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Performance of Mid Rised RCC Structure using Flat Slab System

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Abstract: *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. The critical moment in design of these systems is the slab-column connection, i.e., the shear force in the slab at the connection, which should retain its bearing capacity even at maximal displacements. The behavior of flat slab building during earthquake depends critically on 'Building Configuration'. This fact has resulted in to ensure safety against earthquake forces of tall structures hence, there is need to determine seismic responses of such building for designing earthquake resistant structures. Response Spectrum analysis is one of the important techniques for structural seismic analysis. In the present work analysis of 4 models of multi-storied RCC Flat slab structure is carried out by response spectrum analysis. The BIS guideline in IS 1893:2002 says "Regular and Irregular Configuration to perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, and adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well, suffer much less damage than buildings with irregular configurations". Similarly, in IS 4326:1993 it is mentioned that "The building should have a simple rectangular plan and be symmetrical both with respect to mass and rigidity so that the center of mass and rigidity of the building coincide with each other." But the limiting "plan aspect ratio" and "Slenderness ratio" for the regular structure is not prescribed. This study is concerned with the behavior of structure having same plan area but different plan aspect ratio (L/B) and slenderness ratio (H/B) under seismic condition. The structures are simulated in ETABS software and analyzed using Response Spectrum method.*

Keywords: Aspect Ratio, Slenderness Ratio, Response Spectrum Analysis, RCC flat slab structure

I. INTRODUCTION

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 in the different seismic zone factor in the given site of the building. So, that the Advances in Earthquake Engineering sequence is proposed mainly for the revolution of frontier technologies and study results, as fit as state-of-the-art specialized practices in earthquake engineering. It will include various current areas such as multidisciplinary earthquake engineering, smart structures and resources, finest design and lifecycle cost, geotechnical engineering and soil structure interaction, structural and structure health monitoring, urban earthquake calamity improvement, post-earthquake rehabilitation and restoration, innovative numerical methods, as well as laboratory and field testing. This study, "Seismic Evaluation of Different Slab System in RCC Multi-storey structure." provides structural evaluation and computation of the response of a structure to earthquake. It is structural design, earthquake engineering or structural evaluation where earthquakes are widespread form so that practicing engineers and researchers can use them eagerly with no solving complex problems. The scope and the main idea of this study are lateral analysis used for high building due to the seismic performance used for dissimilar reinforced concrete slab system. While the different type of seismic load resisting system usually presented. Subsequently, different systems of slabs performance for high-rise buildings through seismic loads are introduced. This flat slab consists of 4 no. of models namely, flat slab structure without column drop, flat slab structure with column drops, flat slab structure without drops and additional shear wall and flat slab structure with column drop and additional shear wall. To study the seismic performance of mid rised rcc structure and to compare with response spectrum for the given flat slab building.

II. DESIGN PHILOSOPHY

The design scope consists of Basement + Ground Floor + 9 Floor of medical College and hospital building. The Medical college and Hospital buildings comprises of basements for Sewage Treatment Plant and other services. The design of structures, especially tall buildings (Basement + ground +9), shall consider human comfort as one of the prime factors in design. The adopted structural system shall not cause any discomfort to the residents living therein due to action fluctuating wind loads and seismic loads. All the structure shall satisfy the deformation criteria as per latest codes. The building which it consists of Open terraces, Office, X-ray room, Pharmacy room, library, research Lab staff room, Exam room, Waiting Hall, Meditation room, corridors, lobby, staircases, balconies, toilets, and so on. The building consists of basement as 5.5m height, ground to third floor as 5m height, fourth floor as 4.2 height, and other floors as 4.3m height.

III. STRUCTURAL SYSYTEM

The structural system consists of Beams, Slabs, Columns, Footing, flat slab, and Lift core walls are in RCC construction.

3.1 Comparisons of Model and Results

Comparison of frequencies of mode shapes in all 4 models.

Mode No.	MODEL1 (Hz)	MODEL2 (Hz)	MODEL3 (Hz)	MODEL4 (Hz)
1	0.558	0.669	1.096	1.189
2	0.562	0.673	1.101	1.193
3	0.616	0.707	1.923	1.985
4	1.956	2.262	4.503	4.656
5	1.969	2.277	4.51	4.662
6	2.153	2.403	5.401	6.233
7	4.126	4.545	5.487	6.358
8	4.144	4.566	5.54	6.404
9	4.532	4.854	5.601	6.442
10	5.386	6.211	5.705	6.568

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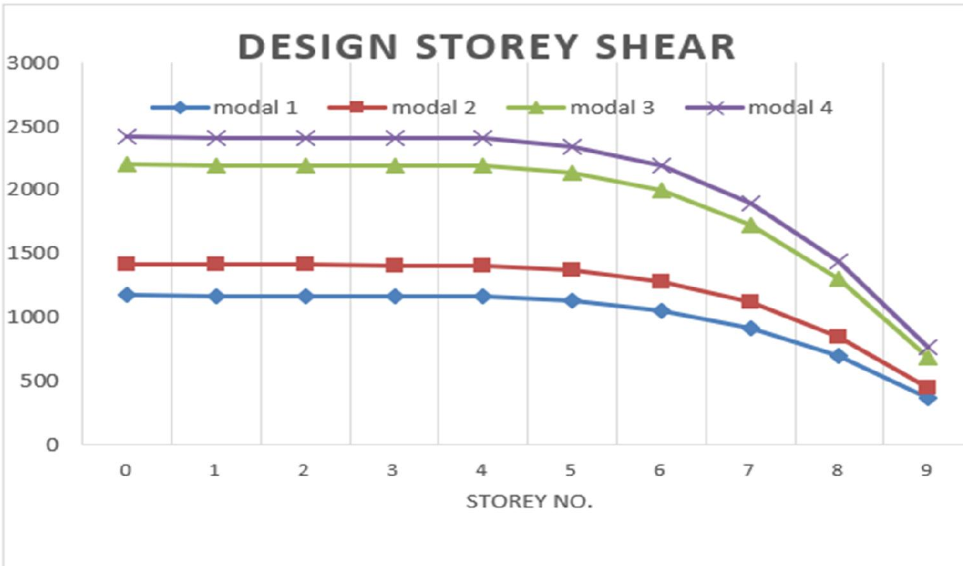
11	5.476	6.369	5.721	6.588
12	5.513	6.369	5.788	6.666

Graph for Comparison of design storey shear



Comparison of design storey shear

height of building(m)	Story	MODEL1 (KN)	MODEL2 (KN)	MODEL3 (KN)	MODEL4 (KN)
5.5	GROUND	1174.5	1421.03	2199.8	2420.1
5	STOREY1	1168.51	1419.2	2197.2	2414.5
5	STOREY2	1166.3	1416.4	2195.52	2408.6
5	STOREY3	1164.53	1412.03	2194.68	2405.98
4.2	STOREY4	1163.58	1410.9	2193.15	2404.32
4.3	STOREY5	1133.17	1374.32	2135.56	2341.74
4.3	STOREY6	1058.17	1284.14	1993.87	2187.75
4.3	STOREY7	918.77	1116.53	1730.55	1901.58
4.3	STOREY8	695.25	847.75	1308.3	1442.68
4.3	STOREY9	367.7	453.88	689.55	770.21

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Comparison of storey displacements in x-direction in 4 models

Storey	MODEL1 (mm)	MODEL2 (mm)	MODEL3 (mm)	MODEL4 (mm)
STOREY1	3.1	3	1.1	1.1
STOREY2	5.7	5.2	2.2	2.1
STOREY3	8.1	6.3	3.5	3.3
STOREY4	10.2	7.1	4.8	4.5
STOREY5	11.8	8.7	6	5.6
STOREY6	13.1	9.9	7.2	6.6
STOREY7	14.2	10.7	8.1	7.5
STOREY8	15.1	11.6	9.2	8.4
STOREY9	15.9	12.2	9.9	9.2

PUNCHING SHEAR FAILURE IN FLAT SLAB BUILDINGS

Comparison of shear stresses, corresponding to M_x moments in column C13 (centre column).

Storey	DD+LL (N/mm^2)	DD+LL+EQX (N/mm^2)
9	1.1792	1.1336
8	1.1754	1.1452
7	1.1826	1.1672
6	1.1802	1.1778
5	1.181	1.1852
4	1.1789	1.2166
3	1.1832	1.2413

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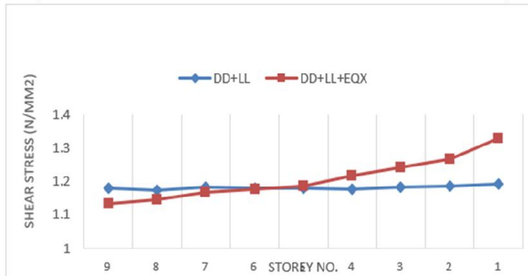
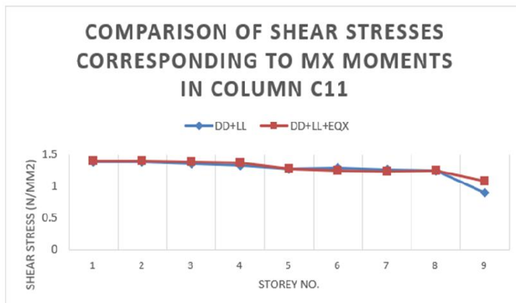
2	1.1858	1.2689
1	1.1927	1.3293





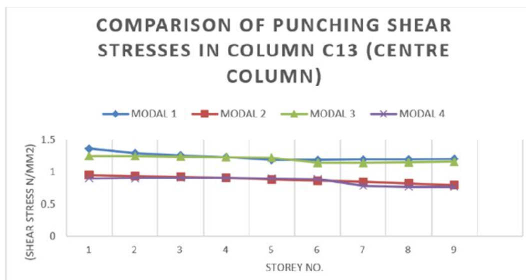
Comparison of shear stresses corresponding to M_x moments in column C11 (exterior column)

Story	DD+LL (N/mm^2)	DD+LL+EQX (N/mm^2)
9	1.38	1.399952
8	1.378852	1.392011
7	1.359152	1.384125
6	1.331665	1.362915
5	1.269498	1.269238
4	1.28516	1.241355
3	1.254228	1.23
2	1.25	1.251425
1	0.891808	1.073618

Comparison of punching shear stresses in column C13 (Centre column) corresponding to 4 models.

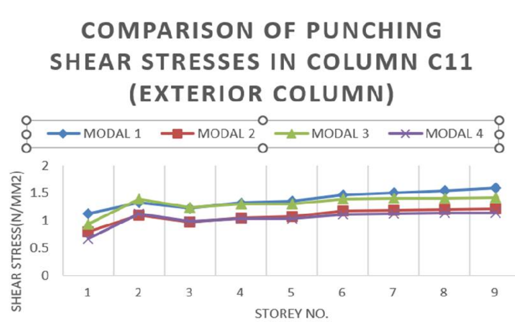
STOREY NO	MODEL1 (N/mm^2)	MODEL2 (N/mm^2)	MODEL3 (N/mm^2)	MODEL4 (N/mm^2)
9	1.1998	0.790	1.158	0.742
8	1.1965	0.820	1.150	0.762
7	1.1920	0.848	1.142	0.780

6	1.1879	0.858	1.140	0.890
5	1.1868	0.878	1.217	0.893
4	1.224	0.905	1.230	0.904
3	1.254	0.920	1.239	0.909
2	1.287	0.932	1.244	0.901
1	1.359	0.948	1.245	0.893



STOREY NO	MODE1 (N/mm^2)	MODE2 (N/mm^2)	MODE3 (N/mm^2)	MODEL4 (N/mm^2)
9	1.592	1.215	1.420	1.138
8	1.540	1.198	1.408	1.132
7	1.498	1.188	1.398	1.125
6	1.466	1.179	1.387	1.115
5	1.354	1.068	1.298	1.031
4	1.320	1.042	1.303	1.033
3	1.225	0.973	1.238	0.980
2	1.332	1.096	1.391	1.118
1	1.119	0.801	0.931	0.674

Comparison of punching shear stresses in column C11 (exterior column) corresponding to 4 models



IV. CONCLUSION

Within the scope of present work following conclusions are drown

- Fundamental mode of frequencies of a flat slab structure increases 20% when drops panels are present, as further increasing of stiffness by providing shear walls those values increases to 96%.
- Base Shear values increases from model1 to model 4. As weight of structure increases from model1 to model4
- Flat slab attracts more shear value, when flat slab provided with shear wall rather than flat slab having column drops.
- Providing column drops to flat slab, storey displacements reduce slightly, as stiffness increases slightly. But when flat slabs combine with shear walls, these displacements reduce tremendously as stiffness of shear walls increases overall lateral stiffness of structure.
- For inner columns, punching shear stresses are increasing linearly from top stories to bottom stories. As earthquake moments are many changes from storey to storey. This shows that earthquake moments are more effective in producing punching shear at bottom stories.
- Because of exterior panel moments and earthquake moments, punching shear stresses varying slightly irregular in exterior columns. In exterior columns punching shear stress is more in columns at top stories than the columns in the bottom stories.
- Punching shear failure occurs, more in flat plate. On provision of column drops its punching shear stress decreases upto 25%.
- Provision of shear walls may not be effective in reducing punching shear on intermediate storey's but effective in top and bottom storeys as shear wall attracts lateral moments from columns

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