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Examining the Interaction between Shear Walls and Reinforced Concrete Frames in Tall Buildings using a two-dimensional model

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Abstract - Today, there is a pressing need to set aside arable land in addition to meeting rising demand for it to accommodate residential, commercial, and industrial development across the board. That's why there's a recent surge in the construction of skyscrapers. Wind and earthquakes exert lateral stresses on these high-rises. This research also makes an attempt to simulate the shear wall's interaction with the RC frame in two dimensions for buildings of 20, 30, and 35 stories. Two outside frames with shear walls are treated as a single frame with double stiffness, strength, and weight in the corresponding simplified 2-dimensional model. It is assumed that the internal frames without a shear wall have the same stiffness, strength, and weight, hence they are represented as a single frame. Every story in the model requires a stiff link to connect the frames. The lateral force distribution between the outside frame with a shear wall and the inside frame without a shear wall is examined using a 2-dimensional plane frame model. Analysis shows that up to the lowest seven or eight stories, the frame with shear wall bears more than half the load, and the bottom three stories bear almost 75% of the whole story's shear. This research examines a 30-story skyscraper with and without shear wall apertures. Specifically, dynamic analysis makes use of the response spectrum approach.

Keywords - Shear walls, RC Frame, interaction, Lateral forces

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INTRODUCTION

To enhance the functionality of buildings under dynamic earthquake loads, seismic design of structures is required. Seismic design has grown more logical in recent decades as a result of increased understanding gained through thorough study and the development of more efficient analytical methodologies. To properly mimic the real seismic behavior of buildings, however, there are still constraints. As a result, modern practices include simplifying aspects of architectural design. As there are a practically infinite number of alternative cross-sections (e.g., T, L, or C forms) for reinforced concrete shear walls, these simplifications become even more important. The seismic response of shear walls with non-rectangular cross-sections (i.e., nonplanar walls) is a difficult issue that is now the subject of study.[1]

The seismic reaction of non-planar walls has been the object of much study, leading to the development of models capable of properly simulating such response. Applying these models accurately calls for precise calibration and advanced knowledge of structural dynamics. Although some of these models have lately been included into nonlinear analysis software, their usage is confined to research and Performance Based Design since elastic analysis is so central to structural design practice. For conventional strength-based design, modeling non-planar walls using 2D finite elements is a common practice since it is thought to be precise enough to evaluate the (linearly elastic) global response. However, a high degree of uncertainty is introduced into the estimation of the real capacity and demands when dealing with complicated shear wall geometry, even when elastic behavior is considered. [2]

Pushover analysis is a performance-based design method used to assess the resilience of both newly constructed and preexisting buildings to earthquakes. Pushover analysis, also known as nonlinear static analysis, provides valuable insight into how well a building can withstand earthquake forces in relation to the demands of an actual earthquake. [3]

By using inelastic analysis to compute a structural system's strength and deformation capacity under design earthquakes, nonlinear static analysis may assess how well that system performs under seismic loads. Important performance characteristics such overall drift, inter-story drift, inelastic element deformations, deformations between elements, and element connection forces are included in the evaluation, with specific attention paid to components and connections that cannot tolerate inelastic deformations. In the event that extensive renovations are planned for an existing structure, pushover analysis may be used to readily assess the effect of the renovations on the building's seismic performance. [4]

LITERATURE REVIEW

Nayel, waleed & vara, t. (2022) There is a pressing need to set aside agricultural land in addition to meeting the rising demand for it to house people and host businesses and factories. That's why there's a recent surge in the construction of skyscrapers. Wind and earthquakes exert lateral stresses on these high-rises. The increasing slenderness of modern high-rises increases the risk of structural instability. There is a need for new structural systems that can enhance the dynamic responsiveness of these tall, skinny structures. Shear walls are one kind of structural structure used in RC construction. Shear walls are often installed parallel to the direction of lateral load and are used to counteract lateral forces caused by wind or earthquakes. These shear walls convey the lateral stresses to the foundation because of their shearing resistance and overturning resistance. This research looks at a 30-story skyscraper with and without shear wall apertures. For a more in-depth and dynamic examination, try using the response spectrum approach. [5]

Seyyed Mostafa Ayatollahi Moosavi(2022) Researchers analyzed the dynamic response of many reinforced concrete wall-frame structures, taking into account failure criteria and the buildings' particular substrate, to determine the impact of soil-structure interactions. It was determined that the most up-to-date and accurate approach for calculating tensile and compressive damage parameters in concrete necessitated using a modified version of Concrete damaged plasticity (CDP) in order to represent the material accurately. The analytical model was used to examine the seismic reactions of the three laboratory models, and a comparison of the data indicates that the suggested model is very accurate. Then, Abaqus was used to model three-, seven-, and twelve-story reinforced concrete frames with shear walls. Interactions between the land and the building were also taken into account. Numerical modeling findings demonstrate that plastic behavior of concrete and the impacts of soil and structure interaction significantly affect the seismic response of reinforced concrete wall-frames. When compared to the rigid support, these reactions were either gradual or diminishing. When earth and buildings interact, the result is a weakening of the foundation and a lengthening of the structure's lifespan. This is an increase of around 3.57% for the 3-story building, 4.4% for the 7-story building, and 10.2% for the 12-story building. When the impacts of soil and structure interaction are taken into account, a noticeable shift in the base shear may be seen. Based on these findings, a base shear increases of 2.03 for a three-story building and 2.63 for a twelve-story building may be expected. When the impacts of soil and structure interaction are taken into account, the findings show that the relative displacement increases. [6]

Muhammet Kamal, Mehmet Inel, Bayram Tanik Cayci, (2022) The purpose of this research is to examine the seismic behavior of mid-rise reinforced concrete (RC) structures on soft soil while assuming different levels of structure-soil-structure interaction (SSSI), soil-structure interaction (SSI), and fixed-base (FB). High ductility RC frame elements are designed in 3D as completely nonlinear structures for buildings with 5, 8, 10, 13, and 15 stories. There are five distinct structural cases: pounding-enabled and -disabled SSSI models, pounding-enabled and -disabled FB models, and pounding-enabled SSI models. The volume of 3D inelastic soil was directly modeled using finite elements for this research. Sixty-five model permutations representing SSSI, SSI, and FB modeling techniques were considered in the comprehensive study. As a consequence, the lateral displacement requirements of the structures and displacement profiles were analyzed and displayed a total of 1365 times using 21 distinct ground motion recordings. It is discovered that nearby structures situated on soft soils exhibit seismic behavior that deviates from the fixed-base assumption. Buildings on soft soils have a reciprocal effect on one another, therefore they should not be assessed in isolation. Even if there is no collision, structures up to 8 stories need take into account the impact of their surroundings, including the earth and the buildings themselves. In the absence of a collision, it may be appropriate to focus only on SSI for structures taller than eight stories. Regardless of the height of the structures in question, soil-structure interaction and the impacts of other buildings must be considered if there is a risk of seismic pounding due to inadequate separation between them. [7]

Rohit Maheshwari (2022) It is important for high-rise buildings to be stable, low-maintenance, long-lasting, and able to fit all of the necessary features into as little space as possible. Precision is required to provide enough strength and stability against lateral loads. The optimum sizing takes into consideration the ideal stiffness co-relationships among structural sections, which is of paramount relevance for the economy. Lateral loads, axial forces, shear forces, base shear, maximum story drift, and tensile forces are only some of the stresses that may affect a building's structural structure, especially at heights. With and without shear walls, G+20 RC tie-column and tie-beam framed buildings are analyzed and compared in this research. E-Tabs, a software program, is used to do the analysis. According to Indian Coda Provisions, the applied loads and load combinations are computed and taken into account. The area around the building is classified as Seismic Zone IV. Maximum drift figures show that with suitable shear wall configuration, maximum drift is reduced. [8]

Mohd Danish (2013) When an earthquake hits, it strikes the weakest part of the whole three-dimensional structure and exerts a force that is quite different from that of gravity or wind. It's not earthquakes that kill people; it's the earthquakes' victims' own stupidity in design and shoddy building that causes so much destruction. It is often assumed that masonry infills will not take part in resisting any form of load, axial or lateral, and therefore they are employed to fill the space between the vertical and horizontal resisting sections of the building frames. As a result, designers often overlook its worth in the study. In actuality, the frame's stiffness and strength are greatly improved with the addition of infill walls and shear walls. Many multi-story structures have collapsed due to earthquakes because of the designers' inability to realize that bare frames had far less stiffness and strength than infill frames and frames with shear walls. Three different RC frame models (a bare frame, a frame with shear wall taking infill, and a bare frame with shear wall) with varying story heights (G+3, G+5, G+7, and G+9) were analyzed using finite elements. All RC frame constructions have undergone linear analysis in accordance with IS: 1893 (Part 1) - 2002 and IS: 456 - 2000. Only the in-plane stiffness of the brick wall has been taken into account, with the infill panels being modeled as equal diagonal strut members. Response Spectrum Analysis using FEM based software has been used to monitor the behavior of structures exposed to Gravity and Seismic loads, including the influence on Time Period, Mass Participation factor, and Story Drift. Once infill panels and shear walls are added to RC bare frame structures, the structures' strength and rigidity are observed to improve. [9]

RESEARCH METHODOLOGY

A 30-story structure was used for the parametric research. The structures under consideration have a square footprint of 25 meters, with 5 bays that are each 5 meters in length. In Figure 1 you can see the building's ground layout. According to Indian Standards IS 456 [10] and IS 1893[9], the dimensions of structural elements of a typical 30-story symmetric RC frame structure were calculated for the most severe load combination. Cast in situ reinforced concrete beams measure 300 x 500 millimeters, whereas 1-15 stories use 900 x 900-millimeter columns and 16-30 stories use 600 x 600-millimeter columns. Thickness of the slab is 150 mm, the height of each story is 3.5 m, and the shear wall thickness is 250 mm. Steel Grade: fey 415 MPa, Concrete Grade: M30.

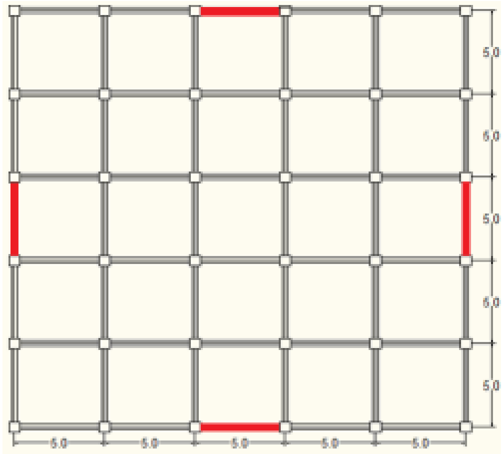

Figure 1: Building Plan

MODEL SPECIFICATION

A 30-storeyed reinforced concrete building with and without shear wall in Seismic In this case, we took into account Zone-V [IS: 1893, 2002]. Special Moment Resisting Frames and RC shear walls work together to withstand the lateral pressures of the design.

General data:

- Plan of the model is 30m × 18m.
- Typical floor height is 3m
- Grade of concrete = M25
- Grade of steel = Fe500
- Earthquake zone = V
- Importance Factor = 1.5
- Soil type = II(Medium)
- Response reduction factor R = 5

DATA ANALYSIS

2-D 3D Modeling of Considered Building

Computer-aided design (CAD) is a suite of software tools that helps designers construct virtual models of structures, machines, components, and other items. Both 2D and 3D modeling use comparable procedures, and both may be created using CAD. However, 3D modeling goes beyond this by providing a third dimension, along with additional data and functionality. When comparing 2D drawings with 3D models, what are the key differences?

To model in 2 dimensions is to make 2D drawings, plans, and blueprints. These records may outline a site's geometry and indicate where various things are located, but they lack the third dimension of depth. These two-dimensional designs may be drawn out on paper or used in two-dimensional modeling software.

Fiber-based, two-dimensional, frame-element modeling for model validation:

IZ-Model The limitations of the Z-Model are addressed by developing a new 2-noded fiber-based model (IZ-Model) that incorporates the 3D slab-columns-web wall interaction effect. In this model, the web wall centerline is connected to the gravity columns on each floor by a stiff link, and at both ends of the connection, a 3D joint element is inserted. To represent the slab's out-of-plane flexural stiffness, the model's 2D plane parts are given a bilinear asymmetric moment-curvature relation. The top and bottom slabs of the test construction have different reinforcing matting, which accounts for the asymmetrical relationship. High stiffness values were assigned to the 3D joint's nodes 1 and 2, restricting their five remaining degrees of freedom. Improvements in the anticipated narrative shear and moment envelopes are seen on Figure 2 for EQ1 through EQ4 using the IZ-Model. The need of considering the 3D interaction impact of all structural parts in the building in order to effectively anticipate the seismic reaction is shown by this exercise.

Lateral Force Analysis for Considered Building

To examine the interaction between the shear wall and the RC frame, a 2-dimensional plane model of a 20-story structure is shown in Fig. 2.

Lateral loads for a 20-story, 30-story, and 35-story structure are shown in Tables 1, 2, and 3 for the external frame with shear wall and inside frame without shear wall, respectively. Lateral force sharing/distribution is shown in Figures 3-4-5 for a 20-story, 30-story, and 35-story structure, respectively, between the outer frame with a shear wall and the internal frame without a shear wall.

In the instance of a 20-story structure, it has been shown that the RC frame resists about half of the lateral loads and the shear wall resists the other half at levels 8 and 9. In the eleventh floor and above, the structural dimensions of the columns alter, which causes a shift in the load distribution patterns. Nearly half of the lateral stresses on a 30-story structure are resisted by the RC frame, while the other half are resisted by the shear wall. This is shown at levels 7 through 12, and again at levels 16 through 20. Changes in the structural size of columns beginning at the 16th floor cause shifts in the load distribution patterns seen on lower floors. There is a shift in the load distribution pattern at the 16th and 26th floors of a 35-story structure because the structural dimensions of the columns vary at those floors.

Table 1: Shear wall-frame interaction for 20-storeyed building

No. Of	INTERIOR FRAME		EXTERIOR FRAME		Story shear
story	Story shear	**% Of total**	Story shear	**% Of total**	(KN)
20	456.9186	107.2	-30.68856	-7.2	426.23
19	804.4363	93.45	56.38371	6.55	860.82
18	906.0677	72.435	344.80232	27.565	1250.87
17	1003.241	62.75	595.54928	37.25	1598.79
16	1045.025	54.8	861.95496	45.2	1906.98
15	1137.543	52.23	1040.4067	47.77	2177.95
14	1218.542	50.48	1195.3682	49.52	2413.91
13	1279.104	48.87	1338.2562	51.13	2617.36
12	1347.36	48.28	1443.3604	51.72	2790.72
11	1145.779	39.02	1790.6106	60.98	2936.39
10	1846.473	60.17	1222.2871	39.83	3068.76
9	1605.899	50.39	1581.0409	49.61	3186.94
8	1587.342	48.39	1692.968	51.61	3280.31
5	1366.338	39.71	2074.4523	60.29	3440.79
7	1537.471	45.87	1814.3293	54.13	3351.8
6	1466.921	43.09	1937.3985	56.91	3404.32
4	1231.498	35.55	2232.6318	64.45	3464.13
3	1056.044	30.37	2421.2161	69.63	3477.26
2	847.7865	24.34	2635.3135	75.66	3483.1
1	694.4728	19.93	2790.0872	80.07	3484.56

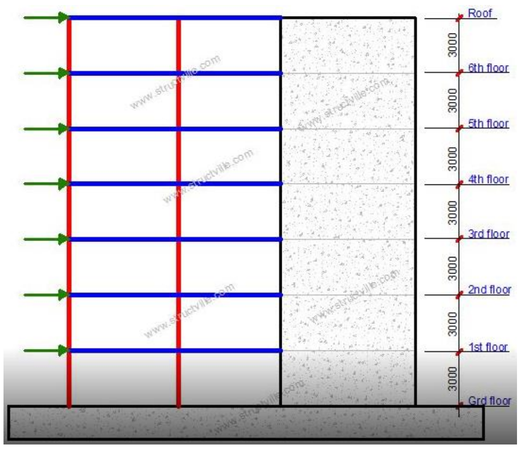

Figure 2: 2-D plane frame model of 20 story shear wall building

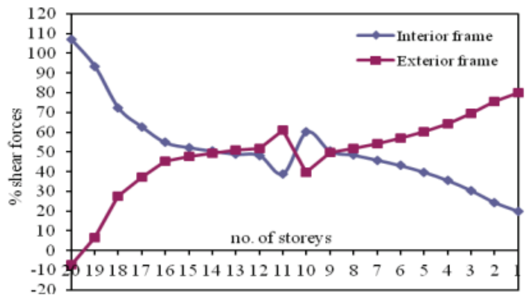

Figure 3: Interaction between frame with shear wall and without shear wall for 20-storey building

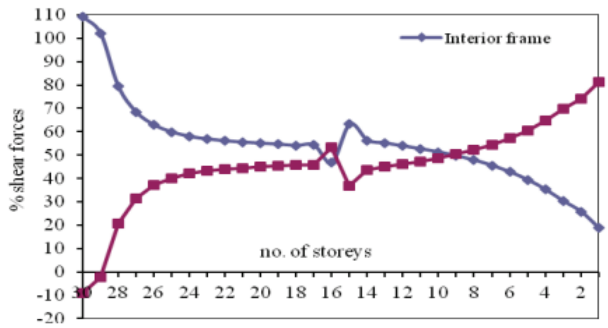

Figure 4: Interaction between frame with shear wall and without shear wall for 30-storey building

Table 2: Shear wall-frame interaction for 30-storeyed building

No. Of	INTERIOR FRAME		EXTERIOR FRAME		Story shear
story	Story shear	% Of total	Story shear	% Of total	(KN)
30	324.63	109.2	-27.3498	-9.2	297.28
29	633.269	102.16	-13.3894	-2.16	619.88
28	731.064	79.41	189.5557	20.59	920.62
27	821.338	68.43	378.9221	31.57	1200.26
26	918.507	62.93	541.0626	37.07	1459.57
25	1016.87	59.84	682.4469	40.16	1699.32
24	1113.56	57.99	806.7054	42.01	1920.27
23	1206.61	56.83	916.5811	43.17	2123.19
22	1294.34	56.06	1014.509	43.94	2308.85
21	1375.3	55.5	1102.714	44.5	2478.01
20	1448.35	55.04	1183.1	44.96	2631.45
19	1512.94	54.62	1256.994	45.38	2769.93
18	1564.61	54.06	1329.6	45.94	2894.21
17	1629.05	54.21	1376.022	45.79	3005.07
16	1449.23	46.7	1654.043	53.3	3103.27
15	2020.75	63.17	1178.155	36.83	3198.9
14	1853.62	56.32	1437.609	43.68	3291.23
13	1858.34	55.13	1512.496	44.87	3370.84
12	1852.41	53.87	1586.258	46.13	3438.67
11	1840.47	52.65	1655.2	47.35	3495.67
10	1816.74	51.28	1726.042	48.72	3542.78
9	1779.37	49.69	1801.571	50.31	3580.94
8	1726.46	47.81	1884.628	52.19	3611.09
7	1655.36	45.55	1978.806	54.45	3634.17
6	1561.95	42.78	2089.177	57.22	3651.13
5	1443.19	39.4	2219.723	60.6	3662.91
4	1293.83	35.25	2376.616	64.75	3670.45
3	1113.8	30.31	2560.891	69.69	3674.69
2	947.452	25.77	2729.118	74.23	3676.57
1	689.445	18.75	2987.595	81.25	3677.04

Table 3: Shear wall-frame interaction for 35-storeyed building

No. Of	INTERIOR FRAME		EXTERIOR FRAME		Story shear
story	Story shear	% Of total	Story shear	% Of total	(KN)
35	286.9491	111.1	-28.6691	-11.1	258.28
34	536.5217	100.54	-2.88166	-0.54	533.64
33	621.902	78.42	171.138	21.58	793.04
32	701.5034	67.65	335.4566	32.35	1036.96
31	788.0041	62.25	477.8659	37.75	1265.87
30	876.012	59.18	604.2381	40.82	1480.25
29	963.1404	57.31	717.4396	42.69	1680.58
28	1044.958	55.96	822.3721	44.04	1867.33
27	1138.663	55.79	902.3173	44.21	2040.98
26	1080.521	49.07	1121.479	50.93	2202
25	1549.788	65.74	807.6624	34.26	2357.45
24	1480.767	59.05	1026.883	40.95	2507.65
23	1547.406	58.49	1098.184	41.51	2645.59

22	1597.943	57.65	1173.857	42.35	2771.8
21	1645.765	57.01	1241.035	42.99	2886.8
20	1687.28	56.41	1303.82	43.59	2991.1
19	1722.175	55.82	1363.055	44.18	3085.23
18	1746.516	55.1	1423.204	44.9	3169.72
17	1781.224	54.89	1463.856	45.11	3245.08
16	1583.386	47.81	1728.444	52.19	3311.83
15	2116.543	62.65	1261.817	37.35	3378.36
14	1936.488	56.23	1507.382	43.77	3443.87
13	1919.592	54.84	1580.758	45.16	3500.35
12	1706.464	48.09	1842.016	51.91	3548.48
11	1683.203	46.9	1905.717	53.1	3588.92
10	1838.338	50.75	1784.002	49.25	3622.34
9	1790.765	49.07	1858.645	50.93	3649.41
8	1728.947	47.1	1941.853	52.9	3670.8
7	1650.382	44.76	2036.798	55.24	3687.18
6	1552.189	41.96	2147.021	58.04	3699.21
5	1431.493	38.61	2276.077	61.39	3707.57
4	1285.784	34.63	2427.136	65.37	3712.92
3	1123.697	30.24	2592.233	69.76	3715.93
2	872.4433	23.47	2844.827	76.53	3717.27
1	652.4388	17.55	3065.161	82.45	3717.6

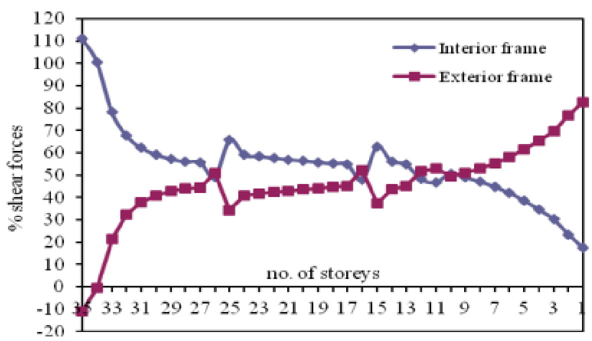

Figure 5: Interaction between frame with shear wall and without shear wall for 35-storey building

The study findings of all investigated RC frames show that the RC frame alone bears the full lateral load at the top two or three stories, whereas the shear wall's role in resisting lateral force at the top is minimal. In contrast, the RC frame resists just 25% of the lateral stress, whereas the shear wall bears 75% of it at the first three basement floors. Almost 40% of the lateral load at intermediate stores is resisted by the frame with shear wall, while the remaining 60% is resisted by the frame without shear wall. The exterior load at the ground and second levels is shared between the shear wall and the RC frame. Nonetheless, outside frame with shear wall provides superior force resistance than interior frame without shear wall when story/height declines. At a certain intermediate height, the shear wall and frame are both supporting the same load, however at the lower height/story, the shear wall is supporting a greater percentage of the load than the RC frame. Shear walls and RC frames experience different amounts of lateral force at different heights. More than 75% of total story shear is handled by frame with shear wall at lowest three stories, and this percentage rises to 100% at lowest eight stories.

CONCLUSIONS

In this work, we use simplified equivalent 2-D modeling of respective frames to examine the shear wall-RC frame interaction for a 20, 30, and 35-story RC frame structure with a shear wall. Based on the results of the study of the 2-dimensional model of the building with RC frame and shear wall, it can be concluded that the shear wall and the RC frame work together to bear the external load at the basement and the middle levels. The study findings of all investigated RC frames show that the RC frame alone bears the full lateral load at the top two or three stories, whereas the shear wall's role in resisting lateral force at the top is minimal. In contrast, the RC frame resists just 25% of the lateral stress, whereas the shear wall bears 75% of it at the first three basement floors. Almost 40% of the lateral load at intermediate story's is resisted by the frame with shear wall, while the remaining 60% is resisted by the frame without shear wall. External frames with shear walls also withstand more force than interior frames without shear walls, especially when story/height diminishes. At a certain intermediate height, both the shear wall and the RC frame are bearing the same load, but at the lower height/store, the shear wall bears a greater proportion of the lateral stresses.

REFERENCE

1. Nayel, Waleed & Vara, T. (2022). Seismic Performance of High-Rise RC Structures with and Without Openings in Shear Wall.
2. Seyyed Mostafa AyatollahiMoosavi, Ramin Tabatabaei Mirhoseini, MohamadhoseinKebriaie, Investigation of seismic behavior of the reinforced concrete wall-frame system on a flexible bed, Results in Engineering, Volume 15, 2022, 100581, ISSN 2590-1230, https://doi.org/10.1016/j.rineng.2022.100581.
3. Muhammet Kamal, Mehmet Inel, Bayram TanikCayci, Seismic behavior of mid-rise reinforced concrete adjacent buildings considering soil-structure interaction, Journal of

Building Engineering, Volume 51, 2022, 104296, ISSN 2352-7102, https://doi.org/10.1016/j.jobe.2022.104296.

4. Rohit Maheshwari (2022)," Comparative Seismic Analysis of G+20 RC Framed Structure Building for Maximum Drift with and without Shear Wall," International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 09 Issue: 06 | June 2022 www.irjet.net p-ISSN: 2395-0072
5. Mohd Danish (2013)," Seismic Performance of R.C Buildings with Shear wall," International Conference on Trends and Challenges in Concrete Structures Ghaziabad, UP, IndiaDecember 19-21, 2013
6. Ashok Kankuntla et al. (2016), "Effects of Openings in Shear Wall", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 13, Issue 1 Ver. II (Jan. - Feb. 2016), PP 01-06
7. Saleem Malik Yarnal et al. (2015), "Non-Linear Analysis of Asymmetric Shear Wall with Openings", International Journal of Engineering Research & Technology (IJERT) Vol. 4 Issue 08, August-2015, PP 467-471
8. Aarthi Harini T et al. (2015) "Behavior of R.C. Shear Wall with Staggered Openings under Seismic Loads s", International Journal for Research in Emerging Science and Technology, Volume-2, Issue-3, March-2015
9. Mazen A. et al. (2013) "Analysis of Shear Wall with Openings Using Solid65 Element" published in Jordan Journal of Civil Engineering, Vol. 7, No. 2, 2013, pp 164- 173
10. Satpute S G et al. (2013) "Comparative Study of Reinforced Concrete Shear Wall Analysis in Multi-Strayed Building with Openings By Nonlinear Methods" International Journal of Structural and Civil Engineering Research Vol. 2, No. 3, August 2013
11. Shaik Kamal Mohammed Azam, Vinod Hosur, (2013) "Seismic Performance Evaluation of Multistoried RC framed buildings with Shear wall" published in International Journal of Scientific & Engineering Research, ISSN 2229-5518, Volume 4, Issue 1, January-2013, pp 1-6
12. Essam M. Awdy, Hilal A. M. Hassan, (2013) "Capacity of Open Rectangular Shear Walls" published in International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 1, January 2013 ISSN: 2319-5967 pp- 375-383
13. Islam M. Ezz EL-Arab, (2012) "Seismic Analysis of Monolithic Coupling Beams of Symmetrical Coupled Shear Wall System" published in International Journal of Current Engineering and Technology ISSN 2277-4106, Volume 2, No.4, Dec. 2012, pp. 345-356
14. Burak.B. and Comlekoglu. H (2012), "Effect of Shear Wall Area to Floor Area Ratio on the Seismic Behavior of Reinforced Concrete Buildings" published in journal of structural Engineering, 10.1061/(ASCE)ST.1943-541X. 0000 785, Dec.7, 2012
15. Romy Mohan, et al. (2011) "Dynamic Analysis of RCC Buildings with Shear Wall" published in International Journal of Earth Sciences and Engineering, ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 659-662
16. Dr. S.K. Dubey, (2011) "Seismic Behavior of Asymmetric RC Buildings", published in International Journal of Advanced Engineering Technology E-ISSN 0976-3945, IJAET, Volume II, Issue IV, October-December, 2011, pp 296-301
17. Dr. B. Kamesh Wari (2011) "Dynamic Response of High-Rise Structures Under the Influence of Discrete Staggered Shear Walls" published in International Journal of Engineering Science and Technology (IJEST),

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