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Analysis of Bare Frame and Infilled Frame with Different Position of Shear Wall

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Abstract*: Shear wall is one of the most commonly used lateral load resisting in high rise building. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal load and support gravity load. The scope of present work was to study investigates the effectiveness of RC shear wall in medium rise building. The residential medium rise building is analyzed for earthquake and wind force by considering two type of structural system. i.e. Bare Frame system and Infilled Frame system. Effectiveness of shear wall has been studied with the help of eight different models. Four models are bare frame structural system and other four models are Infilled Frame structural system with different position of shear wall. Analysis is carried out by using standard package STADD Pro V8i. The comparison of these models for different parameters like Storey Drift and Axial fore in column is carried out.

***Index Terms*: Bare Frame Structure, Diagonal strut, Infilled Frame Structure, Shear Wall.**

I. INTRODUCTION

Reinforced concrete shear walls are used in Bare Frame building to resist lateral force due to wind and earthquakes. They are usually provided between column lines, in stair wells, lift wells, in shafts that house other utilities. Shear wall provide lateral load resisting by transferring the wind or earthquake load to foundation. Besides, they impart lateral stiffness to the system and also carry gravity loads. But bare frame with shear wall still become economically unattractive. If the structural engineer considered property of the non structural element in structural design along with other elements like shear wall gives better results. The non structural element which is already exists in structure but not considered in a structural design as a structural element like curtain wall. The curtain wall means partition wall which is made up of brick masonry therefore it is called as a masonry wall and also it is called as an infill wall. If the properties of the infill wall like density and modulus elasticity of brick masonry are considered in structural design, it will helps to improve the strength and stiffness of the structure. But in India infill wall is not considered as a structural element due to this, stiffness of infill wall is not estimated and not considered in design of structure.

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But nowadays the structural engineers and researchers are accepted that infill wall or masonry wall is effective in enhancing the strength and rigidity of the structure. But there is no any provisions for infill wall in IS code and also properties, advantages, disadvantages and limitation are not clearly define. So here necessity to required lot of research works and developments regarding with infill wall considering all point of views of structural designs. This can be done by making some models in the software like STADD ProV8i. Analyze these models in different condition such as bare frame model, RC frame with shear wall, Infilled frame, and Infilled frame with shear wall and calculate the storey drift, axial forces. From this result understand the behavior of the structure. In this present paper four model for bar frame type public building and fore models for Infilled structural system are generated with the help of STADD Pro V8i and effectiveness has been checked.

II. BUILDING DISCRIPTION

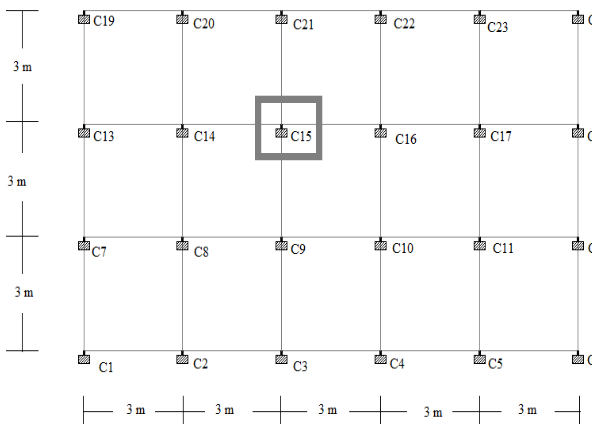

Fig. 1 Plan of Public Building

A Building considered is the public building having (G+9) stories and ground storey act as a soft storey. Other details are given below.

A. *Preliminary Data*

Type of structure = Multi-storey rigid jointed frame
Layout = as shown in fig. 1
Zone = III
Response Reduction Factor 5
Importance Factor 1
Soil Condition hard
Number of stories = Ten (G+9) as shown in fig.
Height of Building 31 m
Ground storey height = 4 m.
Floor to floor height = 3 m
Parapet wall =150 mm thick including plaster

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Wall thickness =230 mm thick including plaster
Total depth of the slab =150 mm
Size of all columns = 700 × 350 mm
Size of all beams = 600 × 230 mm
Size of all shear walls = 3000 × 200 mm
Size of all infill wall which is equivalent to diagonal strut = 360 × 230 mm
Unit weight of RCC concrete is assumed $25kN/m^3$
Unit weight of brick masonry is $20kN/m^3$
Weight of floor finish (FF) = $1kN/m^2$
Weight of terrace water proofing (TWF) = $1.5kN/m^2$
Live load on floor = $4kN/m^2$
Live load on roof = $1.5kN/m^2$
Elastic modulus of masonry wall =13800MPa
Elastic modulus of concrete = 21718MPa.

B. Equivalent Diagonal Strut

Infill wall without openings

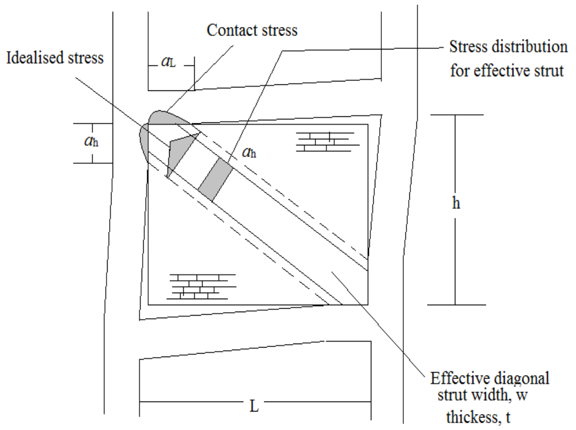

Fig. 2 Equivalent Diagonal Strut

The geometric and material properties of the equivalent diagonal strut are required for conventional braced frame analysis to determine the increased stiffness of the infilled frame. The geometric properties are of effective width and the thickness of strut. The thickness and material properties of strut are similar to infill wall. The width of diagonal strut depends on the length of contact between wall and the columns, α_h, and between the wall and beams, α_L in (Fig. 2.) The proposed range of contact length is between one-fourth and one –tenth of the length of panel. The following equations are proposed to determine α_h and α_L, which depends on relative stiffness of the frame and infill, and on the geometry of the panel.

$$\alpha_h = \frac{\pi}{2}\sqrt[4]{\frac{E_f I_c h}{2E_m t \sin 2\theta}}$$

$$\alpha_L = \pi\sqrt[4]{\frac{E_f I_b h}{E_m t \sin 2\theta}}$$

Where,
h = height of masonry infill panel, cm.
L = length of infill panel, cm.
t = thickness of infill panel and equivalent strut, cm.
Ef = modulus of elasticity of frame material, MPa
Em = modulus of elasticity of infill material, MPa
I_c = moment of inertia of column, cm4.
I_b = moment of inertia of beam, cm4.
θ = angle whose tangent is the infill height-to-length aspect ratio, radians.

The following equation to determine the equivalent or effective strut width w, where the strut is assumed to be subjected to uniform compressive stress

$$W = \frac{1}{2}\sqrt{\alpha_h^2 + \alpha_L^2}$$

L_d = Diagonal length of strut = $\sqrt{h^2 + L^2}$
A = Cross-sectional area of diagonal strut = w × t
And stiffness of infill is $\frac{AE_m}{L_d}\cos^2\theta$

$\theta = \tan^{-1}\frac{h}{L}$

III. MODELING AND ANALYSIS

To understand the effect of shear wall in bare frame and infilled frame, for that total 8 models are developed and analysis in standard computer program like STADD PRO V8i. In which four model for bar frame type public building and fore models for Infilled structural system with different position of shear walls. From this different condition all models are identify by their names which is given below.
Model 1:- Bare frame without shear wall.

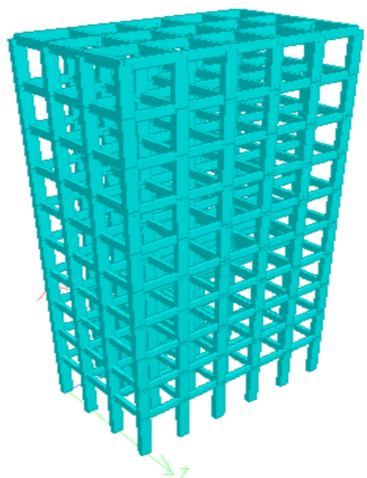

Fig. 3 3D View of Model 1

Model 2:- Infilled Frame without shear wall

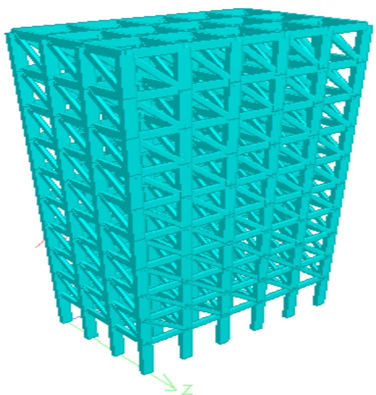

Fig. 4 3D View of Model 2

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Model 3:- Bare Frame with one wall on each side at middle.
Model 4:- Infilled Frame with one wall on each side at middle.

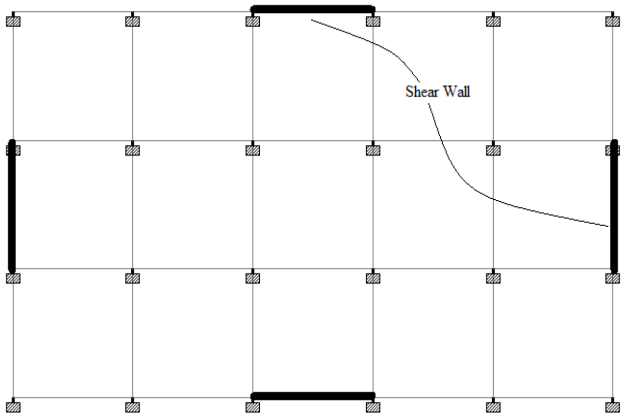

Fig. 5 Plan of Model 3 and 4

Model 5:- Bare Frame with corner shear wall.
Model 6:- Infilled Frame with corner shear wall.

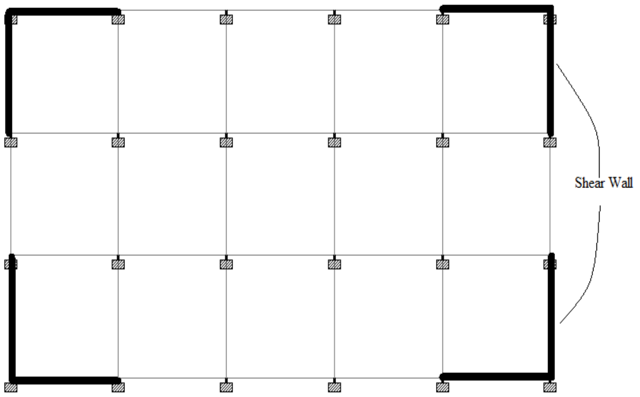

Fig. 6 Plan of Model 5 and 6

Model 7:- Bare Frame with Interior shear wall.
Model 8:- Infilled Frame with Interior shear wall.

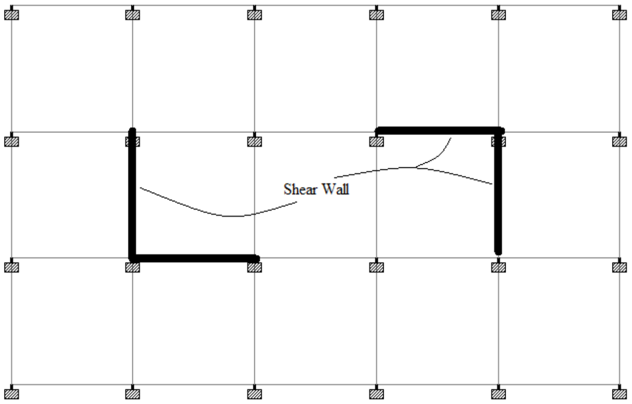

Fig. 7 Plan of Model 7 and 8

IV. ANALYSIS OF THE BUILDING

Analyses has been performed as per IS 1893 (part-1) 2002 for each model using STADD Pro V8i (computer and structures) software. Lateral load calculation and its distribution along the height is done. The seismic weight is calculated using full dead load plus 50% of live load. Wind load calculation done as per IS 875. The results obtained from analyses are compared with respect to the following parameters.

LOAD COMBINATION (used in STADD Pro V8i)

1) DL-(Self Weight)
2) DL-(Member Weight i.e. Wall Load)
3) DL-(Floor Weight i.e. Slab Load)
4) LL
5) WIND-X
6) WIND-Z
7) SEISMIC-X
8) SEISMIC-Z
9) 1.5 (DL+LL)
10) 1.2(DL+LL+WIND-X)
11) 1.2(DL+LL+WIND-Z)
12) 1.2(DL+LL-WIND-X)
13) 1.2(DL+LL-WIND-Z)
14) 1.2(DL+LL+SEISMIC-X)
15) 1.2(DL+LL+SEISMIC-Z)
16) 1.2(DL+LL-SEISMIC-X)
17) 1.2(DL+LL-SEISMIC-Z)
18) 1.5(DL+WIND-X)
19) 1.5(DL+WIND-Z)
20) 1.5(DL-WIND-X)
21) 1.5(DL-WIND-Z)
22) 1.5(DL+SEISMIC-X)
23) 1.5(DL+SEISMIC-Z)
24) 1.5(DL-SEISMIC-X)
25) 1.5(DL-SEISMIC-Z)
26) 0.9(DL)+1.5(SEISMIC-X)
27) 0.9(DL)+1.5(SEISMIC-Z)
28) 0.9(DL)-1.5(SEISMIC-X)
29) 0.9(DL)-1.5(SEISMIC-Z)

V. RESULT AND DISCUSSION

Here standard computer program software used for analysis like STADD ProV8i. All required data provided in software and analyzed total 8 models, so get the result in terms of storey drift and axial force. To understand the effect shear wall in bare frame and infilled frame for that the results are divided in to sub parts such as 1) storey drift in all models 2) Axial force in column. These subparts are described briefly in further section.

A. Storey Drift

After analyzed all models in STADD ProV8i get the results in terms of storey drift of the models, first of all consider model 1 "BARE FRAME (G+9)" because, it is a basic or traditional structure in which no other element are included or considered in structure for improving the performance of the building, so the results of the Bare frame (G+9) can compare with the results of the other models. The storey drifts at each floor height of the model 1 (i.e. Bare Frame (G+9) with all load combination) get from software, from this result understand that the load combination 23 shows maximum storey drift. So here storey drift of load combination 23 in all models can considered as a benchmark to state the comparative statement. Thus Storey drift of all models are given in a table no 1 and in Graph.

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Table no. 1 Storey Drift in All Models

LOAD COMBINATION 23									
STOREY DRIFT (mm)		**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
HIEGHT (m)	0	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031
	4	29.053	27.121	13.2196	13.8578	9.4253	11.5844	11.2645	10.9734
	7	26.5638	6.5761	16.0123	4.2635	12.0575	3.3233	14.9469	4.2471
	10	26.3605	6.3097	17.6839	4.2355	13.8023	3.4216	17.308	4.1897
	13	26.2489	5.4857	18.6972	3.7308	14.9325	3.0784	18.5739	3.6834
	16	25.5144	4.6905	18.9024	3.2004	15.3617	2.8092	18.8335	3.5036
	19	24.0123	3.8988	18.3323	3.2021	15.1293	3.1306	18.2567	4.1846
	22	21.648	3.1395	16.9956	3.5825	14.2659	3.2731	16.9584	4.6672
	25	18.289	3.6747	14.9181	3.7644	12.794	3.2467	15.0266	4.9473
	28	13.8702	3.9835	12.081	3.7376	10.7007	3.0517	12.4899	5.0316
	31	8.7768	4.002	8.7152	3.4605	8.1536	2.6439	9.3939	4.9679

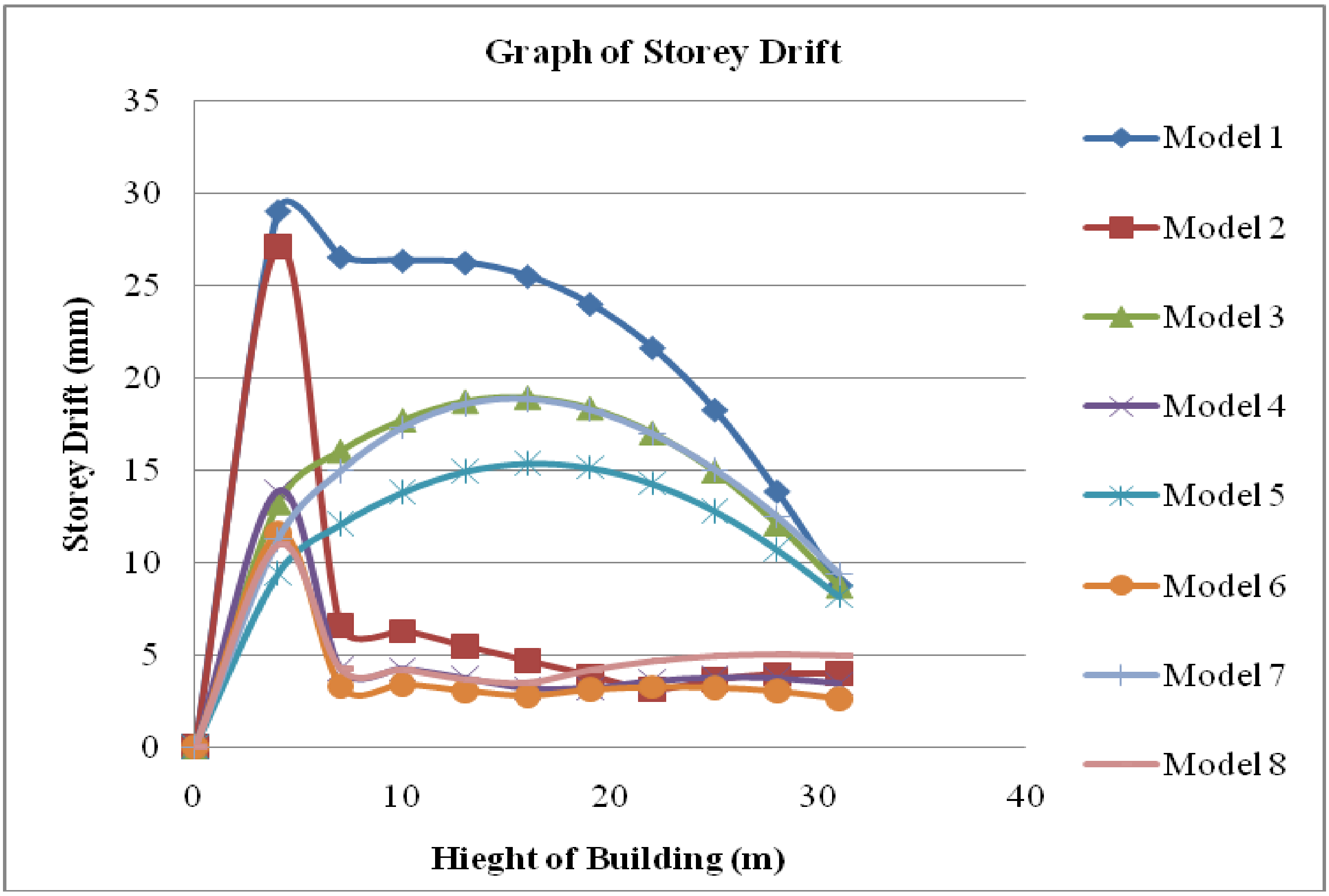

Fig. 8 Graph of Storey Drift Considering Load Combination 23

B. Axial Force in Column

In this project for understand the effect of different position of the shear wall in bare frame and infilled frame; study the behavior of the column in all models. Total 8 models are analysed in STADD ProV8i and all models have same plan of building, therefore the position and numbers of columns are same in all plan of models which is shown in figure.

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After analysis consider the column no. 15 shown in fig.1 from all models for load combination 23 and get the maximum axial forces of columns at every floor from software, which is given in table no 2.

Table no. 2 Axial Force of Column no. 15 Considering Load Combination 23

Maximum Axial force kN		**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
(column no 15) Beam no.	6	2063.04	1807.8	1883.58	1508.703	1926.36	1461.62	1598.95	1444.82
	30	1815.17	1509.48	1644.57	1229.475	1687.58	1191.59	1374.34	1154.87
	54	1588.22	1338.42	1428.74	1073.766	1468.68	1038.84	1179.41	1004.34
	78	1366.94	1157.6	1221.84	916.867	1258.14	887.155	998.504	854.147
	102	1150.63	981.251	1022.56	769.336	1054.47	745.746	828.668	713.125
	126	938.291	807.536	829.619	629.141	856.586	612.143	667.063	578.36
	150	729.195	635.825	641.908	495.121	663.527	484.992	511.305	447.649
	174	522.812	465.595	458.517	366.508	474.456	362.899	359.447	319.501
	198	318.82	295.921	278.826	241.985	288.722	242.913	209.785	193.153
	222	117.449	121.263	102.649	109.747	106.115	109.534	62.643	68.967

VI. CONCLUSION

From above results it is clear that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake. For residential building shear walls can be used as a primary vertical load carrying element, thus serving the load and dividing space. The Infilled frame type structural system become economical as compared to the Bare Frame structural system. The infilled frame is superior to the bare frame. When shear wall provided in the infilled frame storey drift drastically reduced than the bare frame. The axial force of the bare frame is maximum than the infilled frame. But when shear wall provided in bare frame and infilled frame it will help to reduce axial force significantly in bare frame and infilled frame. When Shear wall provided at corner on each side the structure gives better result than the all position.

REFERENCES

1. Duggal S.K. (2007). Earthquake Resistant Design of Structures; Reinforced concrete buildings, Masonry buildings, OXFORD UNIVERSITY PRESS.
2. Pankaj Agrawal and Manish Shrikhande (2007). Earthquake Resistant Design of Structures; Consideration of Infill Wall in Seismic Analysis of RC Buildings, PRENTICE HALL OF INDIA.
3. P.C. Varghese (2003). Advanced Reinforced Concrete Design; Design of Shear Wall, PRENTICE HALL OF INDIA.
4. Wolfgang, Schueller, (1977). High Rise Building Structure; shear wall arrangement Page no. 72 75 76. New York Wiley c.
5. Rajesh J. P. and Vinubhai. R. Patel (2013), "Effect of Different Position of Shear Wall on Deflection in High Rise Building." International Journal of Advances in Engineering & Technology, Sept. 2013. @IJAET, ISSN: 22311963, Vol. 6, Issue 4, pp. 1848-1854.
6. Sachin G. Maske, Dr. P. S. Pajgade (2013), " Torsional Behaviour of Asymmetrical Buildings." International Journal of Modern Engineering Research (IJMER), ISSN: 2249-6645, Vol.3, Issue.2, March-April. 2013 pp-1146-1149.
7. M.D. Kevadkar, P.B. Kodag (2013), "Lateral Load Analysis of R.C.C. Building."(IJMER), ISSN: 2249-6645, Vol.3, Issue.3, May-June. 2013 pp-1428-1434.
8. Wakchaure M. R, Nagare Y U (2013), "Effect of Torsion Consideration in Analysis of Multi Storey frame." International Journal of Engineering Research and Applications (IJERA) ISSN:
9. 2248-9622 www.ijera.com Vol. 3, Issue 4, Jul-Aug 2013, pp.1828-1832.
10. Misam Abidi, Mangulkar Madhuri. N. (2012), "Review on Shear Wall for Soft Story High-Rise Buildings." (IJEAT), ISSN: 2249 – 8958, Volume-1, Issue-6, August 2012.
11. P. P. Chandurkar and Dr. P. S. Pajgade (2013), "Seismic Analysis of RCC Building with and Without Shear Wall." (IJMER), www.ijmer.com Vol. 3, Issue. 3, May - June 2013 pp-1805-1810 ISSN: 2249-6645.
12. AshishS.Agrawal, S.D.Charkha (2012), "Effect of change in shear wall location on storey drift of multi-storey building subjected to lateral loads." (IJERA), ISSN: 2248-9622, Vol. 2, Issue 3, May-Jun 2012, pp.1786-1793.
13. Himalee Rahangdale , S.R.Satone (2013), "Design And Analysis Of Multistoried Building With Effect Of Shear Wall." (IJERA), ISSN: 2248-9622, Vol. 3, Issue 3, May-Jun 2013, pp.223-232.
14. Shahzad Jamil Sardar and Umesh. N. Karadi (2013), "Effect of change in shear wall location on storey drift of multistorey building subjected to lateral loads." International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) (IJIRSET) Vol. 2, Issue 9, September 2013, ISSN: 2319-8753, pp.4241-4249.
15. P. S. Kumbhare, A. C. Saoji (2012), "Effectiveness of Reinforced Concrete Shear Wall for Multi-storeyed Building." International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 4, June - 2012 ISSN: 2278-0181, pp.1-5.
16. S.S. Patil, S.A. Ghadge,C.G. Konapure, and C.A. Ghadge (2013), "Seismic Analysis of High-Rise Building by Response Spectrum Method." (Ijceronline.Com) Vol. 3 Issue. 3, March-2013 ISSN: 2250-3005, pp. 272-279.
17. Anshuman. S, Dipendu Bhunia, Bhavin Ramjiyani (2011), "Solution of Shear Wall Location in Multi-Storey Building." (IJCSE) Volume 2, No 2, Nov- 2011, ISSN 0976 – 4399, pp.493-506.
18. V. P. Jamnekar1, P. V. Durge (2013), "Seismic Evaluation of Brick Masonry Infill." International Journal of Emerging Trends in Engineering & Technology (IJETET) Vol. 02, No. 01, 2013, ISSN No. 2248-9592.

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19. Mulgund G. V and Kulkarni A. B (2011), "Seismic-Assesement-of-RC-Frame-Buildings-With-Brick-Masonry-Infills."(IJAEST)-Volume-No-2,Issue-No-2, ISSN: 2230-7818 pp.140-147.
20. Alireza Mohyeddin-Kermani, Helen M Goldsworthy and Emad Gad, "A review of the seismic behaviour of RC frames with Masonry infill."
21. J. Dorji and D.P. Thambiratnam (2009), "Modelling and Analysis of infilled frame structures under seismic loads." The Open Construction and Building Technology Journal, 2009, vol-3, pp.119-126, 1874-8368/09.
22. Elena Vaseva (2009), "Seismic Analysis of Infilled RC frames with Implementation of a masonry panel models." 11th National Congress on Theoretical and Applied Mechanics, 2-5 Sept. 2009, Borovets, Bulgaria.
23. S. Hak, P. Morandi, and G. Magenes (2013), "Local effect in the seismic design of RC frame structure with masonry infills." 4th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering M. Papadrakakis, N.D.Lagaros, V. Plevris (eds.) Kos Island, Greece, 12–14 June 2013.
24. Sachin R Patel, Sumant B patel (2011), "Effect of Brick infill panel in Design of high rise buildings." (NCRTET), B.V.M. Engineering College, V.V. Nagar, Gujarat, India 13-14 May 2011.
25. Kashif Mahmud, Md. Rashadul Islam and Md. Al-Amin (2010), "Study the reinforced concrete frame with brick masonry infill due to lateral loads." IJCEE-IJENS Vol: 10 No:04 pp. 35-40. 108504-2727-August 2010.
26. Md Irfanullah , Vishwanath. B. Patil (2013), "Seismic Evaluation of RC framed buildings with influence of masonry infill panel." (IJRTE) ISSN: 2277-3878, Volume-2, Issue-4, September 2013 pp.117-120.
27. Nikhil Agrawal, Prof.P.B Kulkarni, Pooja Raut (2013), "Analysis of masonry infilled RC frame with & without opening including soft storey by using equivalent diagonal strut method." (IJSR) Publications, Volume 3, Issue 9, September 2013 1 ISSN 2250-3153.
28. Haroon Rasheed Tamboli and Umesh.N.Karadi (2012), "Seismic analysis of RC frame structure with and without masonry infill wall." (IJNS) ISSN: 0976 – 0997 Vol.3 / Issue 14/ October2012 pp.1137-1148.
29. Catherin Jeselia M., Jayalekshmi B.R., KattaVenkataramana (2013), "Modelling of masonry infill-A review."(AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-2 pp-59-63.
30. M. M. Gaikwad and P. M. Mohite, "Comparative study of a structure with different arrangement and thickness of infill walls subjected to earthquake force."

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