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Numerical Analysis of High Rise Building with Openings on Shear Wall

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ABSTRACT: *Shear walls are located on each level of the structure, to form an effective box structure, equal length shear walls are placed symmetrically on opposite sides of exterior walls of the building. Shear walls are added to the building interior to provide extra strength and stiffness to the building when the exterior walls cannot provide sufficient strength and stiffness or when the allowable span-width ratio for the floor or roof diaphragm is exceeded. Shear walls are analyzed to resist two types of forces: shear forces and uplift forces. Shear forces are created throughout the height of the wall between the top and bottom shear wall connections. Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Shear walls are analyzed to the provide necessary lateral strength to resist horizontal forces. Shear walls are strong enough, to transfer these horizontal forces to the next element in the load path below them.*

In this paper 20 story building with Shear walls are analyzed for two cases

1) With openings and

2) Without openings.

By using dynamic analysis and the results are compared and tabulated. All the analyses have been carried out as per the Indian Standard code books.

Keywords: *Shear Walls, Openings in Shear Wall, Frame Structure, Seismic Load, Frame System, Dynamic Analysis*

I. INTRODUCTION

What is a shear wall building?

Reinforced concrete (RC) buildings often have *vertical plate-like* RCwalls called *shear walls* in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along *both* length and width of buildings shear walls are like *vertically-oriented* wide *beams* that carry earthquake loads downwards to the foundation.

What are the functions of a shear wall?

Shear walls must provide the necessary lateral *strength* to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings. Shear walls also provide lateral *stiffness* to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.

Where should shear walls be located?

Shear walls should be located on each level of the structure including the crawl space. To form an effective box structure, equal length shear walls should be placed symmetrically on all four exterior walls of the building. Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness or when the allowable span-width ratio for the floor or roof diaphragm is exceeded. For subfloors with conventional diagonal sheathing, the span-width ratio is 3:1. This means that a 25-foot wide building with this subfloor will not require interior shear walls until its length exceeds 75 feet unless the strength or stiffness of the exterior shear walls are inadequate.

What types of forces do shear walls resist?

Shear walls resist two types of forces: shear forces and uplift forces. Connections to the Structure above transfer horizontal forces to the shear wall. This transfer creates shear forces throughout the height of the wall between the top and bottom shear wall connections. The strength of the lumber, sheathing and fasteners must resist these shear forces or the wall will tear or "shear" apart uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. Bearing walls have less uplift than non-bearing walls because gravity loads on shear walls help them resist uplift. Shear walls need holdown devices at each End when the gravity loads cannot resist all of the uplift. The holdown device then provides the necessary uplift resistance.

Advantages of shear walls in RC buildings

Properly designed and detailed buildings with shear walls have shown *very good* performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote: *"we cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls."* Mark fintel, a noted consulting engineer in usa shear walls in high seismic regions requires special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like chile, new zealand and usa. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and nonstructural elements (like glass windows and building contents).

Seismic Effect on Buildings

Importance of architectural features

The behavior of buildings during earthquake depends critically on its overall shape, size and geometry in addition to how the earthquake forces are carried to the ground. Hence, at the planning stage itself, architects and structural engineers must work together to ensure that the unfavorable features are avoided and good buildings configuration chosen.

Importance of seismic design codes

Ground vibration during earthquake cause forces and deformations in structures. Structures need to be designed withstand such forces and deformations. Seismic codes help to improve the behavior of structures so that may withstand the earthquake effect without significant loss of life and property. Countries around the world have procedures outlined in seismic code to help design engineers in the planning, designing, detailing and constructing of structures.

A) An earthquake resistant has four virtues in it, namely:

(i). *Good Structural Configuration:* its size, shape and structural system carrying loads are such that they ensure a direct and smooth flow of inertia forces to the ground.

(ii). *Lateral Strength:* The maximum lateral (horizontal) force that it can resist is such that the damage induced in it does not result in collapse.

(iii). *Adequate Stiffness:* Its lateral load resisting system is such that the earthquake – indeed deformations in it do not damage its contents under low-to- moderate shaking.

(iv). *Good Ductility*: Its capacity to undergo large deformations under severe earthquake shaking even after yielding is improved by favorable design and detailing strategies.

B) Indian Seismic Codes

Seismic codes are unique to a particular region or country. They take into account the local seismology, accepted level of seismic risk, buildings typologies, and materials and methods used in construction.

The Bureau of Indian Standards (BIS) the following Seismic Codes:

IS 1893 (PART 1) 2002, *Indian Standard Criteria* for Earthquakes Resistant of Design Structures (5^{th} revision).

IS 4326, 1993, Indian Standard Code of practice for Earthquake Resistant Design and Construction of Buildings. (2^{nd} revision).

IS 13827, 1993, Indian Standard Guidelines for improving Earthquake Resistant of Earthen buildings.

IS 13828, 1993 Indian Standard Guidelines for improving Earthquake Resistant of Low Strength Masonry Buildings.

IS 13920, 1993, Indian Standard Code for practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.

The regulations in these standards do not ensure that structures suffer no damage during earthquake of all magnitude. But, to the extent possible, they ensure that structures are able to respond to earthquake shaking of moderate intensities without structural damage and of heavy intensities wit out total collapse.

Earthquake effect on reinforced concrete buildings

In recent times, reinforced concrete buildings have become common in India, particularly in towns and cities. Reinforced Concrete (or Simply RC) consists of two primarily materials, namely Concrete with Reinforcing Steel bars.

Concrete is made of *sand*, *crushed stone (*called aggregates) and cement, all mixed with pre-determined amount of water. Concrete can be molded into any desire shape and steel bars can be bent into many shapes. Thus structure of complex shapes is possible with RC.

A typical RC buildings is made of horizontal members (beams and slabs) and vertical members (columns and walls), and supported by foundations that rest on ground. The system comprising of RC columns and connecting beams called a Reframe. The RC frame participates in resisting the earthquakes forces. Since most of the buildings mass is present at floor levels. These forces travel downwards through slab and beams to columns a walls, and then to the foundations from where they are dispersed to three ground. As inertia forces accumulate downwards from the top of the buildings, the columns and walls at lower storey experience higher earthquake induced forces and are therefore designed to be stronger than that storey above.

Horizontal earthquake effect

Gravity loading (due to self weight and contents) on buildings causes RC frames to bend resulting in stretching and shortening at various locations. Tension is generated at surfaces that stretch and compression at those that shorten. Under gravity loads, tension in the beams is at the bottom surface of the beam in the central location and is the top surface at the ends. On other hand earthquake loading causes tension on beam and column faces at locations different from those under gravity loading the relative levels of the tension (in technical terms, bending moment) generated in members. The level of bending moment due to earthquake loading depends on severity of shaking and can exceed that due to gravity loading. Thus, under strong earthquake shaking, the beam ends can develop tension on either of the top and bottom faces. Since concrete can not carry this tension, steel bars are required both face on beams to resist of reversal of being moment. Similarly, steel bars are required on all faces of columns too.

Design Issues for seismic and Wind in Buildings

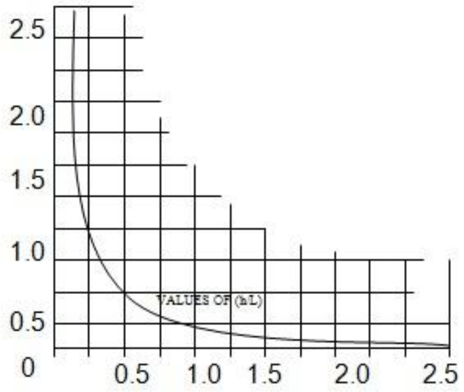
Critical issues for the design of high rise buildings in regions prone to significant wind and seismic effects typically include:

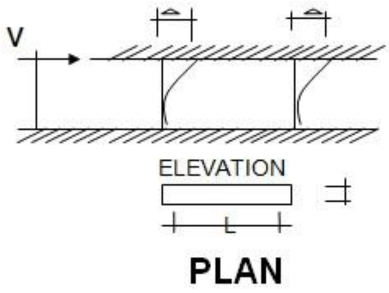
1. High base overturning moment and foundation design (wind, Seismic).
2. High shear capacity requirements near base (seismic).
3. High gravity stresses in the vertical elements (and use of high strength materials) to minimize structural design and to maximize net floor area.
4. Development of ductility in elements at the base of a structure under high compressive gravity stress (Seismic).
5. Controlling lateral accelerations (wind).
6. Controlling storey drift (wind and seismic).
7. Controlling damage so as to permit repair (seismic).
8. Ensuring ductile energy dissipation mechanisms and preventing brittle failures (seismic).

Shear Walls with Openings

Pipers in a wall formed by openings may be regarded as fixed at both ends, which changes the bending deflection tremh^3/3EI to h3/12EI in esq. the rigidity of a pier is then given in the direction of its length.

$$R = \frac{E_t}{(\frac{h}{L})^3 + 2.64(\frac{h}{L})}$$





$$R = \frac{V}{\Delta} = \frac{E_t}{(\frac{h}{L})^3 + 2.64(\frac{h}{L})}$$

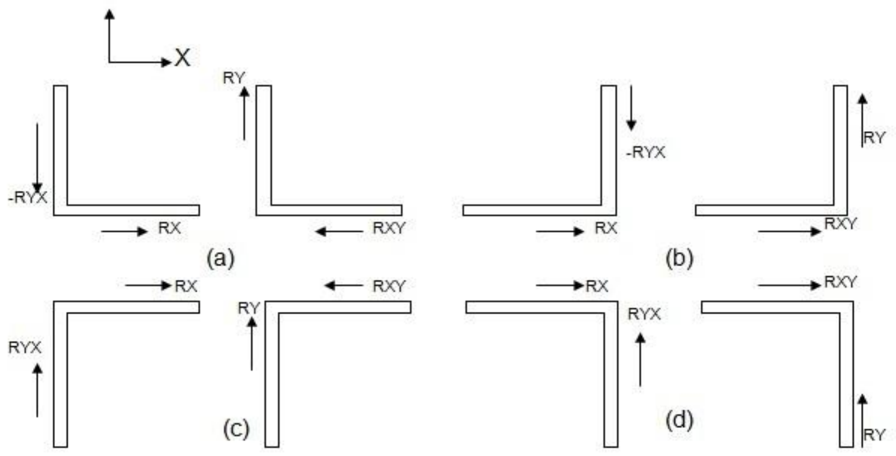
Rigidity of wall element fixed at both ends. It gives a curve for rapid evaluations of the rigidity of piers. The rigidity of a pier in the direction of its thickness in negligibly small.

The rigidity of a wall with openings may be calculated neglecting the effect of the axial shortening of piers by the judicious use of the principles of series and parallels in the same way. It is seen that for normal window or door openings, the rigidity of the wall is not affected to any appreciable extent. The rigidity of a shear wall is due more to its form than it its mass.

In size of the openings should be relatively small and these should be spaced at least a distance equal to the size of the openings in each direction. To restrict the stresses in the shear wall, the width of openings should be limited approximately to 15% of the total length of the connected shear walls and the depth of the connecting beam should be greater than 20% of the storey height.

Rigidity of a Wall Element

Ryx is defined as the horizontal force necessary to prevent y- distortions of a wall element when Rx is applied in the x-directions producing a unit deflection Rxy is also defined. When the principal axes of the shape of a shear wall are parallel to the x and y axes, Rxy and Ryx vanish.



Direction of Rxy and Ryx for various dispositions of the angle wall element. (a) angle in position 1; (b) angle in position 2; (c) angle in position 3; (d) angle in position 4.

Overall Geometry Of shear walls

Shear walls are oblong in cross section, i.e. one dimension of the cross-section is much larger than the other. While recentalgular cross-section is common, L- and U- shaped sections are also used. Thin-walled hollow RC shafts around the elevator core of buildings also act as shear walls, and should be taken advantage to resist earthquake forces.

Reinforcement Bars in shear walls

Steel reinforcing bars are to be provided in walls in regularly spaced vertical and horizontal grids. The vertical and horizontal reinforcement in the wall can be placed in one or two parallel layers called curtains. Horizontal reinforcement needs to be anchored at the ends of walls. The minimum area of reinforcing steel to be provided is 0.0025 times the cross-sectional area, along each of the horizontal and vertical directions. This vertical reinforcement should be distributed uniformly across the wall cross-section.

II. METHODOLOGY

Dynamic Analysis

Dynamic analysis shall be performed to obtain to design seismic force, and its distribution to different levels along the height of the building and to various lateral loads resisting elements for the following buildings:

Regular buildings-those greater than 40 m in height in zones 4 and 5, those greater than 90 m in height in zones 2 and 3. The analysis model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the types of irregularities present in the building configuration. Buildings with plan irregularities (as defined in the Table 4 of IS 1893-2002) can not be modeled for dynamic analysis.

Dynamic analysis may be performed either by the time history method or by the response spectrum method. However, in either method, the design base shear $(\bar{V}_B)$ shall be compared with a base shear (V_B) calculated using a fundamental period t. where $(\bar{V}_B)$ is less than (V_B) , all response quantities (for example member forces, displacements, storey forces, storey shears and base reactions) shall be multiplied by $(V_B)/(\bar{V}_B)$. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic analysis of steel and reinforce concrete buildings, respectively.

a) **Time history method-** the usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics.
b) **Response spectrum method-** this method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site.

Response spectrum analysis

According to IS 1893:2002, high rise and irregular buildings must be analyzed by response spectrum method using response spectra shown in Fig 3.3. Sufficient modes to capture at least 90% of the participating mass of the building (in each of two orthogonal principal horizontal directions) have to be considered in the analysis. If base shear calculated from the response spectrum analysis $(\bar{V}_B)$ is less than the design base shear (V_B) , the response quantities (member forces, displacements, storey shears and base reactions) have to be scaled up by the factor $V_B/\bar{V}_B$.

III. NUMERICAL MODELLING AND ANALYSIS

Geometrical Properties

1. No. of stories of the Building model = 20
2. Column Sizes: -
a) Outer periphery columns = 600mm x 600mm
3. Beam Size = 400mm x 600mm
4. Slab thickness = 150mm

5.4 Loads Calculations

1. Live load
a) Corridor = 3 KN/m2
b) Floor = 2 KN/m2
2. Dead Load (Floor Finishing) = 1.5 KN/m2
3. Wall load
a) 9’’ = 12.4 KN/m
b) 41/2’’ = 7 KN/m
4. Wind load
a) Wind Exposure parameters
i) Wind direction angle = 0 Degree
ii) Windward coff. Cp = 0.8
iii) Leeward coff Cp = 0.5

b) Wind coefficients

i) Wind speed = 50 KN/m
ii) Terrain category = 2
iii) Structure class = B
iv) Risk coefficient (k1) = 1
v) Topography (k3) = 1

5. Seismic loading

i) Seismic zone factor (Z) = 0.16
ii) Soil Type = Medium (II)
iii) Response Reduction factor = 5%

Load Combinations

The following Load Combinations have been considered for the Serviceability

1. (DL+ LL)
2. (DL ± EQXTP)
3. (DL ± EQYTP)
4. (DL ± EQXTN)
5. (DL ± EQYTN)
6. (DL + LL ± EQXTP)
7. (DL + LL ± EQYTP)
8. (DL + LL ± EQXTN)
9. (DL + LL ± EQYTN)
10. (DL ± WLX)
11. (DL ± WLY)
12. (DL + LL ± WLX)
13. (DL + LL ± WLY)

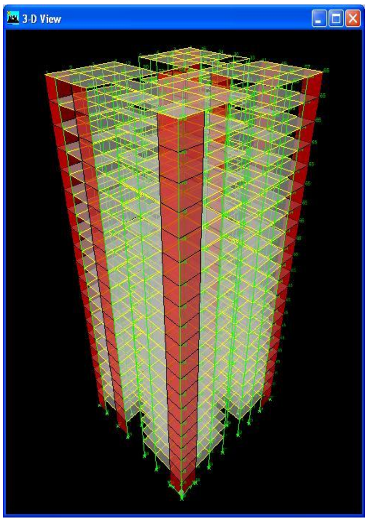
DL – Dead Load
LL – Live Load
EQTP–Earthquake load
With torsion positive
EQTN–Earthquake load
With torsion negative
WL- Wind load

The following Load Combinations have been considered for the design

14. 1.5(DL+ LL)
15. 1.5(DL ± EQXTP)
16. 1.5(DL ± EQYTP)
17. 1.5(DL ± EQXTN)
18. 1.5(DL ± EQYTN)
19. 1.2(DL + LL ± EQXTP)
20. 1.2(DL + LL ± EQYTP)
21. 1.2(DL + LL ± EQXTN)
22. 1.2(DL + LL ± EQYTN)
23. 1.5(DL ± WLX)
24. 1.5(DL ± WLY)
25. 1.2(DL + LL ± WLX)
26. 1.2(DL + LL ± WLY)

DL – Dead Load
LL – Live Load
EQTP–Earthquake load
With torsion positive
EQTN–Earthquake load
With torsion negative
WL- Wind load

FIG 1: PLAN



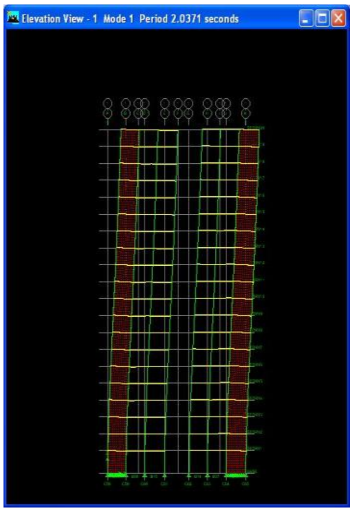
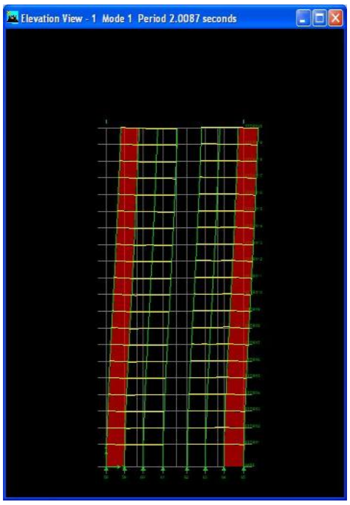


FIG 2: 3-D MODEL OF A BUILDING **FIG 3:** MODE SHAPE - 1 SHEAR WALL WITH OPENING



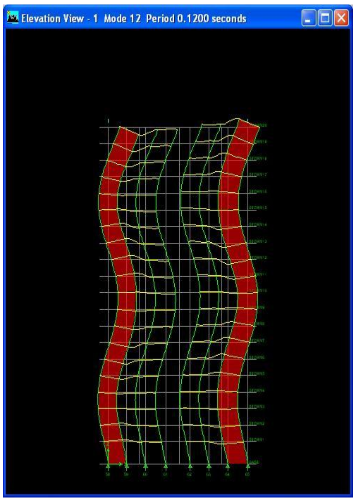


Fig 4: Modeshape - 1 Shear Wall With Out Opening
Fig 5: Mode Shape - 12 Shear Wall With Opening

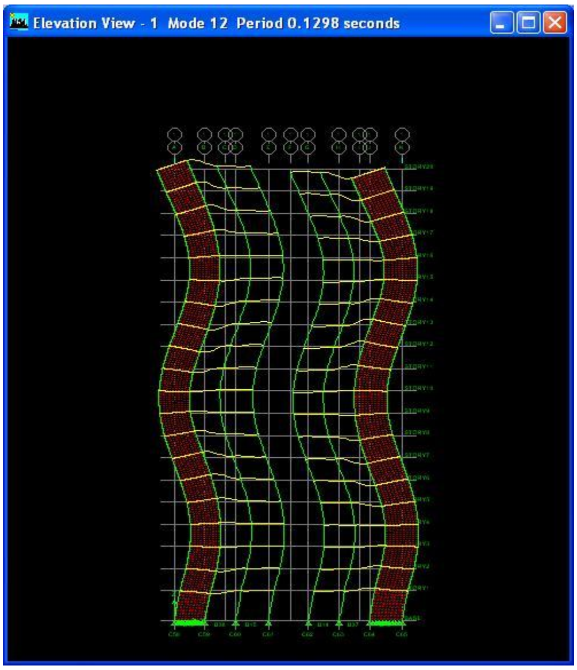
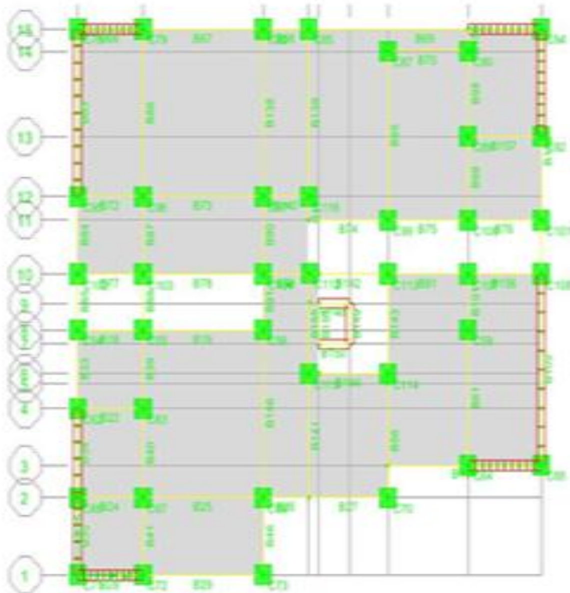
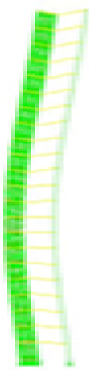


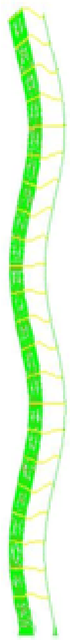
FIG 6: MODE SHAPE – 12 SHEAR WALL WITH OUT OPENING

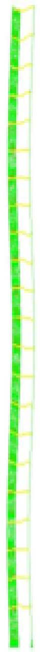


PLAN



Mode Shape 6





Mode Shape 8 Mode Shape 11

IV. RESULTS AND DISCUSSIONS

For 20% Opening in Shear wall

	Displacement	drift
20% Opening	3.98	0.01%
20% Opening split into two	4.82	0.02%
30%	4.75	0.10%
30% split into two	3.8	0.01%
40%	4.5	0.02%
40% split into two	4.8	0.01%

% Torsion of shear wall without opening is compared with different % openings and tabulated for column C89, which is nearer to shear wall

% opening	**For single opening the % increase in Torsion**	**For two openings the % increase in Torsion**
20%	37.6	14.4
30%	39.5	17.5
40%	39.4	20.43

% Shear Force of shear wall without opening is compared with different % openings and tabulated for column C89,which is nearer to shear wall

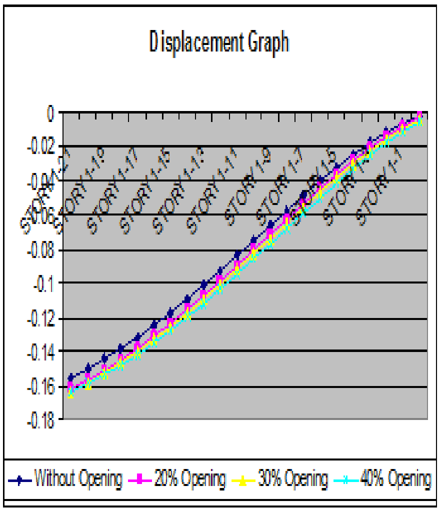
% opening	**For single opening the % increase in Shear Force**	**For two openings the % increase in Shear Force**
20%	16.4	17.1
30%	17.24	18.6
40%	18.5	19.3

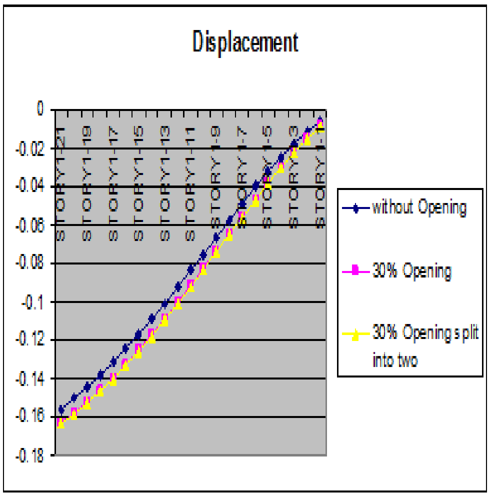
% Bending Moment is tabulated when compared with shear wall without opening for column C89, near to Shear wall

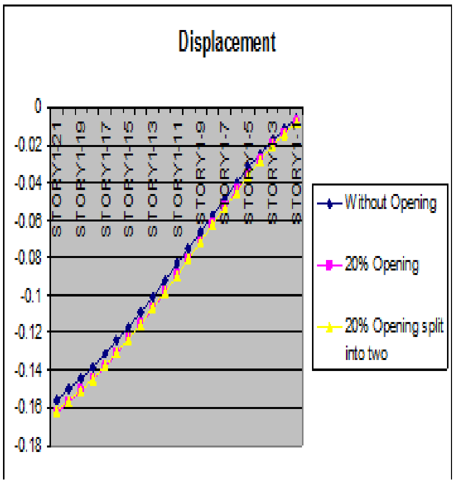
% opening	**For single opening the % increase in Bending Moment**	**For two openings the % increase in Bending Moment**
20%	1.9	2.46
30%	2.1	2.5
40%	2.17	1.5

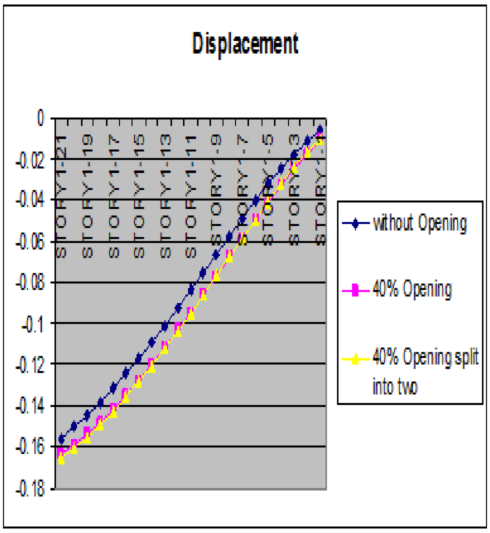
Displacement Table:
Displacement in Mts:

	without SW	20%	30%	40%	20%_2	30%_2	40%_2
STORY1-21	-0.1557	-0.1619	-0.1632	-0.1631	-0.1612	-0.1633	-0.1651
STORY1-20	-0.1501	-0.1566	-0.1582	-0.1585	-0.156	-0.1583	-0.1603
STORY1-19	-0.1442	-0.1509	-0.1526	-0.1534	-0.1503	-0.1527	-0.1549
STORY1-18	-0.138	-0.1446	-0.1465	-0.1477	-0.1442	-0.1467	-0.149
STORY1-17	-0.1313	-0.138	-0.1399	-0.1415	-0.1376	-0.1401	-0.1426
STORY1-16	-0.1242	-0.1308	-0.1328	-0.1347	-0.1305	-0.1331	-0.1356
STORY1-15	-0.1168	-0.1233	-0.1253	-0.1275	-0.123	-0.1256	-0.1281
STORY1-14	-0.1089	-0.1153	-0.1174	-0.1197	-0.1151	-0.1177	-0.1202
STORY1-13	-0.1008	-0.107	-0.1091	-0.1117	-0.1068	-0.1094	-0.112
STORY1-12	-0.0924	-0.0984	-0.1005	-0.1032	-0.0983	-0.1009	-0.1034
STORY1-11	-0.0837	-0.0895	-0.0917	-0.0946	-0.0895	-0.092	-0.0946
STORY1-10	-0.075	-0.0805	-0.0827	-0.0857	-0.0806	-0.083	-0.0856
STORY1-9	-0.0661	-0.0714	-0.0736	-0.0768	-0.0715	-0.0739	-0.0764
STORY1-8	-0.0573	-0.0623	-0.0645	-0.0678	-0.0625	-0.0648	-0.0673
STORY1-7	-0.0487	-0.0533	-0.0555	-0.0588	-0.0535	-0.0557	-0.0582
STORY1-6	-0.0402	-0.0445	-0.0466	-0.0499	-0.0448	-0.0469	-0.0493
STORY1-5	-0.0321	-0.036	-0.038	-0.0413	-0.0363	-0.0382	-0.0405
STORY1-4	-0.0244	-0.028	-0.0298	-0.0329	-0.0283	-0.03	-0.0322
STORY1-3	-0.0175	-0.0205	-0.0222	-0.025	-0.0208	-0.0223	-0.0243
STORY1-2	-0.0113	-0.0138	-0.0152	-0.0176	-0.0141	-0.0154	-0.017
STORY1-1	-0.0061	-0.008	-0.0091	-0.0108	-0.0083	-0.0092	-0.0105
STORY1	-0.0024	-0.0024	-0.0041	-0.005	-0.0037	-0.0042	-0.0049



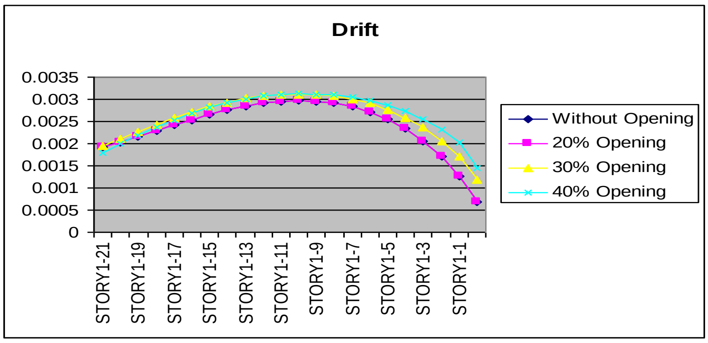


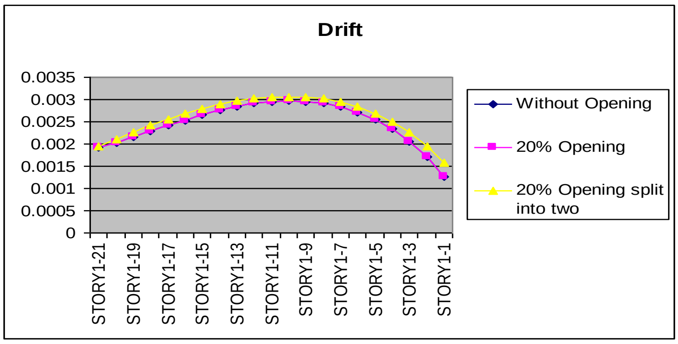


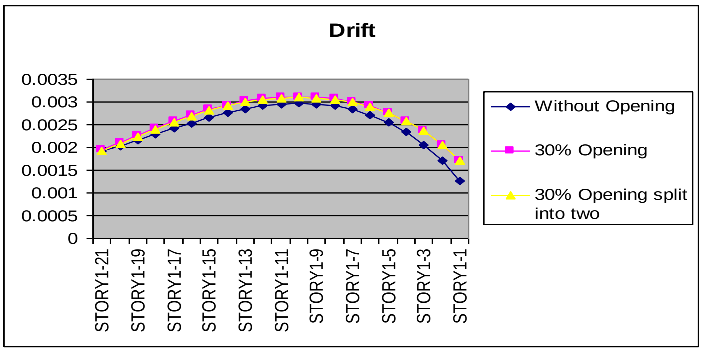


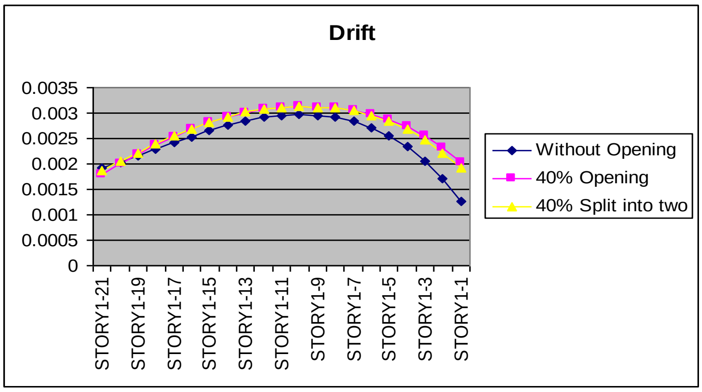
Drift Table:
Drift in Mts.

	without SW	20%	30%	40%	20%_2	30%_2	40%_2
STORY1-21	0.001929	0.001929	0.001938	0.001801	0.00196	0.001918	0.001857
STORY1-20	0.002037	0.002037	0.002101	0.001995	0.002108	0.002081	0.002041
STORY1-19	0.002153	0.002153	0.002264	0.002186	0.002259	0.002244	0.00222
STORY1-18	0.002281	0.002281	0.002424	0.002366	0.00241	0.002405	0.002392
STORY1-17	0.002411	0.002411	0.002575	0.002533	0.002553	0.002557	0.002552
STORY1-16	0.002538	0.002538	0.002712	0.002681	0.002685	0.002695	0.002697
STORY1-15	0.002655	0.002655	0.002833	0.002811	0.002801	0.002816	0.002824
STORY1-14	0.002758	0.002758	0.002934	0.002919	0.002898	0.002919	0.00293
STORY1-13	0.002844	0.002844	0.003014	0.003006	0.002973	0.002999	0.003014
STORY1-12	0.002909	0.002909	0.00307	0.003068	0.003026	0.003055	0.003074
STORY1-11	0.00295	0.00295	0.003101	0.003107	0.003052	0.003087	0.003111
STORY1-10	0.002966	0.002966	0.003109	0.003121	0.003057	0.003095	0.003124
STORY1-9	0.002953	0.002953	0.0031	0.003114	0.003048	0.003088	0.003116
STORY1-8	0.002908	0.002908	0.00307	0.003098	0.003014	0.00306	0.003094
STORY1-7	0.002829	0.002829	0.003008	0.003054	0.002946	0.002999	0.003043
STORY1-6	0.00271	0.00271	0.002911	0.002981	0.002842	0.002904	0.002959
STORY1-5	0.002548	0.002548	0.002774	0.002877	0.002697	0.002769	0.00284
STORY1-4	0.002334	0.002334	0.002592	0.002739	0.002505	0.002589	0.00268
STORY1-3	0.00206	0.00206	0.002359	0.00256	0.002258	0.002356	0.002475
STORY1-2	0.001713	0.001713	0.002063	0.002326	0.001945	0.002059	0.002213
STORY1-1	0.001271	0.001271	0.001706	0.002024	0.001568	0.001708	0.001909
STORY1	0.000688	0.000688	0.001183	0.00144	0.00109	0.001255	0.001443





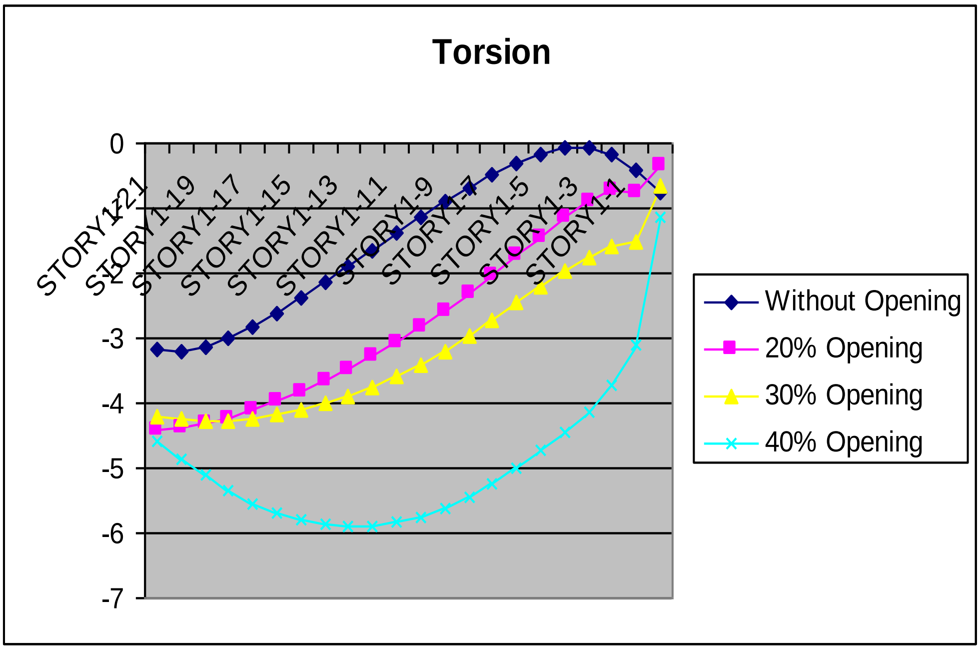




Torsion table for column C89:

	without SW	20%	30%	40%
STORY1-21	-3.169	-4.424	-4.198	-4.577
STORY1-20	-3.202	-4.384	-4.235	-4.847
STORY1-19	-3.122	-4.327	-4.271	-5.117
STORY1-18	-2.987	-4.232	-4.271	-5.352
STORY1-17	-2.812	-4.114	-4.239	-5.546
STORY1-16	-2.607	-3.978	-4.184	-5.697
STORY1-15	-2.382	-3.828	-4.107	-5.807
STORY1-14	-2.143	-3.662	-4.01	-5.876
STORY1-13	-1.896	-3.482	-3.891	-5.905
STORY1-12	-1.645	-3.284	-3.751	-5.894
STORY1-11	-1.394	-3.069	-3.588	-5.841
STORY1-10	-1.146	-2.835	-3.403	-5.747
STORY1-9	-0.906	-2.582	-3.194	-5.613
STORY1-8	-0.681	-2.311	-2.965	-5.441
STORY1-7	-0.475	-2.026	-2.718	-5.234
STORY1-6	-0.299	-1.731	-2.459	-4.998
STORY1-5	-0.164	-1.435	-2.2	-4.738
STORY1-4	-0.084	-1.153	-1.952	-4.456
STORY1-3	-0.08	-0.911	-1.744	-4.141
STORY1-2	-0.162	-0.718	-1.57	-3.709
STORY1-1	-0.397	-0.759	-1.534	-3.109
STORY1	-0.762	-0.357	-0.658	-1.135

TORSION:

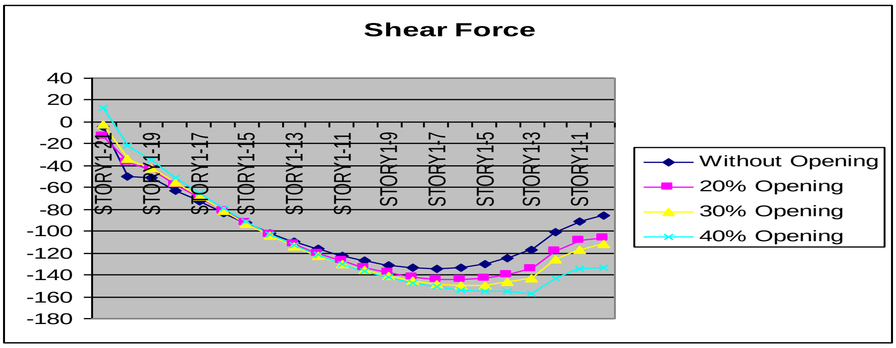


Torsion for C89 column which is nearer to the shear wall

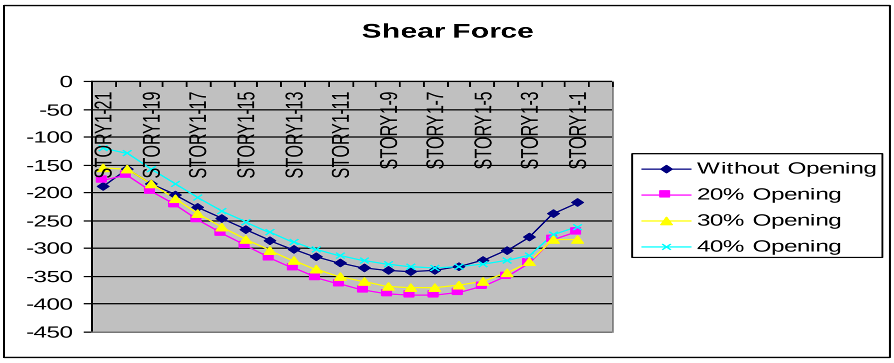
Shear Force table for column C89:

	without SW	20%	30%	40%
STORY1-21	-4.95	-12.61	-1.9	12.64
STORY1-20	-49.92	-36.64	-33.49	-21.62
STORY1-19	-50.7	-43.99	-41.99	-35.14
STORY1-18	-62.93	-57.01	-55.85	-51.19
STORY1-17	-73	-69.28	-68.89	-65.66
STORY1-16	-83.18	-81.14	-81.38	-79.14
STORY1-15	-92.74	-92.27	-93.03	-91.49
STORY1-14	-101.59	-102.53	-103.74	-102.71
STORY1-13	-109.58	-111.83	-113.44	-112.8
STORY1-12	-116.6	-120.1	-122.08	-121.79
STORY1-11	-122.57	-127.28	-129.63	-129.71
STORY1-10	-127.4	-133.33	-136.08	-136.58
STORY1-9	-131	-138.18	-141.37	-142.42
STORY1-8	-133.25	-141.76	-145.45	-147.26
STORY1-7	-134.01	-143.94	-148.23	-151.08
STORY1-6	-133.08	-144.51	-149.53	-153.82
STORY1-5	-130.23	-143.32	-149.24	-155.57
STORY1-4	-124.8	-139.46	-146.37	-155.42
STORY1-3	-117.55	-134.6	-143.25	-156.84
STORY1-2	-101.22	-118	-126.3	-143.41
STORY1-1	-90.64	-108.34	-116.88	-134.27
STORY1	-85.55	-106.43	-111.78	-133.24

SHEAR FORCE:



Shear force for C89 column which is nearer to the shear wall

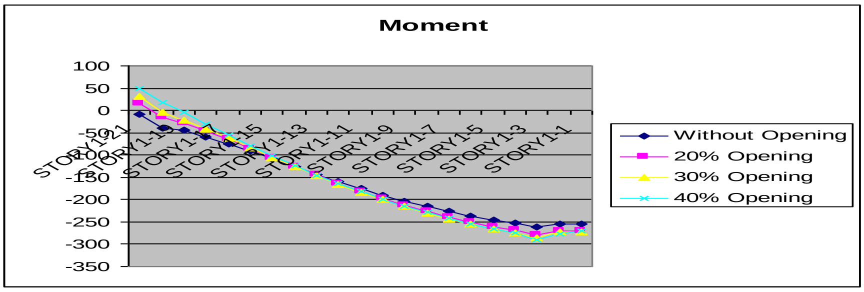


Shear force for C89 column which is away from the shear wall

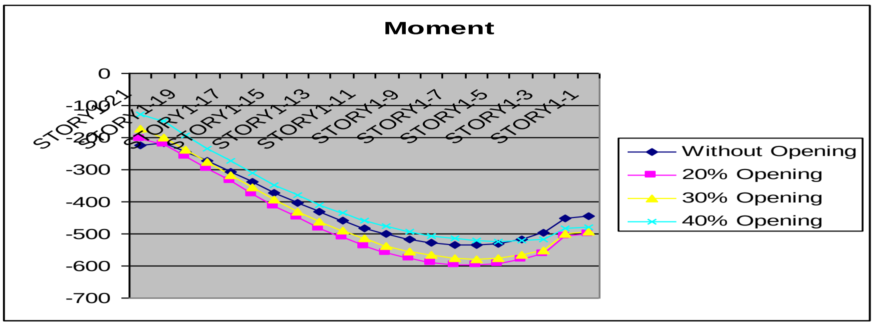
Moment table for column C89:

	without SW	20%	30%	40%
STORY1-21	-7.934	15.231	31.455	48.322
STORY1-20	-40.58	-14.32	-4.165	17.864
STORY1-19	-44.42	-27.508	-21.154	-4.447
STORY1-18	-58.851	-45.535	-41.633	-29.834
STORY1-17	-74.218	-64.91	-62.857	-54.768
STORY1-16	-91.123	-85.113	-84.478	-79.027
STORY1-15	-108.543	-105.438	-105.903	-102.25
STORY1-14	-126	-125.421	-126.74	-124.268
STORY1-13	-143.094	-144.738	-146.724	-144.984
STORY1-12	-159.545	-163.173	-165.687	-164.361
STORY1-11	-175.154	-180.584	-183.529	-182.401
STORY1-10	-189.779	-196.888	-200.201	-199.135
STORY1-9	-203.328	-212.04	-215.687	-214.614
STORY1-8	-215.736	-226.016	-229.984	-228.894
STORY1-7	-226.965	-238.815	-243.112	-242.06
STORY1-6	-236.949	-250.356	-254.987	-254.093
STORY1-5	-245.795	-260.859	-265.9	-265.489
STORY1-4	-252.79	-269.035	-274.235	-274.584
STORY1-3	-260.993	-279.991	-286.525	-290.446
STORY1-2	-255.003	-270.546	-272.478	-276.794
STORY1-1	-254.655	-269.421	-271.498	-270.105

Bending moment:



Bending moment for C89 column which is nearer to the shear wall



Bending moment for C89 column which is away from the shear wall

For Load Combinations 1.2 (D.L + L.L + EQYNX) following are the values of the drift

Story	Item	Load	Point	X	Y	Z	DriftX
STORY20	Max Drift X	DCON25	8	1139.37	1056.89	2401.574	0.000324
STORY19	Max Drift X	DCON25	8	1139.37	1056.89	2283.464	0.000328
STORY18	Max Drift X	DCON25	65	1139.37	0	2165.354	0.000334
STORY17	Max Drift X	DCON25	65	1139.37	0	2047.244	0.000341
STORY16	Max Drift X	DCON25	65	1139.37	0	1929.133	0.000347
STORY15	Max Drift X	DCON25	65	1139.37	0	1811.023	0.000352
STORY14	Max Drift X	DCON25	65	1139.37	0	1692.913	0.000356
STORY13	Max Drift X	DCON25	65	1139.37	0	1574.803	0.000358
STORY12	Max Drift X	DCON25	65	1139.37	0	1456.693	0.000357
STORY11	Max Drift X	DCON25	65	1139.37	0	1338.582	0.000353
STORY10	Max Drift X	DCON25	65	1139.37	0	1220.472	0.000346
STORY9	Max Drift X	DCON25	65	1139.37	0	1102.362	0.000336
STORY8	Max Drift X	DCON25	65	1139.37	0	984.252	0.000321
STORY7	Max Drift X	DCON25	65	1139.37	0	866.142	0.000302
STORY6	Max Drift X	DCON25	65	1139.37	0	748.031	0.000279
STORY5	Max Drift X	DCON25	65	1139.37	0	629.921	0.000251
STORY4	Max Drift X	DCON25	65	1139.37	0	511.811	0.000216
STORY3	Max Drift X	DCON25	65	1139.37	0	393.701	0.000175
STORY2	Max Drift X	DCON25	65	1139.37	0	275.591	0.000126
STORY1	Max Drift X	DCON25	65	1139.37	0	157.48	0.000059

Table 1. Shear Wall Without Opening

For Load Combinations 1.2 (D.L + L.L + EQYNX) following are the values of the drift

Story	Item	Load	Point	X	Y	Z	DriftX
STORY20	Max Drift X	DCON25	14-Jul	975	1056.89	2366.141	0.000305
STORY19	Max Drift X	DCON25	10-Jul	975	1056.89	2177.165	0.000307
STORY18	Max Drift X	DCON25	4-Jul	975	1056.89	2070.866	0.000312
STORY17	Max Drift X	DCON25	11-Jul	975	1056.89	1964.566	0.000316
STORY16	Max Drift X	DCON25	12-Jul	975	1056.89	1858.267	0.00032
STORY15	Max Drift X	DCON25	13-Jul	975	1056.89	1751.968	0.000321
STORY14	Max Drift X	DCON25	7-Jul	975	1056.89	1645.669	0.000321
STORY13	Max Drift X	DCON25	14-Jul	975	1056.89	1539.37	0.00032
STORY12	Max Drift X	DCON25	15-Jul	975	1056.89	1433.07	0.000316
STORY11	Max Drift X	DCON25	574	1090.059	0	1338.582	0.000312

STORY10	Max Drift X	DCON25	602	90.827	0	1220.472	0.000307
STORY9	Max Drift X	DCON25	603	75.689	0	1102.362	0.000299
STORY8	Max Drift X	DCON25	604	60.551	0	984.252	0.000287
STORY7	Max Drift X	DCON25	604	60.551	0	866.142	0.000272
STORY6	Max Drift X	DCON25	605	45.413	0	748.031	0.000252
STORY5	Max Drift X	DCON25	605	45.413	0	629.921	0.000227
STORY4	Max Drift X	DCON25	605	45.413	0	511.811	0.000197
STORY3	Max Drift X	DCON25	606	30.276	0	393.701	0.00016
STORY2	Max Drift X	DCON25	576	1057.185	0	275.591	0.000116
STORY1	Max Drift X	DCON25	604	60.551	0	157.48	0.000053

Table 2. Shear Wall with Opening

For Load Combinations - 1.5 EQX + 9 D.L following are the values of the drift

Story	Item	Load	Point	X	Y	Z	DriftX
STORY20	Max Drift X	DCON40	65	28.94	0	61	0.002016
STORY19	Max Drift X	DCON40	65	28.94	0	58	0.002127
STORY18	Max Drift X	DCON40	65	28.94	0	55	0.002239
STORY17	Max Drift X	DCON40	65	28.94	0	52	0.002363
STORY16	Max Drift X	DCON40	65	28.94	0	49	0.002487
STORY15	Max Drift X	DCON40	65	28.94	0	46	0.002603
STORY14	Max Drift X	DCON40	65	28.94	0	43	0.002705
STORY13	Max Drift X	DCON40	65	28.94	0	40	0.002789
STORY12	Max Drift X	DCON40	65	28.94	0	37	0.002851
STORY11	Max Drift X	DCON40	65	28.94	0	34	0.002887
STORY10	Max Drift X	DCON40	65	28.94	0	31	0.002893
STORY9	Max Drift X	DCON40	65	28.94	0	28	0.002867
STORY8	Max Drift X	DCON40	65	28.94	0	25	0.002804
STORY7	Max Drift X	DCON40	65	28.94	0	22	0.002701
STORY6	Max Drift X	DCON40	65	28.94	0	19	0.002553
STORY5	Max Drift X	DCON40	65	28.94	0	16	0.002354
STORY4	Max Drift X	DCON40	65	28.94	0	13	0.002095
STORY3	Max Drift X	DCON40	65	28.94	0	10	0.001768

STORY2	Max Drift X	DCON40	65	28.94	0	7	0.001348
STORY1	Max Drift X	DCON40	65	28.94	0	4	0.000748

Table 3. Shear Wall With Out Opening
For Load Combinations - 1.5 EQX + 9 D.L following are the values of the drift

Story	Item	Load	Point	X	Y	Z	DriftX
STORY20	Max Drift X	DCON40	59-10	3.845	0	58.3	0.002129
STORY19	Max Drift X	DCON40	59-10	3.845	0	55.3	0.002245
STORY18	Max Drift X	DCON40	59-10	3.845	0	52.3	0.002372
STORY17	Max Drift X	DCON40	59-10	3.845	0	49.3	0.002499
STORY16	Max Drift X	DCON40	59-10	3.845	0	46.3	0.002619
STORY15	Max Drift X	DCON40	59-10	3.845	0	43.3	0.002726
STORY14	Max Drift X	DCON40	59-10	3.845	0	40.3	0.002814
STORY13	Max Drift X	DCON40	59-10	3.845	0	37.3	0.002879
STORY12	Max Drift X	DCON40	575-10	27.27	0	34.3	0.002918
STORY11	Max Drift X	DCON40	575-11	27.27	0	31.9	0.002929
STORY10	Max Drift X	DCON40	575	27.27	0	31	0.002927
STORY9	Max Drift X	DCON40	575	27.27	0	28	0.002901
STORY8	Max Drift X	DCON40	575	27.27	0	25	0.002837
STORY7	Max Drift X	DCON40	575	27.27	0	22	0.002733
STORY6	Max Drift X	DCON40	575	27.27	0	19	0.002583
STORY5	Max Drift X	DCON40	575	27.27	0	16	0.00238
STORY4	Max Drift X	DCON40	575	27.27	0	13	0.002116
STORY3	Max Drift X	DCON40	604	1.538	0	10	0.00178
STORY2	Max Drift X	DCON40	576	26.852	0	7	0.001349
STORY1	Max Drift X	DCON40	65	28.94	0	4	0.00076

Table 4. Shear Wall With Opening

The following are the values of the Center Of Rigidity and Center Of Mass

Story	MassX	MassY	XCM	YCM	XCCM	YCCM	XCR	YCR
STORY20	1853.364	1853.364	14.686	13.417	14.686	13.417	14.742	14.466
STORY19	2206.123	2206.123	14.678	13.413	14.682	13.415	14.742	14.47
STORY18	2206.123	2206.123	14.678	13.413	14.681	13.414	14.743	14.476
STORY17	2206.123	2206.123	14.678	13.413	14.68	13.414	14.744	14.483
STORY16	2206.123	2206.123	14.678	13.413	14.68	13.414	14.745	14.49

STORY15	2206.123	2206.123	14.678	13.413	14.679	13.414	14.746	14.499
STORY14	2206.123	2206.123	14.678	13.413	14.679	13.414	14.748	14.508
STORY13	2206.123	2206.123	14.678	13.413	14.679	13.414	14.749	14.517
STORY12	2206.123	2206.123	14.678	13.413	14.679	13.414	14.751	14.526
STORY11	2206.123	2206.123	14.678	13.413	14.679	13.414	14.752	14.535
STORY10	2206.123	2206.123	14.678	13.413	14.679	13.414	14.754	14.542
STORY9	2206.123	2206.123	14.678	13.413	14.679	13.414	14.756	14.549
STORY8	2206.123	2206.123	14.678	13.413	14.679	13.414	14.759	14.553
STORY7	2206.123	2206.123	14.678	13.413	14.679	13.414	14.76	14.554
STORY6	2206.123	2206.123	14.678	13.413	14.679	13.414	14.761	14.551
STORY5	2206.123	2206.123	14.678	13.413	14.679	13.414	14.76	14.54
STORY4	2206.123	2206.123	14.678	13.413	14.679	13.414	14.755	14.517
STORY3	2206.123	2206.123	14.678	13.413	14.678	13.414	14.741	14.475
STORY2	2206.123	2206.123	14.678	13.413	14.678	13.414	14.711	14.399
STORY1	2320.887	2320.887	14.676	13.413	14.678	13.414	14.651	14.272

Table 5. Shear Wall With Out Opening
The following are the values of the Center Of Rigidity and Center Of Mass

Story	MassX	MassY	XCM	YCM	XCCM	YCCM	XCR	YCR
STORY20	1743.045	1743.045	14.683	13.475	14.683	13.475	14.734	14.494
STORY19	1985.384	1985.384	14.672	13.514	14.677	13.496	14.734	14.5
STORY18	1985.384	1985.384	14.672	13.514	14.676	13.502	14.735	14.507
STORY17	1985.384	1985.384	14.672	13.514	14.675	13.505	14.735	14.516
STORY16	1985.384	1985.384	14.672	13.514	14.674	13.507	14.736	14.526
STORY15	1985.384	1985.384	14.672	13.514	14.674	13.508	14.736	14.536
STORY14	1985.384	1985.384	14.672	13.514	14.674	13.509	14.737	14.547
STORY13	1985.384	1985.384	14.672	13.514	14.673	13.51	14.737	14.558
STORY12	1985.384	1985.384	14.672	13.514	14.673	13.51	14.738	14.57
STORY11	1985.384	1985.384	14.672	13.514	14.673	13.511	14.739	14.581
STORY10	1985.384	1985.384	14.672	13.514	14.673	13.511	14.739	14.592
STORY9	1985.384	1985.384	14.672	13.514	14.673	13.511	14.74	14.602
STORY8	1985.384	1985.384	14.672	13.514	14.673	13.511	14.741	14.61
STORY7	1985.384	1985.384	14.672	13.514	14.673	13.512	14.741	14.616
STORY6	1985.384	1985.384	14.672	13.514	14.673	13.512	14.74	14.618
STORY5	1985.384	1985.384	14.672	13.514	14.673	13.512	14.736	14.612

STORY4	1985.384	1985.384	14.672	13.514	14.673	13.512	14.729	14.592
STORY3	1985.384	1985.384	14.672	13.514	14.673	13.512	14.714	14.549
STORY2	1985.384	1985.384	14.672	13.514	14.673	13.512	14.692	14.466
STORY1	2063.341	2063.341	14.669	13.526	14.673	13.513	14.658	14.342

Table 6. Shear Wall With Opening

The following are the values of the Model Mass Contributions

Mode	Period	UX	UY	UZ	SumUX	SumUY
1	2.008698	65.6283	0.5892	0	65.6283	0.5892
2	1.895758	0.6233	72.4332	0	66.2516	73.0224
3	1.75645	6.369	0.0291	0	72.6205	73.0515
4	0.554075	13.8419	0.1119	0	86.4625	73.1634
5	0.53466	0.1138	13.5512	0	86.5763	86.7146
6	0.453777	0.5506	0.0041	0	87.1268	86.7187
7	0.263488	5.5609	0.0142	0	92.6877	86.7329
8	0.256385	0.0148	5.2883	0	92.7025	92.0211
9	0.203708	0.1221	0.0013	0	92.8246	92.0224
10	0.160475	2.9063	0.0006	0	95.7309	92.023

11	0.153942	0.0006	2.9382	0	95.7315	94.9612
12	0.119972	0.0556	0.0006	0	95.7871	95.2659

Table 7. Shear Wall Without Opening

The following are the values of the Model Mass Contributions

Mode	Period	UX	UY	UZ	SumUX	SumUY
1	2.037052	64.4361	0.3771	0	64.4361	0.3771
2	1.933803	0.412	72.9029	0	64.8481	73.2801
3	1.794027	7.6779	0.033	0	72.5261	73.3131
4	0.564611	13.6862	0.1278	0	86.2123	73.4409
5	0.551598	0.1336	13.4243	0	86.3459	86.8653
6	0.47132	0.7877	0.003	0	87.1336	86.8682
7	0.269714	1.8097	3.4556	0	88.9433	90.3238
8	0.269188	3.7129	1.6846	0	92.6563	92.0084
9	0.216015	0.2079	0.0007	0	92.8642	92.0091
10	0.165567	0.005	2.7647	0	92.8692	94.7738
11	0.164697	2.8754	0.0048	0	95.7446	94.7786

12	0.129794	0.0964	0.0002	0	95.8409	95.2785

Table 8. Shear Wall With Opening
Shear Force, Bend Motion and Torsion

Story	Column	Load	Loc	P	V2	V3	T	M2	M3
STORY20	C1	DCON25	0	2.02	-1.65	-1.73	-40.438	-131.804	-95.113
STORY19	C1	DCON25	0	-19.22	-1.17	-0.23	-41.052	-82.463	-67.071
STORY18	C1	DCON25	0	-45.7	-0.75	0.21	-41.763	-65.459	-44.916
STORY17	C1	DCON25	0	-75.89	-0.47	0.73	-42.477	-39.823	-28.327
STORY16	C1	DCON25	0	-109.85	-0.24	1.13	-43.11	-14.595	-14.411
STORY15	C1	DCON25	0	-146.8	-0.06	1.45	-43.588	10.864	-2.769
STORY14	C1	DCON25	0	-186.1	0.09	1.71	-43.852	36.441	7.319
STORY13	C1	DCON25	0	-227.23	0.22	1.93	-43.852	62.296	16.357
STORY12	C1	DCON25	0	-269.83	0.33	2.11	-43.547	88.732	24.807
STORY11	C1	DCON25	0	-313.61	0.43	2.28	-42.897	116.223	33.095
STORY10	C1	DCON25	0	-358.39	0.54	2.44	-41.868	145.454	41.652
STORY9	C1	DCON25	0	-404.12	0.65	2.61	-40.425	177.379	50.941
STORY8	C1	DCON25	0	-450.81	0.78	2.8	-38.534	213.299	61.481
STORY7	C1	DCON25	0	-498.66	0.93	3.03	-36.153	254.96	73.873
STORY6	C1	DCON25	0	-548.01	1.13	3.31	-33.238	304.679	88.765
STORY5	C1	DCON25	0	-599.47	1.36	3.68	-29.735	365.432	106.758
STORY4	C1	DCON25	0	-654.03	1.65	4.15	-25.575	441.027	128.177
STORY3	C1	DCON25	0	-713.75	1.94	4.75	-20.679	535.254	149.457
STORY2	C1	DCON25	0	-779.24	2.43	5.55	-14.896	664.729	188.689
STORY1	C1	DCON25	0	-909.26	0.89	4.69	-22.293	827.283	93.282

Table 9. Shear Wall With Out Opening

Shear Force, Bend Motion and Torsion

Table 10. Shear Wall With Opening

Story	Column	Load	Loc	P	V2	3	T	M2	M3
STORY20	C1	DCON25	0	-9.96	-3.28	-0.57	-39.395	-95.537	-75.547
STORY19	C1	DCON25	0	-43.41	-3.21	0.41	-26.34	-18.444	-78.621
STORY18	C1	DCON25	0	-77.36	-3.7	1.15	-26.047	28.153	-90.964
STORY17	C1	DCON25	0	-114.84	-4.58	1.95	-22.344	79.885	-110.743
STORY16	C1	DCON25	0	-155.09	-5.76	2.78	-18.989	132.114	-136.172
STORY15	C1	DCON25	0	-197.62	-7.18	3.63	-15.261	184.514	-166.086
STORY14	C1	DCON25	0	-241.95	-8.79	4.51	-11.268	236.97	-199.515
STORY13	C1	DCON25	0	-287.72	-10.55	5.41	-6.932	289.454	-235.705
STORY12	C1	DCON25	0	-334.64	-12.42	6.32	-2.186	342.035	-274.046
STORY11	C1	DCON25	0	-382.48	-14.38	7.23	3.066	394.853	-314.056
STORY10	C1	DCON25	0	-431.13	-16.42	8.12	8.944	448.143	-355.36
STORY9	C1	DCON25	0	-480.53	-18.51	8.99	15.604	502.261	-397.67
STORY8	C1	DCON25	0	-530.72	-20.64	9.81	23.232	557.75	-440.769
STORY7	C1	DCON25	0	-581.86	-22.82	10.56	32.04	615.435	-484.475
STORY6	C1	DCON25	0	-634.27	-25.03	11.24	42.228	676.565	-528.595
STORY5	C1	DCON25	0	-688.51	-27.27	11.86	53.879	743.732	-572.769
STORY4	C1	DCON25	0	-745.16	-29.51	12.4	66.685	816.39	-616.104
STORY3	C1	DCON25	0	-809.39	-31.68	14.27	79.79	950.787	-656.493
STORY2	C1	DCON25	0	-857.41	-33.98	13.21	66.934	932.265	-692.654
STORY1	C1	DCON25	0	-1024.48	-16.59	7.13	56.577	188.021	-25.123

Shear Force, Bend Motion and Torsion

Story	Column	Load	Loc	P	V2	V3	T	M2	M3
STORY20	C4	DCON25	0	-38.9	7.37	9.6	-35.714	469.86	346.807
STORY19	C4	DCON25	0	-86.23	4.38	9.35	-36.409	495.889	274.907
STORY18	C4	DCON25	0	-135.87	5.19	11.03	-37.163	583.093	300.351

STORY17	C4	DCON25	0	-188.88	5.21	12.67	-37.922	677.21	306.5
STORY16	C4	DCON25	0	-245.25	5.4	14.28	-38.612	774.836	317.983
STORY15	C4	DCON25	0	-304.9	5.56	15.81	-39.16	871.046	328.933
STORY14	C4	DCON25	0	-367.63	5.73	17.23	-39.513	962.855	340.003
STORY13	C4	DCON25	0	-433.19	5.88	18.5	-39.625	1048.416	350.54
STORY12	C4	DCON25	0	-501.27	6.02	19.61	-39.455	1126.6	360.184
STORY11	C4	DCON25	0	-571.51	6.13	20.57	-38.968	1196.688	368.521
STORY10	C4	DCON25	0	-643.57	6.21	21.35	-38.131	1258.112	375.132
STORY9	C4	DCON25	0	-717.04	6.25	21.94	-36.911	1310.211	379.568
STORY8	C4	DCON25	0	-791.49	6.25	22.33	-35.274	1351.992	381.346
STORY7	C4	DCON25	0	-866.39	6.19	22.47	-33.18	1381.792	379.886
STORY6	C4	DCON25	0	-941.13	6.06	22.32	-30.583	1397.161	374.743
STORY5	C4	DCON25	0	-1014.91	5.85	21.77	-27.429	1392.884	364.377
STORY4	C4	DCON25	0	-1086.71	5.58	20.76	-23.645	1369.52	352.364
STORY3	C4	DCON25	0	-1154.99	4.99	18.61	-19.15	1272.932	314.97
STORY2	C4	DCON25	0	-1218.49	5.38	18.59	-13.773	1424.887	371.359
STORY1	C4	DCON25	0	-1269.57	0.56	-0.99	0	0	0

Table 11. Shear Wall With Opening

For Load Combinations - 1.5 EQX + 9 D.L following are the values for Shear Force, Bending Motion and Torsion

Story	Column	Load	Loc	P	V2	V3	T	M2	M3
STORY20	C1	DCON40	0	82.06	12.42	5.52	-3.298	7.347	22.135
STORY19	C1	DCON40	0	115.95	1.33	3.38	-3.366	3.779	10.489
STORY18	C1	DCON40	0	58.59	-0.42	1.15	-3.438	0.655	8.315
STORY17	C1	DCON40	0	-29.17	-3.34	-0.3	-3.519	-1.446	4.664
STORY16	C1	DCON40	0	-148.95	-5.35	-1.45	-3.597	-3.064	1.431
STORY15	C1	DCON40	0	-294.14	-7.03	-2.37	-3.665	-4.315	-1.785
STORY14	C1	DCON40	0	-460.21	-8.39	-3.13	-3.716	-5.296	-4.974
STORY13	C1	DCON40	0	-643.63	-9.54	-3.78	-3.746	-6.074	-8.19
STORY12	C1	DCON40	0	-841.78	-10.54	-4.34	-3.749	-6.701	-11.474
STORY11	C1	DCON40	0	-1052.85	-11.44	-4.84	-3.722	-7.221	-14.881
STORY10	C1	DCON40	0	-1275.76	-12.29	-5.32	-3.66	-7.674	-18.48
STORY9	C1	DCON40	0	-1510.15	-13.16	-5.79	-3.56	-8.1	-22.365
STORY8	C1	DCON40	0	-1756.4	-14.1	-6.29	-3.417	-8.548	-26.661
STORY7	C1	DCON40	0	-2015.82	-15.18	-6.86	-3.227	-9.079	-31.54
STORY6	C1	DCON40	0	-2290.78	-16.52	-7.56	-2.985	-9.782	-37.252
STORY5	C1	DCON40	0	-2585.3	-18.28	-8.46	-2.685	-10.785	-44.169
STORY4	C1	DCON40	0	-2905.28	-20.62	-9.74	-2.319	-12.346	-52.736
STORY3	C1	DCON40	0	-3265.73	-24.45	-11.29	-1.88	-14.157	-64.74
STORY2	C1	DCON40	0	-3652.65	-27.57	-15.85	-1.35	-21.952	-77.307
STORY1	C1	DCON40	0	-4650.85	-31.59	-4.11	1.003	1.446	-114.211

Table 12. Shear Wall Without Opening

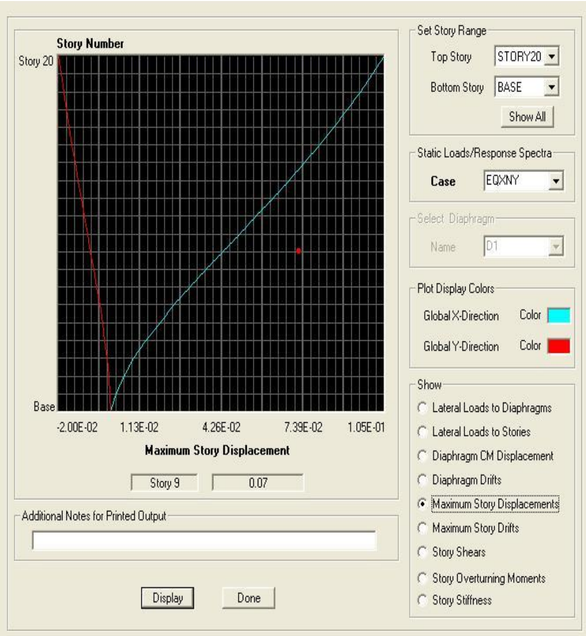
Story	Column	Load	Loc	P	V2	V3	T	M2	M3
STORY20	C1	DCON40	0	145.17	29.59	-3.71	-2.548	5.364	24.267
STORY19	C1	DCON40	0	115.33	5.89	-4.71	-2.177	3.622	11.051
STORY18	C1	DCON40	0	40.66	-4.35	-2.6	-2.04	3.255	6.703
STORY17	C1	DCON40	0	-78.09	-14.74	0.85	-2.173	4.372	1.211
STORY16	C1	DCON40	0	-229.86	-24.33	5.37	-2.282	6.576	-4.387
STORY15	C1	DCON40	0	-408.15	-33.5	10.74	-2.423	9.652	-10.203
STORY14	C1	DCON40	0	-608.07	-42.37	16.8	-2.572	13.425	-16.22
STORY13	C1	DCON40	0	-826.04	-51.06	23.46	-2.723	17.762	-22.434
STORY12	C1	DCON40	0	-1059.49	-59.65	30.65	-2.875	22.565	-28.845
STORY11	C1	DCON40	0	-1306.7	-68.19	38.31	-3.027	27.766	-35.458
STORY10	C1	DCON40	0	-1566.75	-76.72	46.46	-3.184	33.321	-42.292
STORY9	C1	DCON40	0	-1839.57	-85.29	55.12	-3.354	39.208	-49.379
STORY8	C1	DCON40	0	-2126.03	-93.94	64.35	-3.551	45.431	-56.767
STORY7	C1	DCON40	0	-2428.24	-102.71	74.3	-3.798	52.02	-64.531
STORY6	C1	DCON40	0	-2750.15	-111.66	85.16	-4.129	59.026	-72.767
STORY5	C1	DCON40	0	-3099.62	-120.93	97.27	-4.597	66.659	-81.681
STORY4	C1	DCON40	0	-3487.22	-130.06	110.12	-5.232	74.063	-90.961
STORY3	C1	DCON40	0	-3988.75	-142.61	133.1	-6.323	92.426	-104.155
STORY2	C1	DCON40	0	-4310.66	-137.87	125.99	-10.912	68.458	-103.035
STORY1	C1	DCON40	0	-5484.34	-66.74	46.12	-5.668	3.813	-25.271

Table 13. Shear Wall With Opening

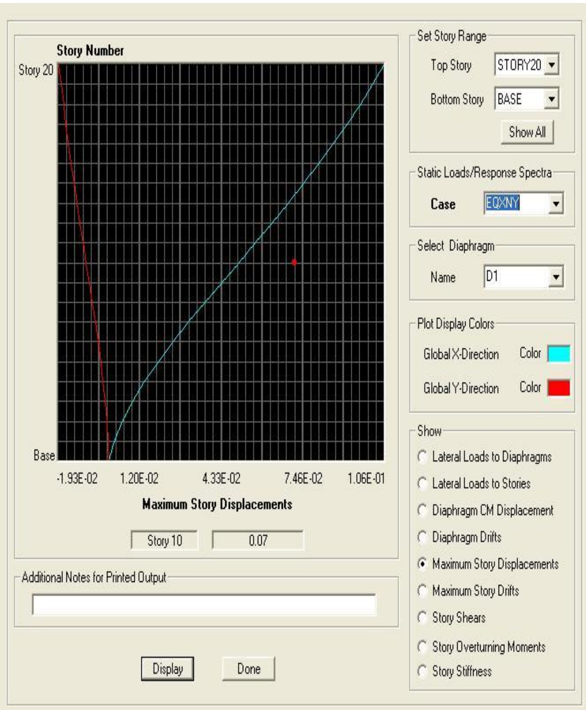
Story	Column	Load	Loc	P	V2	V3	T	M2	M3
STORY20	C4	DCON40	0	-85.08	-47.48	46.02	-3.067	61.24	-59.559
STORY18	C4	DCON40	0	-239.1	-53.46	35.62	-3.258	52.943	-72.4
STORY17	C4	DCON40	0	-301.68	-61.15	35	-3.363	52.159	-83.463
STORY16	C4	DCON40	0	-353.64	-68.57	34.6	-3.465	51.479	-94.963
STORY15	C4	DCON40	0	-394.86	-75.84	34.05	-3.556	50.63	-106.597
STORY14	C4	DCON40	0	-425.62	-82.58	33.41	-3.629	49.631	-117.781
STORY13	C4	DCON40	0	-446.5	-88.6	32.64	-3.681	48.451	-128.145
STORY12	C4	DCON40	0	-458.36	-93.69	31.73	-3.704	47.071	-137.371
STORY11	C4	DCON40	0	-462.24	-97.71	30.67	-3.696	45.468	-145.2
STORY10	C4	DCON40	0	-459.41	-100.51	29.45	-3.653	43.618	-151.4
STORY9	C4	DCON40	0	-451.28	-101.94	28.04	-3.571	41.495	-155.756
STORY8	C4	DCON40	0	-439.47	-101.83	26.43	-3.445	39.074	-158.049
STORY7	C4	DCON40	0	-425.79	-100.01	24.6	-3.271	36.323	-158.043
STORY6	C4	DCON40	0	-412.29	-96.22	22.52	-3.042	33.208	-155.451
STORY5	C4	DCON40	0	-401.34	-90.2	20.17	-2.752	29.668	-149.972
STORY4	C4	DCON40	0	-395.69	-81.56	17.53	-2.391	25.745	-141.193
STORY3	C4	DCON40	0	-398.79	-69.26	14.32	-1.948	20.798	-127.348
STORY2	C4	DCON40	0	-413.57	-59.34	12.01	-1.395	18.245	-124.223
STORY1	C4	DCON40	0	-462.82	4.84	1.59	0	0	0

Table 14. Shear Wall With Opening

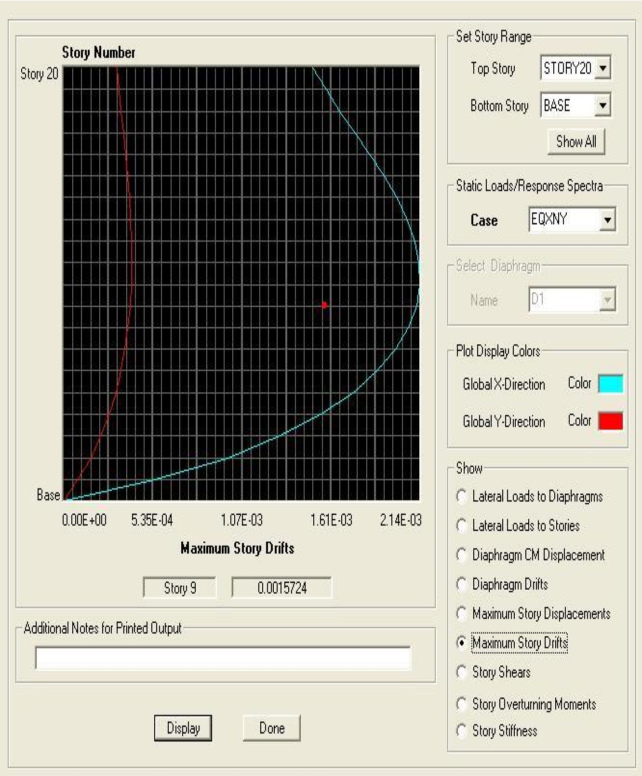
Check for Drift and Displacement
From IS 1893 (Part – I) – 2002
Allowable drift = 0.004h = 0.004 x 3 =0.012m
Allowable displacement =H / 500 = 0.122m
Case 1:- Shear Wall with Openings
For Load Combination EQXNY
Drift = 0 .0021522m
Displacement = 0.11m



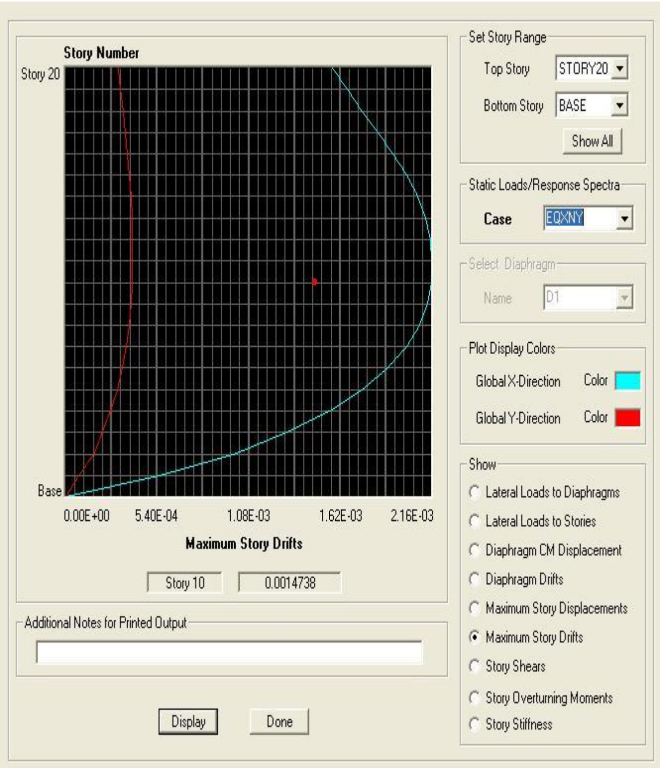
Graph 1. Displacement Shear Wall



Graph 2. Displacement Opening



Graph 3. Drift Shear Wall



Graph 4. Drift With Opening

V. CONCLUSIONS

1. With the provision of shear wall the shear force in the columns, decreased.
2. With the provision of shear wall the moment in the columns, increased.
3. No significant difference in shear force and moment provision of 20 % opening in the shear wall.
4. With the provision of the shear walls drift and displacement is decreasing.
5. With the provision of the shear wall the drift and displacement is increasing.

SCOPE FOR FURTHUR STUDY

The size of opening and placement of the openings can be changed and a study can be made.

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