iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** III **Month of publication:** March 2021

DOI: https://doi.org/10.22214/ijraset.2021.33188

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue III Mar 2021- Available at www.ijraset.com

Comparison of Different Types of RCC Bracing with Shear Wall in High Rise Building

Abhishek Jain[1], Prof. Kavita Golghate[2]
[1]PG Student, [2]Professor, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore (MP), India

***Abstract:** Tall buildings are subjected to horizontal movement or deflection under the impact of earthquake loads. To prevent lateral movement of the structure, the structure should be rigid enough to support the lateral load. The bracing system is a system provided to minimize the lateral deflection of the structure. The members of the braced frame are subjected to tension and compression, so they are provided to withstand these forces similar to a gantry. Different types of bracing approaches are applied according to the mechanism.*

The Articles deals with comparative study of different types of bracing using a G+15 Storey. The plinth area taken as 30m x 24 m (rectangular section pattern) i.e. 720m^2. The Structural parameters are used in three different stage levels which storey as per the need of the structure. The earthquake response can evaluate by using response spectrum method into it. The zone V. Etabs software mechanism is used for the modelling and analysed by Response Spectrum Analysis. To Analysis of structure based on varying the bracing types such X, V and combination of both are used in model 2 to 4. Model 1 taken as reference model as a rigid frame structure. Model 5 is Resisting Frame with shear wall System. The final conclusion made such that model 4 is the safest and most economical from the all the five models analyses

***Keywords:** Tall Buildings, X, V Bracing, zone V, Response Spectrum Method, Etabs software*

I. INTRODUCTION

During earthquake motions, deformations take position across the elements of the weight-bearing method as a result of the response of constructions to the ground motion. Because of these deformations, interior forces boost across the factors of the load-bearing approach and displacement behaviour seems across the building. The consequent displacement demand varies relying on the stiffness and mass of the constructing. As a rule, buildings with higher stiffness and diminish mass have smaller horizontal displacements demands. On the contrary, displacement needs are to increase. Then again, every building has a specific displacement potential. In different words, the quantity of horizontal displacement that a building can have the funds for without collapsing is restricted. The reason of strengthening ways is to ensure that the displacement demand of a constructing is to be kept beneath its displacement potential. It will most commonly be finished by means of decreasing anticipated displacement demand of the constitution for the period of the strong motion or improving the displacement ability of the constitution. To oppose lateral earthquake loads, shear dividers are normally utilized in RC confined structures, while, steel propping is the regularly utilized in steel structures. In the previous two decades, various reports have likewise demonstrated the compelling utilization of steel propping in RC outlines. A Bracing is a system that is provided to minimize the lateral deflection of structure. The members of a braced frame are subjected to tension and compression, so that they are provided to take these forces similar to a truss A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression. The beams and columns that form the frame carry vertical loads, and the bracing system carries the lateral loads. The positioning of braces, however, can be problematic as they can interfere with the design of the façade and the position of openings. Buildings adopting high-tech or post-modernist styles have responded to this by expressing bracing as an internal or external design feature.

II. METHODOLOGY AND MODELLING

The modelling of the structure is done by using engineering software Etabs. The different type of moment resisting frames considered for analysis is as follows;

1) Moment Resisting Frame (Model 1)
2) Moment Resisting Frame with RCC V-Bracing System (Model
3) Moment Resisting Frame with RCC X-Bracing System (Model
4) Moment Resisting Frame with X-Bracing along X-direction and V-Bracing along Y-direction (Model 4)
5) Moment Resisting Frame with shear wall System (Model 5)

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A. Building Configuration and Data

Table 1 represents the Structure Details of a Building, Table 2: Concrete Property, Table 3 is for Seismic Parameters.

Table 1: Structure Details of a Building

Plan size	30m x 24m
No. of bays along X	5
No. of bays along Y	6
Bay length along X	6m.
Bay length along y	4m.
No. of storey	G+15
Height of storey	3.0 meters
Total height of the building	48 meters
Concrete grade	M30
Steel grade	Fe 500
Size of column, At edge and corner, At interior	0.60m x 0.60 m, 0.45m x 0.45m
Size of beam: Along 6 m. span , Along 4m span	0.45m x 0.60m. 0.30m x 0.45m
Size of bracing	0.4m x 0.4m
Shear wall thickness	0.250 m
Thickness of slab	0.125m

Table 2: Concrete Property

Concrete		
Density	Modulus Of Elasticity	Poisson ratio
24.2kN/m^3	21.72 GPa	0.3

Table 3: Seismic Parameters

Seismic zone	V
Importance factor	1.2
Response reduction factor	5
Soil type	medium

B. Models Descriptions

Fig 1 to 5 shows the plan and3Dview with bracing system.

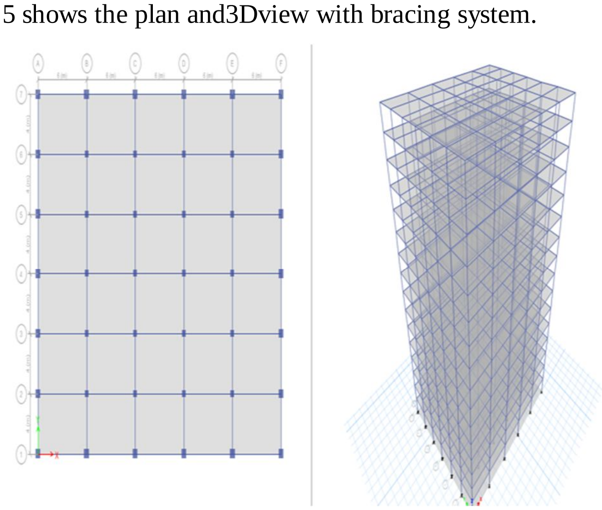

Fig1: Model 1: Moment Resisting Frame

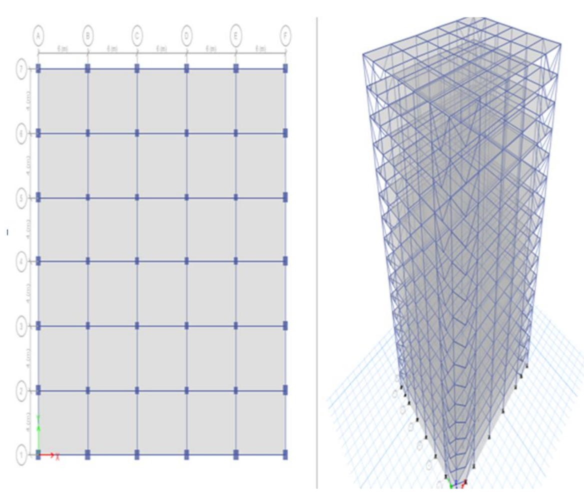

Fig2: Model 2: Moment Resisting Frame with RCC V-Bracing System

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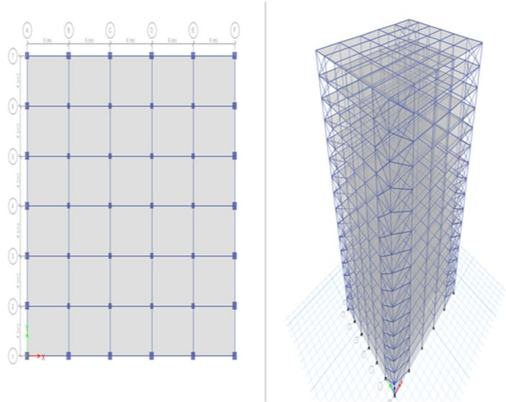

Fig 3 : Model 3: Frame with RCC X-Bracing System

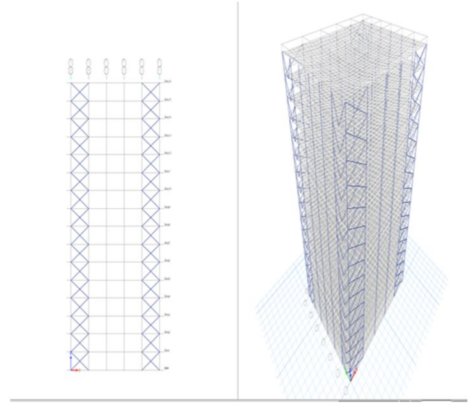

Fig4: Model 4; Frame with X-Bracing along X and V-Bracing along Y-dir.

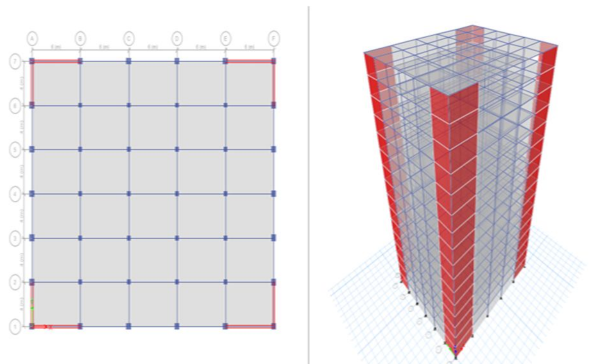

Fig 5: Model 5: Moment Resisting Frame with shear wall System

III. RESULT AND DISCUSSIONS

The modelling of G+15 storey building with X, V bracing and shear wall models the following basic parameters are to be evaluated**.**

A. Parameter 1: Base Shear Results

Table 4: Comparison of base shear of model 1 and model 2

	MODEL 1(MRF)	MODEL 2 (V-BRACE)
Story16	528.6062	911.464
Story15	988.9154	1649.031
Story14	1337.0208	2152.5877
Story13	1591.0536	2445.6018
Story12	1796.2789	2584.7344
Story11	1985.9322	2645.6365
Story10	2164.679	2698.7273
Story9	2328.0421	2788.0538
Story8	2480.6106	2930.6488
Story7	2628.4353	3133.3218
Story6	2766.635	3402.2438
Story5	2888.6564	3732.8017
Story4	3004.4444	4094.9461
Story3	3134.0338	4431.2263
Story2	3274.8624	4686.9836
Story1	3382.3194	4818.6875
Base	0.00	0.00

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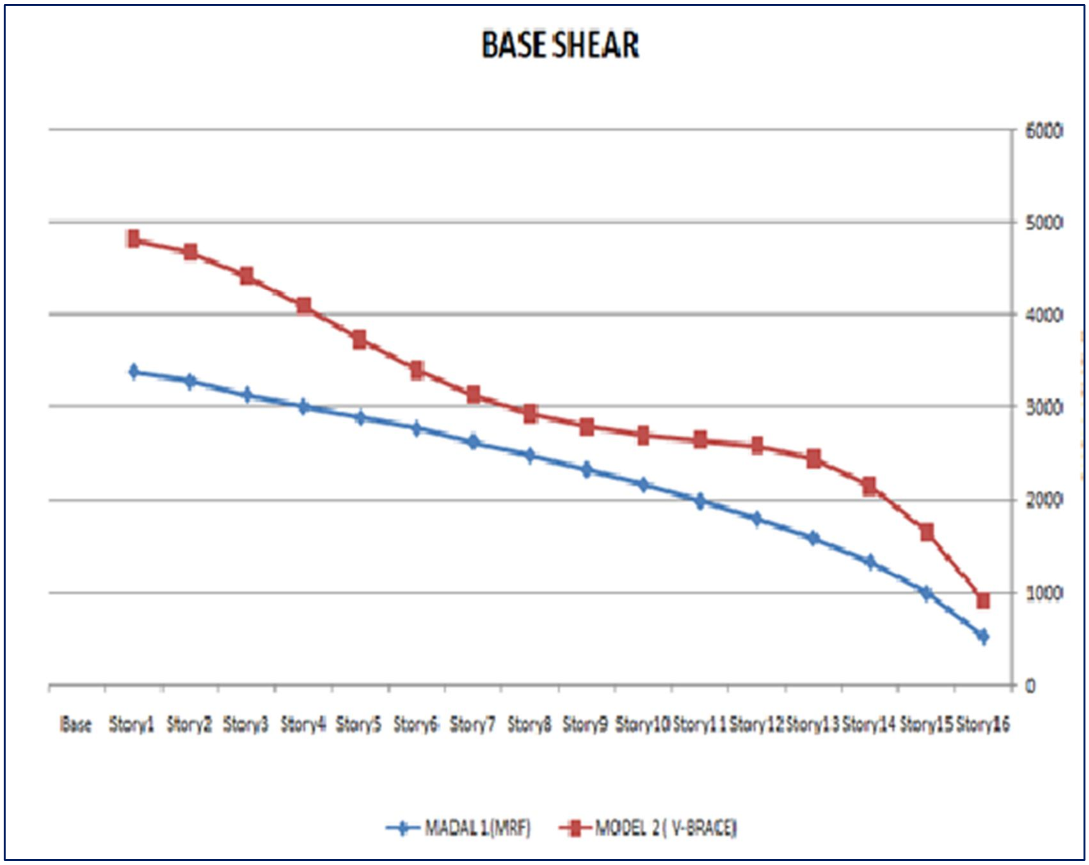

Fig 6: Graphical Representation of Base Shear of model 1 and model 2

Table 5: Comparison of base shear of model 2 and model 3

	MODEL 2 (V-BRACE)	MODEL 3(X - BRACE)
Story16	911.464	972.9562
Story15	1649.031	1755.3652
Story14	2152.5877	2282.0653
Story13	2445.6018	2581.0781
Story12	2584.7344	2715.2359
Story11	2645.6365	2767.88
Story10	2698.7273	2817.7154
Story9	2788.0538	2915.5383
Story8	2930.6488	3081.3539
Story7	3133.3218	3320.3139
Story6	3402.2438	3632.7915
Story5	3732.8017	4006.2134
Story4	4094.9461	4403.6955
Story3	4431.2263	4764.361
Story2	4686.9836	5034.6636
Story1	4818.6875	5174.0649
Base	0.00	0.00

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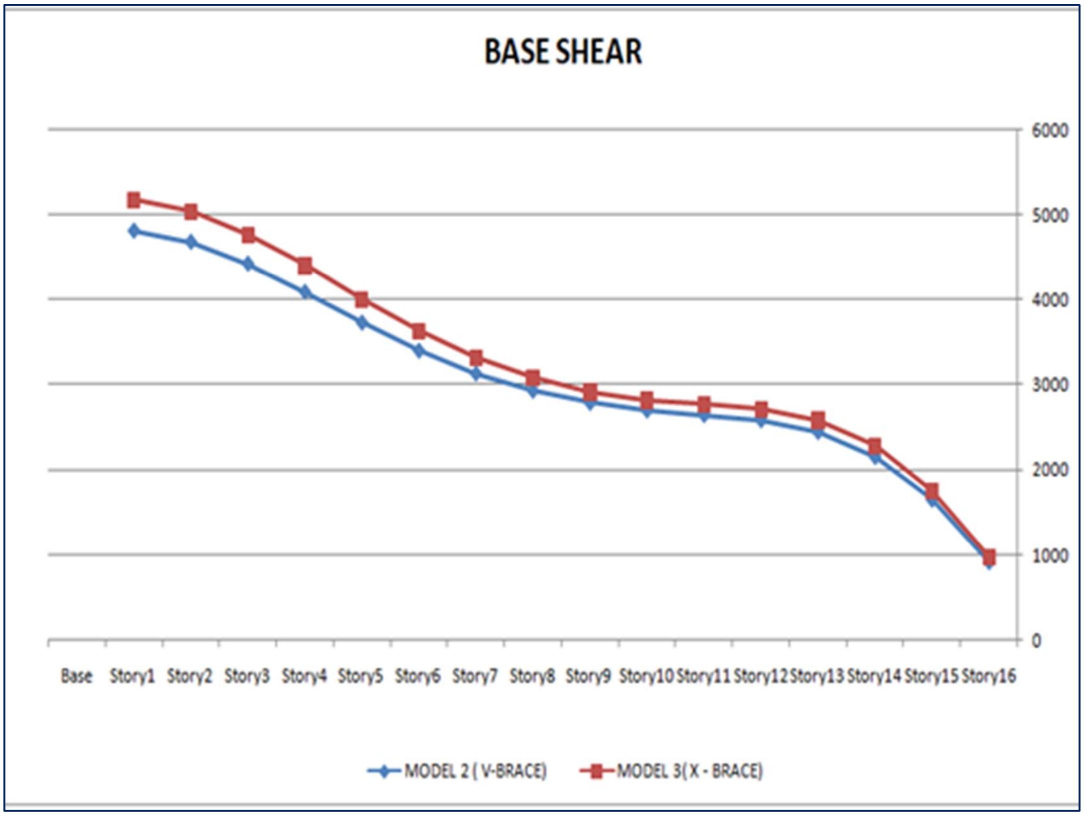

Fig 7: Graphical Representation of Base Shear of model 2 and model

Table 6: Comparison of base shear of model 3 and model 4

	MODEL 3(X - BRACE)	MODEL 4 (X+V BRACE)
Story16	972.9562	1063.7223
Story15	1755.3652	1942.4689
Story14	2282.0653	2560.2835
Story13	2581.0781	2942.1473
Story12	2715.2359	3148.8276
Story11	2767.88	3261.3682
Story10	2817.7154	3356.1361
Story9	2915.5383	3483.7194
Story8	3081.3539	3667.2122
Story7	3320.3139	3916.3253
Story6	3632.7915	4235.5111
Story5	4006.2134	4615.3345
Story4	4403.6955	5020.6174
Story3	4764.361	5393.3285
Story2	5034.6636	5671.9448
Story1	5174.0649	5816.2757
Base	0.00	0.00

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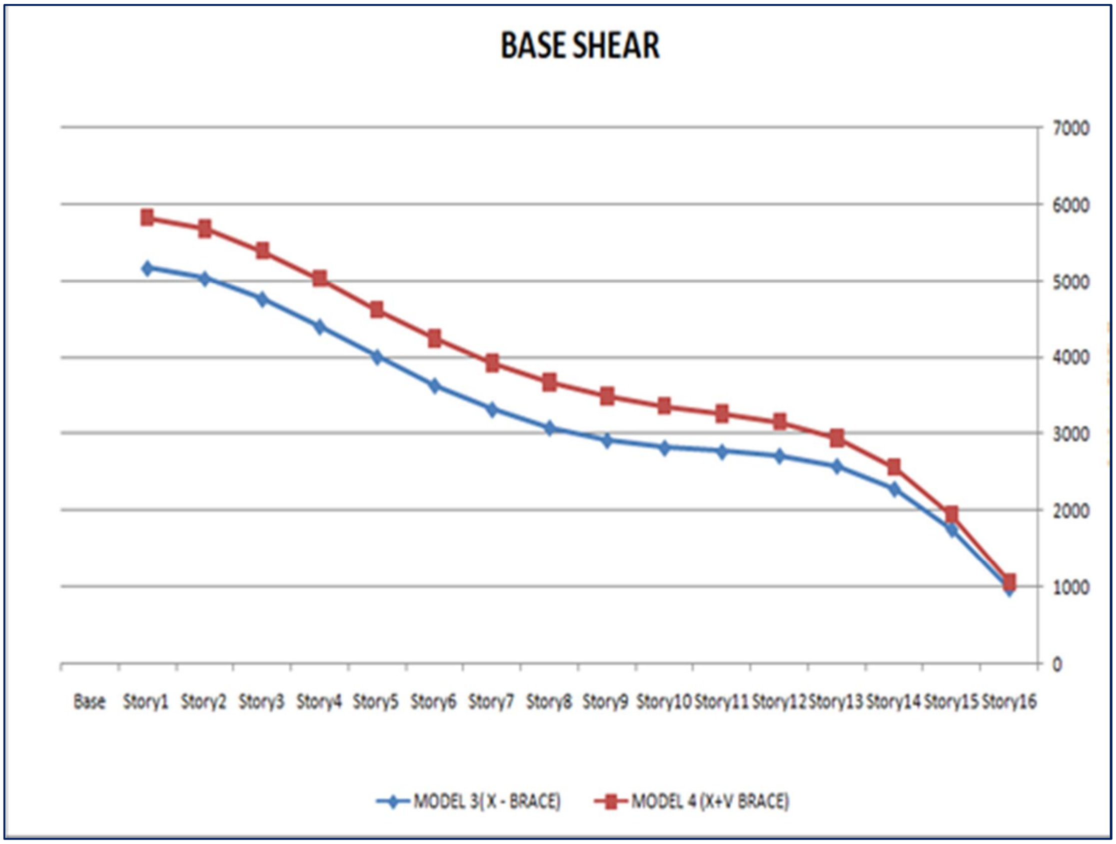

Fig. 8: Graphical Representation of Base Shear of model 3 and model 4

Table 7: Shows the comparison of base shear of model 4 and model 5

	MODEL 4 (X+V BRACE)	MODEL 5(SHEAR WALL)
Story16	1063.7223	1318.0195
Story15	1942.4689	2434.043
Story14	2560.2835	3256.6886
Story13	2942.1473	3814.048
Story12	3148.8276	4158.5918
Story11	3261.3682	4369.2532
Story10	3356.1361	4543.6407
Story9	3483.7194	4775.4748
Story8	3667.2122	5121.7664
Story7	3916.3253	5582.0053
Story6	4235.5111	6107.263
Story5	4615.3345	6628.0696
Story4	5020.6174	7079.6913
Story3	5393.3285	7416.9649
Story2	5671.9448	7621.4391
Story1	5816.2757	7705.4926
Base	0.00	0.00

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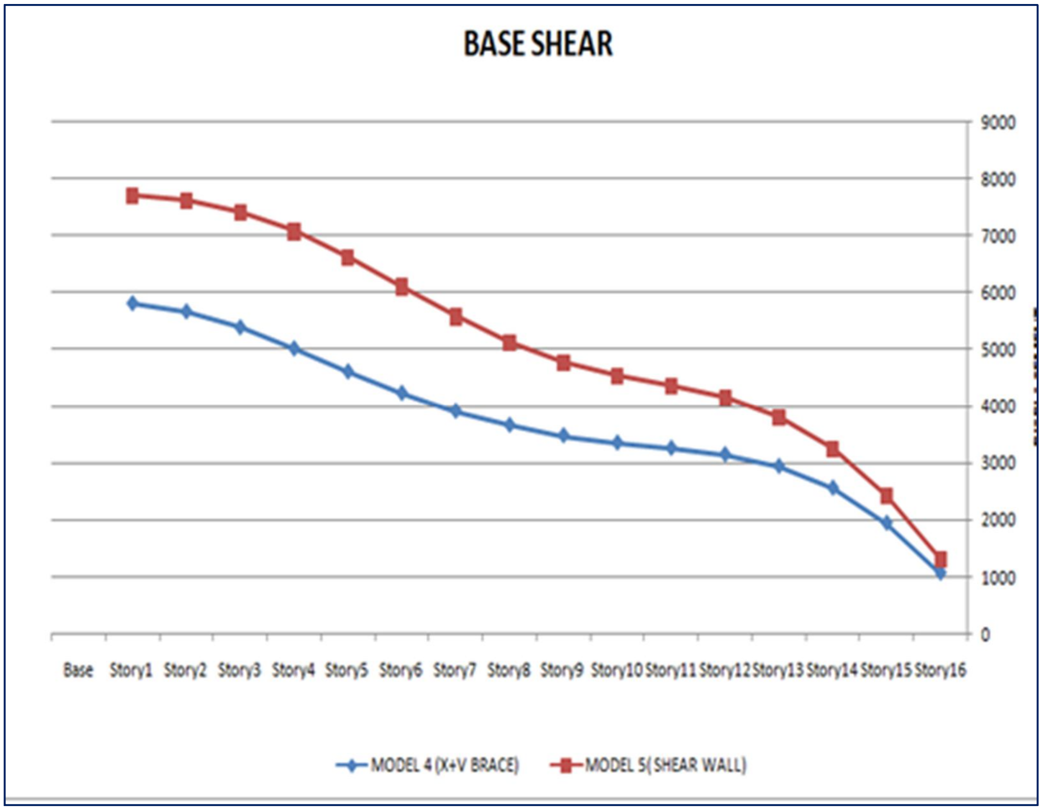

Fig. 9: Graphical Representation of Base Shear of model 4 and model 5

B. Parameter 2: Storey Displacement

Table 8: comparison of displacement of model 1 and model 2

	MODEL 1(MRF)	MODEL 2 (V-BRACE)
Story16	70.39	49.335
Story15	69.44	46.269
Story14	67.98	43.006
Story13	65.97	39.66
Story12	63.46	36.259
Story11	60.48	32.827
Story10	57.06	29.392
Story9	53.22	25.97
Story8	49.01	22.578
Story7	44.42	19.231
Story6	39.50	15.949
Story5	34.24	12.758
Story4	28.67	9.692
Story3	22.77	6.802
Story2	16.47	4.164
Story1	9.40	1.889
Base	0.00	0.00

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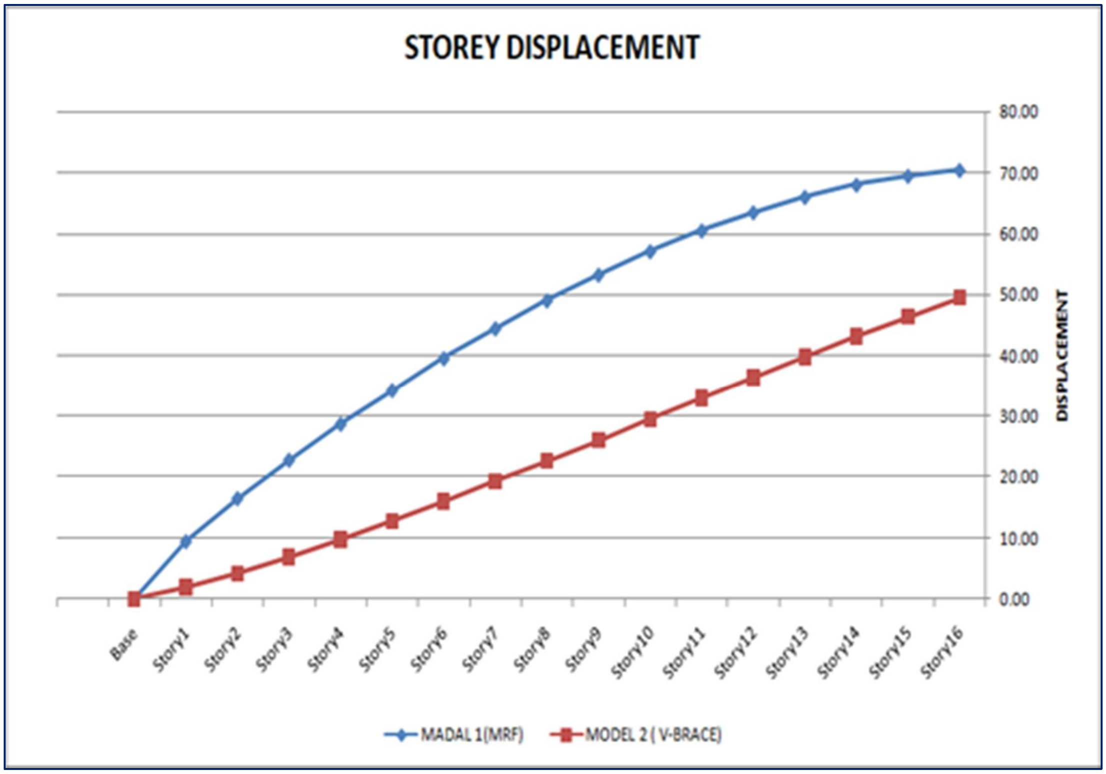

Fig. 10: Graphical Representation of Displacement of model 1 and model 2

Table 9: comparison of displacement of model 2 and model 3

	MODEL 2 (V-BRACE)	MODEL 3(X - BRACE)
Story16	49.335	47.62
Story15	46.269	44.51
Story14	43.006	41.22
Story13	39.66	37.87
Story12	36.259	34.47
Story11	32.827	31.06
Story10	29.392	27.65
Story9	25.97	24.28
Story8	22.578	20.95
Story7	19.231	17.69
Story6	15.949	14.52
Story5	12.758	11.47
Story4	9.692	8.57
Story3	6.802	5.89
Story2	4.164	3.51
Story1	1.889	1.55
Base	0.00	0.00

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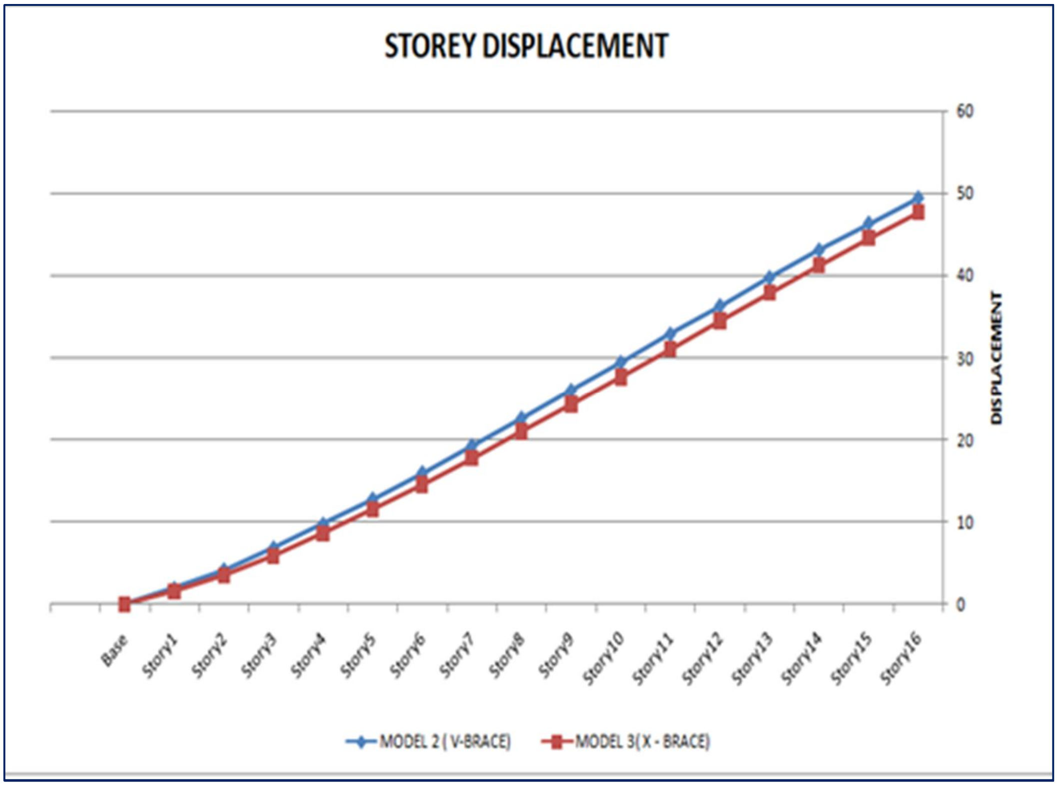

Fig. 11: Graphical Representation of Displacement of model 2 and model 3

Table 10: comparison of displacement of model 3 and model 4

	MODEL 3(X - BRACE)	MODEL 4 (X+V BRACE)
Story16	47.62	44.204
Story15	44.51	41.595
Story14	41.22	38.794
Story13	37.87	35.896
Story12	34.47	32.917
Story11	31.06	29.879
Story10	27.65	26.806
Story9	24.28	23.714
Story8	20.95	20.622
Story7	17.69	17.548
Story6	14.52	14.514
Story5	11.47	11.551
Story4	8.57	8.704
Story3	5.89	6.034
Story2	3.51	3.631
Story1	1.55	1.636
Base	0.00	0.00

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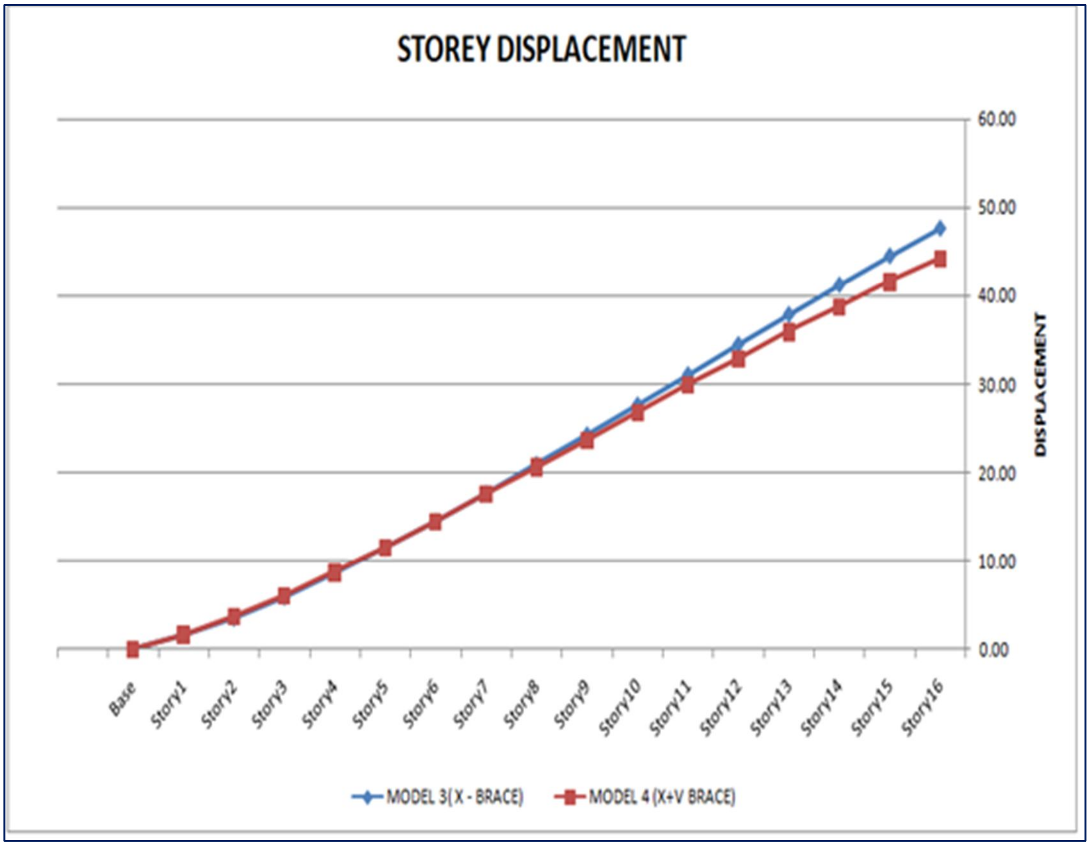

Fig. 12: Displacement of model 3 and model 4

Table 11: Comparison of displacement of model 4 and model 5

	MODEL 4 (X+V BRACE)	MODEL 5(SHEAR WALL)
Story16	44.204	39.51
Story15	41.595	36.66
Story14	38.794	33.66
Story13	35.896	30.64
Story12	32.917	27.59
Story11	29.879	24.54
Story10	26.806	21.51
Story9	23.714	18.53
Story8	20.622	15.62
Story7	17.548	12.81
Story6	14.514	10.14
Story5	11.551	7.64
Story4	8.704	5.38
Story3	6.034	3.40
Story2	3.631	1.79
Story1	1.636	0.65
Base	0.00	0.00

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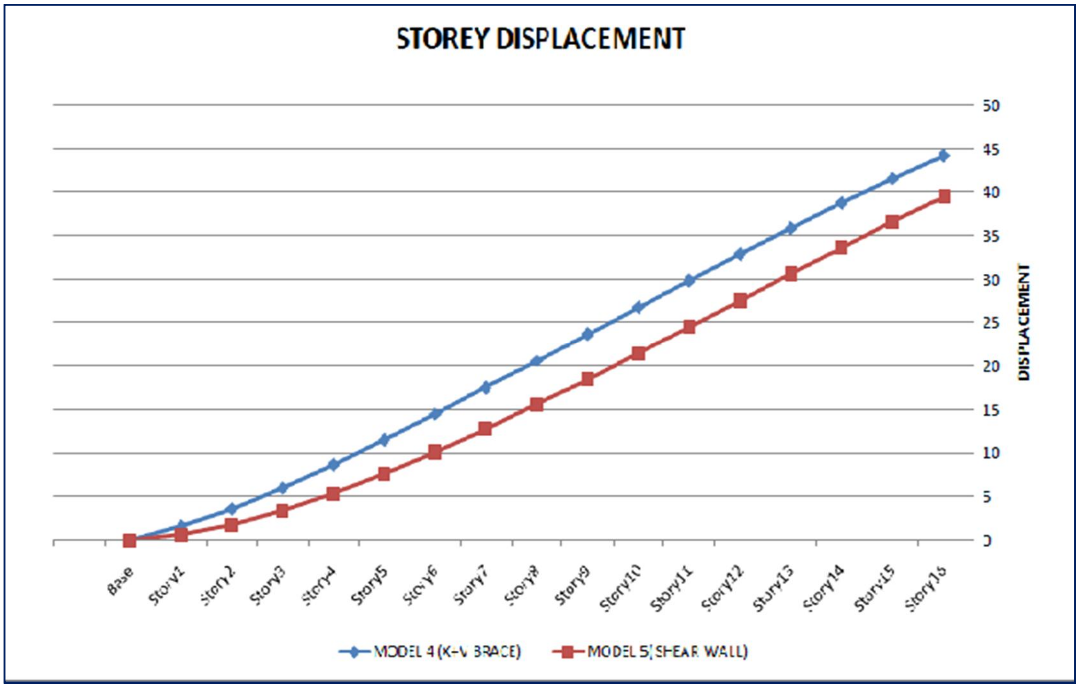

Fig. 13: Graphical Representation of Displacement of model 4 and model 5

IV. CONCLUSIONS

In this study the different models based on the use and location of shear walls and RCC X-Bracing system, RCC V-Bracing system were studied and the seismic parameters in terms of base shear and storey displacement were compared. The following conclusions are made based on the post analysis results:

A. In high rise buildings, the parameters like lateral strength and stiffness are more important. So for this purpose shear walls and RCC bracing system are adopted to enhance both these parameters. Moment resisting frames show higher storey displacement thus are weak as compared to other MRFs stiffened with shear wall and RCC bracing system.
B. The base shear of buildings with shear wall and RCC bracing system is more as compared to the buildings without shear wall and bracing system which results in the increase of stiffness of building.
C. The storey displacement of the building is reduced by the use of shear wall and RCC bracing system.
D. The top storey displacement for model 2 (The RCC V-bracing system paced at the 4 corners on both transverse as well as longitudinal bays) is reduced by 34.2 %, for model 3 (The RCC X-bracing system paced at the 4 corners on both transverse as well as longitudinal bays) is reduced by 34.3 %, and for model 4 (MRF stiffened with RCC V-bracing system and RCC X-bracing system) is reduced by 37.12% for model 5 (MRF stiffened with shear wall system) is reduced by 43.81% when compared to bare MRF.
E. It is concluded that the storey displacement in case of structures stiffened with shear walls (Model 5) is more as compared to structures stiffened with either RCC V-Bracing system, X -Bracing system or both RCC V-Bracing system and RCC X-Bracing system in lower storeys (storey1-10).
F. The model 4 and model 5 are the safest and show least storey displacement.
G. It is found that the RCC bracing also increases the primary strength of the structure.
H. The most effective relative locations of RCC X-bracing system and RCC V-bracing system is provided in Model 4.
I. The model 4 is the safest and most economical of all the five models analyses.

Dynamic analysis (Response spectrum Method) reduces storey displacement, storey drift etc; this shows that dynamic analysis gives improved estimate of forces and therefore analysis of building become more accurate as well as economical. As per new IS 1893-2016 Equivalent static analysis shall be applicable for regular buildings with height < 15m in seismic Zone II. i.e. Dynamic analysis is compulsory for almost all buildings in all zones.

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V. ACKNOWLEDGEMENTS

I extend my deepest gratitude to Prof. Kavita Golghate, Professor, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore, (M.P.) for providing all the necessary data for current research, facilities and feel thankful for his innovative ideas, which led to successful completion of this work.

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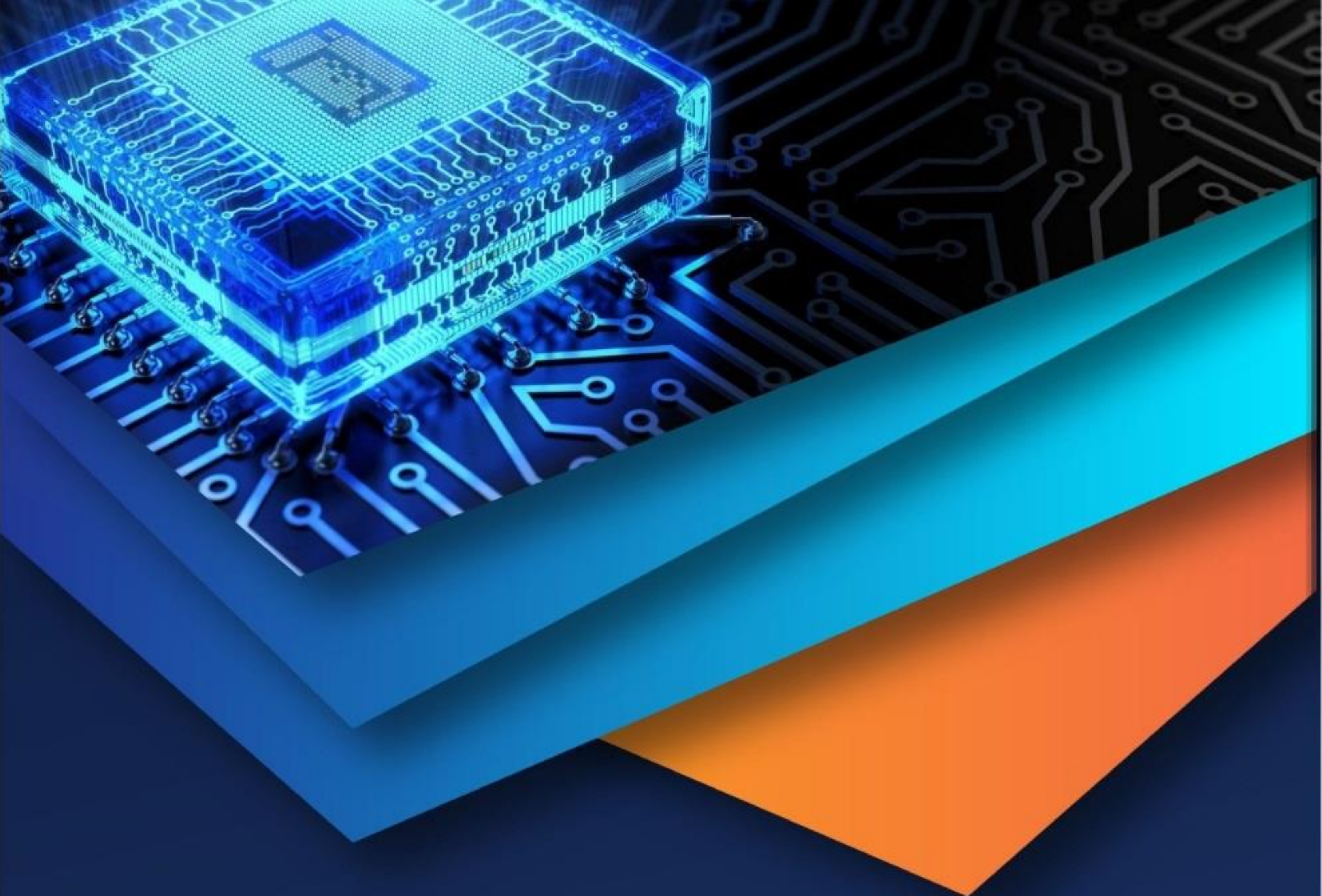

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