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Analysis of Beam-Column Joint subjected to Seismic Lateral Loading

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Abstract: In reinforced concrete structures, portions of columns that are common to beams at their intersections are called Beam-Column Joint. Beam-column joint is an important part of reinforced concrete frames in terms of seismic lateral loading. The two major failure at joints are, joint shear failure and end anchorage failure. As we know that nature of shear failure is brittle so the structural performance cannot be accepted especially in seismic conditions. In past decades, shear walls are one of the most appropriate and important structural component in multi-storied building. Therefore, it would be very interesting to study the structural response and their systems in multi-storied structure. Shear walls contribute the stiffness and strength during earthquakes which are often neglected during design of structure and construction. The scope of present work is to study the effect of seismic loading on placement of shear wall in building at different alternative location. This study presents analysis of beam-column joint of the structure as well as the effect of shear walls which significantly affect the vulnerability of structures. In order to test this hypothesis, G+10 storey building is considered with and without shear walls. Equivalent Static Coefficient Method is used for dynamic analysis and structure was assumed to be situated in zone IV. As the building with shear wall and without shear wall is analyzed for seismic forces in X and Z direction the following results were found for the load combination of 1.2 (DL + LL + EQ X) for earthquake forces in X direction and 1.2 (DL + LL + EQ Z) for earthquake forces in Z direction. Some parameter like node displacements, axial forces, bending moment, shear force and deflection of a structure are determined by using STAAD Pro software and comparison is made for models with shear wall and without shear wall structures. From the comparison of results, it has been observed that the bending moment, shear force and deflection in corner column, middle column and central column are minimum in structure having shear wall as compared to simple frame building. The bending moment, shear force and deflection in beams at all levels is minimum having shear wall in periphery in comparison to simple frame building. The max. Bending moment, shear force and deflection of structure having shear wall is less as compared to simple frame building.

Key words: Beam-Column Joint, Shear Failure, Seismic Action, Moment Resisting Frame Reinforced Concrete Frames, Shear Reinforcement, Shear Wall, Staddpro.

I. INTRODUCTION

Nowadays, it has become important to study the effect of shear walls on earthquake design structure. Structures are subjected to earthquake shaking at their base oscillate back and forth in all three directions. Under low levels of shaking, their amplitudes of shaking and directions of shaking are dependent on how they are proportioned geometrically and in terms of stiffness throughout the building in plan and elevation. Under strong earthquake shaking, buildings undergo damage also. Controlling the damage type and sequence of damage in various structural elements is the main focus of earthquake-resistant design. It is possible to get a reasonable understanding of the overall mechanism of failure of the building by suitable nonlinear static analysis. Many deficiencies discussed in this document can be identified at the design stage itself, and the structural configurations and design and detailing of members modified to make the building resist the earthquake effects generated in the building during strong earthquake shaking. An earthquake resistant building is able to accumulate a lot of energy without major failure. It will swing and sway and it might be damaged. But it would not collapse before giving very visible signs. Therefore, people would be able to leave the building before it would collapse. An earthquake resistant building, which has been damaged, could most of the time be repaired.

A. Earthquake

Earthquake cause random motion of ground which can be resolved in any three mutually perpendicular direction s. This motion cause the structure to vibrate. The predominant direction of vibration is horizontal. Since the design vertical forces proposed in the Code (IS:1893) are small as compared to the acceleration due to gravity, the emphasis has not been given to vertical forces as compared to horizontal forces. However, the Code emphasizes that in case of structures where stability is a criterion for design, vertical seismic forces must be considered. The vibration intensity of ground expected at location depends upon the magnitude of earthquake, the depth of focus, distance from the epicenter and the strata on which the structure stands. The important structures shall be designed for the maximum vibration intensity expected at the place. The response of the structure to the ground vibration is a function of the nature of foundation soil, form, size and mode of construction of the structure and the duration and the intensity of ground motion.

B. Earthquake in India

1) *Zone I and II:* This region is liable to MSK VI or less and is classified as the load Damaged Risk Zone. The IS code assigns zone factor of 0.10 for zone I and II. Areas: Rest of the country.
2) *Zone III :* The Andaman and Nicobar Island, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII and also 7.8. The IS code assigns zone factor of 0.16 for Zone III.

a) *Areas:* The Andaman Nicobar Islands, some parts of Kashmir and Western Himalayan plains.

3) *Zone IV:* This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns factor of 0.24 for Zone IV.
4) *ZoneV :* Zone V covers the areas with the highest risk zone that suffers earthquake of intensity MSK IX or greater. The IS code assigns zone factor of 0.36 for Zone V.

Areas: Punjab, The state of Kashmir, the North-East Indian region, Rann of Kutch and the western and central Himalayas.

C. Beam-Column Joint

In RC buildings, portions of columns that are common to beams at their intersections are called Beam-Column Joints. Since their constituent materials have limited strengths, the joints have limited force carrying capacity. When forces larger than these are applied during earthquakes, joints are severely damaged. Repairing damaged joints is difficult, and so damage must be avoided. Thus, beam-column joints must be designed to resist earthquake effects.

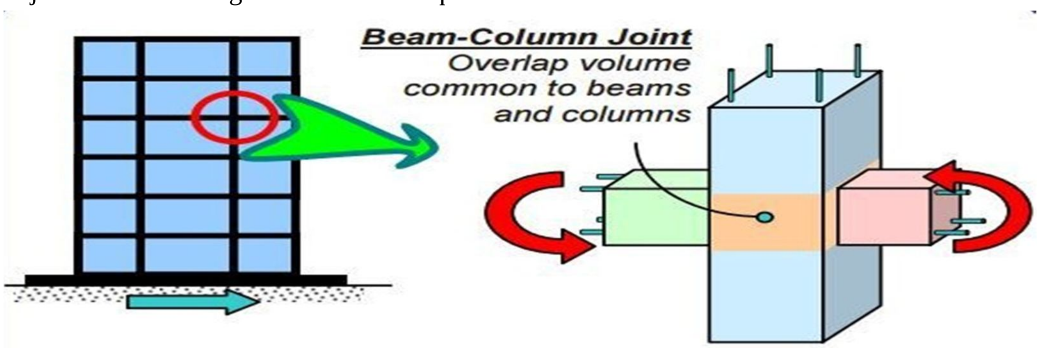

Fig. 1 Beam-column joints are critical parts of a building- they need to be designed.

As a consequence, seismic moments of opposite signs are develop in columns above and below the joints and at the same time beam moment reversal across the joints. A horizontal and vertical shear force whose magnitude is many times higher than in the adjacent beams and columns developed at the joint region. If not design for, joint failure can result.

Under the action of seismic forces, beam-column connections are subjected too large shear stresses in the joint region. These shear stresses are a result of moments and shear forces of opposite signs on the member ends on either side of the joint core. Typically, high bond stresses are also imposed on reinforcement bars entering into the joint. The axial compression in the column and joint shear stresses result in principal tension and compression stresses that lead to diagonal cracking and or crushing of concrete in the joint core.

D. Types of Joints

The

1) joint is defined as the portion of the column within the depth of the deepest beam that frames into the column.
2) *According to loading conditions and structural behavior:*

a) Type-I
b) Type-II

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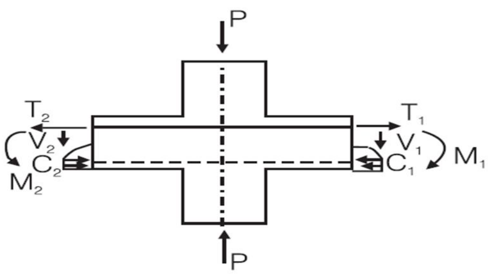
E. Interior Joint

When four beams frame into the vertical faces of a column, the joint is called as an **interior joint**.



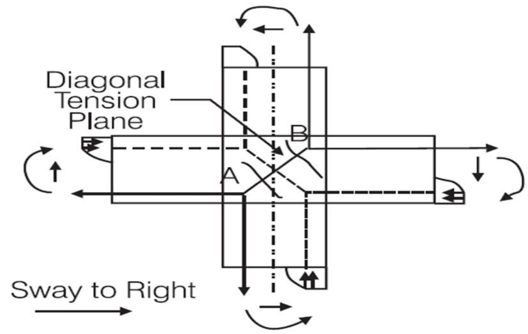
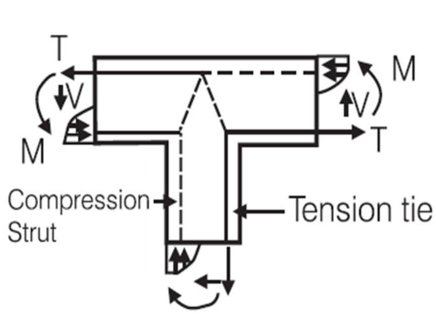
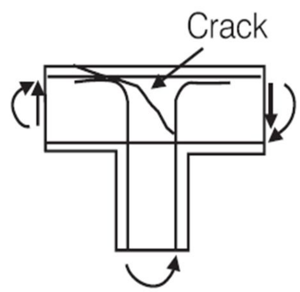


Fig. 2 (a) Gravity loading, Fig. 4 (b) Seismic loading

F. Exterior Joint

When one beam frames into a vertical face of the column and two other beams frame from perpendicular directions into the joint, then the joint is called as an exterior joint.





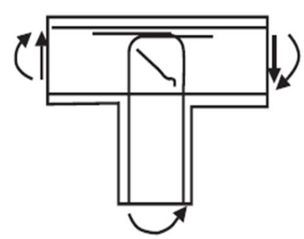


Fig. 3 T-Joints (a) Forces and strut-and-tie model, Fig. 5 (b) poor detail, Fig. 5 (c) Satisfactory detail

G. Corner Joint

When a beam each frames into two adjacent vertical faces of a column, then the joint is called as a corner joint.

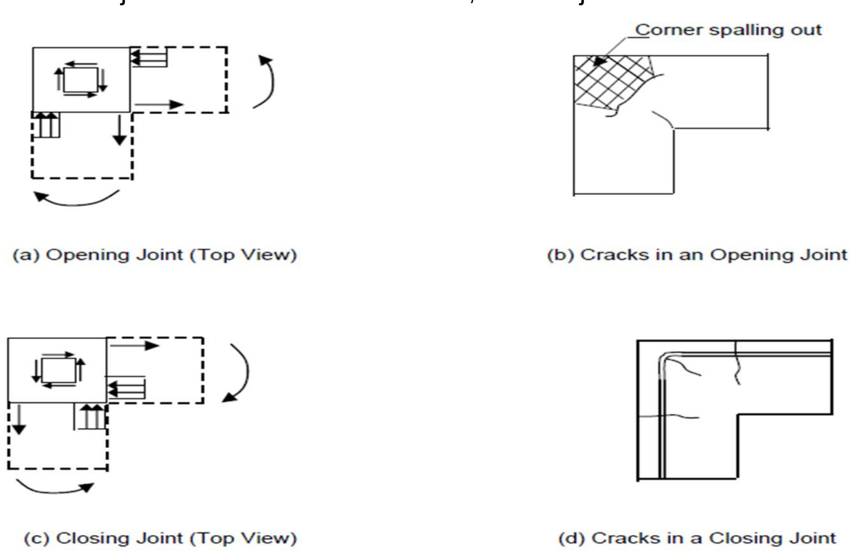


Fig. 4 Corner Joint

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In a moment resisting frame, three types of joints can be identified viz. Interior Joint, Exterior Joint and Corner Joint (Fig. 7).

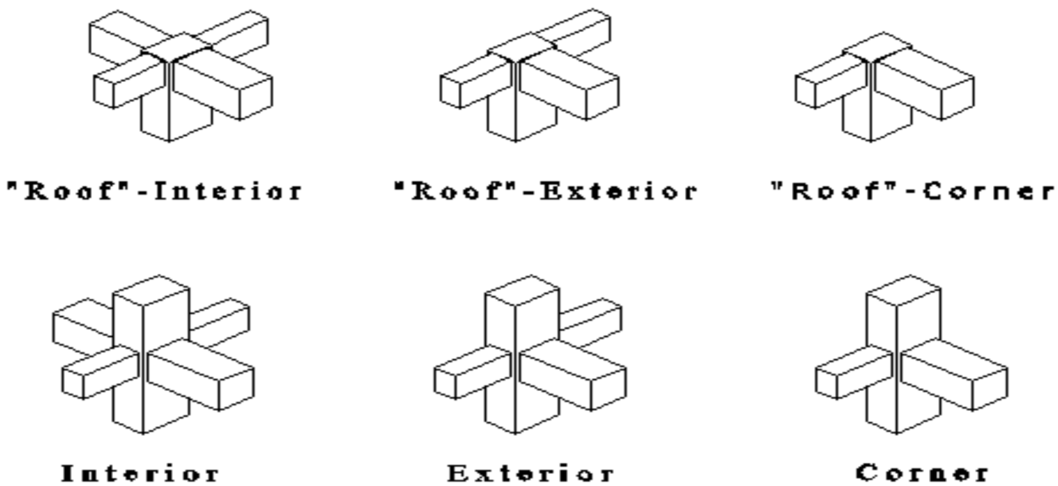

Fig. 7 Typical Beam-Column Joints

H. Introduction of Shear Wall

Shearwall is a structural member positioned at different places in a building from foundation level to top parapet level, used to resist lateral forces i.e. parallel to the plane of the wall. When lateral displacement is large in a building with moment frames only, structural walls, often commonly called shear walls, can be introduced to help reduce overall displacement of buildings, because these vertical plate-like structural elements have large in-plane stiffness and strength.

Shear walls resist lateral forces through combined axial-flexure-shear action. Earthquake resistant buildings should possess, at least a minimum lateral stiffness, so that they do no swing too much during small levels of shaking. Moment frame buildings may not be able to offer this always. Also, structural walls help reduce shear and moment demands on beams and columns in the moment frames of the building, when provided along with moment frames as lateral load resisting system. Shear walls should be provided throughout the height of buildings for best earthquake performance. Also, shear walls offer best performance when rested on hard soil strata. Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes.

Well-designed shear walls not only provide adequate safety but also provide great measure of protection against costly nonstructural damage during moderate seismic damages. Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings. Under the large overturning effects caused by horizontal earthquake forces, edges of shear walls experience high compressive and tensile stresses. To ensure that shear walls behave in a ductile way, concrete in the wall end regions must be reinforced in a special manner to sustain these load reversals without losing strength.

I. Purpose of Constructing Shear Walls

Shear walls are not only designed to resist gravity i.e. due to its self-weight and other living / moving loads, but they are also designed for lateral loads of earthquakes and wind. Shear wall systems are more stable as their supporting area with reference to total area of building, is comparatively more, as compare to RCC framed structures. Shear walls should resist the uplift forces caused by the pull of the wind. It should resist the shear forces that try to push the walls over. Shear walls are very much quick in construction, as the method adopted to construct is concreting the members using formwork. Shear walls does not need any extra plastering or finishing as the wall itself gives such a high level of precision.

J. Objectives of Project

1) To analyse beam-column joint for seismic forces.
2) To do critical analysis of beam-column joint primarily considering three positions which are interior joint, exterior joint, corner joint.

3) To find out nodal displacements at beam-column joint for all three joint.
4) To compare axial force, shear force and bending moments for different types of beam-column joints with and without shear wall.

II. METHODOLOGY

Analysis of any structure for resisting earthquake is the basic need of this study. In this project analysis of a seismic resistant structure is a need of concern, and thereby establishing a comparison between structures without shear wall and with shear wall. There are many methods for analysis and design such as equivalent static method, response spectrum method and time history method. Among all these methods in this study only equivalent static method is adopted. In this study STADDPro.v8i is used for analysis.
The structure selected for this project is a simple residential building with the following description as stated below.

A. Overview of STAADPro V8i Software

STAADPro V8i is a comprehensive and integrated finite element analysis and design offering, including a state-of-the-art user interface, visualization tools, and international design codes. It is capable of analyzing any structure exposed to static loading, a dynamic response, wind, earthquake, and moving loads. STAADPro V8i is the premier FEM analysis and design tool for any type of project including towers, culverts, plants, bridges, stadiums, and marine structures. The program hence consists of the following facilities to enable this task. Graphical model generation utilities as well as text editor based commands for creating the mathematical model. Beam and column members are represented using lines. Walls, slabs and panel type entities are represented using triangular and quadrilateral finite elements. Analysis engines for performing linear elastic and p-delta analysis, finite element analysis, frequency extraction, and dynamic response (spectrum, time history, steady state, etc.). Result viewing, result verification and report generation tools for examining displacement diagrams, bending moment and shear force diagrams, beam, plate and solid stress contours, etc.

B. Building Properties

1) Building Specification

a) Details of Building = G+10 story
b) Plan of building = 24 x 24 m
c) Size of beam = 600 x 300 mm
d) Size of column = 300 x 600 mm
e) No. of storey = 10
f) Height of storey = 3m
g) D.L of slab including finishes = 4 KN/m^2
h) Weight of partition on floor = 2 KN/m^2
i) Live load on each floor = 3 K/m^2
j) Live load on the roof = 1.5 KN/m^2

2) Seismic Parameters:

a) Zone Factor, Z = 0.24 (for zone IV, from Table no. 2 of IS code 1893 (Part 1) : 2002 in page No. 16)
b) Importance Factor, I = 1.0 (from Table no. 6 of IS code 1893 (Part 1) : 2002 in page No. 18)
c) Response reduction factor, R = 3.0 (from Table no. 7 of IS code 1893 (Part 1) : 2002 in page No. 23)
d) Type of soil = Hard soil

3) Seismic Weight:

a) Floor Area = 24 x 24 = 576 m^2
b) Dead Load = 4 KN/m^2
c) Live Load = 3 KN/m^2
d) Weight of Partition = 2 KN/m^2
e) For Live Load to considered =25%

C. Calculation of Seismic Weight of Structure

Total seismic weight on the floor,

$$W = \sum W_i$$

$$W = W1+W2+W3+W4+W5+W6+W7+W8+W9+10$$

Where $\sum W_i$, is the sum of loads from all the floors, which includes dead loads and appropriate percentage of live loads.
Effective Weight at each floor except the roof = 4.0 + 2.0 + 0.25 X 3 = 6.75 KN/m^2
And the roof = 4.0 KN/m^2
Weight of the beams at each floor and the roof = 3.0 X 0.6 X 240 X 25 = 1080 KN
Weight of the Column at each floor = 3.0 X 0.6 X 2.4 X 25 X 25 = 270 KN
Weight of the column at the roof = 0.5 X 270 =135 KN
Total plan area of the building is 24 m X 24 m= 576 m^2
Equivalent load at roof level (W10) = 4 X 576 + 1080 + 135 = 3519 KN
Equivalent load at each floor (W1+W2+W3+W4+W5+W6+W7+W8+W9)
= 6.75 X 576 X 1080 + 270 = 5238 KN
Seismic weight of the building, W = 3519 + 5238 X 9 = 50661 KN

D. Seismic Base Shear Calculation

Fundamental natural period of vibration of a moment-resisting RC frame without infill walls
T_a= 0.075 h $^{0.75}$ = 0.075 (30) $^{0.75}$ = 0.96 s
Average response acceleration coefficient Sa/g for 5 % damping and Type 1 soil is 1.04.
Design horizontal seismic coefficient,
A_h = (ZI (Sa/g)) / 2R = (0.24 x 1.0 x 1.04) / (2 x 3) = 0.0416
Base Shear, V_B= A_hW = 0.0416 x 50661 = 2107.5 KN
So the base shear for 10 story building is found to be equal to 2107.5 kN
Now the base shear is laterally distributed as per IS-1893-2002.

III. MODELING AND ANALYSIS

This project deals with the comparative study and effect of bare frame (without shear wall) and shear wall frame on seismic behavior of the structure.

For modeling and analysis G+10 storeys building with a 3-meters height for each story is analyzed by using software STAADPro. Equivalent static coefficient method is used for dynamic analysis and structure was assumed to be situated in Zone IV as per IS 1893:2002(part1) and the zone factor is 0.24 (Z=0.24). Some parameter like bending moment, shear force, axial forces, node displacement and deflection of a structure are determined using STAAD Pro software and comparison is made for structure with shear wall and without shear wall. For modeling and analysis various data was collected and calculated. This chapter describes about model development and analysis.

A. Plan and Model Generated for Problem Statement

From the values mentioned in the problem definition basically two models are generated to study the 335ehavior seismic forces on beam-column joint structure. Fig. 8 (a) and Fig. 8 (b) shows plan of the structure generated in STAADPro. Following are the models generated.

1) Model 1: Simple structure without any shear wall. Fig. 9 illustrates this model. In this model all the parameters are considered for designing the structure as earthquake proof as per IS1893:2003.
2) Model 2: Structure with symmetrical shear wall on outer walls of structure concentrically located. Fig. 10 illustrates the model. In this model all the parameters are same as model 1 also parameters of shear wall are added for design of shear wall as per IS 13920:1993.

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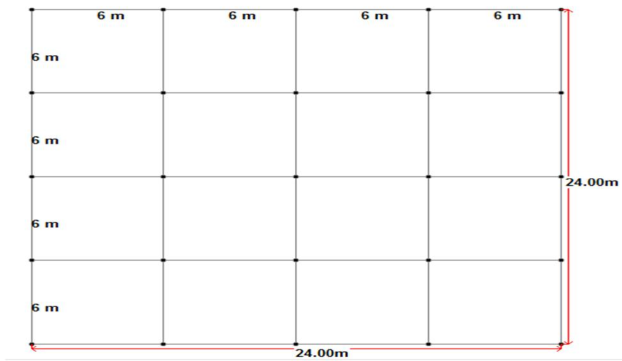


Fig. 8 (a) Plan of Structure without Shear Wall

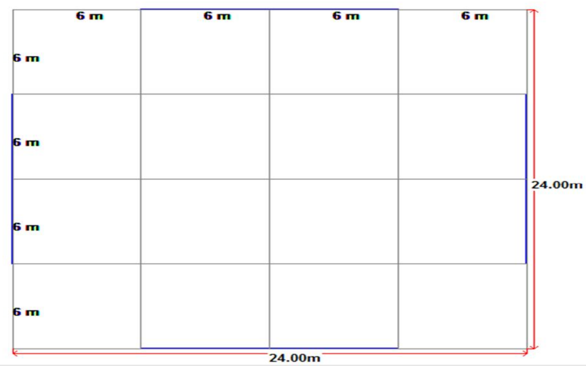


Fig. 8 (b) Plan of Structure with Shear Wall

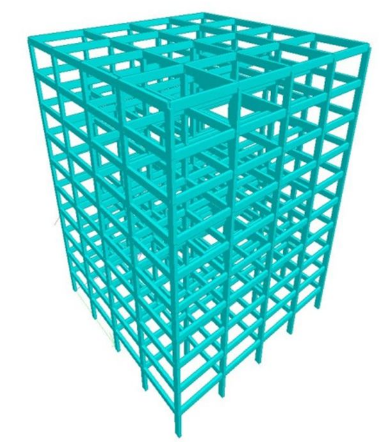


Fig. 9 MODEL 1: 3D Rendering of Structure without Shear Wall

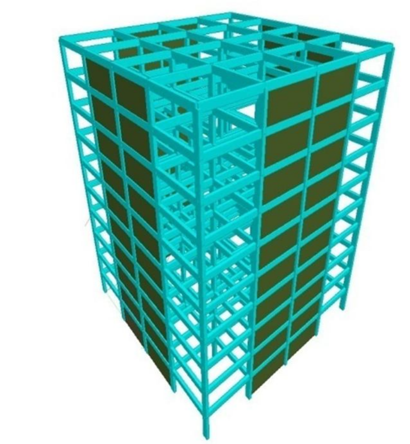


Fig. 10 MODEL 1: 3D Rendering of Structure without Shear Wall

B. Loadings and Analysis

1) *Load Applied in Structure Without Shear Wall:* The following figures show the different loads acting on structure without shear wall.

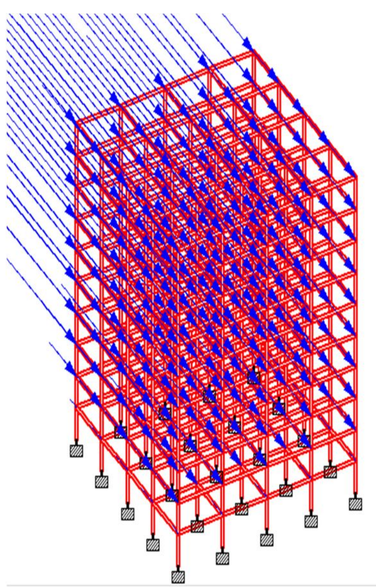


Fig. 11 Showing Seismic Load Acting from X-Direction

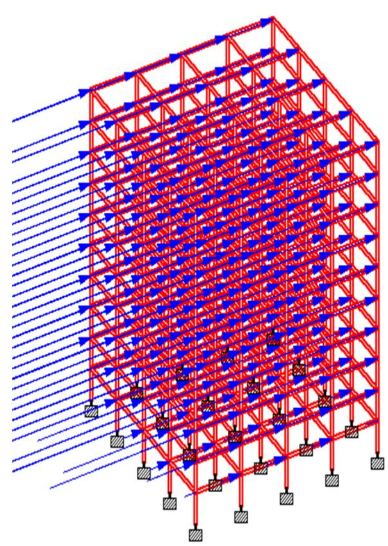
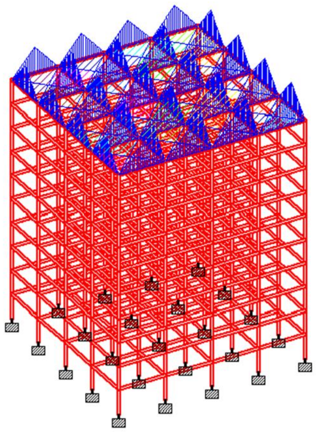
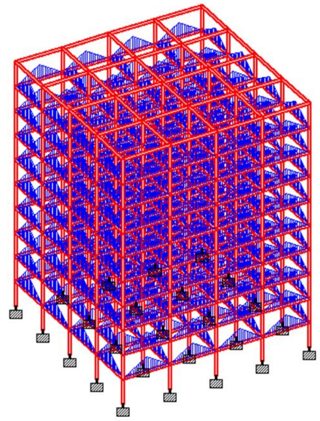
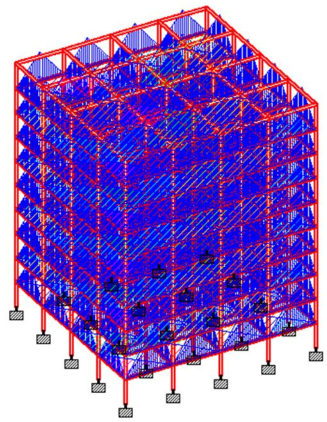


Fig. 12 Showing Seismic Load Acting from Z-Direction







Dead Load Live Load Roof Live Load

Fig. 13 Load Distribution for Model 1 (StaadPro Model)

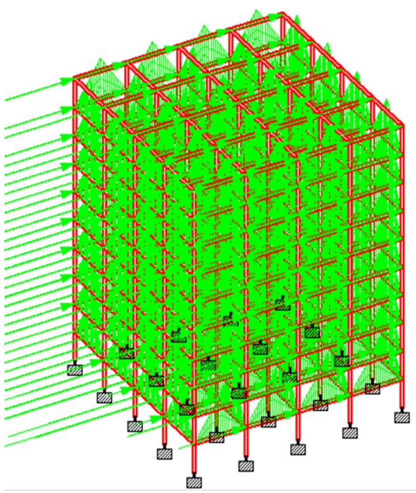


Fig. 14 Load Combination Along X-Direction

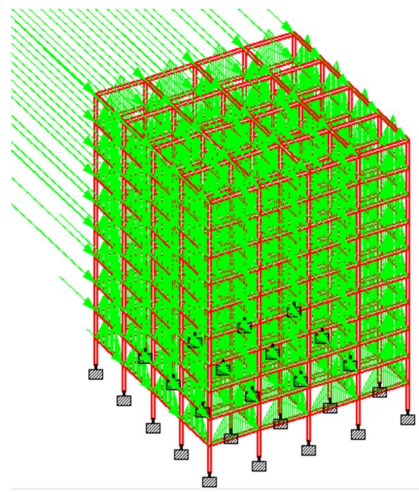


Fig. 15 Load Combination Along Z-Direction

2) Load Applied in Structure With Shear Wall: The following figures show the different loads acting on structure with shear wall.

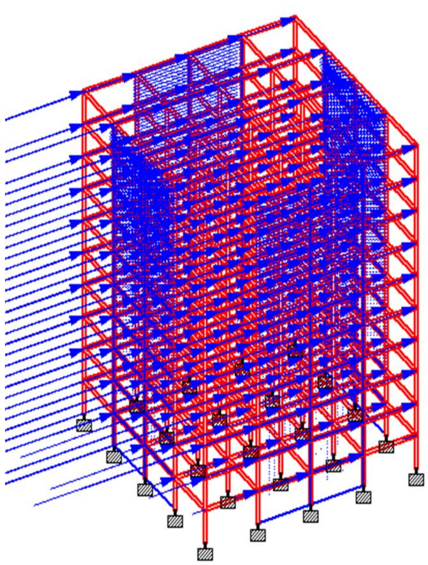


Fig. 16 Showing Seismic Load Acting from X-Direction

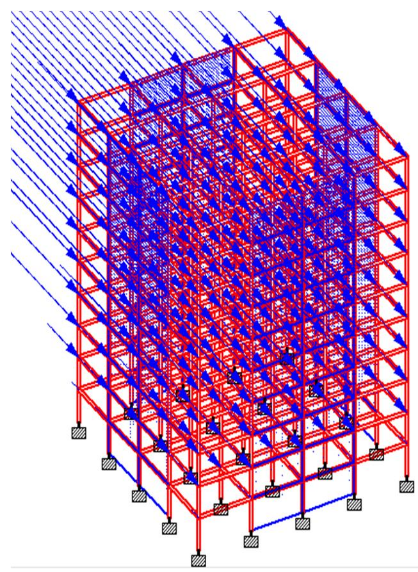


Fig. 17 Showing Seismic Load Acting from Z-Direction

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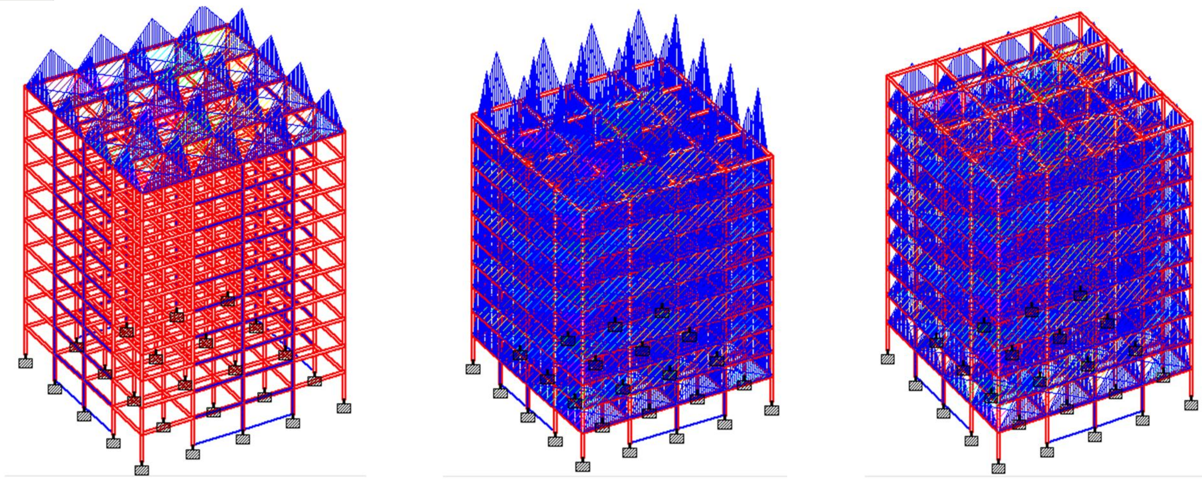

Dead Load | Live Load | Roof Live Load

Fig. 18 Load Distribution for Model 1 (StaadPro Model)

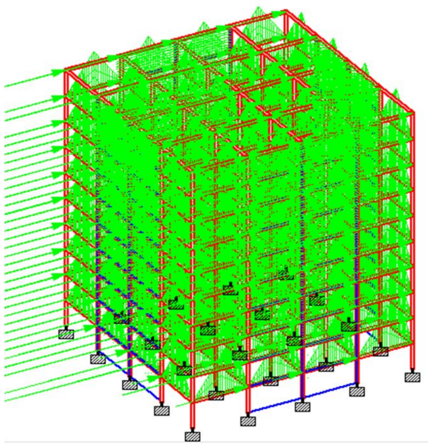

Fig. 19 Load Combination Along X-Direction

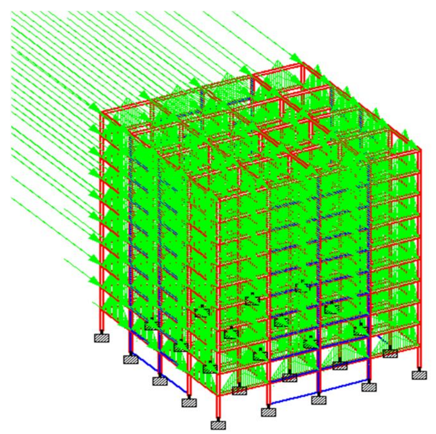

Fig. 20 Load Combination Along Z-Direction

3) After Run Analysis Structure without Shear Wall

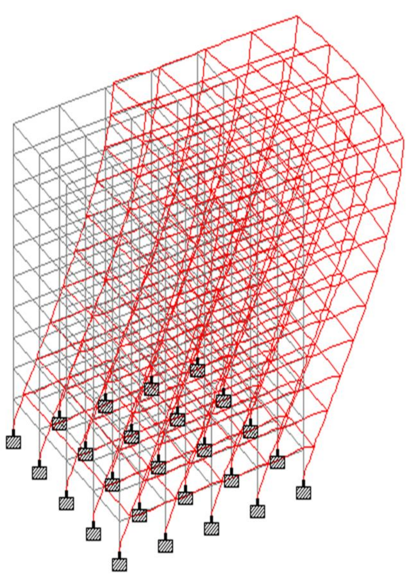

Fig. 21 Structure displacement in X- direction

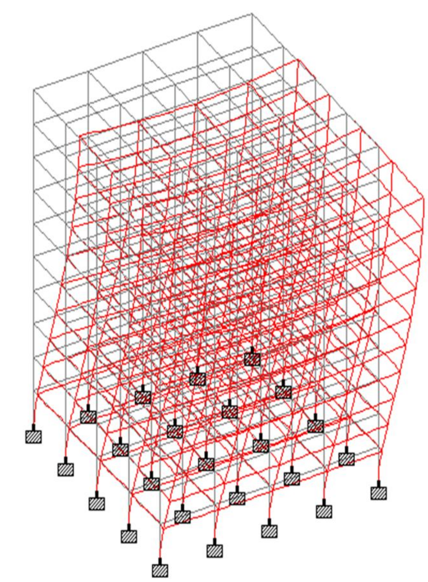

Fig. 22 Structure displacement in Z- direction

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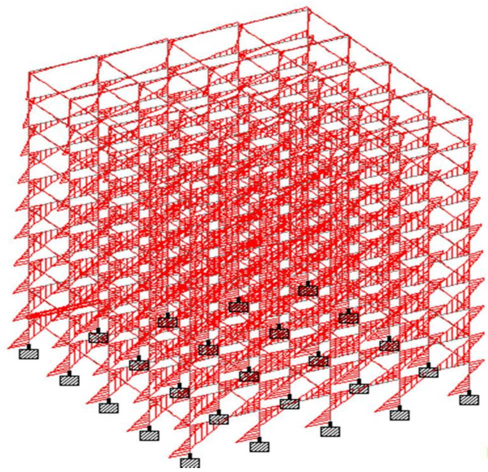


Fig. 23 Axial Forces, Shear Forces and Bending Moment Daigram Along Beam Forces

4)After Run Analysis Structure with Shear Wall

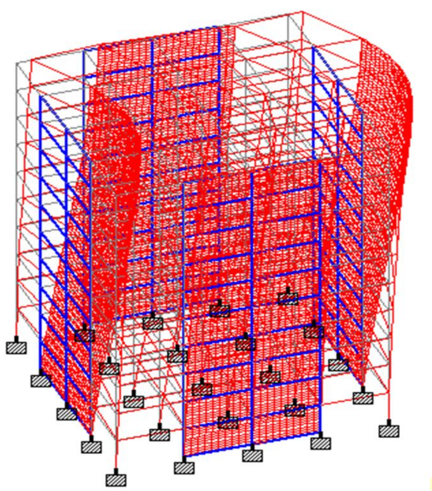


Fig. 24 Structure displacement in X- direction

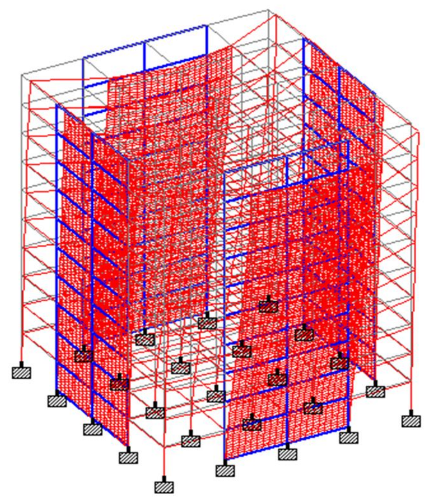


Fig. 25 Structure displacement in Z- direction

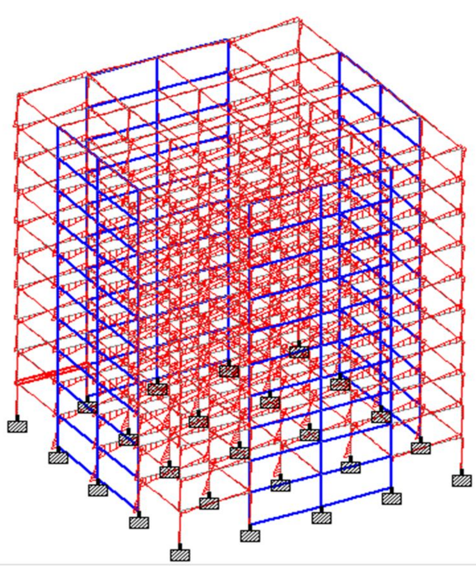


Fig. 26 Axial Forces, Shear Forces and Bending Moment Daigram Along Beam Forces

IV. RESULT AND DISCUSSION

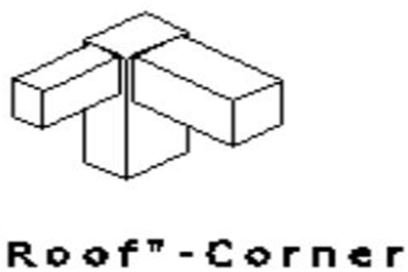
The Equivalent Static method is used for the analysis of the building models. The comparison of the results is done for bare frame i.e. without shear wall and with shear wall. Modeling and analysis are done by STAAD Pro.v8i software. From the results, comparison is done on the basis of maximum bending moment, maximum shear force, axial force and node displacements for different types of beam-column joints.

As the building with shear wall and without shear wall is analyzed for seismic forces in X and Z direction the following results were found for the load combination of 1.2 (DL + LL + EQ X) for earthquake forces in X direction and 1.2 (DL + LL + EQ Z) for earthquake forces in Z direction.

A. Corner Beam-Column Joint (In X-Direction)

Table 1

Graph showing different forces and moment generated on beam-column joint for normal building and shear wall building



Top Corner			Simple building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	F_x (KN)	F_x (KN)	F_y (KN)	F_y (KN)	M_z (KNm)	M_z (KNm)
40	1.2 (DL + LL + EQ X)	55	33.2	-22.089	25.4	28.046	-36	-53.7
90		55	-2.24	-55.215	-21.822	-35.585	30.061	54.857
500		55	-7.57	30.723	10.8	27.169	1.67	49.72

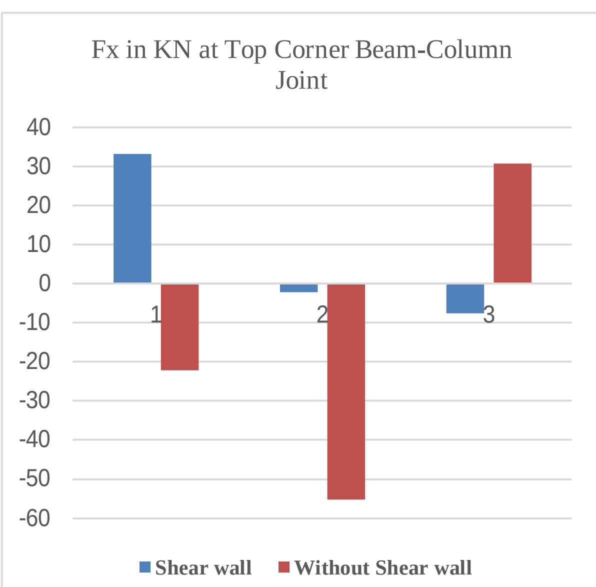


Fig. 27 Fx in KN at Top Corner Beam-Column Joint

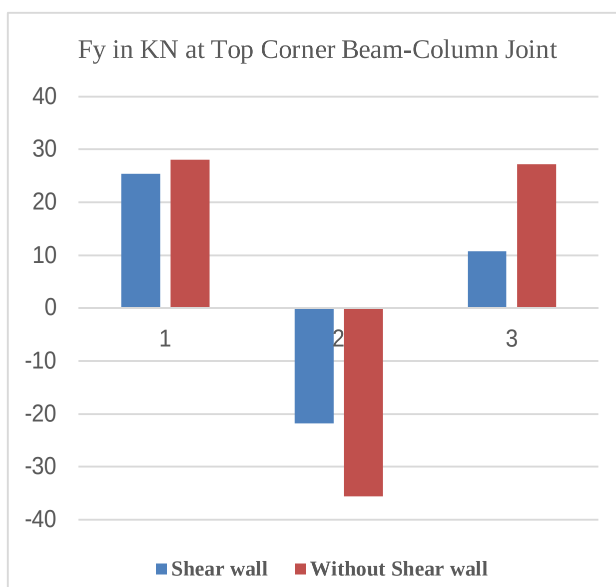


Fig. 28 Fy in KN at Top Corner Beam-Column Joint

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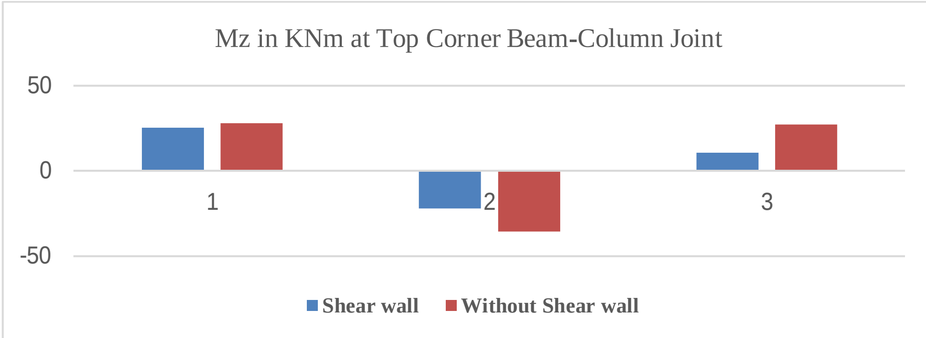


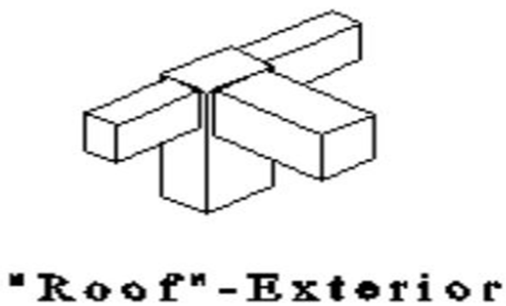
Fig. 29 Mz in KNm at Top Corner Beam-Column Joint

From the above graphs we understand that the bema column connecting at top corner of building provided with shear wall generate less shear force and bending moment at the beam-column joint as compared to the normal building.

B. Exterior Beam-Column Joint (In X-Direction)

Table 2

Graph showing different forces and moment generated on beam column joint for normal building and shear wall building



TOP middle			Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	Fx (KN)	Fx (KN)	Fy (KN)	Fy (KN)	Mz (KNm)	Mz (KNm)
38	1.2 (DL + LL + EQ X)	53	-36.4	36.7	-11.5	-26.8	12.5	41
39		53	-47.1	31.5	18.8	10.2	19.6	-2.93
498		53	91.1	57.4	58.1	37.4	142	80.8
88		53	9.91	74.5	-2.28	27.1	3.78	-43.9

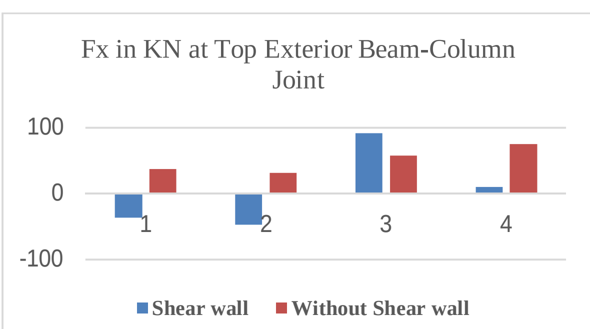


Fig. 30 Fx in KN at Top Exterior Beam-Column Joint

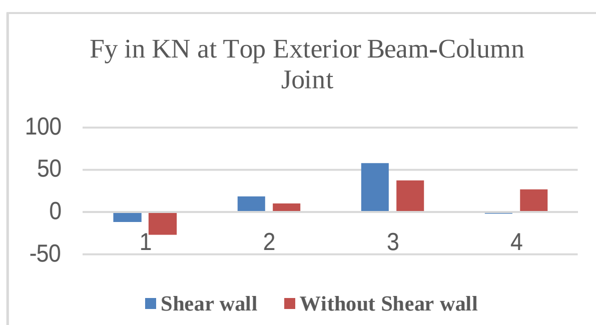


Fig. 31 Fy in KN at Top Exterior Beam-Column Joint

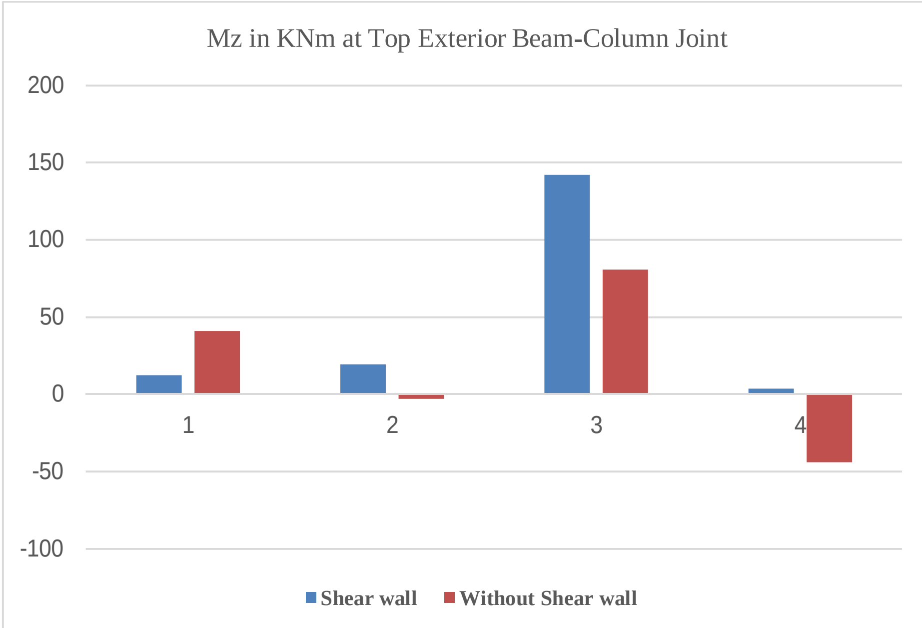


Fig. 32 Mz in KNm at Top Exterior Beam-Column Joint

From the above graphs we understand that the beam column connecting at top middle of building provided with shear wall generate less shear force and bending moment at the beam column joint as compared to the normal building.

C. Interior Beam-Column Joint (In X-Direction)

Table 3

Graph showing different forces and moment generated on beam column joint for normal building and shear wall building

TOP Central			Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	Fx (KN)	Fx (KN)	Fy (KN)	Fy (KN)	Mz (KNm)	Mz (KNm)
218	1.2 (DL + LL + EQ X)	163	94.1	58	-28.1	-30	34.3	46
219		163	91.9	53.2	20	12.3	11.3	-0.921
548		163	154	89.1	-18.1	-17.1	10.2	13.7
598		163	154	89.1	18.1	17.1	10.2	13.7

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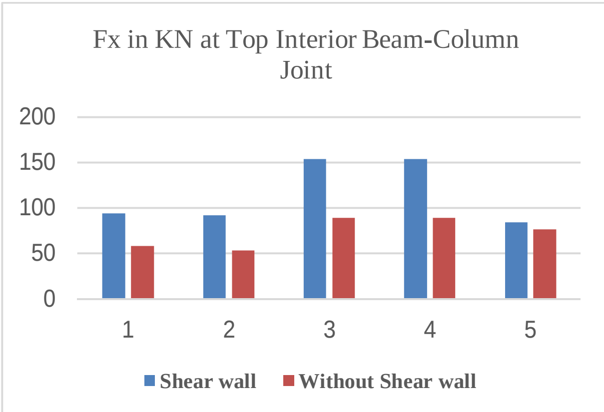

Fig. 33 Fx in KN at Top Interior Beam-Column Joint

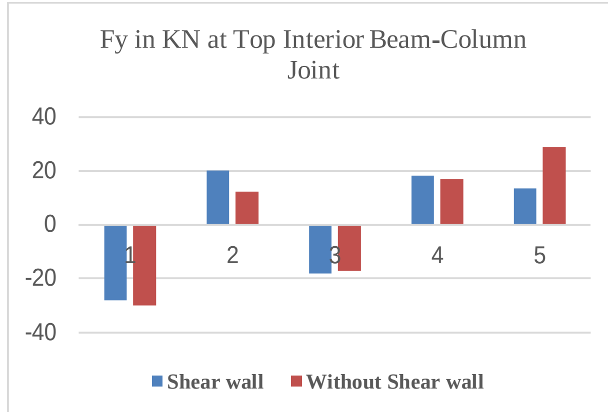

Fig. 34 Fy in KN at Top Interior Beam-Column Joint

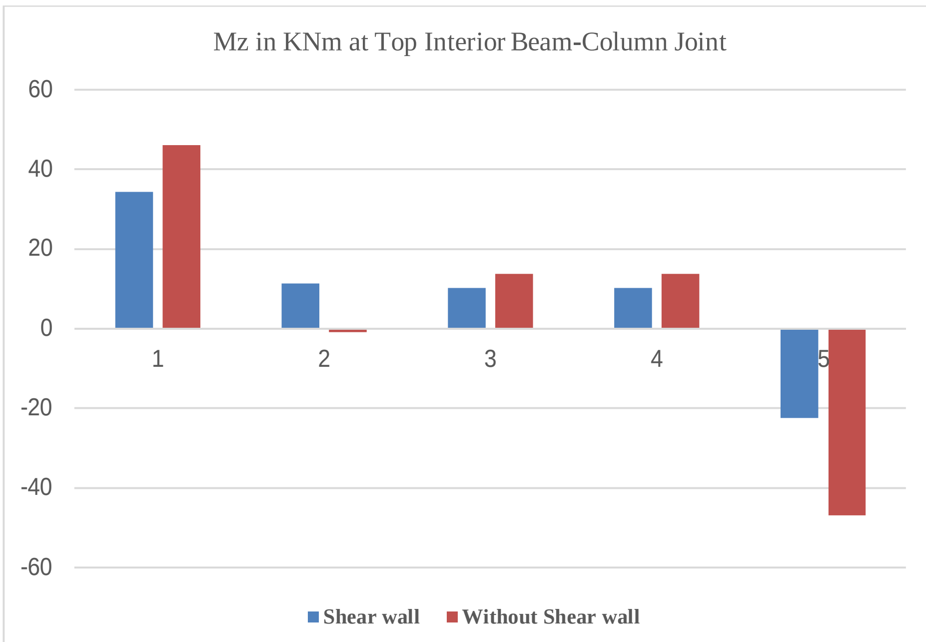

Fig. 35 Mz in KNm at Top Interior Beam-Column Joint

From the above graphs we understand that the beam column connecting at Central Beam column of building provided with shear wall generate less shear force and bending moment at the beam column joint as compared to the normal building.

D. Corner Beam-Column Joint (In Z-Direction)

Table 4

Graph showing different forces and moment generated on beam column joint for normal building and shear wall building

Top Corner			Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	Fx (KN)	Fx (KN)	Fy (KN)	Fy (KN)	Mz (KNm)	Mz (KNm)
40	1.2 (DL + LL+ EQ Z)	55	24.3	28.2	-12.5	-23	4.85	33.3
90		55	44	-55.215	10.9	24.7	-12.5	-34.7
500		55	14.4	40.6	-1.07	21	-32.6	28.7

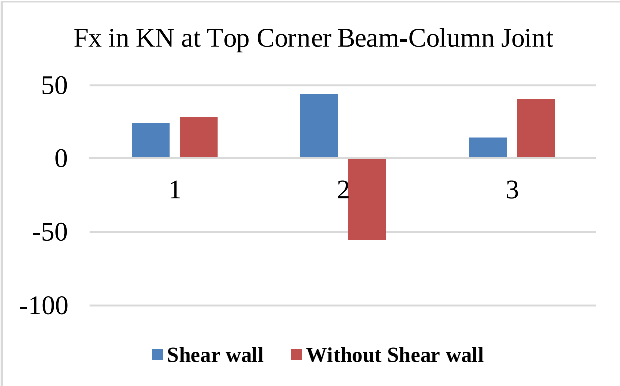

Fig. 36 Fx in KN at Top Corner Beam-Column Joint

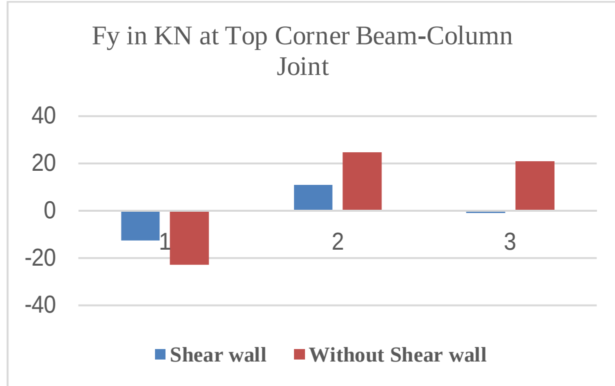

Fig. 37 Fy in KN at Top Corner Beam-Column Joint

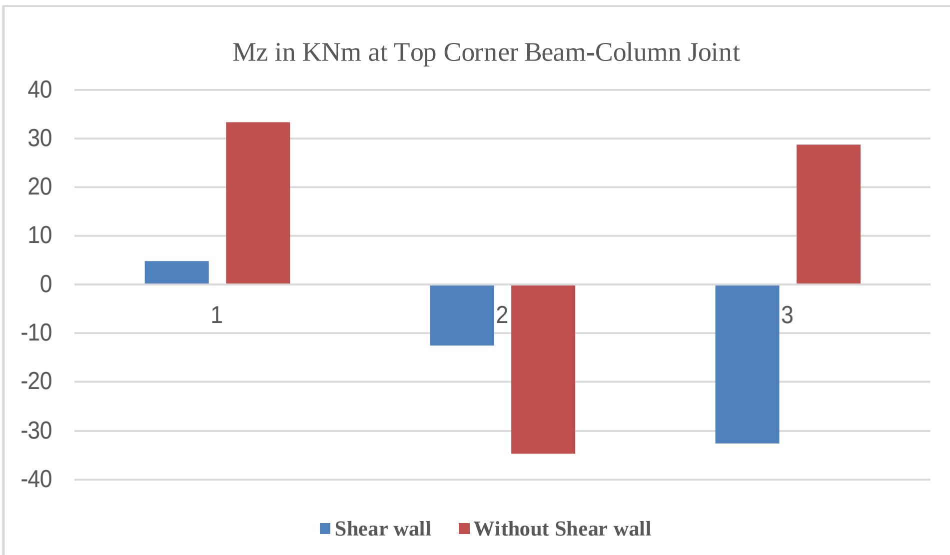

Fig. 38 Mz in KNm at Top Corner Beam-Column Joint

From the above graphs we understand that the beam column connecting at Corner Beam column of building provided with shear wall generate less shear force and bending moment at the beam column joint as compared to the normal building.

E. Exterior Beam-Column Joint (In Z-Direction)

table 5

Graph Showing Different Forces And Moment Generated On Beam Column Joint For Normal Building And Shear Wall Building

TOP Middle			Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	Fx (KN)	Fx (KN)	Fy (KN)	Fy (KN)	Mz (KNm)	Mz (KNm)
38	1.2 (DL + LL+ EQ Z)	53	-20.4	40.3	-15.6	-18.6	16.7	19.5
39		53	-20.4	40.3	15.6	18.6	16.7	19.5
498		53	97.7	64.4	52.4	30.8	123	58.1
88		53	8.68	68	0	0	0	0

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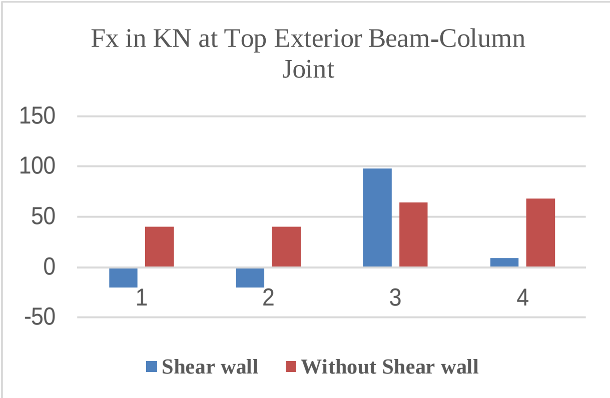

Fig. 39 Fx in KN at Top Exterior Beam-Column Joint

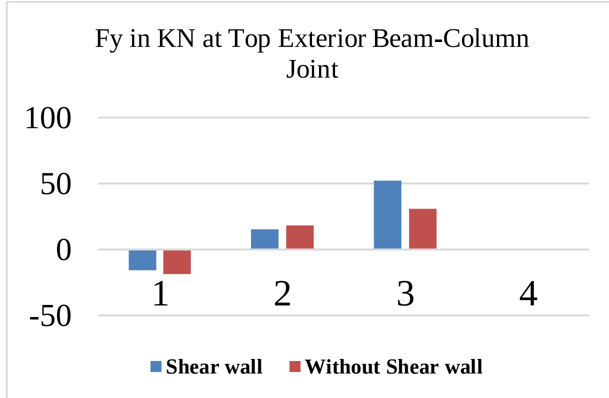

Fig. 40 Fy in KN at Top Exterior Beam-Column Joint

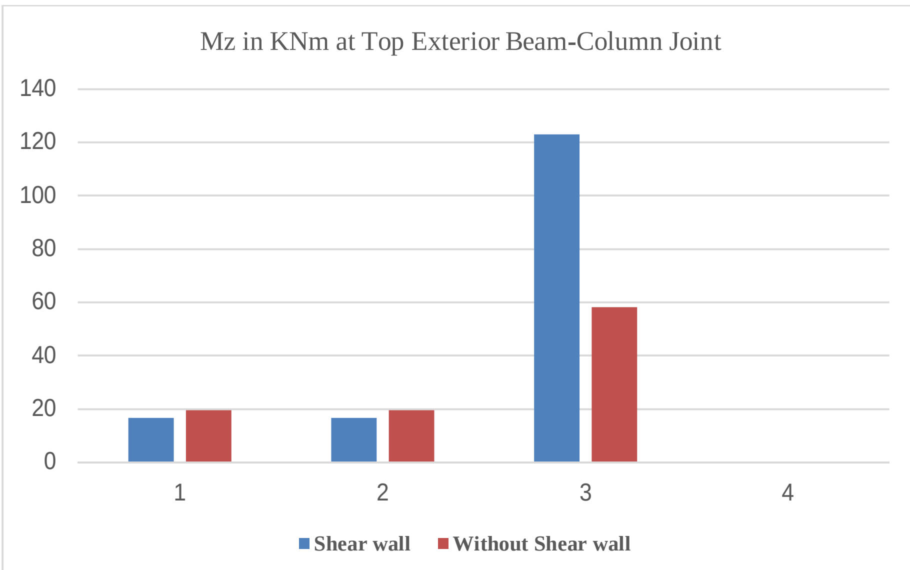

Fig. 41 Mz in KNm at Top Exterior Beam-Column Joint

From the above graphs we understand that the beam column connecting at top Middle of building provided with shear wall generate less shear force and bending moment at the beam column joint as compared to the normal building.

F. Interior Beam-Column Joint (In Z-Direction)

Table 6
Graph Showing Different Forces And Moment Generated On Beam Column Joint For Normal Building And Shear Wall Building

TOP Middle			Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall	Simple Building	Building with Shear Wall
Beam	L/C	Node	Fx (KN)	Fx (KN)	Fy (KN)	Fy (KN)	Mz (KNm)	Mz (KNm)
218	1.2 (DL + LL+ EQ Z)	163	93	55.6	-24.1	-21.1	22.8	22.5
219		163	93	55.6	24.1	-21.1	22.8	22.5
548		163	157	93.8	-25	-28.3	30.5	46
598		163	152	84.4	11.2	5.58	10.2	-18.6
268		163	84.3	76.4	0	0	0	0

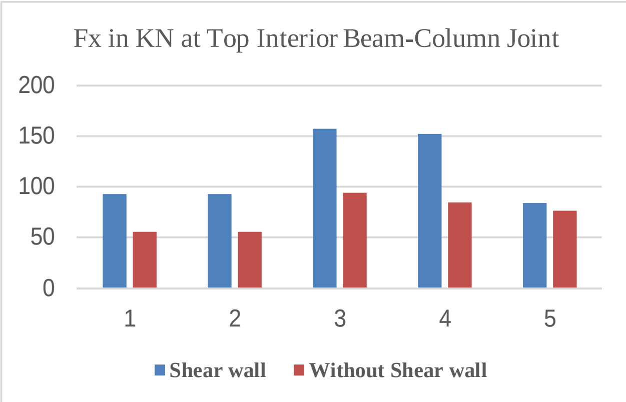

Fig. 42 Fx in KN at Top Interior Beam-Column Joint

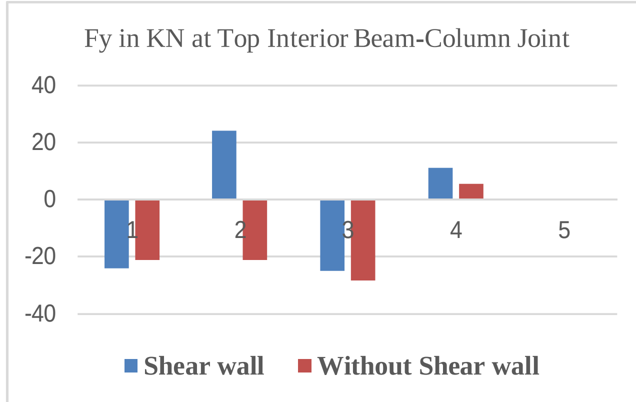

Fig. 43 Fy in KN at Top Interior Beam-Column Joint

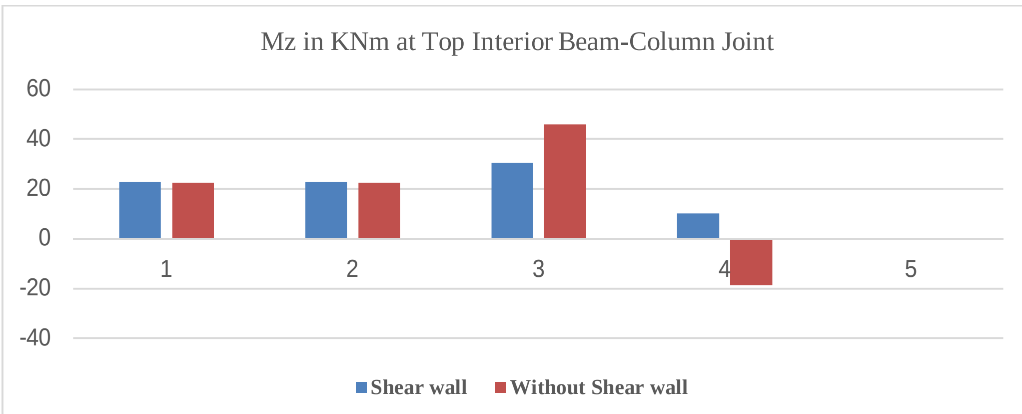

Fig. 44 Mz in KNm at Top Interior Beam-Column Joint

From the above graphs we understand that the beam column connecting at central beam column of building provided with shear wall generate less shear force and bending moment at the beam column joint as compared to the normal building.

V. CONCLUSION

Two different models are studied in this present research. STADDPro software is used for analysis and the results obtained were satisfactory and following are the concluded remarks that can be established from the results.

A. In multi-storey buildings, provision of shear walls is found to be effective in increasing the overall seismic response and characteristics of the structure.
B. The presence of shear wall can affect the seismic behavior of frame structure to large extent, and the shear wall increases the strength and stiffness of structure.
C. Shear wall ultimately increases the stiffness and strength of the structure and affect the seismic behavior of the structure.
D. The max. Bending moment, shear force and deflection of structure having shear wall is less as compared to simple frame building.
E. The bending moment, shear force and deflection in corner column is minimum in structure having shear wall as compared to simple frame building.
F. The bending moment, shear force and deflection in exterior column is minimum in structure having shear wall as compared to simple frame building.
G. The bending moment, shear force and deflection in interior column is minimum in structure having shear wall as compared to simple frame building.

H. The bending moment, shear force and deflection in beams at all levels is minimum having shear wall in periphery in comparison to simple frame building.

Therefore, it is necessary to consider the shear walls in the seismic analysis of the structure which significantly increases the strength of overall frame and decreases the probability of collapse of the structure.

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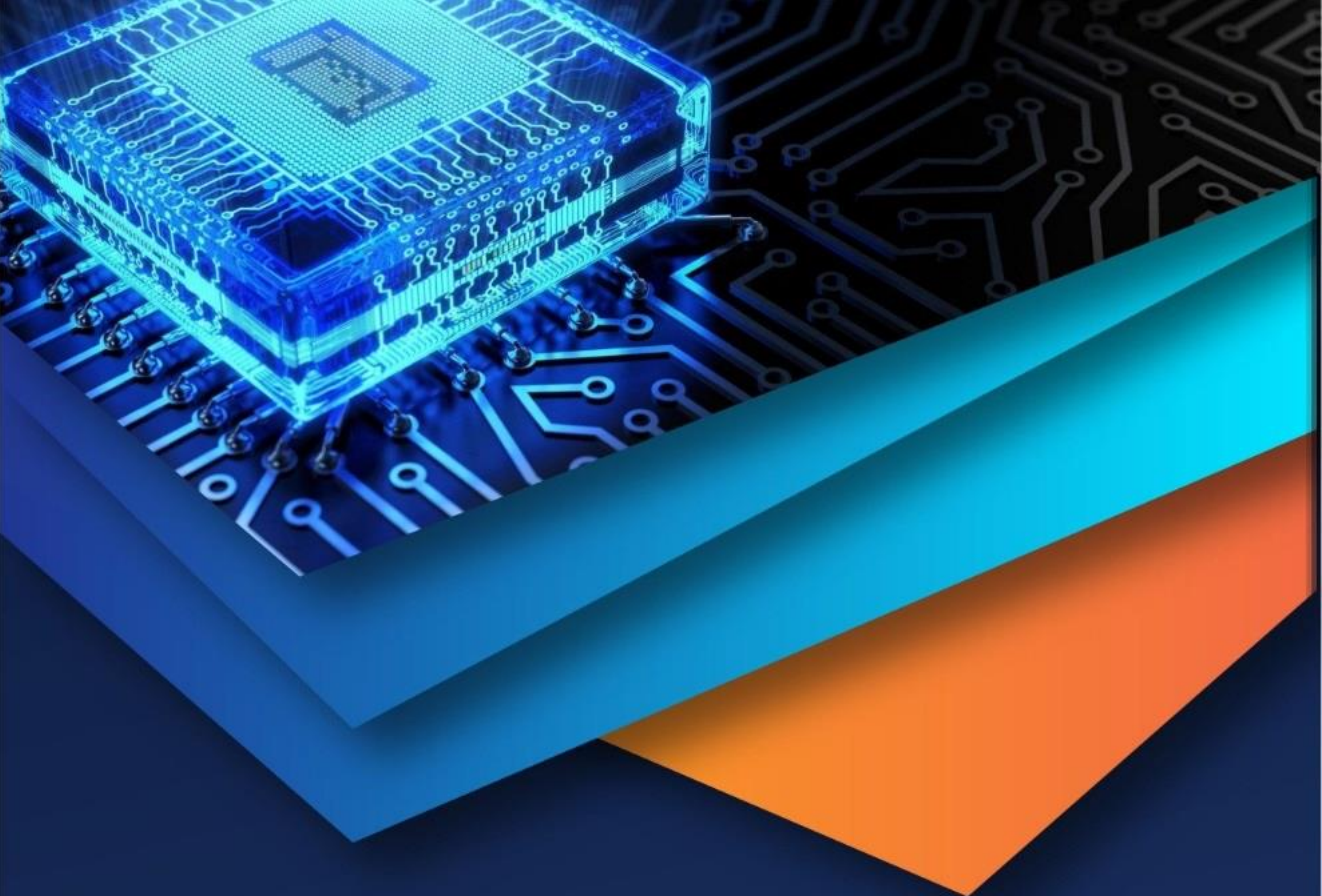

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