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Seismic Response of shear Wall Building with Openings

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Abstract: This study consist in finding the most effective way of modelling shear walls in structural analyses of building. The program used for this purpose, is the ETABS design program. It is obtained by analysing a 6-storey vertical structure in elevation, a dual system frame + shear wall. For this case, three models of shear wall, beam with rigid arm, and plates with columns and plates only are going to be compared. Referred to the satisfactorily idealized of the first model (beam with rigid arm), the two other models are going to be compared with it, in order to reflect the good behaviour of shear wall element. The best model is the simplest one that still provides the required results with acceptable accuracy.

I. INTRODUCTION

Shear walls have been usually adopted as the lateral force resisting system in Reinforced Concrete (RC) buildings. Since 1940s, a significant number of experimental investigations have been conducted in many countries on RC shear walls. Most of these investigations focused on the determination of ultimate strength of walls subjected to various loading conditions such as monotonic, cyclic, dynamic and blast (high-speed monotonic). Significant experimental investigations on shear wall subjected to monotonic loading were conducted develop design procedures for shear-wall structures as well as to prepare a basis for the evaluation of existing shear wall structures to study the behavior of RC shear walls surrounded by RC frames under monotonic loading to develop the analytical procedures for the design of shear wall framed structures, The major design variables considered in their study were aspect ratio, reinforcement ratio, and openings etc. In order to simulate the dynamic loading, in the 1970s, the dynamic loading began to replace the monotonic tests. Since then, many experimental and analytical investigations have been performed to determine the responses of shear walls under various loading conditions. For the analysis of shear wall, several analytical methods have been proposed by various researchers which range from simplified conventional approach to the sophisticated finite element approach. Due to the complexity of numerous factors which influence the overall behaviour of RC shear walls, the validity of modelling and analysis techniques could only be established by comparing the same with experimental results.

II. PROBLEM STATEMENT

In order to fulfil the objective of the research, a 3D 6 storey building has been modelled in FE based software i.e. SAP 2000. Initially analysis has been carried out without considering any shear wall in the building i.e. a bare frame. Further three different alternatives has been done. In the first case shear wall is considered in each fully and analysis is carried out. In the second case, shear wall with door opening has been provided and lastly shear wall with window opening has been considered.
Building is consider to be located in the critical zone of earthquake i.e Zone V of India and is resting on the hard strata. The plan of the building is 12 x 9 m, height at each storey being 3m, shear wall has been modelled using shell element in the software. Concrete of grade M25 and steel Fe 415 has been used as material for the building designing. Table 4.1 shows the details of the different components of the building being used

Table 4.1 Basic Details of Building

Parameter	**Value**
Slab Thickness	150 mm
Beam size	300 x 450 mm
Column Size	450 x 450 mm
Thickness of the wall	250 mm
Opening size of window	1.5 x 1 m
Opening size of door	1 x 2.1 m
Live Load on each floor	3 kN/m^2
Floor finish	1 kN/m^2

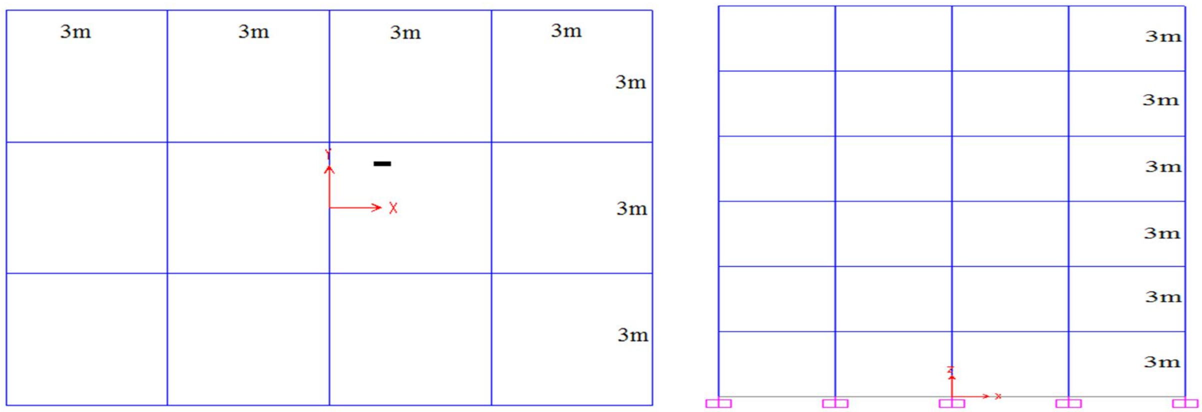

Fig. 4.1 Plan and elevation of the building

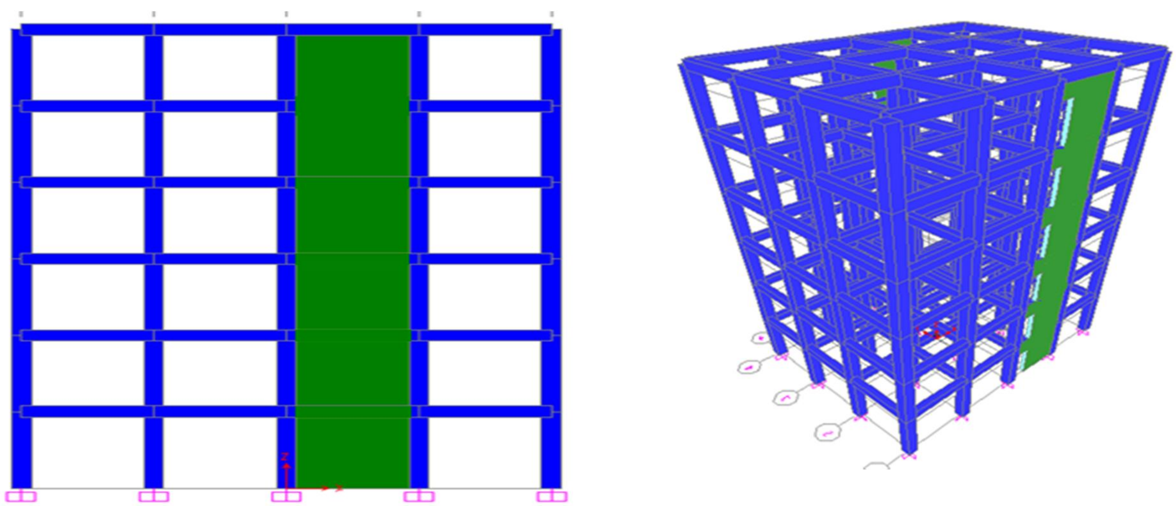

Fig. 4.2 Elevation and 3D view of building frame with shear wall

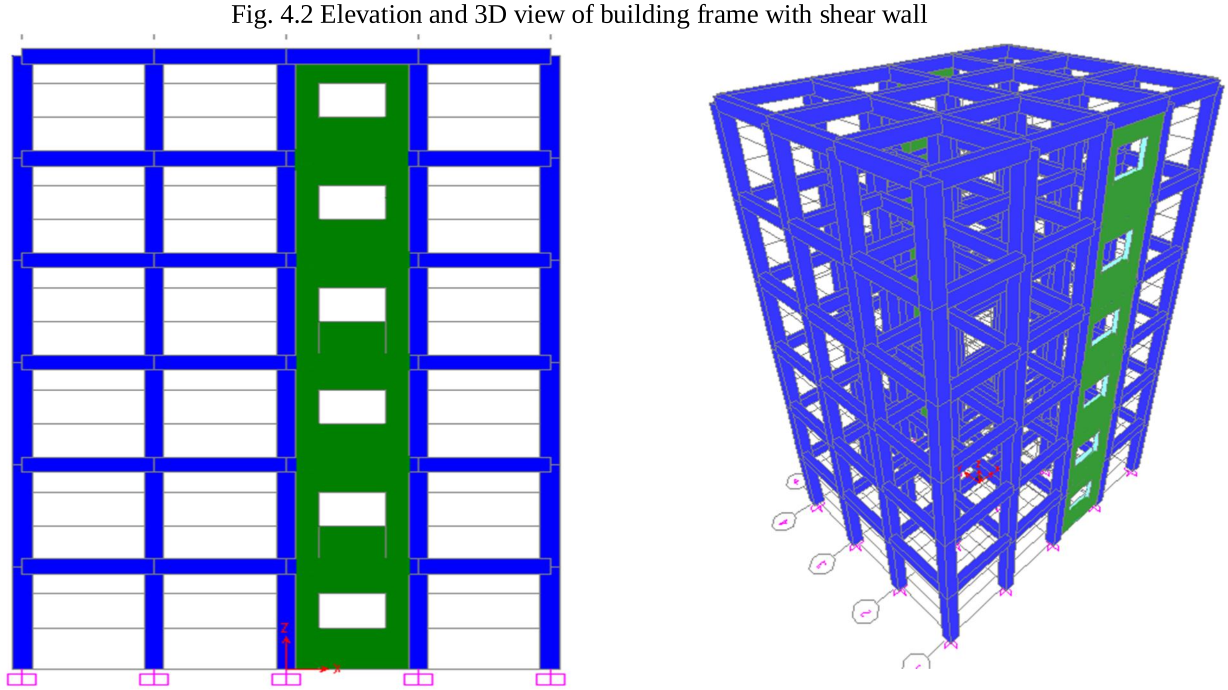

Fig. 4.3 Elevation and 3d view of building frame with window opening shear wall

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III. RESULTS

Following are the results obtained from the analysis carried out on the building with shear wall openings at different locations. As discussed before, total three alternative shear wall opening location have been undertaken. The results are shown in tabulated as well as graphically.

Table 5.1 and fig. 5.1 shows displacement at each storey of the building and it has been observed that incorporation of the shear wall within the building reduces the joint displacement of each storey by considerable amount. Further, it has been observed that shear with window opening reduces the joint displacement by considerable amount and is least from the two alternative openings chosen so far.

Table 5.1 Joint Displacement at each storey

Storey number	Bare frame	Overall shear wall frame	Shear wall with door opening	Shear wall with window opening
1	23.8	18.7	12.8	10.7
2	60.8	44.8	31.4	26.2
3	97.5	70.7	50.1	42.9
4	129.5	95	67.7	59.6
5	154.8	116.7	82.9	75.3
6	172.4	136	95.4	89.6

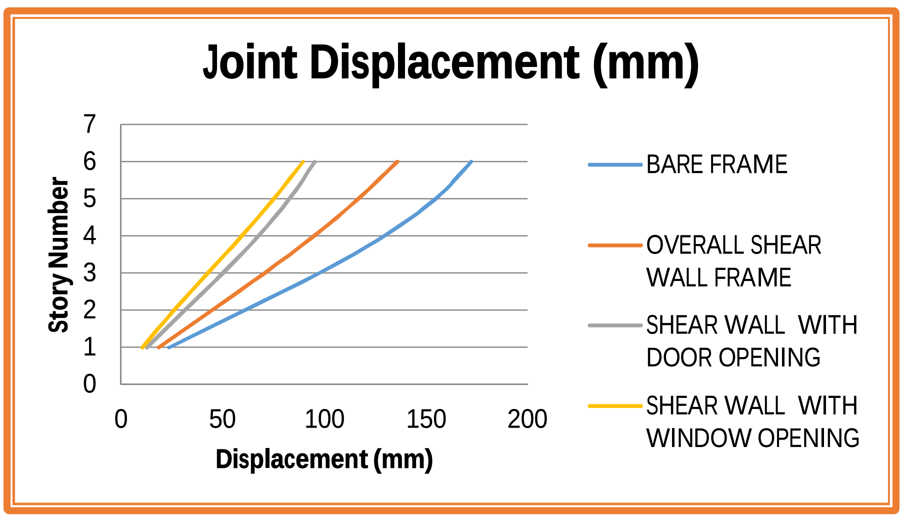


Fig. 5.1 Joint Displacement at each floor

Table 5.2 and fig. 5.2 shows the results of storey drift incorporating the effect of shear wall with different shear wall openings. Further, shear wall with window opening reduces the storey drift by more than 50%. Almost in every opening considerable reduction has been observed.

Table 5.2 Storey Drift

Storey drift (mm)				
Storey number	Bare frame	Overall shear wall frame	Shear wall with door opening	Shear wall with window opening
1	23.8	18.7	12.8	10.7
2	37	26	18.6	15.5
3	36.7	25.9	18.8	16.8
4	32.1	24.3	17.5	16.7
5	25.3	21.7	15.3	15.7
6	17.6	19.3	12.5	14.3

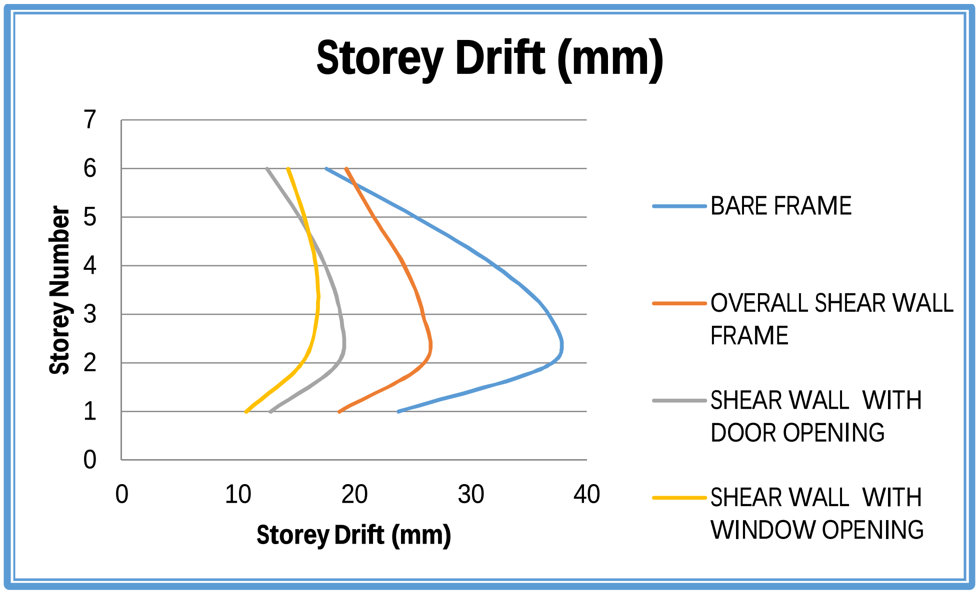


Fig. 5.2 Storey drift

Table 5.3 and fig. 5.3 shows the results of shear force in column incorporating the effect of shear wall with different shear wall openings. Further, shear wall with window opening reduces the shear force in the column by more than 50%. Almost in every opening considerable reduction has been observed.

Table 5.3 Column Shear

Column shear (kN)				
Storey number	Bare frame	Overall shear wall frame	Shear wall with door opening	Shear wall with window opening
1	255.8	55.2	88.7	130.6
2	220.6	54.2	81	113.8
3	184.2	43.5	66.2	93.7
4	155	33.7	51.5	73.8
5	137.1	22.5	36.9	52.5
6	106	13.3	22.5	31.5

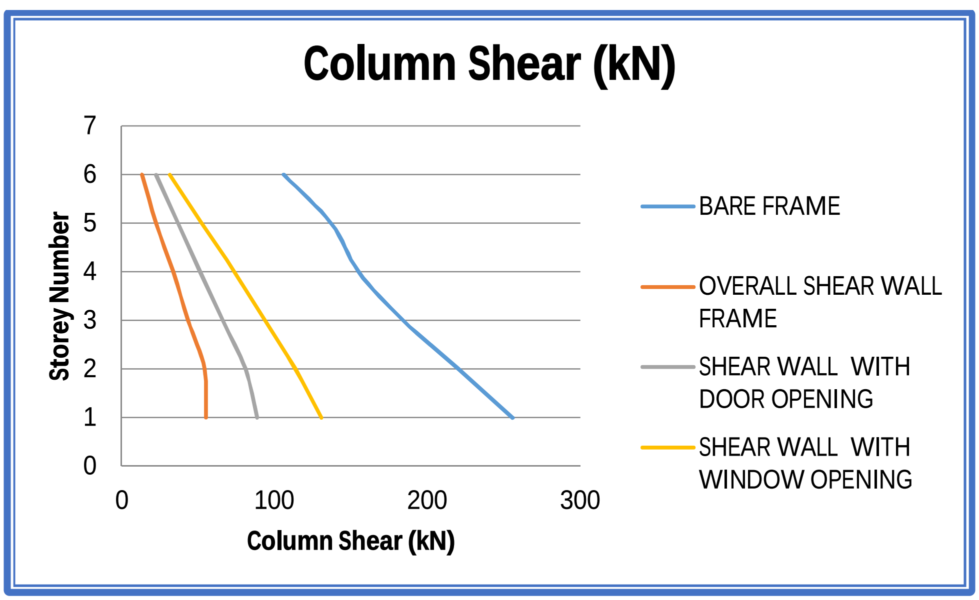


Fig 5.3 Shear force in column

Table 5.4 and fig. 5.4 shows the results of bending moment in column incorporating the effect of shear wall with different shear wall openings. Further, shear wall with window opening reduces the shear force in the column by more than 50%. Almost in every opening considerable reduction has been observed.

Table 5.4 Bending moment in column

Column moment (kN-m)				
Storey number	Bare frame	Overall shear wall frame	Shear wall with door opening	Shear wall with window opening
1	210.664	98.4246	143.8556	185.7799
2	173.104	90.874	118.2631	159.3438
3	131.484	64.5371	87.1891	120.781
4	92.1441	42.2908	61.5909	85.1964
5	51.3283	19.1974	35.1416	46.3929
6	23.5421	6.1978	8.642	23.3047

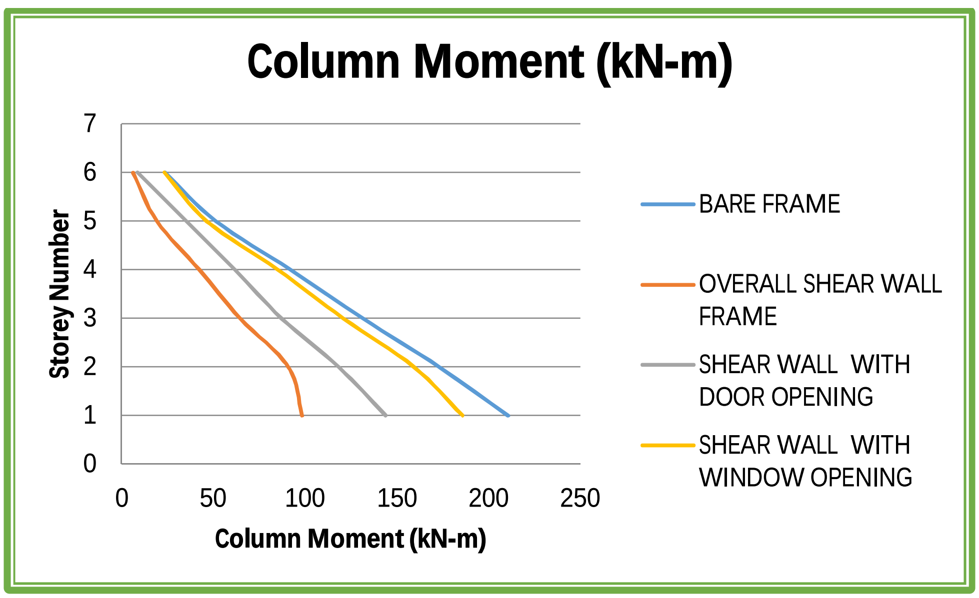


Fig. 5.4 Bending Moment in Columns

IV. CONCLUSIONS

A. Floor displacements are minimized with the intrusion of shear wall in the building. Shear wall with window opening type is proved to performed better during base excitation. Shear wall with door is opening is also found to reduce such damaging parameter.

B. Storey drift is one of most damaging measure during base excitation. Bare frame without any shear wall is found to produce peak response due to lesser infill stiffness. In this analysis, bare frame with window type shear wall is found to have lesser storey drift. More than 50% of the drift is found to reduce using window type shear wall.

C. The shear in the column with and without shear wall indicated that the shear wall with door type opening is found to have minimum shear force. Frame with overall shear wall is found to have minimum shear force in the column.

D. Column bending moment in found to be minimum in case of frame with overall shear wall and almost 50 to 55 % moment has been reduced. Shear wall with window opening is found to reduce the less moment.

E. Location optimization of shear wall at suitable location reduces the response of the structure

REFERENCES

[1] ACI 318 (2011). “Building code requirements for structural concrete and commentary.” *American Concrete Institute*, Michigan, USA.

[2] AIJ (2000). “AIJ standards for structural calculation of steel reinforced concrete structures.” *Architectural Institute of Japan*, Tokyo, Japan.

[3] Atimtay, E., and Kanit, R. (2006). “Learning seismic design from the earthquake itself.” *ASCE Practice Periodical on Structural Design and Construction*, 11(3), 149-160.

[4] Bathe, K.J. (1996). “Finite element procedures.” Prentice-Hall, Upper Saddle River, New Jersey.

[5] Charney, F.A. (2008). “Unintended consequences of modeling damping in structures.” *ASCE Journal of Structural Engineering*, 134(4), 581-592.

[6] Chopra, A. (2006). “Dynamics of structures: Theory and application to earthquake engineering.” 3rd Ed., Prentice-Hall, Englewood Cliffs, New Jersey, USA.

[7] Clough, R.W., and Penzien, J. (2003). “Dynamics of structures.” McGraw-Hill Book Co, New York, USA.

[8] Derecho, A.T, Ghosh, S.K., Iqbal, M., and Fintel, M. (1979). “Strength, stiffness, and ductility required in reinforced concrete structural walls for earthquake resistance.” ACI Structural Journal, 76(37), 875-896.

[9] Elnashai, A., Pilakoutas, K., and Ambrayses, N. (1990). “Experimental behavior of reinforced concrete walls under earthquake loading.” Jo*urnal of Earthquake Engineering and Structural Dynamics,* 43(11-12), 861-869.

[10] Farvashany, F.E., Foster, S.J., and Vijaya Rangan, B. (2008). “Strength and deformation of high-strength concrete shearwalls.” *ACI Structural Journal*, 105(1), 21-29.

[11] Fintel, M. (1977). “Performance of buildings with shear walls in earthquakes of the last thirty years.” *PCI Journal*, 95(2), 62-71.

[12] Ghorbanirenani, I., Tremblay, R., Leger, P., and Leclerc, M. (2012). “Shake table testing of slender RC shear walls subjected to Eastern North America seismic ground motions.” *ASCE Journal of Structural Engineering*, 138(12), 1515-1529.

[13] Helmut K. (2007). “Importance of good non-linear Analysis.” The Structural Design of Tall and Special Buildings, 15(5), 515-531. 14. IBC (2000). “*International Building Code.” International Conference of Building Officials,* Whittier, California.

[14] IS 13920 (1993). “Ductile detailing of reinforced concrete structures subjected to seismic forces.” Bureau of Indian Standards, New Delhi, India.

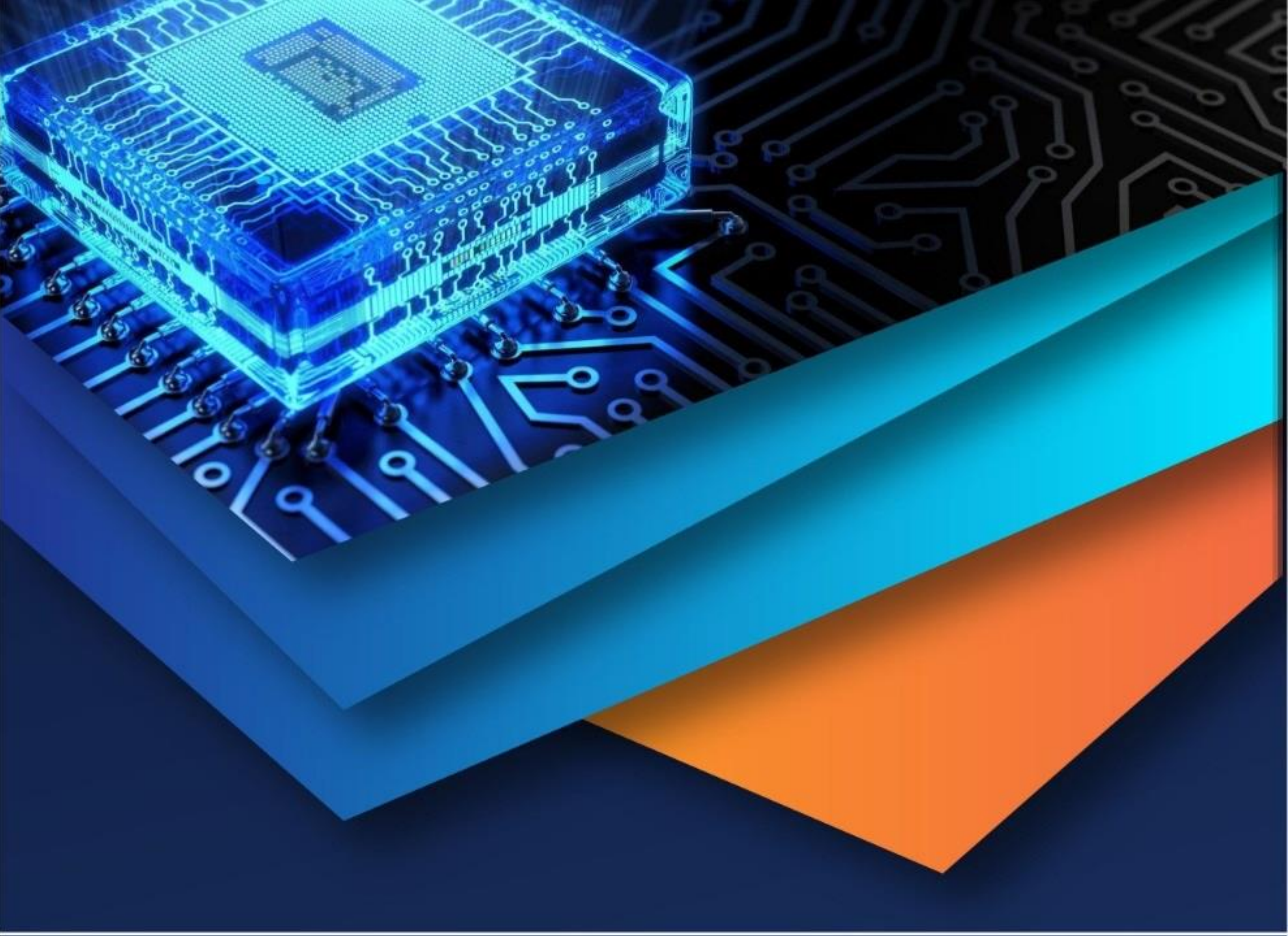
[15] IS 4326 (1993). “Earthquake resistant design and construction of buildings.” Bureau of Indian Standards, New Delhi, India.

[16] Kato, D., Kabeyasawa, T., Otani, S., and Aoyama, H. (1995). “Earthquake resistant design of shear walls with one opening.” *ACI Structural Journal*, 92(4), 495-501.

[17] Klinger, R.E., McLean, D.I., and Shing, P.B. (2012). “Masonry versus reinforced concrete shear walls- should they be designed differently.” *Structures Congress*, 1131-1142.

[18] Lefas, I.D., Kotsovos, M.D., and Ambraseys, N.N. (1990). “Behavior of reinforced concrete structural walls: Strength, deformation characteristics, and failure mechanism.” ACI Structural Journal, 87(1), 23-31.

[19] Michael, G., and Dickson, T., and Nilson, A.H. (1970). “Analysis of cellular buildings for lateral loads.” *ACI Structural Journal*, 67(12), 963-966.



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