) ADVANTAGES OF FLAT SLAB

Major advantages of Flat-slab building structures over slab-beam-column structures are:

1) It is a beamless slab, directly supported on column.
2) Lesser construction time.
3) Simple formwork is required for construction
4) Flat slab structures have the minimum structural depth
5) A flat slab structure generally does not require shear reinforcement at columns.
6) Flat-slab structural system is significantly more flexible for lateral loads than a traditional RC frame system.

International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017



FLAT SLAB IN MULTISTORIED BUILDING FRAME

(iii) SHEAR WALL:

A shear wall is a structural system composed of parallel walls that counter the effects of lateral loads acting on a structure. Wind and seismic loads are the most common loads that shear walls are designed to carry. They are made up of concrete and masonry and are used to resist lateral loads acting on a building. They are continuous down to base to which they are rigidly attached and act as vertical cantilever in the form of separate planar walls. These walls are relatively thin and deep and are subjected to axial forces. Shear walls have great importance in mid and high-rise buildings because it helps to overcome the lateral displacement which is due to earthquake and wind load. The shear wall is in some ways, a misnomer because the walls deform predominantly in flexure and therefore, these are also known as flexure walls.

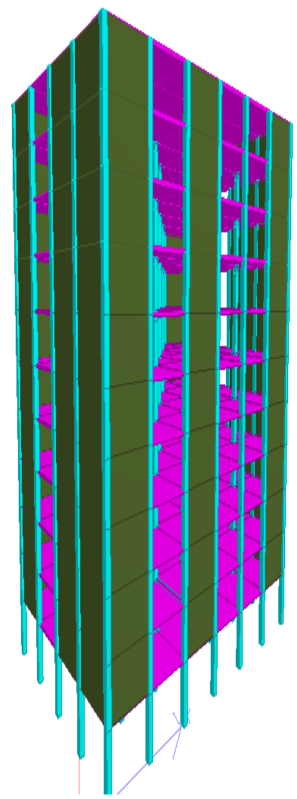
(iv) PURPOSE OF CONSTRUCTING SHEAR WALLS

Shear walls are designed to resist lateral as well as vertical loads. Even these walls are not in direct contact with roof and floors but when it is analyzed three dimensionally, it provides overall stability to the structure. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Shear walls are quick to construct. The appearance of shear wall after construction is so good that even it doesn't need plastering for better appearance.

(v) ADVANTAGES OF SHEAR WALL:

Shear walls are also known as flexure walls.

1. Designed to resist lateral loads on structure due to wind and earthquake loads.
2. These are provided in the entire height of wall



FLAT SLAB WITH SHEAR WALL IN MULTISTORIED BUILDING FRAME

II. OBJECTIVE

The analysis aim is to study the behavior of structure against various forces acting on the components of a multistoried building. The analysis is done on STAAD Pro software (2007). Conventional R.C.C flat slab and shear wall are analyzed for the various combinations of static loading with varying the thicknesses of shear wall and also varying height of multistoried building. The comparison is made between the flat slab structure of 10, 20 and 30 storied with and without shear wall by varying thicknesses of shear wall. The aim of analysis is to study the structural behavior of shear wall and flat slab interaction.

III. METHOD OF ANALYSIS

(i) CASES ANALYSED

Different cases of building considered are as given below:

- Design and analysis of 10 storey flat slab building without shear wall.
- Design and analysis of 10 storey flat slab building with shear wall.
- Design and analysis of 20 storey flat slab building without shear wall.
- Design and analysis of 20 storey flat slab building with shear wall.
- Design and analysis of 30 storey flat slab building without shear wall.
- Design and analysis of 30 storey flat slab building with shear wall.

(ii) CASE STUDY

- Plan area = 20m x 30m
- Panel size = 5m x 5m.
- Young's modulus of concrete = 25,000 MPa
- Poisson's ratio = 0.2

This uniform section throughout the height is appropriate for the given loads for the 10, 20 and 30 storey models are designed according to the IS code 456:2000 and IS code 1893:2002 and the size for the structural member are taken as:

Table-1

S. No	Description	No of stories	Column		Cantilever beam		Slab
			Width (mm)	Depth (mm)	Width (mm)	Depth (mm)	Thickness (mm)
1	Flat Slab without Shear Wall	10	500	500	400	500	300
		20	500	500	400	500	300
		30	500	500	400	500	300

Size of structural elements of flat slab without shear wall in multistoried building

Table-2

S No	Description	No of stories	Column		Cantilever beam		Slab	Shear wall
			Width (mm)	Depth (mm)	Width (mm)	Depth (mm)	Thickness (mm)	Thickness (mm)
1	Flat Slab with Shear Wall	10	500	500	400	500	300	150
		20	500	500	400	500	300	200
		30	500	500	400	500	300	300

Size of structural elements of flat slab with shear wall in multistoried building

(iii) LOADS CONSIDERED

- **Dead Load:**

According to IS code 456:2000,

Density of concrete = 25 kN/m^3

Grade of concrete = M20

Grade of steel = Fe415

Therefore,

The self weight of slab = 0.2 x 1 x 1 x 25 = **5** kN/m^2

Load considered due to floor finish= **1** kN/m^2

International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

- **Live Load:**

According to IS code 875 part- II = **3** kN/m^2.

- **Earthquake Load:**

Earthquake Load	
Earthquake Parameters Zone (Z)	IV
Rock and soil factor (SS)	1
Importance factor (I)	1
Response Reduction factor (RF)	1
Type of structures	1
Damping ratio (DM)	0.05
Time Period	Ta=0.075h

(iv) LOAD COMBINATIONS FOR STATIC ANALYSIS

The load combinations were adopted according to IS 1893:2002 part- I & IS code 456:2000 –

1) 1.5(DL + LL)
2) 1.2(DL + LL + EQX)
3) 1.2(DL + LL - EQZ)
4) 1.2(DL + LL + EQZ)
5) 1.2(DL + LL – EQZ)
6) 1.5(DL + EQX)
7) 1.5(DL – EQX)
8) 1.5(DL + EQZ)
9) 1.5(DL – EQZ)
10) 0.9DL + 1.5EQX
11) 0.9DL - 1.5EQX

Here, X &Z are the directions of earthquake loads considered in the analysis.

(v) THEORIES

To find the value of stresses (von mises, tresca and principal) on the structure these theories are used

- **Maximum Principal stress theory**

This theory states that failure will only be possible when the maximum principle stress reaches the maximum strength value at elastic limit in tension. The theory is associated with Rankine. Generally this theory is ideal for brittle material and cast iron. We can use the formula which is given below for two dimensional stress case.

$$\sigma_1 = 1/2(\sigma x - \sigma y) + 1/2[(\sigma x - \sigma y)^2 + 4\,\tau_{xy}{}^2]^{1/2}$$

- **Distortion energy theory**

This theory proposes that the total strain energy can be separated into two components: the volumetric (hydrostatic) strain energy and the shape (distortion or shear) strain energy. It is proposed that yield occurs when the distortion component exceeds the yield point in a simple tensile test. This leads to a failure criteria, It can be shown by strain energy analysis that the shear strain energy associated with the principal stresses σ_1, σ_2 & σ_3 at elastic failure, is the same as that in the tensile test causing yield at direct stress S_y thus,

$$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_1 - \sigma_3)^2 >= 2\,S_y^2$$

In terms of 3 dimensional stresses using Cartesian co-ordinates,

$$(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6.(\tau_{xy}{}^2 + \tau_{yz}{}^2 + \tau_{zx}{}^2) >= 2\,S_y^2$$

In terms of plane stress, this reduces to..

$$(\sigma_x^2 - \sigma_x \cdot \sigma_y + \sigma_y^2 + 3\,.\tau_{xy}{}^2) >= S_y^2$$

In terms of simple linear stress combined with shear stress.

Factor of Safety FOS = $S_y / (\sigma_x^2 + 3\,.\tau_{xy}{}^2)^{1/2}$

- **Tresca Criterion**

Critical Shear Stress For the principal stresses ordered as $\sigma_1 \geq \sigma_2 \geq \sigma_3$ then,

$$1/2(\sigma_1 - \sigma_2) \leq S^2$$

For the principal stresses not ordered,

$$1/4\,(\sigma_1 - \sigma_2)^2 \leq S^2$$

$$1/4\,(\sigma_2 - \sigma_3)^2 \leq S^2$$

$$1/4\,(\sigma_1 - \sigma_3)^2 \leq S^2$$

Where; C=T S=T/2

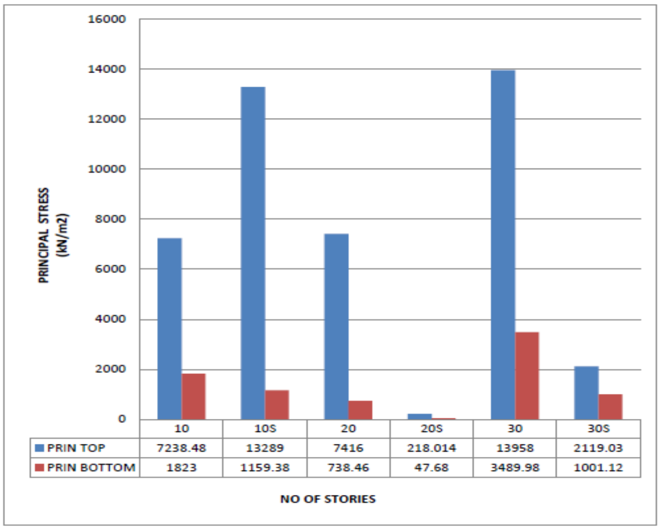
where C denotes : Compressive strength

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

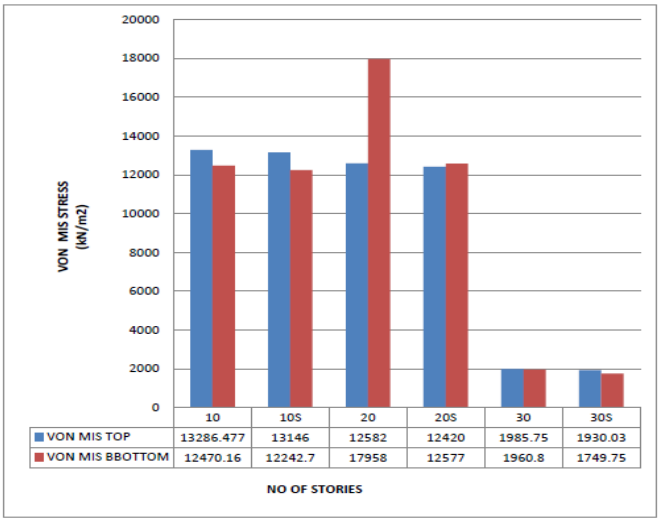
T denotes : Tensile strength ; S denotes : Shear strength

IV. RESULT

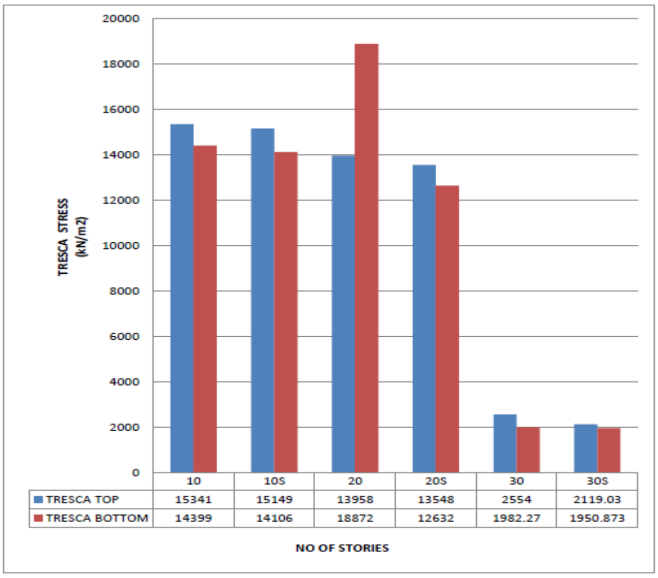
Comparison of principal, von mises and tresca stresses as worked out from software are represented on graph-



SUMMARY OF PRINCIPLE STRESSES



SUMMARY OF VON MISES STRESSES



SUMMARY OF TRESCA STRESSES

➢ **Plate Principal Stresses :**

- The Principal top stress varied by 55% and bottom stress varied by 63% for 10 storied building. (with and without shear wall)
- The Principal top stress varied by 2% and bottom stress varied by 6% for 20 storied building. (with and without shear wall)
- The Principal top stress varied by 15 % and bottom stress varied by 28% for 30 storied building. (with and without shear wall)

➢ **Plate Von Mises Stresses:**

- The Von Mises top stress varied by 98.94% and bottom stress varied by 98.17% for 10 storied building. (with and without shear wall)
- The Von Mises top stress varied by 98.71% and bottom stress varied by 70% for 20 storied building. (with and without shear wall)
- The Von Mises top stress varied by 97% and bottom stress varied by 89% for 30 storied building. (with and without shear wall)

➢ **Plate Tresca Stresses:**

- The Tresca top stress varied by 98.74 % and bottom stress varied by 97.96% for 10 storied building. (with and without shear wall)
- The Tresca top stress varied by 97 % and bottom stress varied by 66% for 20 storied building. (with and without shear wall)
- The Tresca top stress varied by 82 % and bottom stress varied by 98% for 30 storied building. (with and without shear wall)

V. CONCLUSIONS

Analysis of 10, 20 and 30 storied buildings with flat slab system without shear wall and the buildings with flat slab system with shear wall is carried out and the following conclusions are drawn from the study**:**

1. Structure with shear wall along boundary of building is best suitable to resist wind and earthquake load on the building.
2. The flat slab Von Mises Top and bottom stresses increases (in shear wall structure) for 10, 20 and 30 storey building.
3. The Von Mises Bottom stresses is more than the top stresses (in shear wall structure) for 10, 20 and 30 storey building.
4. The flat slab Tresca top and bottom stresses increases (in shear wall structure) for 10, 20 and 30 storey building.
5. The flat slab Tresca bottom stresses is more than top stresses (in shear wall structure) for 10, 20 and 30 storey building.
6. The flat slab principle top stresses is more than bottom stresses (in shear wall structure) for 10, 20 and 30 storey building.

VI. FUTURE SCOPE OF WORK

The review has shown that in the previous decade much progress has been made in developing and understanding practical structural Flat Slab with Shear Wall structures in multistoried building frames. An appraisal of these recommendations indicates that further work is needed in the following areas:

1. Identical building of (5 bay x 5 bay) is taken in problem for simplicity but commercial and residential building are irregular shape in plan can also be taken up for further work.
2. The problem building is only symmetric square building; one can take rectangle, L-shape, C-shape building with eccentricity.
3. Shape of shear wall is taken in this building is rectangular; one can take different shapes such as L, U, C for further work.
4. The structure can be analysed for different seismic zones.
5. The dynamic analysis of structure can also be carried out.

VII. REFERENCES

[1] SHAIK TAHASEEN: (2015): Shear wall design for G+8 FLOOR residential building. IJSR ISSN: 2321-7758 Vol.3. Issue.6., 2015.

[2] SALMAN I.KHAN AND ASHOK R. MUNDHADA :(2014): Comparative study of Seismic Performance of multi-storeyed R.C.C buildings with Flat slab & Grid slab. IJERT INPRESSCO Vol.5, No.3.

[3] NAVYASHREE AND SAHANA (2014): Compared the behavior of multi-storey commercial buildings having flat slabs and conventional RC frame with that of having two way slabs with beams. IJERT E ISSN:2319-6613, P ISSN:2321-7308.

[4] ANUJA WALVEKAR, H.S.JADHAV: (2014): Parametric study of flat slab building with and without shear wall to seismic performance. IJERT EISSN: 2319-1163 | PISSN: 2321-7308

[5] SHYAM BHAT M, N.A.PREMANAND SHENOY, and ASHA U RAO: (2014): Earthquake behavior of buildings with and without shear. (IOSR-JMCE) E-ISSN: 2278-1684, P-ISSN: 2320-334X .

[6] SANJAY P N, MAHESH PRABHU, UMESH S :(2014): Behavior of Flat Slab RCC Structure Under Earthquake

International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 10
September 2017

Loading. IJERT) IJERTIJERT ISSN: 2278-0181 IJERTV3IS051624 www.ijert.org Vol. 3.

[7] MOHD MOHIBUR RAHMAN, B.ANULATHA.G.N, DR. NARAYANA.G, MANU.J: Studied the Behaviour of R.C. Frames Structures with Different Floor Systems Under the Effect of Lateral Loads. (IJARET) Vol. 2,

[8] SHRIKANT HARLE :(2014): Analysis and Design of Earthquake Resistant Multi-Storied Braced R.C.C. Building using NISA Software. IJESISSN: 2277-9655 Impact Factor: 1.852RT

[9] KY LENG, CHATPAN CHINTANAPAKDEE, AND TOSHIRO HAYASHIKAWA (2013): Seismic Shear Forces in Shear Walls of a Medium- Rise Building Designed By Response Spectrum Analysis. Engineering Journal Volume 18 Issue 4 .

[10] RAJIB KUMAR BISWAS, MD.MERAJ UDDIN, MD.ARMAN CHOWDHURY, MD.AL-IMRAN KHAN:(2013):Comparative Analysis of a 15 Story Flat Plate Building with and Without Shear Wall and Diagonal Bracing Under Wind and Seismic Loads. (IOSR-e-ISSN: 2278-1684,p-ISSN: 2320-334X JMCE) Volume 9.

[11] UMESH. N. KARADI AND SHAHZAD JAMIL SARDAR (2013) Effect of Change in Shear wall Location on Storey Drift of Multi-storey Building Subjected to Lateral Loads. (IOSR-JMCE) E-ISSN: 2278-1684,P-ISSN: 2320-334X, Volume 9, Issue 2 .

[12] R.S.MORE, V. S. SAWANT :(2013): Analysis of Flat Slab . IJIRSET Vol. 2, Issue 9.

[13] M. TAMIM .A TANWER (2012): Studied Structural Configuration Optimization of a Multi-storey Building by Optimum Positioning of Shear Wall. (IJSR) ISSN (Online): 2319-7064

[14] PROF. K S SABLE, ER. V A GHODECHOR, PROF. S B KANDEKAR (2012): Comparative Study of Seismic Behaviour of Multi-storey Flat Slab and Conventional Reinforced Concrete Framed Structures. (IJSR) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358

[15] SURUMI R.S., GREESHMA S. AND JAYA K.P. (2012): Reinforced concrete floor wall slab connection. IJCTEE ISSN 2249-6343 Volume 2, Issue 3.

[16] SHYAM BHAT M, N.A.PREMANAND SHENOY, ASHA U RAO :(2012) Earthquake behaviour of building with and without shear wall. Iset Golden Jubilee Symposium .

[17] MURAT MELEK, HUSEYIN DARAMA, AND AYSEGUL GOGUS: (2012): Studied Effects of Modelling of RC Flat Slabs on Nonlinear Response of High Rise Building Systems.(IOSR-JMCE) E-ISSN: 2278-1684, P-ISSN: 2320-334X

[18] MOHAMED ABDEL-BASSET ABDO: (2012): Modeling of shear-wall dominant symmetrical flat-plate reinforced concrete buildings. 15 WCEE LISBOA 2012

[19] R. P. APOSTOLSKA, G. S. NECEVSKA-CVETANOVSKA, J. P.CVETANOVSKA AND N. MIRCIC: (2008) Seismic performance of flat slab building. International Journal of Advanced Structural Engineering 2012. The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

[20] JAMES B DATON: (2008): Design reinforced concrete flat plate systems based on the results of finite element analysis. (IJSR