SEISMIC ANALYSIS OF LATERAL FORCE RESISTING SYSTEM FOR TALL BUILDINGS

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ABSTRACT

In recent years of construction, high rise buildings are widely increased due to highly increasing land cost and scarcity of land in the metropolitan cities. High rise structures are sensitive to wind and earthquake forces. Behavior of these structures can be controlled effectively by lateral force resisting systems, which increases stiffness of building. Although at present computer technology allows for more precise analysis and design of different structural systems for high rise buildings. The enhancement in the performance of the building is studied under earthquake loads by installing lateral force resisting systems, like shear walls and bracing system. In the present paper, shear wall and bracing systems were applied at various positions of the building. Modeling and analysis was carried out using ETABS 9.7.2. From the observations it is seen that all the proposed arrangements provided improve the structural performance of the building in controlling top story displacement, base shear and story drift.

Key words: *lateral force resisting systems, shear walls, bracing.*

1. INTRODUCTION

Amongst all the natural hazards, earthquakes cause the greatest damages. Since earthquake forces are random & unpredictable, it is necessary to that our engineering tools needs to be used beneficially to analyze structures under the action of earthquake forces. Earthquake loads are to be modeled carefully so as to assess the real behavior of structure so that a clear understanding that the damage is expected but it should be minimized. In this context time history and response spectra analysis which is an iterative procedure shall be looked upon as an alternative for the orthodox analysis procedure. Population explosion has made high-rises the order of the day as it is only logical solution and way of accommodating growing population within the boundaries of cities. It is needless to emphasis that tall buildings are prone to larger movement and damages than low rise structures during earthquakes and as the number of people Occupying in high rise building at any given time is far greater so also the risk of collateral damage. Apart from ensuring structural safety during earthquakes high rise are giving engineer another cause of concern that is the wind induced vibrations that cause occupant discomfort should be mitigated. Excessive floor displacements and accelerations which are caused by relatively frequent strong ground motions can render building unserviceable for reasons for occupant discomfort. The effect is more pronounced in tall and slender buildings and for buildings to qualify for serviceability. The dynamic response of structures to earthquakes needs to be reduced. In general, the structural system of building is a complex three dimensional assemblage of various combinations of interconnected structural elements. The primary function of structural system is to carry dynamic and static loads, wind loads, external or internal explosion and impact loads. A variety of factors has to be considered in the process of selecting most suitable structural system for high rise building. The selection is complicated process, and no simple clear cut process available. The design team must use imagination, previous experiences, and relevant literature to decide at the best solution in each particular case. Although present day engineering computer technology allows for precision in analysis and design of different systems of high rise building, it does not provide readily insight for choosing among alternative of these systems to arrive at the best overall design.

2. OBJECTIVE OF RESEARCH

1. To study the response of building for applied lateral force resisting systems.
2. Compare the results between the Lateral force resisting systems.
3. Comparing the Static and dynamic response quantities for different structural systems.
4. To decide most efficient and reliable lateral force resisting system for tall buildings.

3. LITERATURE REVIEW

Jeffrey W. Berman, Michel Bruneau, Oguz C. Celik. (2005)

Braced frames and steel plate shear walls (SPSWs) both have been seen to be useful in the seismic retrofit of buildings. While both these systems have merit, no guidance exists which could help the engineer to determine which of the two approaches will be preferable in terms of providing the stiffness, maximum displacement, ductility, the cumulative hysteretic energy dissipation, and energy dissipation per cycle for a given strength. As an attempt to provide some quantitative data and an insight for this purpose, this paper describes and compares the results by the cyclic testing of six frames of which four are concentrically braced frames, and two are light-gauge steel plate shear walls. The large initial stiffness was seen to be provided by a braced frame specimen with a cold formed steel studs and largest ductility was achieved with the steel plate shear wall with flat infill. After scaling the hysteretic results to same design base shear, it is found that both energy dissipated per cycle and cumulative energy dissipation were similar for the flat plate SPSW and the braced frames containing two tubular braces, till a ductility of four. After that the tubular braces fractured while SPSW containing a flat infill reached to ductility of nine before the energy dissipation per cycle decreased.

Kyoung Sun Moon .(2010)

Braced tubes are an efficient structural system for tall buildings and have been found continuously used for the major tall buildings as since their emergence in late 1960s. This paper, presents a stiffness-based design methodology for determining the preliminary member sizes of the braced tubes for tall buildings. The methodology is applied to a set of buildings which ranges from 40 to 80 stories tall, and the parameters for the most economic design in terms of material usage are been generated for the representative design loadings. The impact of different geometric configurations of the structural members on economic design is also been discussed, and the recommendations for the optimal geometries are made. The stiffness-based method, with a less iterative process, is seen very efficient for the preliminary design of braced tube structures, and can contribute to constructing a built environment using minimum amounts of the resources. Lateral load carrying capacity of braced frame within the building's interior core is much smaller than that of the later-developed exterior braced tube on a building's perimeter. The lateral stiffness of perimeter braced tubes can be enhanced by adding the lateral load resisting core structures, like the steel braced cores or concrete shear cores. Studies show that typical braced cores contribute to about 20% of total lateral rigidity in properly designed braced tube tall buildings.

R.Tremblay, M.H. Archmambault, A. Filiatrault (2003)

This paper describes an experimental study on the seismic performance of the concentrically braced steel frames which are made with cold-formed rectangular tubular bracing members. A total of 24 quasistatic cyclic test was performed on full size X bracing and the single diagonal bracing systems. Two loading sequences were considered i.e the asymmetrical stepwise increasing deformation sequence and a displacement history record that was obtained from the nonlinear dynamic analyses of typical braced steel frame. All the specimens buckled out of plane of the frame and tests were interrupted when the fracture of braces occurred in the region having highest curvature. For X bracing, results clearly show that the effective length of the braces can be used so as to determine their compression strength and for characterizing their hysteretic response, which also includes the energy dissipation capability. Simplified models are made to predict the out of plane deformation of the braces as function of ductility level. These models are then used for developing an empirical expression so as to assess inelastic deformation capacity before the fracture of bracing members made from the rectangular hollow sections. The brace slenderness ratio can be reduced by adopting an X bracing configuration, it is shown that tension acting bracing can provide an efficient support at the brace intersection point for compression bracing with k=0.5. Rectangular hallow section are seen very effective in compression and their use in X bracing forms an efficient means of resisting lateral seismic load.

Prof. Bhosle Ashwini Tanaji, Prof. Shaikh A. N. (2015)

Concrete braced and steel braced reinforced concrete frame is one of the structural systems that is used to resist earthquake loads in multistoried buildings. Many existing reinforced concrete buildings need to be retrofit to overcome deficiencies to resist seismic loads. The use of concrete and steel bracing systems for strengthening the seismically inadequate reinforced concrete frames is a suitable solution for enhancing earthquake resistance. The Concrete and steel bracing is economical, easy to erect, occupies less space and has the flexibility to design for meeting required strength and stiffness also. In this study, the seismic analysis of reinforced concrete (RC) buildings with the different types of bracings (Diagonal, V type, Inverted V type, Combine V type, K type, X type) are studied. The bracing is provided for the peripheral columns and the any two parallel sides of modeled building. A thirteen-storey building is analyzed for seismic zone III according to IS 1893: 2002 using ETAB software. The percentage of reduction in storey displacement is found out. It is seen that the X type of concrete bracing significantly contributes towards structural stiffness and reduces the maximum storey drift of frames. The bracing system improves not only the stiffness and the strength capacity but also the displacement capacity of the structure.

Shahzad Jamil Sardar and Umesh. N. Karadi (2013)

In this paper the study of 25 storied building in zone V is presented with some investigation that is analyzed by changing the location of shear wall for determining parameters like storey drift, storey shear and displacement using ETAB. Building models for both the linear static and the linear dynamic method are prepared for analysis and the influence of concrete core wall which is provided at the center of the building. The seismic analysis of reinforced concrete frame structure is done by both static and dynamic analysis to determine and compare the base shear. It has been found that maximum base shear in the model-5 (i.e. When shear wall placed at the centre and four shear wall are placed at outer edge parallel to X and Y direction) as compared to the other models. In equivalent static analysis it is seen that the model-5 shows lesser displacement as compared to other models in longitudinal direction. In the response spectrum analysis model-5 shows lesser displacement as compared to other models in longitudinal direction. In the equivalent static analysis it has been found that model-5 shows lesser inter storey drift as compared to other models in longitudinal direction. In response spectrum analysis model-5 shows lesser inter-storey drift as compared to other models in longitudinal direction.

Alfa Rasikan , M G Rajendran (2013)

This paper presents the study and comparison of the difference between the wind behavior of buildings with and without the shear wall using the Staad pro software. A 15 storey building and 20 storey building was analysed with shear wall and without shear wall and the displacements of the buildings with shear wall and without shear wall were compared. From the results it is seen that the displacement for a 15 storey building with shear wall was 20.18% less than the 15 storey building without shear wall and the displacement for 20 storey building with shear wall was 14.6% less than that of the 20 storey building without shear wall. It is found that the building with shear wall resists wind load effectively.

Adithya. M , Swathi rani K , Shruthi H , Dr. Ramesh B.R (2015)

A three dimensional structure is taken with 4 horizontal bays of width 4m and 20 stories is taken with storey height of 3m. The beams and columns are designed to withstand dead and live load only, wind load and Earthquake loads are taken by the bracings. The bracings are provided only on the peripheral columns. Maximum 4 bracings are used in a storey for economic purposes. In this study, an attempt is been made to study the effects of various types of the bracing systems, its position in the building and cost of the bracing system with respect to minimum drift index and the inter storey drift. The different parameters are compared for five models and it is found that as per displacement criteria the bracings are good to reduce the displacement and the max reduction of 68.43% is been observed in Single diagonal braces arranged as diamond shape in 3rd and 4th bay model compared to model without brace. The bending moment and the shear force in columns are also reduced in braced models from which it can found that these are less in the single diagonal braced model compare to other models.

P. P. Chandurkar , Dr. P. S. Pajgade (2013)

In seismic design of buildings, the reinforced concrete structural walls, or shear walls, act as a major earthquake resisting members. Structural walls provide an efficient bracing system and offer great lateral load resistance. The properties of these seismic shear walls dominate the response of the buildings, and it is therefore important to evaluate the seismic response of the walls appropriately. In this study, the main focus is to determine solution for shear wall location in multi-storey building. Effectiveness of shear wall has been studied by the help of four different models. Model one is bare frame structural system and other three models are of dual type structural system. An earthquake load is applied to a building of ten storied building located in the zone II, zone III, zone IV and zone V. Parameters like Lateral displacement, story drift and total cost required for ground floor are calculated in both cases replacing column with shear wall.

4. MODELLING AND ANALYSIS

4.1 Description of structure

The building considered for analysis is a G+15 story building designed using Indian codes IS 456-2000.
Material properties are assumed to be M20 and Fe 500.

Table 4.1 Loads on Structure

Loads on Structure	
Live load on Roof and Floor	5kN/m2
Roof/Floor finish	1.5kN/m2
Slab Thickness	150mm thick
Beam size	230mm x 600mm
Column size	450mm x 600mm upto 6^{th} storey Above 6^{th} storey 300mmx450mm
Bracing size	230mm x 230mm (X -bracing)
Story height	3m
Damping	5%

Table 4.2 Seismic parameters

Seismic Parameters(IS 1893)	
Zone	III
Soil Type	II(Medium Soil)
Importance factor(I)	1
Building System	Special Moment Resisting Frame(R=5) and Ordinary Moment Resisting Frame(R=3)

4.2 Models Considered For Analysis

Following types of models were prepared:

1) Bare frame.

2) Brace frame -

- Case 1- Bracing at location A in plan- Bracing is centrally located at exterior frame throughout height.
- Case 2 -Bracing at location B in plan- Bracing is centrally located at exterior frame throughout height.
- Case 3 -Bracing at location A and B in plan- Bracing is centrally located at exterior frame throughout height.
- Case 4- Bracing at location C in plan- Bracing is located at exterior frame end corners throughout height.

3) Shear wall frame -

- Case 1- Shear wall at location A in plan- Shear wall is centrally located at exterior frame throughout height.
- Case 2- Shear wall at location B in plan- Shear wall is centrally located at exterior frame throughout height.
- Case 3- Shear wall at location A and B in plan- Shear wall is centrally located at exterior frame throughout height.
- Case 4- Shear wall at location C in plan- Shear wall is located at exterior frame end corners throughout height.

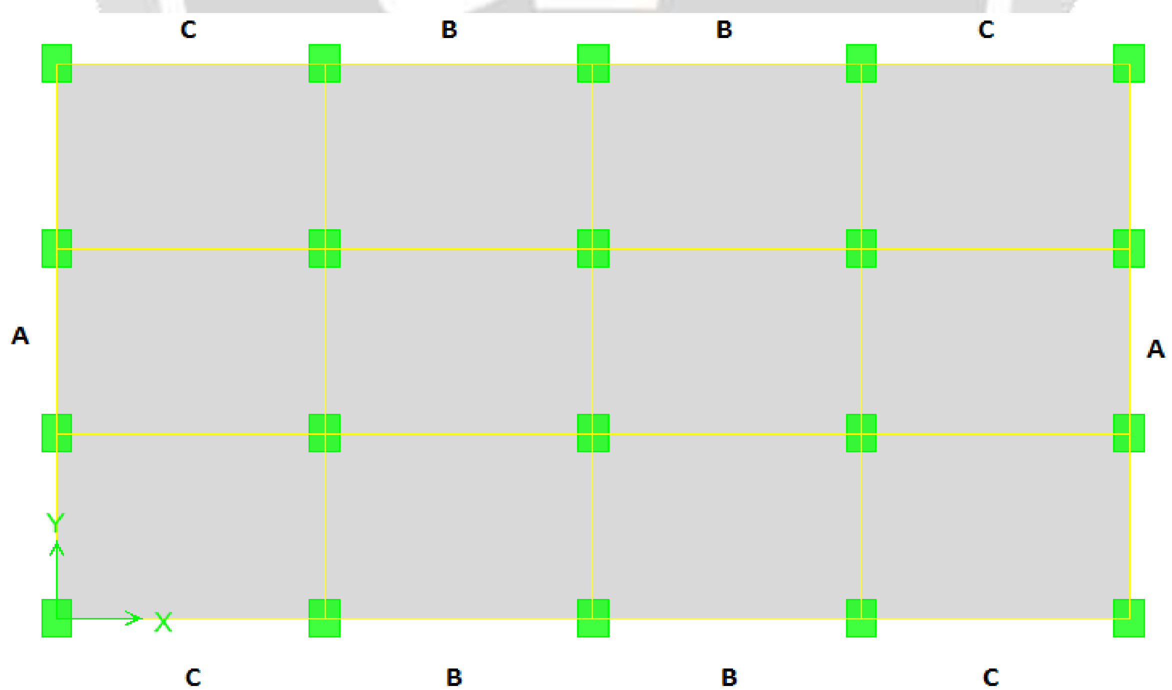


Fig 4.1: Plan of Model Showing Various Locations where shear wall and bracing is placed.

5. RESULT AND DISCUSSION

The variation of base shear, story displacement and storey drift is evaluated for all these models and static and dynamic response of all the models is compared. The load combination 1.2 (DL+LL+EQ/SPEC) is taken for comparison in all models compared. The results for various cases are as follows.

5.1 Base Shear Results -

Table 5.1: Comparison of Base Shear for Bare Frame Model

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	151.91	-540.79	169.03	-405.61
Story 15	283.87	-1045.38	313.11	-784.07
Story 14	378.8	-1482.76	416.66	-1112.13
Story 13	444.31	-1857.75	488.41	-1393.38
Story 12	496.18	-2175.14	543.67	-1631.44
Story 11	544.71	-2439.74	592.35	-1829.89
Story 10	590.75	-2656.33	636.29	-1992.34
Story 9	633.33	-2829.72	676.28	-2122.4
Story 8	673.83	-2964.72	715.23	-2223.65
Story 7	712.29	-3066.12	754.34	-2299.7
Story 6	746.52	-3138.72	792.18	-2354.15
Story 5	777.87	-3187.31	829.98	-2390.6
Story4	813	-3216.71	872.8	-2412.65
Story3	854.32	-3231.71	920.67	-2423.9
Story2	891.08	-3237.11	961.39	-2427.95
Story1	905.59	-3237.69	977.12	-2428.39

Table 5.2: Comparison of Base Shear for Case 1- Bracing at location A in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	166.52	-325.73	243.57	-244.30
Story 15	302.31	-630.62	440.92	-472.97
Story 14	395.14	-894.91	574.25	-671.18
Story 13	462.51	-1121.49	659.18	-841.12
Story 12	517.95	-1313.27	715.61	-984.96
Story 11	566.12	-1473.15	756.30	-1104.86
Story 10	612.19	-1604.03	788.36	-1203.02
Story 9	657.57	-1708.80	820.94	-1281.60
Story 8	698.50	-1790.37	864.13	-1342.78
Story 7	735.47	-1851.64	920.99	-1388.73
Story 6	771.65	-1895.51	987.90	-1421.63
Story 5	807.43	-1924.87	1061.69	-1443.65
Story4	846.18	-1942.64	1138.99	-1456.98
Story3	888.94	-1951.70	1208.79	-1463.77
Story2	920.39	-1954.96	1253.33	-1466.22
Story1	925.81	-1955.31	1262.65	-1466.48

Table 5.3: Comparison of Base Shear for Case 2- Bracing at Location B in Plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	282.65	-327.41	185.43	-245.55
Story 15	532.54	-635.18	334.33	-476.39
Story 14	722.16	-901.98	436.31	-676.48
Story 13	856.00	-1130.70	510.01	-848.03
Story 12	947.47	-1324.30	568.12	-993.23
Story 11	1014.49	-1485.69	615.49	-1114.27
Story 10	1073.19	-1617.81	658.69	-1213.36
Story 9	1133.71	-1723.57	701.00	-1292.68
Story 8	1200.82	-1805.91	740.72	-1354.44
Story 7	1277.06	-1867.76	779.98	-1400.82
Story 6	1363.93	-1912.04	821.98	-1434.03
Story 5	1459.57	-1941.69	865.90	-1456.27
Story4	1555.90	-1959.62	912.99	-1469.72
Story3	1639.35	-1968.77	961.48	-1476.58
Story2	1695.81	-1972.06	994.91	-1479.05
Story1	1713.68	-1972.42	1000.59	-1479.31

Table 5.4: Comparison of Base Shear for Case 3- Bracing at location A and B in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	290.00	-328.64	249.01	-246.48
Story 15	541.86	-638.55	446.96	-478.91
Story 14	728.36	-907.18	579.48	-680.39
Story 13	860.12	-1137.49	667.22	-853.12
Story 12	954.15	-1332.43	725.95	-999.32
Story 11	1025.03	-1494.93	765.31	-1121.20
Story 10	1083.52	-1627.96	797.47	-1220.97
Story 9	1140.41	-1734.46	832.85	-1300.84
Story 8	1206.07	-1817.37	876.06	-1363.03
Story 7	1285.04	-1879.64	931.26	-1409.73
Story 6	1374.50	-1924.23	999.70	-1443.17
Story 5	1469.06	-1954.08	1075.19	-1465.56
Story4	1563.23	-1972.14	1151.25	-1479.10
Story3	1647.81	-1981.35	1221.16	-1486.01
Story2	1708.29	-1984.67	1268.79	-1488.50
Story1	1728.15	-1985.02	1279.18	-1488.76

Table 5.5: Comparison of Base Shear for Case 4- Bracing at location C in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	279.39	-327.41	185.43	-245.55
Story 15	512.65	-635.18	334.33	-476.39
Story 14	675.13	-901.98	436.32	-676.48
Story 13	775.07	-1130.70	510.01	-848.03
Story 12	830.49	-1324.30	568.13	-993.23
Story 11	864.06	-1485.69	615.50	-1114.27
Story 10	895.43	-1617.81	658.70	-1213.36
Story 9	936.16	-1723.57	701.01	-1292.68
Story 8	990.82	-1805.91	740.74	-1354.44
Story 7	1061.56	-1867.76	780.00	-1400.82
Story 6	1149.12	-1912.04	821.99	-1434.03
Story 5	1249.40	-1941.69	865.92	-1456.27
Story4	1350.83	-1959.62	913.01	-1469.72
Story3	1436.88	-1968.77	961.50	-1476.58
Story2	1492.82	-1972.06	994.93	-1479.05
Story1	1509.58	-1972.42	1000.60	-1479.31

Table 5.6: Comparison of Base Shear for Case 1- Shear wall at location A in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	171.74	-321.44	279.34	-241.08
Story 15	308.51	-625.74	501.33	-469.3
Story 14	403.62	-889.51	647.13	-667.13
Story 13	475.1	-1115.65	731.17	-836.74
Story 12	531.63	-1307.06	775.61	-980.29
Story 11	582.14	-1466.62	803.89	-1099.97
Story 10	631.05	-1597.24	833.04	-1197.93
Story 9	676.93	-1701.81	871.46	-1276.36
Story 8	720.16	-1783.22	923.39	-1337.41
Story 7	759	-1844.37	992.68	-1383.28
Story 6	795.21	-1888.15	1079.97	-1416.11
Story 5	833.18	-1917.46	1177.25	-1438.09
Story4	872.83	-1935.19	1268.17	-1451.39
Story3	914.97	-1944.23	1335.38	-1458.17
Story2	948.1	-1947.49	1369.67	-1460.62
Story1	954.1	-1947.84	1375.68	-1460.88

Table 5.7: Comparison of Base Shear for Case 2- Shear wall at location B in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	320.58	-315.95	185.17	-236.96
Story 15	610.46	-622.47	332.09	-466.85
Story 14	837.09	-888.16	438.54	-666.12
Story 13	1007.58	-1115.96	518.35	-836.97
Story 12	1133.97	-1308.76	580.40	-981.57
Story 11	1232.43	-1469.49	633.74	-1102.12
Story 10	1320.40	-1601.06	681.75	-1200.80
Story 9	1412.27	-1706.39	727.50	-1279.80
Story 8	1515.13	-1788.40	770.41	-1341.30
Story 7	1627.24	-1849.99	812.41	-1387.50
Story 6	1740.09	-1894.09	854.29	-1420.57
Story 5	1842.41	-1923.62	898.76	-1442.71
Story4	1924.17	-1941.48	945.61	-1456.11
Story3	1979.38	-1950.59	990.58	-1462.94
Story2	2007.58	-1953.87	1024.76	-1465.40
Story1	2013.72	-1954.21	1031.12	-1465.66

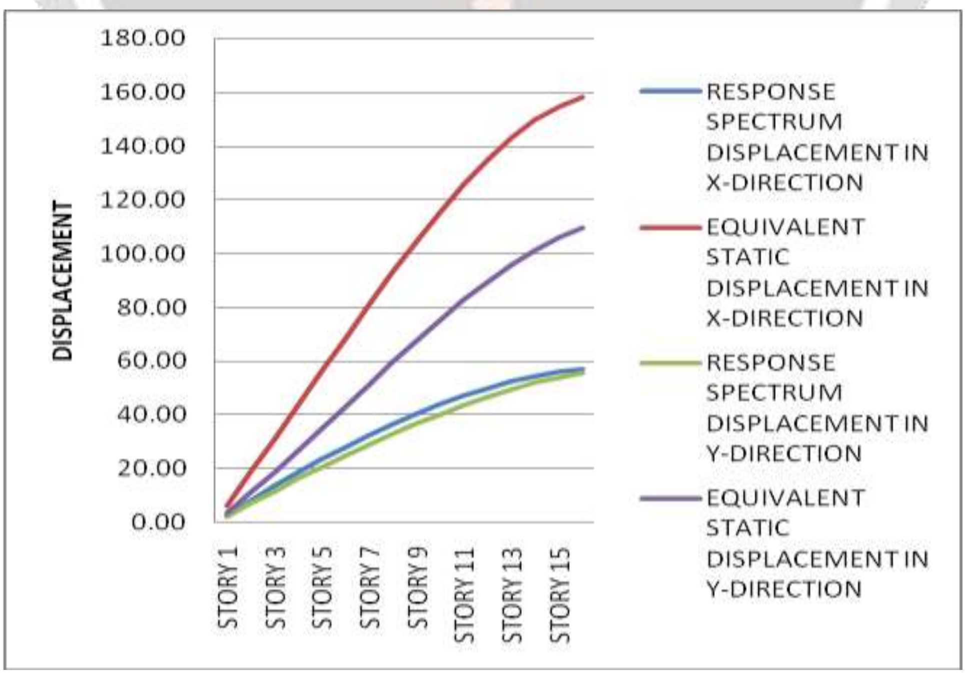
Table 5.8: Comparison of Base Shear for Case 3- Shear wall at location A and B in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	340.79	-312.87	283.95	-234.65
Story 15	640.45	-620.93	500.63	-465.69
Story 14	862.58	-887.95	641.63	-665.97
Story 13	1023.79	-1116.89	734.55	-837.67
Story 12	1146.68	-1310.66	793.41	-982.99
Story 11	1252.31	-1472.19	832.11	-1104.14
Story 10	1353.71	-1604.42	865.02	-1203.32
Story 9	1455.28	-1710.28	903.60	-1282.71
Story 8	1557.30	-1792.70	956.52	-1344.52
Story 7	1660.11	-1854.60	1025.48	-1390.95
Story 6	1763.82	-1898.92	1107.37	-1424.19
Story 5	1865.12	-1928.59	1194.52	-1446.45
Story4	1955.46	-1946.54	1275.96	-1459.91
Story3	2023.74	-1955.70	1343.80	-1466.77
Story2	2062.27	-1959.00	1386.89	-1469.25
Story1	2071.32	-1959.34	1395.90	-1469.51

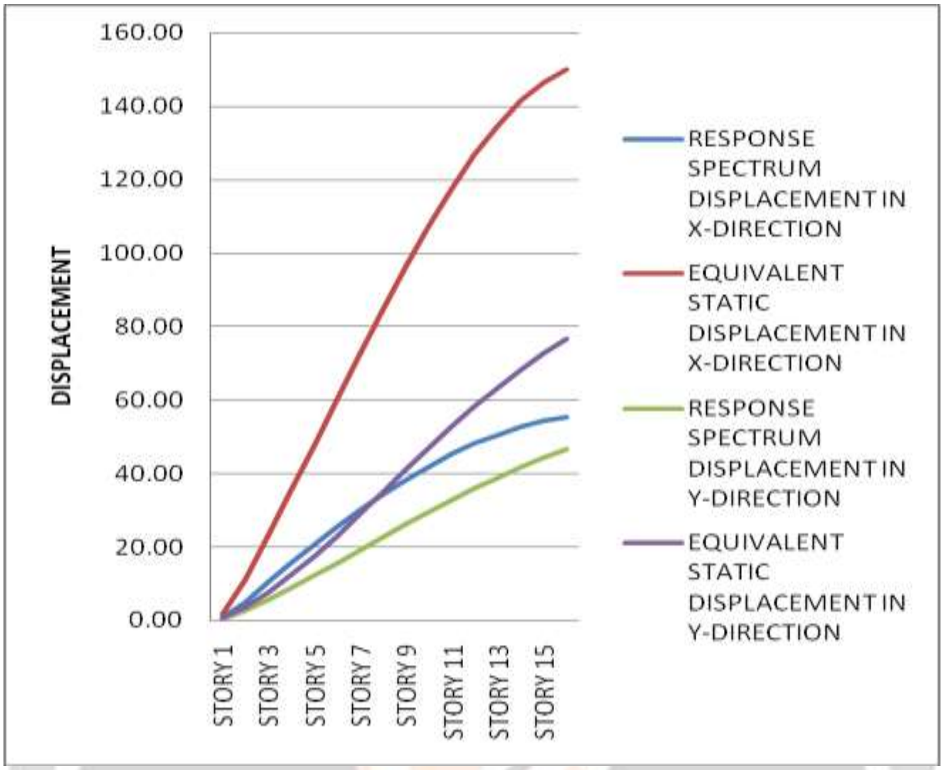
Table 5.9: Comparison of Base Shear for Case 4- Shear wall at location C in plan

Story	Response Spectrum	Equivalent Static	Response Spectrum	Equivalent Static
	Base Shear In X-Direction In KN		Base Shear In Y-Direction In KN	
Story 16	372.95	-315.95	265.64	-236.96
Story 15	673.26	-622.47	479.16	-466.85
Story 14	871.78	-888.16	629.29	-666.12
Story 13	993.01	-1115.96	743.39	-836.97
Story 12	1069.77	-1308.76	832.07	-981.57
Story 11	1132.92	-1469.49	907.38	-1102.12
Story 10	1201.38	-1601.06	977.03	-1200.80
Story 9	1281.17	-1706.39	1041.19	-1279.80
Story 8	1372.98	-1788.40	1103.06	-1341.30
Story 7	1477.87	-1849.99	1162.42	-1387.50
Story 6	1595.06	-1894.09	1221.57	-1420.57
Story 5	1716.30	-1923.62	1284.99	-1442.71
Story4	1825.37	-1941.48	1349.78	-1456.11
Story3	1904.91	-1950.59	1412.69	-1462.94
Story2	1945.99	-1953.87	1457.71	-1465.40
Story1	1954.05	-1954.21	1465.56	-1465.66

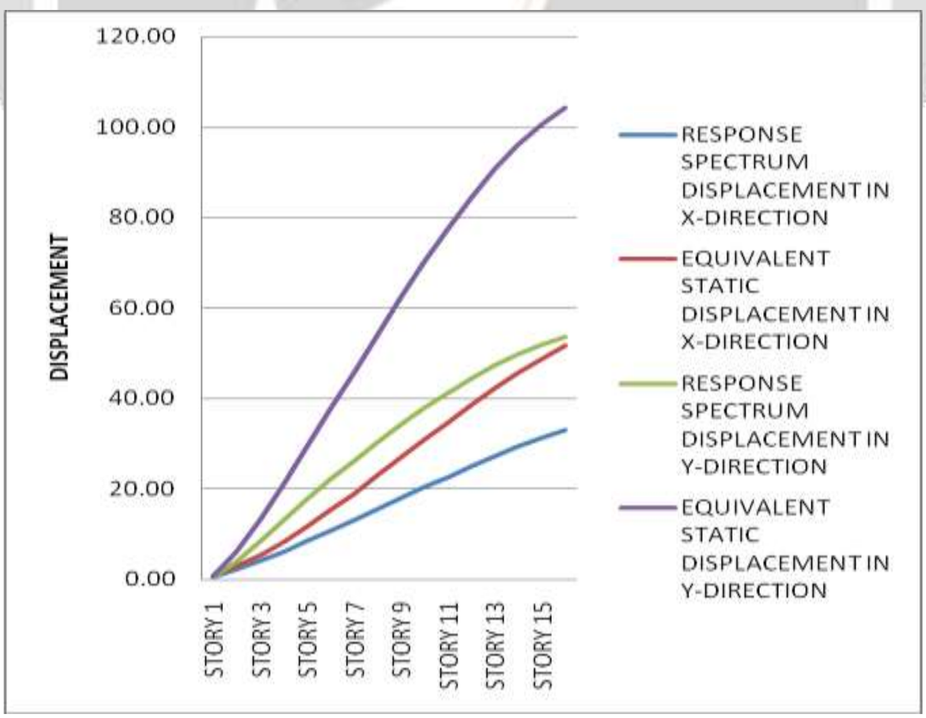
5.2 Displacement Results -



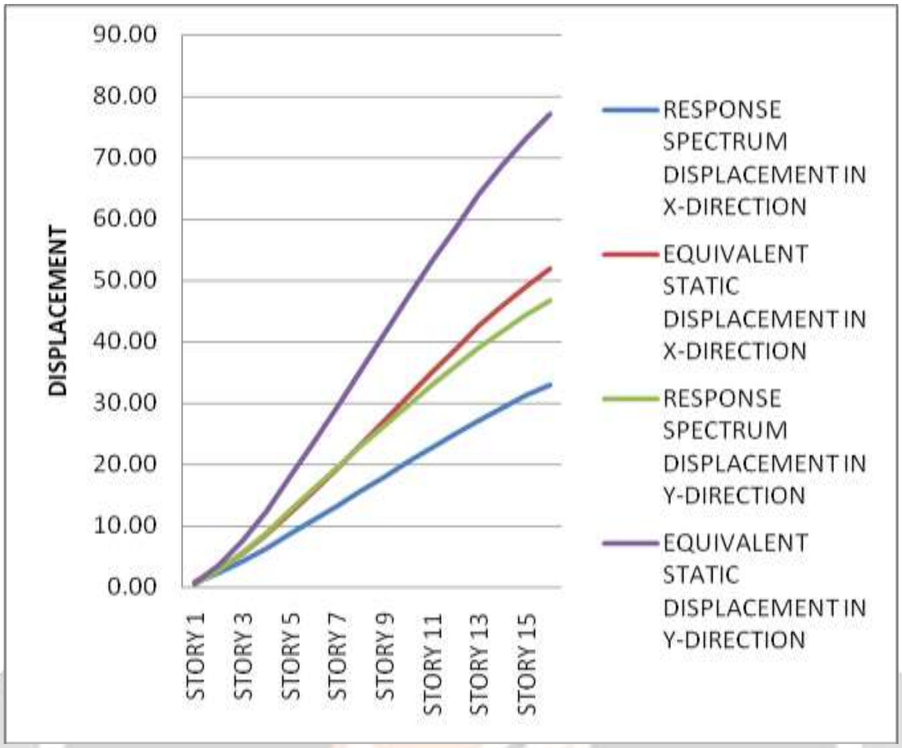
Graph 5.1: Comparison of Displacement for Bare Frame Model



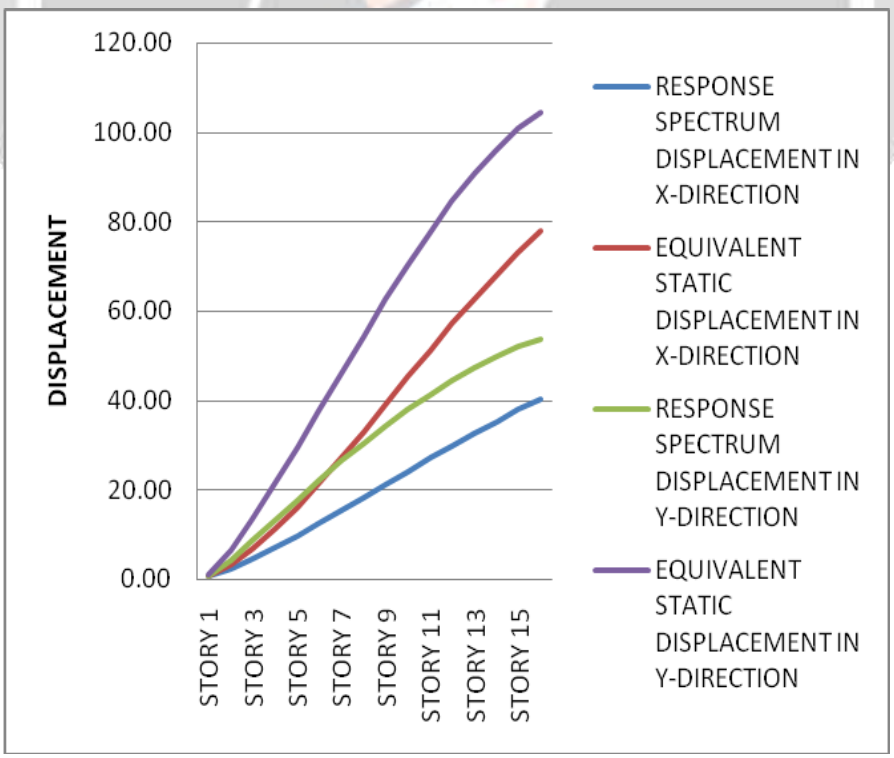
Graph 5.2: Comparison of Displacement for Case 1- Bracing at location A in plan



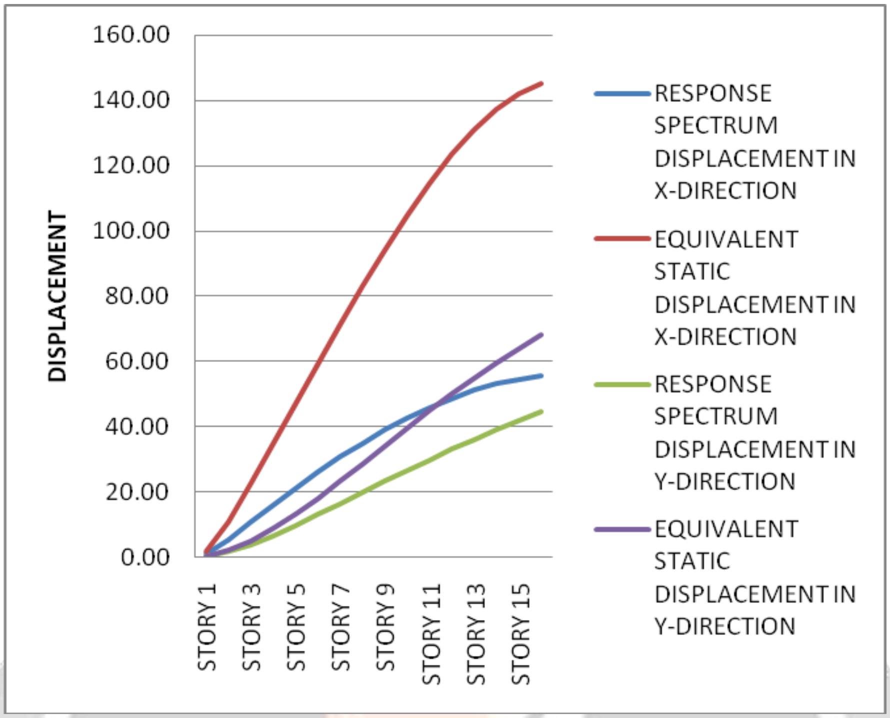
Graph 5.3: Comparison of Displacement for Case 2- Bracing at location B in plan



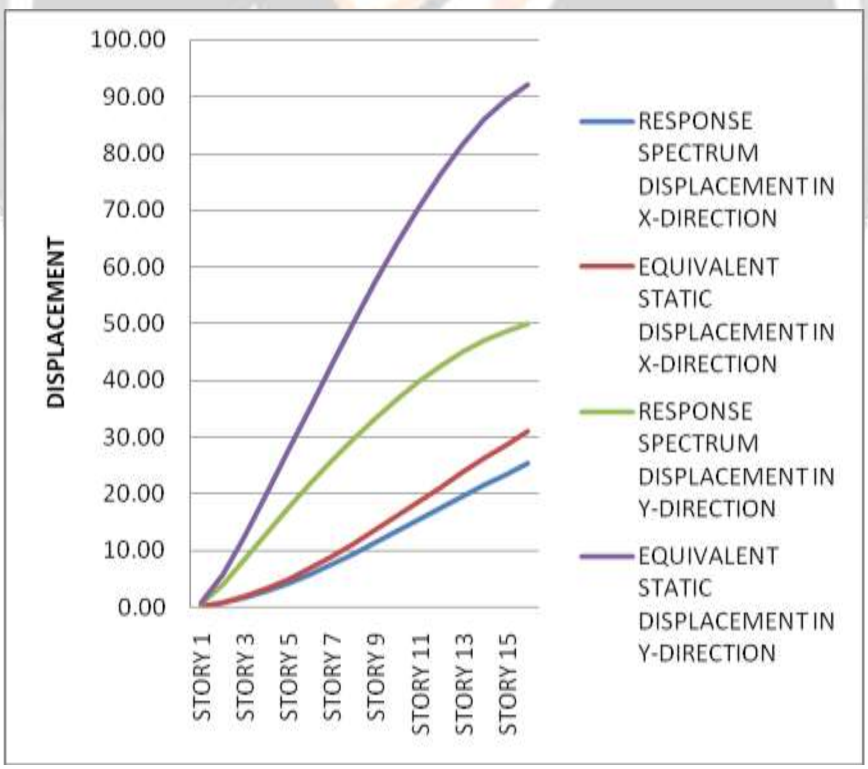
Graph 5.4: Comparison of Displacement for Case 3- Bracing at location A and B in plan



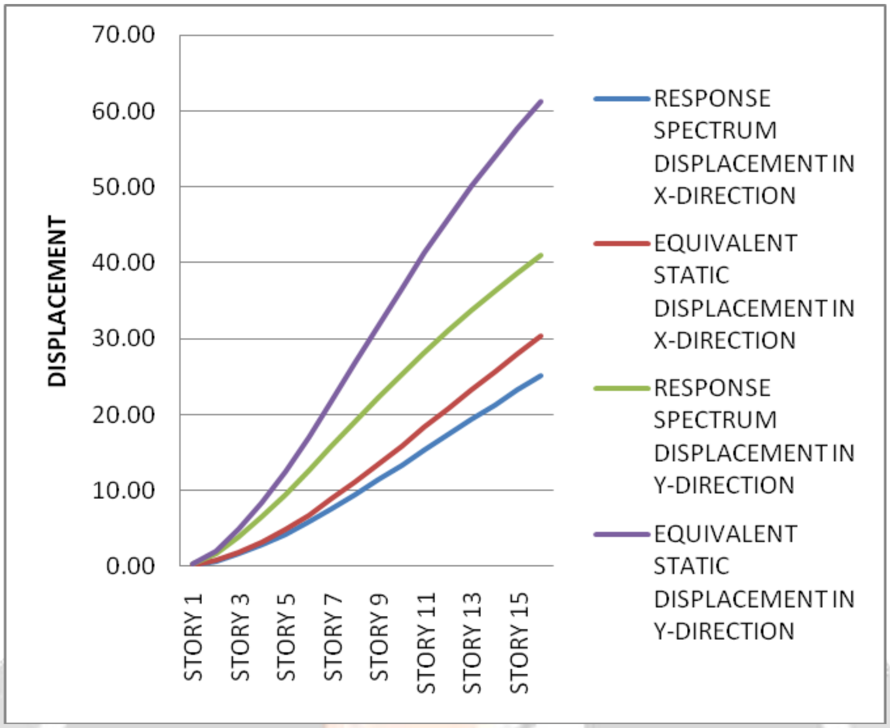
Graph 5.5: Comparison of Displacement for Case 4- Bracing at location C in plan



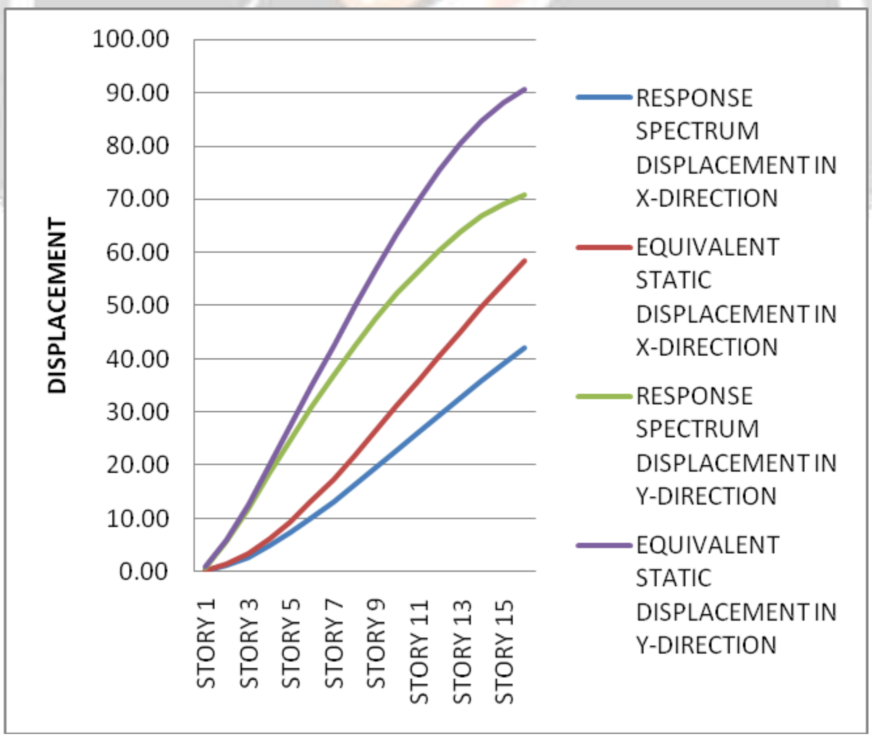
Graph 5.6: Comparison of Displacement for Case 1- Shear wall at location A in plan



Graph 5.7: Comparison of Displacement for Case 2- Shear wall at location B in plan

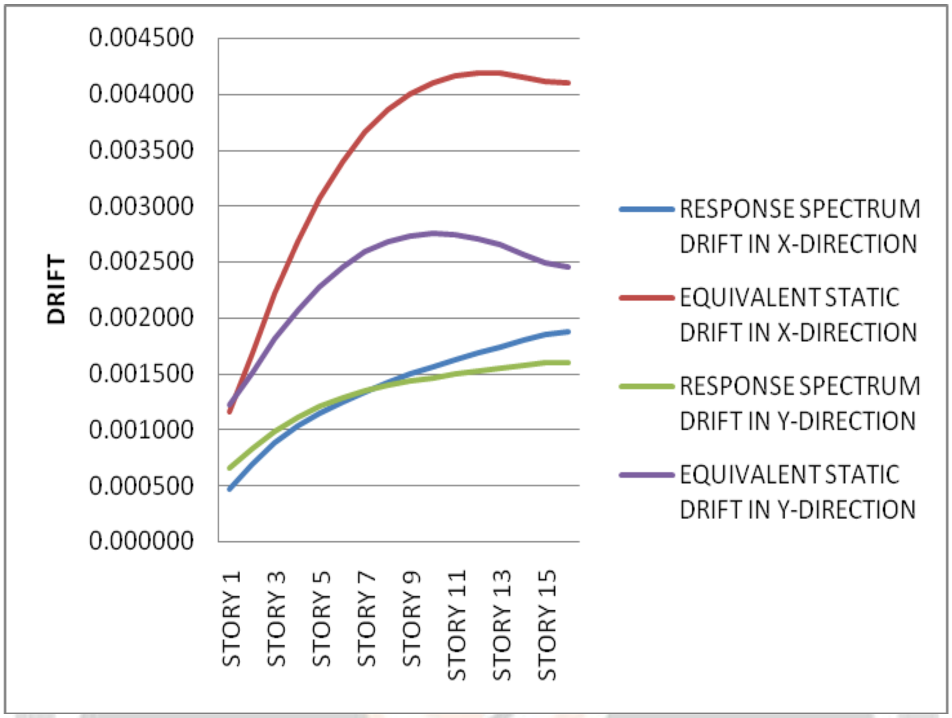


Graph 5.8: Comparison of Displacement For Case 3- Shear wall at location A and B in plan

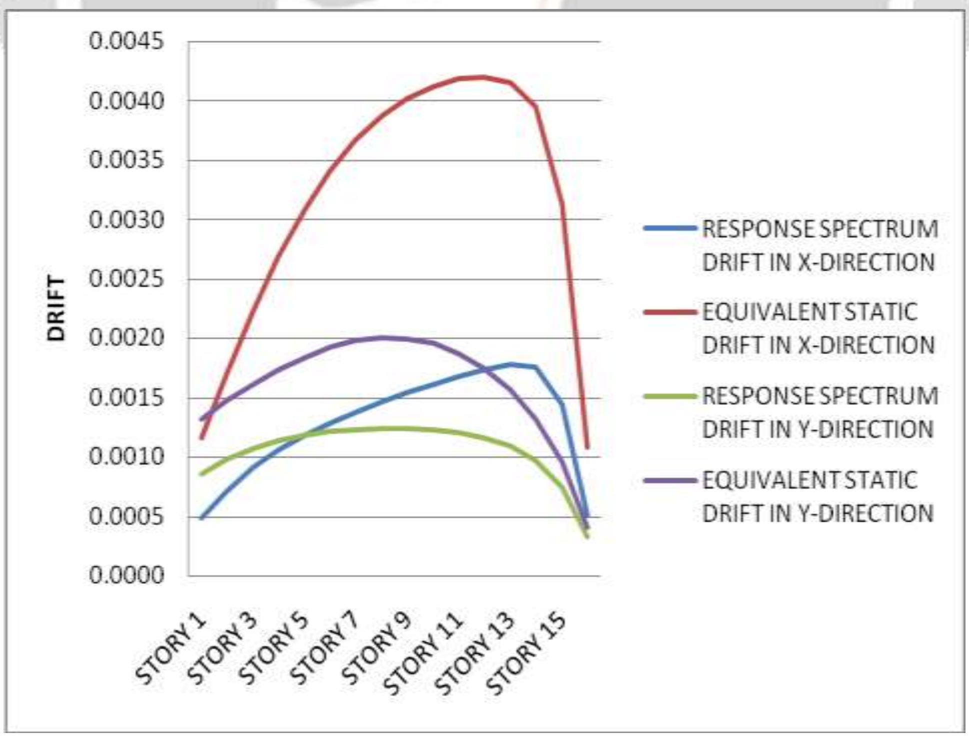


Graph 5.9: Comparison of Displacement For Case 3- Shear wall at location C in plan

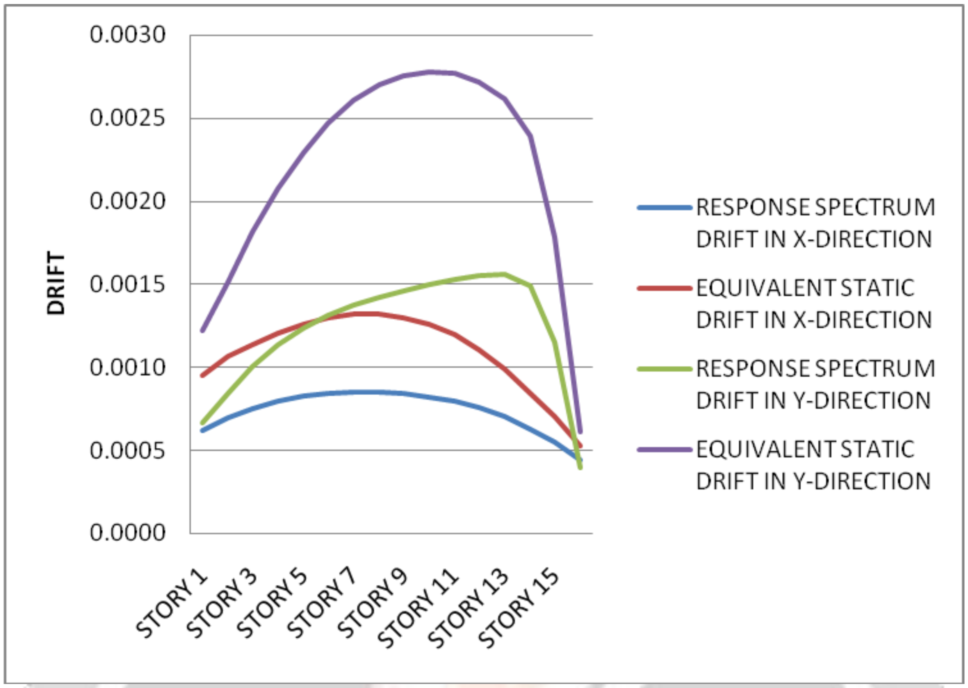
5.3 Storey Drift Results –



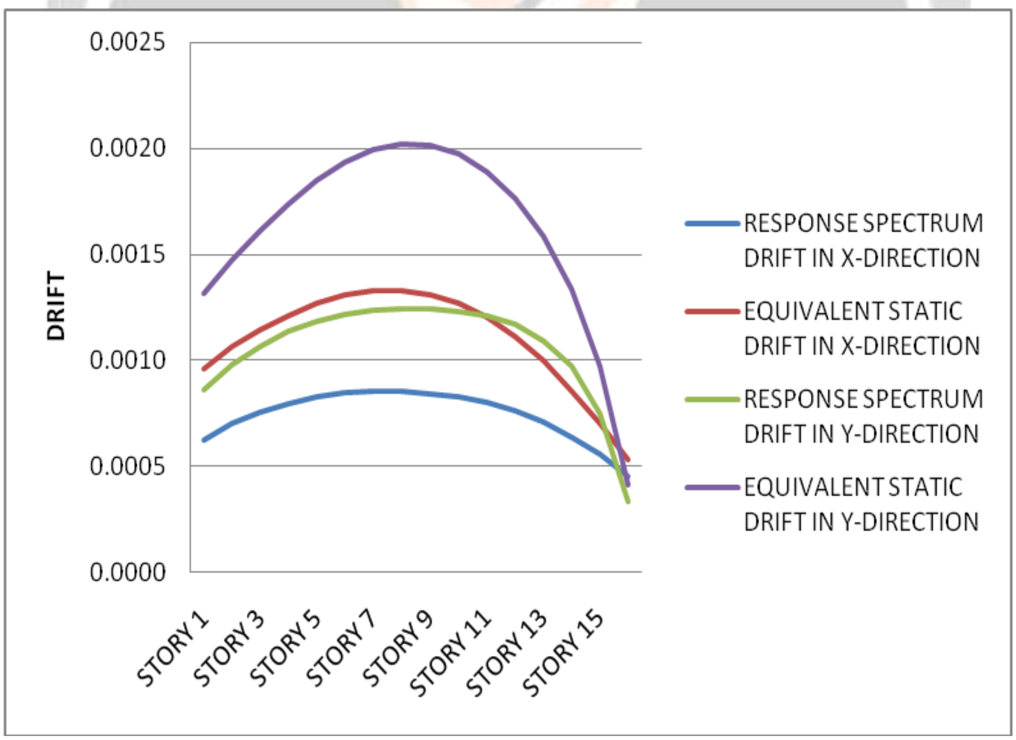
Graph 5.10: Comparison of Drift for Bare Frame Model



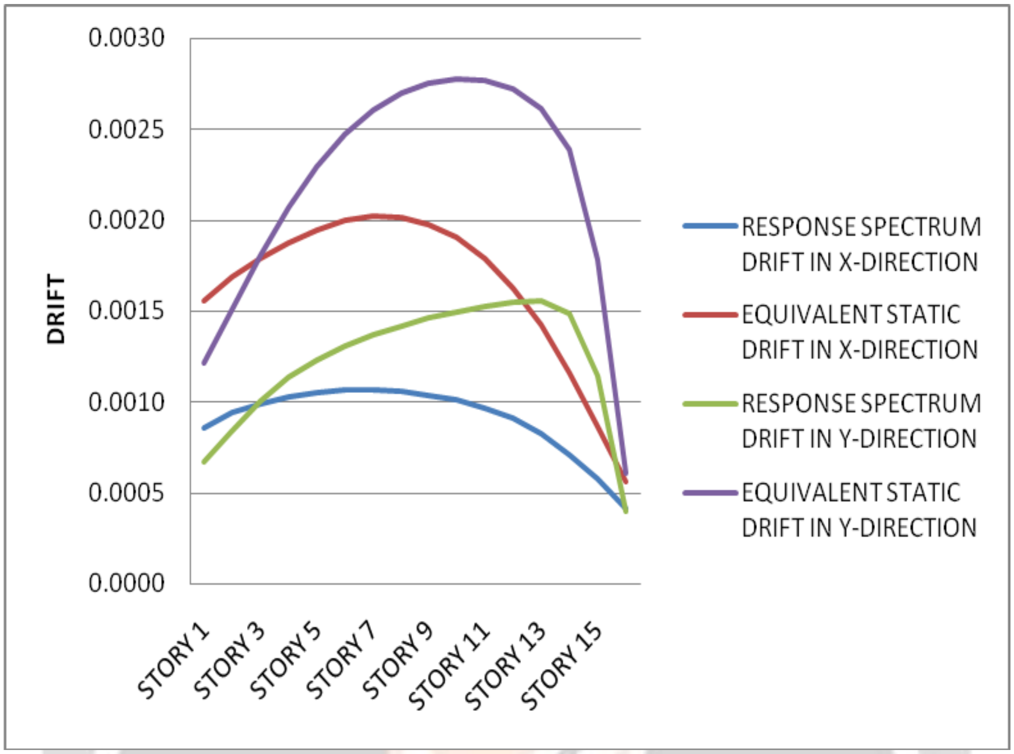
Graph 5.11: Comparison of Drift for Case 1- Bracing at location A in plan



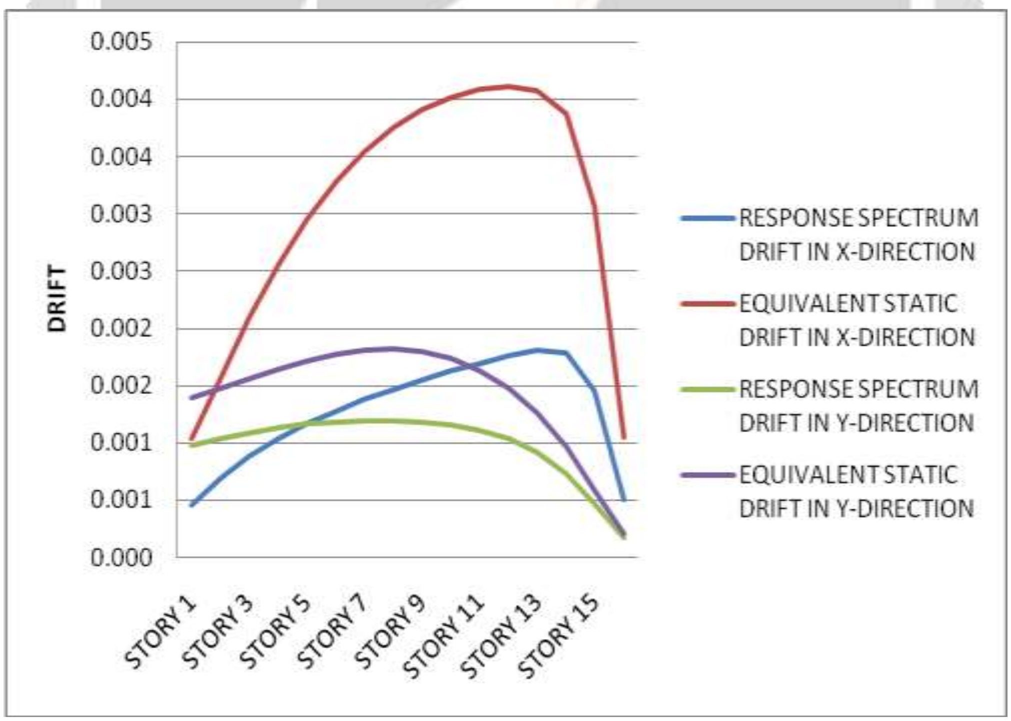
Graph 5.12: Comparison of Drift for Case 2- Bracing at location B in plan



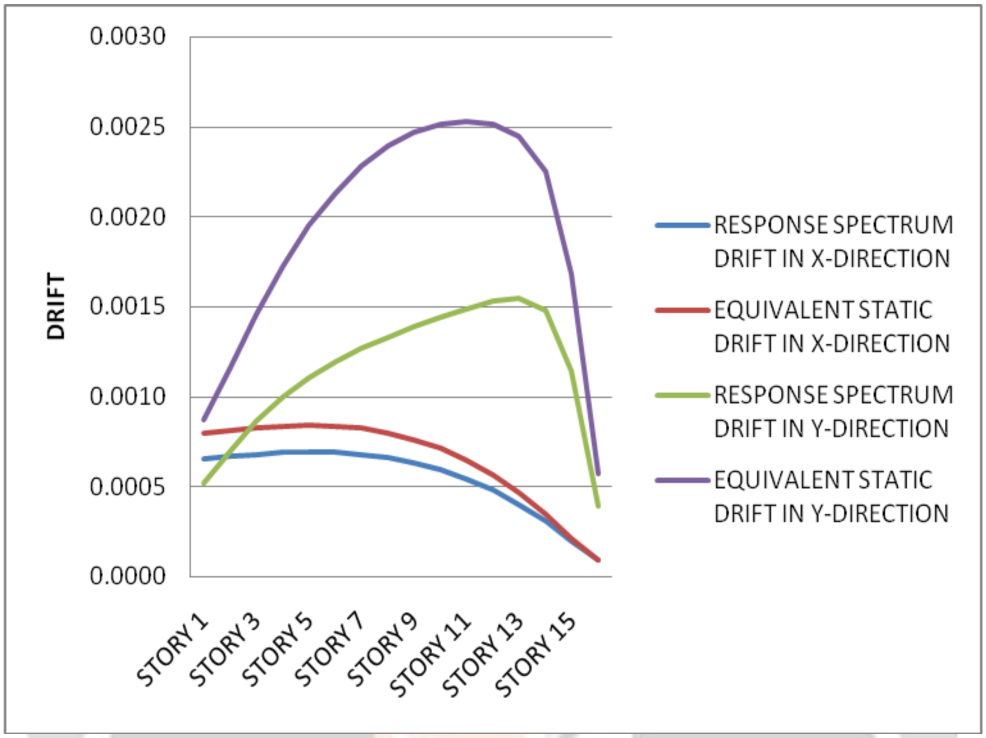
Graph 5.13: Comparison of Drift for Case 3- Bracing at location A and B in plan



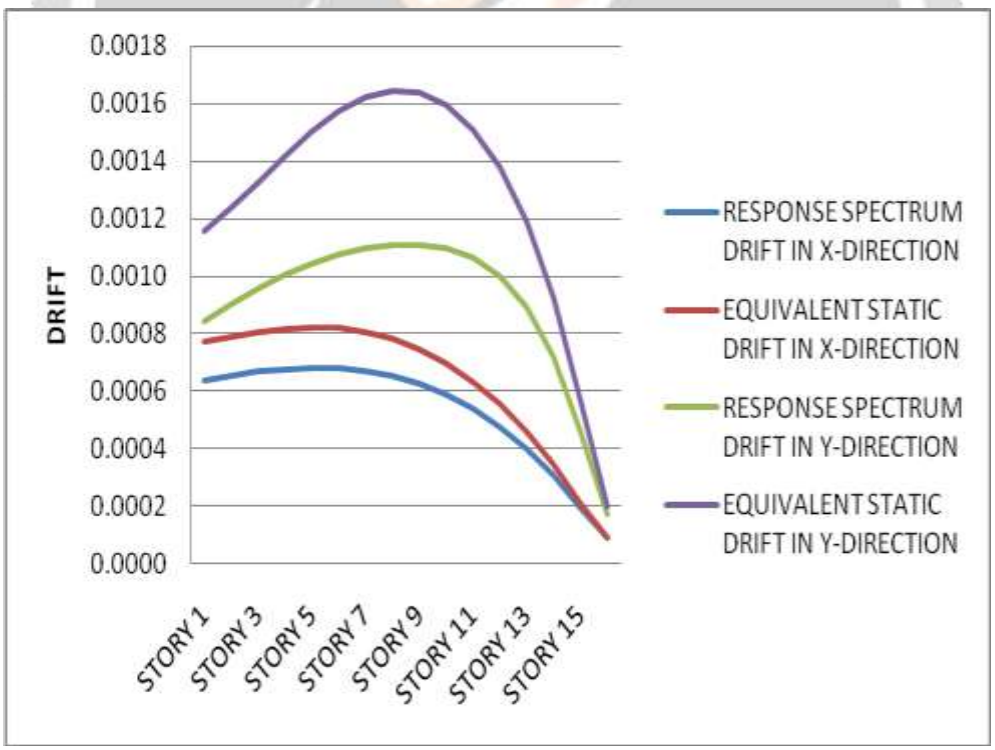
Graph 5.14: Comparison of Drift For Case 4- Bracing at location C in plan



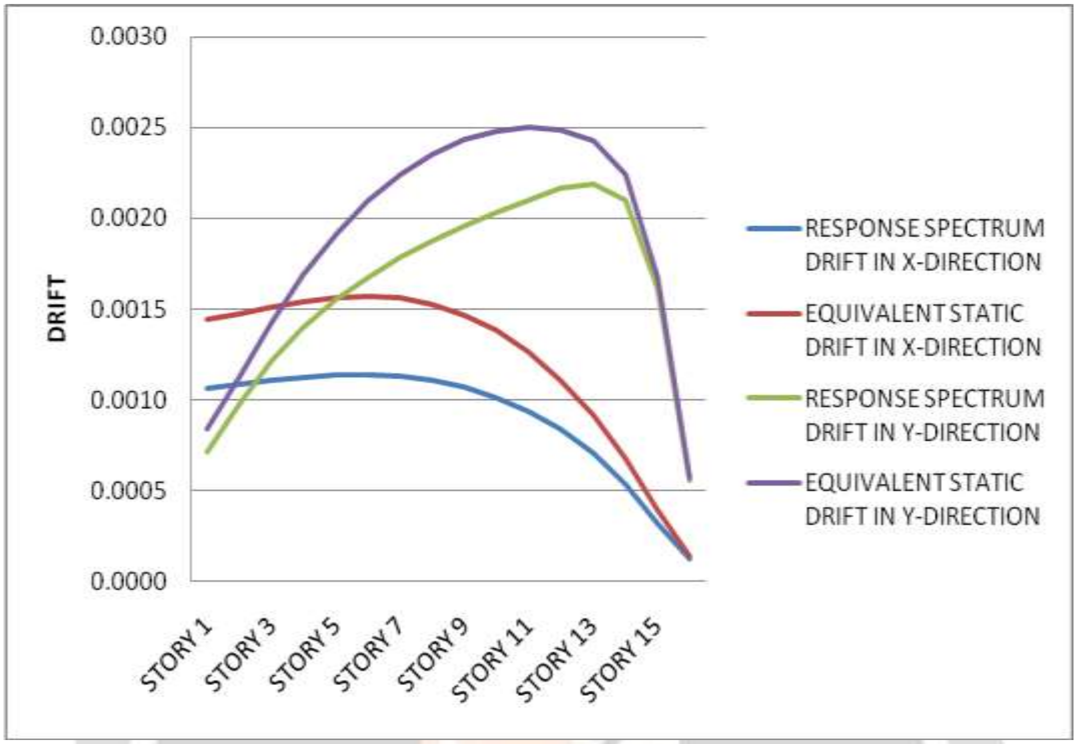
Graph 5.15: Comparison of Drift for Case 1- Shear wall at location A in plan



Graph 5.16: Comparison of Drift for Case 2- Shear wall at location B in plan



Graph 5.17: Comparison of Drift for Case 3- Shear wall at location A and B in plan



Graph 5.18: Comparison of Drift for Case 3- Shear wall at location C in plan

6. CONCLUSION

1. The story shear due to Equivalent Static procedure is found to be greater than the story shear of the Dynamic analysis procedure.
2. As a result of comparison between different models it is observed that displacement obtained in equivalent static analysis are higher than that in dynamic analysis procedure. The maximum displacement in equivalent static analysis is 25 % to 40% greater than dynamic analysis.
3. Story drift observed in Equivalent static analysis are greater compared to dynamic analysis procedure. The pattern of variation of Maximum story drift is similar in both Eq. static procedure and dynamic analysis procedure.
4. There is increase in base shear with the addition of shear walls and cross bracing as compared to bare frame making the structure more stable at storey levels against lateral loading.
5. The structure has a minimum lateral displacement with the use of shear walls and cross bracings as compared with bare frame.
6. The location of shear wall in case -3 i.e. shear wall at location A and B is favorable as they are effective in reducing the actions induced in frame with less horizontal deflection and drift.

7. REFERENCES

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