International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

A Comparative Study on Static & Dynamic Analysis of High Rise Building with & Without Open Ground Storey

Mr. Surjeet Kumar Verma[1], Er. Shubham Srivastava[2] , Mr. Mohd. Zain[3,]
[1]M.tech (structural engineering), Shri Ramswaroop Memorial University,LUCKNOW
[2]Assistant Professor, Shri Ramswaroop Memorial University,LUCKNOW
[3]Assistant Professor, Shri Ramswaroop Memorial University,LUCKNOW

`

Abstract

Analysis and design of buildings for static forces is a routine affair these days because of availability of affordable computers and specialized programs which can be used for the analysis. On the other hand, dynamic analysis is a time consuming process and requires additional input related to mass of the structure, and an understanding of structural dynamics for interpretation of analytical results. Reinforced Concrete (RC) frame buildings are most common type of constructions in urban India, which are subjected to several types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forces due to earthquake.

Soft storey is an unavoidable feature in the multistorey building. It is an open for the purpose of parking or reception lobbies and soft storey at different levels of the building for office use. It is also called stilts storey. Masonry infill's are normally considered as non-structural elements and their stiffness contributions are generally ignored in practice, such as approach can lead to an unsafe design. In the soft storey, the inter storey drifts andseismic demands of the columns are excessive that causes heavy damage or collapse of the buildingduring severe earthquake.

Keywords- Seismic zone, Jointdisplacement, Stiffness, Maximum axial force, Maximum storey drift, base shear

1. INTRODUCTION

Structural analysis is mainly concerned with finding out the behavior of a structure when subjected to some action. This action can be in the form of load due to weight of things such as people , furniture , wind snow etc.or some other kind of excitation such as earthquake, shaking of the ground due to a blast nearby ,etc. In essence all these loads are dynamic including the self-weight of the structure because at some point in time these loads were not there. The distinction is made between the dynamic and static analysis on the basis of whether the applied action has enough acceleration in comparison to the structure's natural frequency. If a load is applied sufficiently slowly, the inertia forces (Newton's second law of motion) can be ignored and the analysis can be simplified as static analysis. Structural dynamics, therefore, is a type of structural analysis which covers the behavior of structures subjected to dynamic (actions having high acceleration) loading. Dynamic loads include people, wind, waves, traffic, earthquake, and blasts. Any structure can be subjected to dynamic loading. Dynamic analysis can be used to find dynamic displacements, time history, and modal analysis.

Civil engineering structures are mainly designed to resist static loads. Generally the effect of dynamic loads acting on the structure is not considered. This feature of neglecting the dynamic forces sometimes becomes the cause of disaster, particularly in case of earthquake. In case of earthquake forces the demand is for ductility. Ductility is an essential attribute of a structure that must respond to strong ground motions. Larger is the capacity of the structure to deform plasticity without collapse, more is the resulting ductility and the energy dissipation. This causes reduction in effective earthquake forces.

In the present study describes the effect of earthquake load which is one of the most important dynamic loads along with its consideration during the analysis of the structure. In the present study a multi-storied framed structure of (G+14) pattern is selected. Linear seismic analysis is done for the building by equivalent static method (ESA) and dynamic method (Response Spectrum Method) using STAAD-Pro as per the IS-1893-2002-Part-1. A comparison is done between the static analysis for normal storey and in case of open ground storey multiplication factor apply in soft storey and dynamic analysis for both cases, the results such as joint displacement, storey drift and axial forces are observed, compared and sections for Beams, Columns and Structure as a whole during both the analysis.

I. METHODS OF ANALYSIS

A. Code-based Procedure for Seismic Analysis

Main features of seismic method of analysis based on Indian standard 1893 (Part1):

2002 are described as follows

- Equivalent static lateral force method
- Dynamic analysis method
- Response spectrum method
- Square roots of sum of squares (SRSS method)
- Complete Quadratic combination method (CQC)
- Time history methods

B. By STAAD PRO software - for static and dynamic analysis both

1) Equivalent Static Analysis:

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low-to medium-rise buildings. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildings without significant coupled lateral-torsional effects, are much less suitable for the method, and require more complex methods to be used in these circumstances.

2) Response Spectrum Method:

The representation of the maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. The maximum response plotted against of un-damped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement. For this purpose response spectrum case of analysis have been performed according to IS 1893.

II. MODELLING AND ANALYSIS

For the analysis of high rise building following dimensions are considered which are elaborated below. In the current study main goal is to compare the Static and Dynamics Analysis building with and without open ground storey.

Static and Dynamic Parameters:-

S.No	*Particulars*	*Dimension/Size/Value*
1	Staad Model	G+14
2	Seismic Zone	IV
3	Floor Height	3.3 m
4	Plan Sizes	(19.23 x 42.23) m
5	Column sizes	(0.5 x 0.75) m
6	Beam sizes	(0.23 x 0.6) m
7	Wall	External wall =0.23 m Internal wall = 0.115 m
8	Thickness of slab	150 mm
9	Type of soil	Type-II, Medium soil as per IS-1893
10	Material used	Concrete M-30 and Reinforcement Fe-415
11	Static analysis	Equivalent Lateral force method
12	Dynamic analysis	Response spectrum method
13	Earthquake load	as per IS-1893-2002
14	Specific weight of RCC	25 KN/m2
15	Specific weight of infill	20 KN/m2
16	Software used	STAAD-Pro

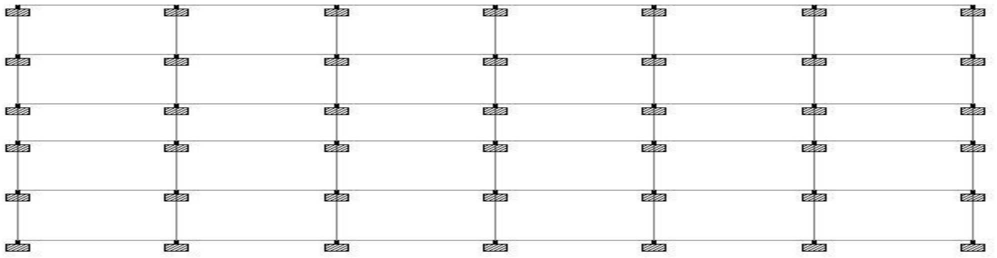


Fig -1: Plan of building

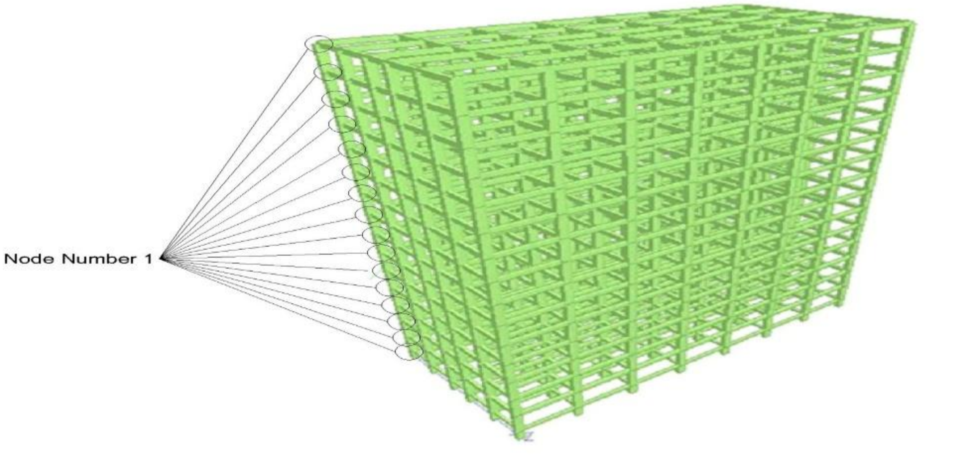


Fig 2: 3D Rendered View of Building showing node number 1 in the building

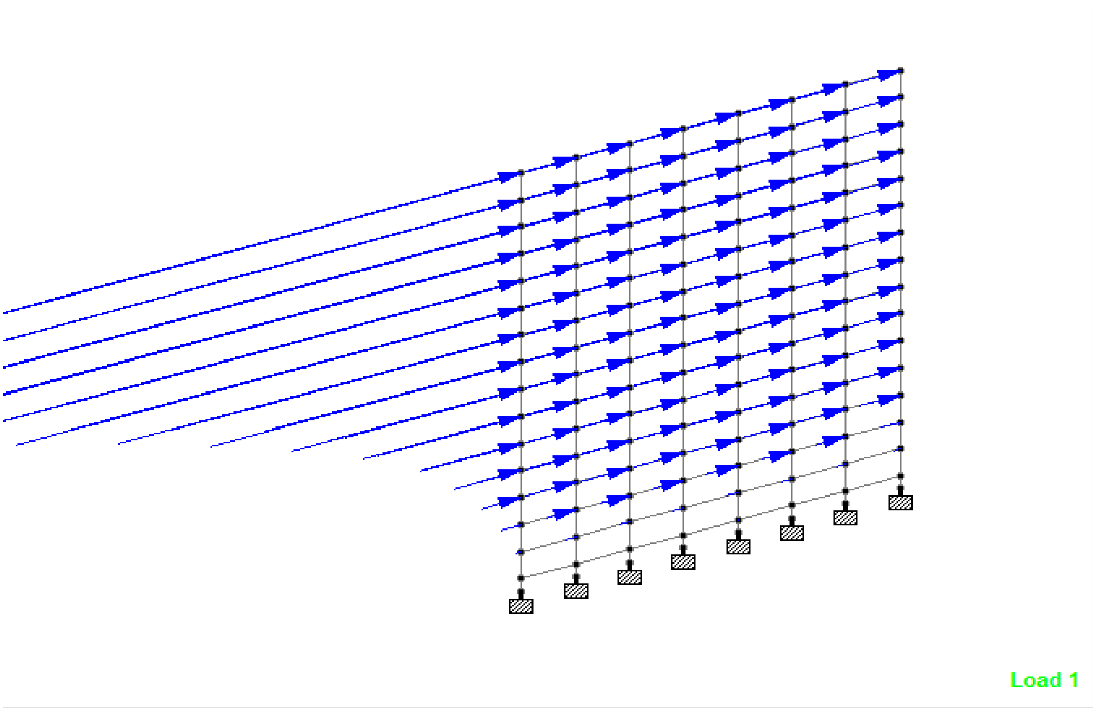


Fig 3 Seismic forces in x-direction

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

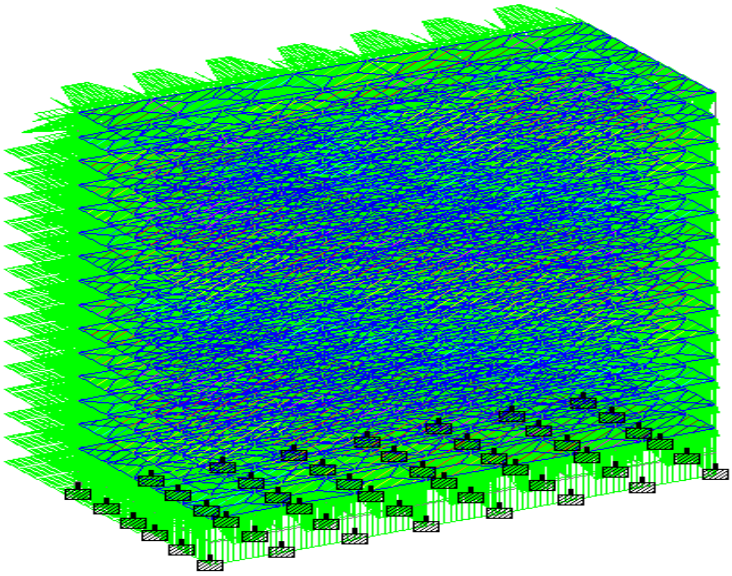


Fig 4: Dynamic loading in x-direction

III. RESULTS AND DISCUSSIONS

The above RCC frame structure is analyzed both statically and dynamically for both cases with open ground storey and without open ground storey and results are compared for the following three categories namely joint displacement, storey drift and axial forces and the result are tabulated as a shown below.

Table 1: Displacement of node at first floor in X-dir

Load Combinations	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
(DL+LL)*1.5	-0.103	-0.129	-0.103
(DL+X+VE SL)*1.5	6.193	6.693	15.605
(DL+X-VE SL)*1.5	-6.357	-6.896	-15.769
(DL+Z+VE SL)*1.5	-0.078	-0.088	-0.072
(DL+Z-VE SL)*1.5	-0.085	-0.116	-0.091
(DL+LL+X+VE SL)*1.2	4.946	5.344	12.476
(DL+LL+X-VE SL)*1.2	-5.094	-5.528	-12.624
(DL+LL+Z+VE SL)*1.2	-0.071	-0.081	-0.066
(DL+LL+Z-VE SL)*1.2	-0.077	-0.103	-0.081
0.9DL+1.5 X+VE SL	6.226	6.734	15.638
0.9DL+1.5 X-VE SL	-6.324	-6.856	-15.736
0.9DL+1.5 Z+VE SL	-0.045	-0.047	-0.04
0.9DL+1.5 Z-VE SL	-0.053	-0.075	-0.058

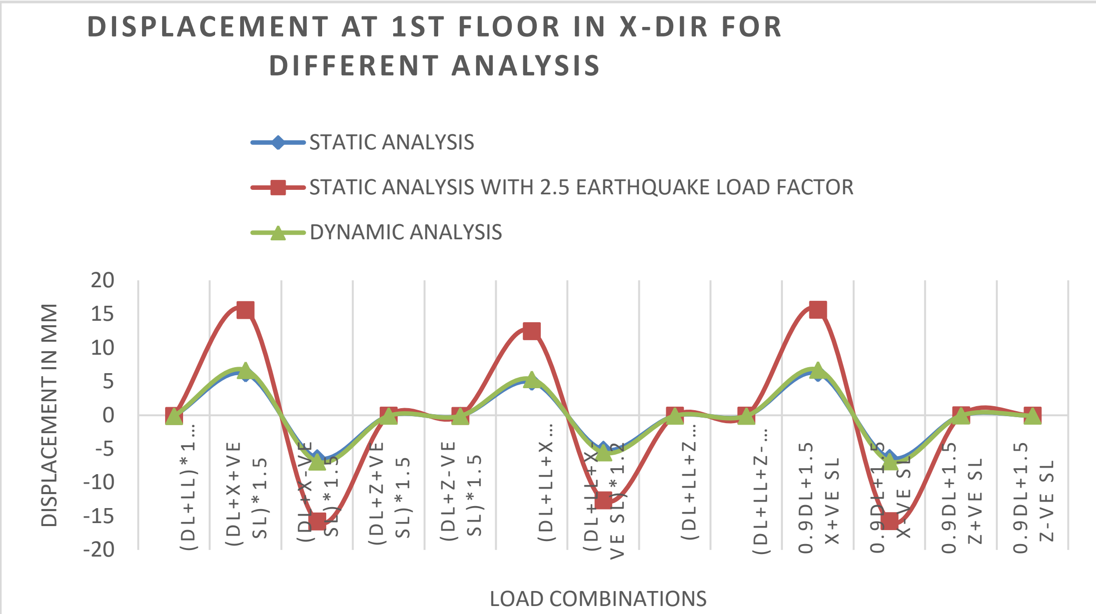


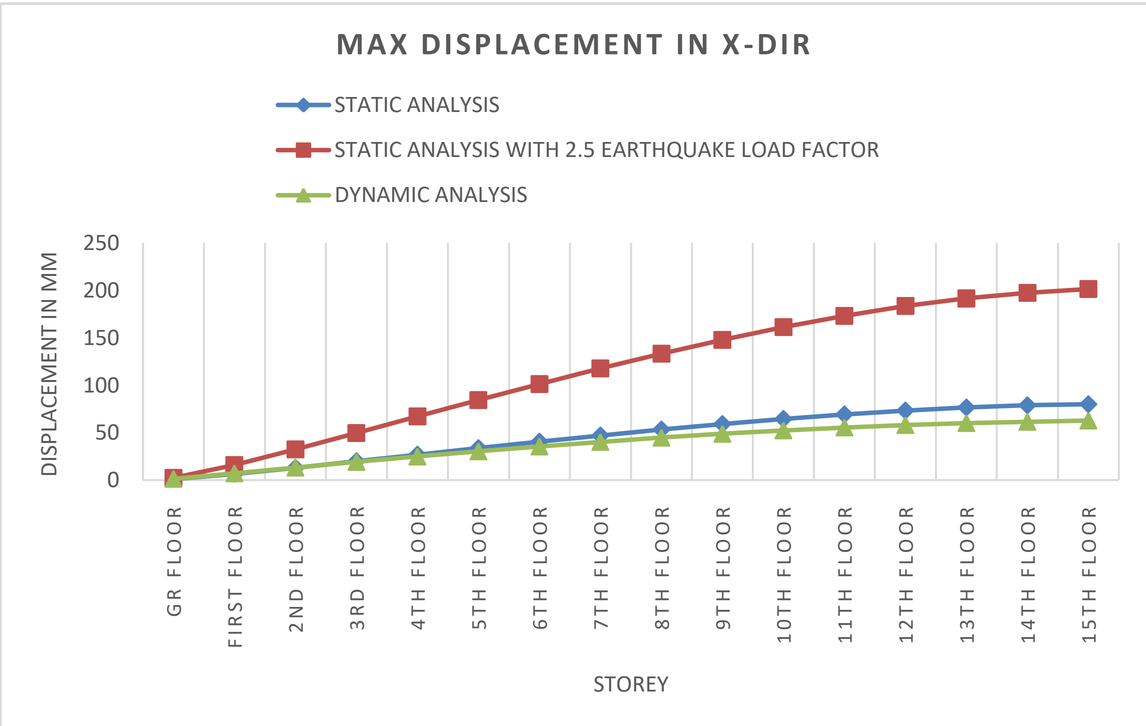
Table 2: Displacement of node at first floor in Z-dir

Load Combinations	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
(DL+LL)*1.5	-0.02	-0.03	-0.02
(DL+X+VE SL)*1.5	-0.007	0.087	0.004
(DL+X-VE SL)*1.5	-0.02	-0.127	-0.03
(DL+Z+VE SL)*1.5	7.451	11.733	18.648
(DL+Z-VE SL)*1.5	-7.478	-11.773	-18.674
(DL+LL+X+VE SL)*1.2	-0.008	0.066	0
(DL+LL+X-VE SL)*1.2	-0.018	-0.106	-0.027
(DL+LL+Z+VE SL)*1.2	5.958	9.383	14.916
(DL+LL+Z-VE SL)*1.2	-5.985	-9.423	-14.942
0.9DL+1.5 X+VE SL	-0.001	0.095	0.009
0.9DL+1.5 X-VE SL	-0.015	-0.119	-0.025
0.9DL+1.5 Z+VE SL	7.457	11.741	18.653
0.9DL+1.5 Z-VE SL	-7.472	-11.765	-18.669

International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Table 3: Max Displacement in X-dir

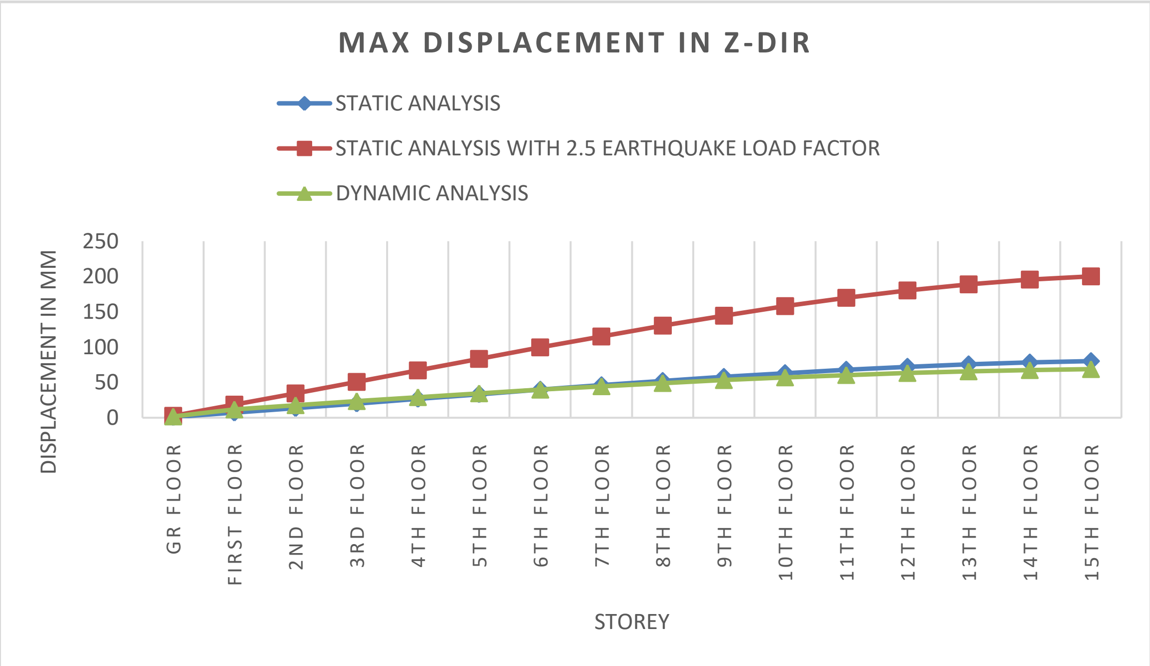
Storey	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
Gr Floor	0.972	1.1	2.364
First Floor	6.324	6.896	15.769
2nd Floor	12.91	12.93	32.228
3rd Floor	19.819	18.887	49.516
4th Floor	26.793	24.611	66.956
5th Floor	33.706	30.058	84.239
6th Floor	40.474	35.208	101.163
7th Floor	47.024	40.038	117.539
8th Floor	53.272	44.511	133.164
9th Floor	59.13	48.581	147.81
10th Floor	64.496	52.199	161.214
11th Floor	69.264	55.316	173.138
12th Floor	73.324	57.891	183.292
13th Floor	76.562	59.891	191.372
14th Floor	78.839	61.248	197.152



International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Table 4: Max Displacement in Z-dir

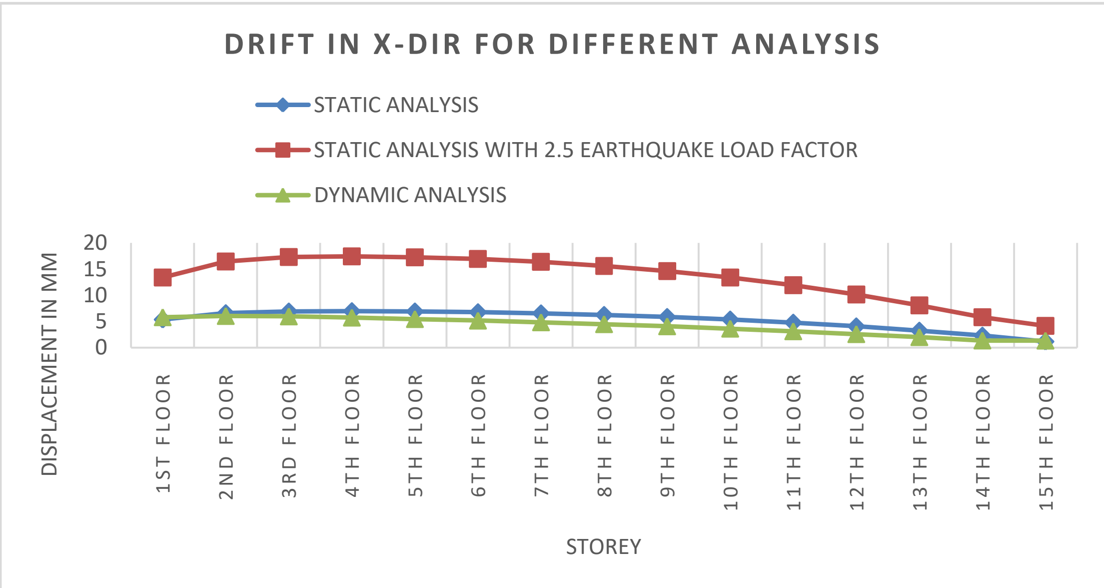
Storey	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
Gr Floor	1.232	1.828	3.056
First Floor	7.478	11.773	18.674
2nd Floor	13.9	17.799	34.73
3rd Floor	20.397	23.59	50.956
4th Floor	26.935	29.215	67.285
5th Floor	33.455	34.625	83.568
6th Floor	39.893	39.784	99.647
7th Floor	46.178	44.655	115.343
8th Floor	52.23	49.202	130.457
9th Floor	57.962	53.389	144.772
10th Floor	63.281	57.178	158.054
11th Floor	68.086	60.528	170.053
12th Floor	72.271	63.396	180.504
13th Floor	75.726	65.742	189.134
14th Floor	78.338	67.522	195.669
15th Floor	80.257	68.928	200.28



International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

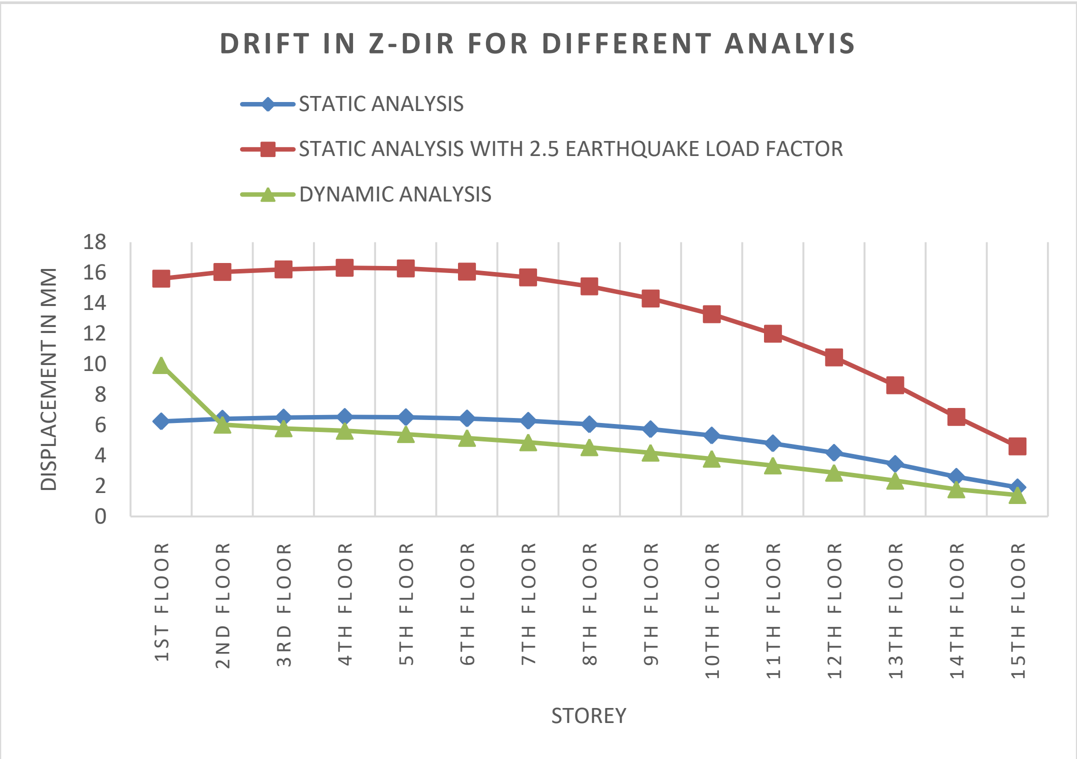
Table 5: Storey drift in X-dir

Storey	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
1st Floor	5.352	5.796	13.405
2nd Floor	6.586	6.034	16.459
3rd Floor	6.909	5.957	17.288
4th Floor	6.974	5.724	17.44
5th Floor	6.913	5.447	17.283
6th Floor	6.768	5.15	16.924
7th Floor	6.55	4.83	16.376
8th Floor	6.248	4.473	15.625
9th Floor	5.858	4.07	14.646
10th Floor	5.366	3.618	13.404
11th Floor	4.768	3.117	11.924
12th Floor	4.06	2.575	10.154
13th Floor	3.238	2	8.08
14th Floor	2.277	1.357	5.78
15th Floor	1.139	1.335	4.149



. **Table 6: Storey drift in Z-dir**

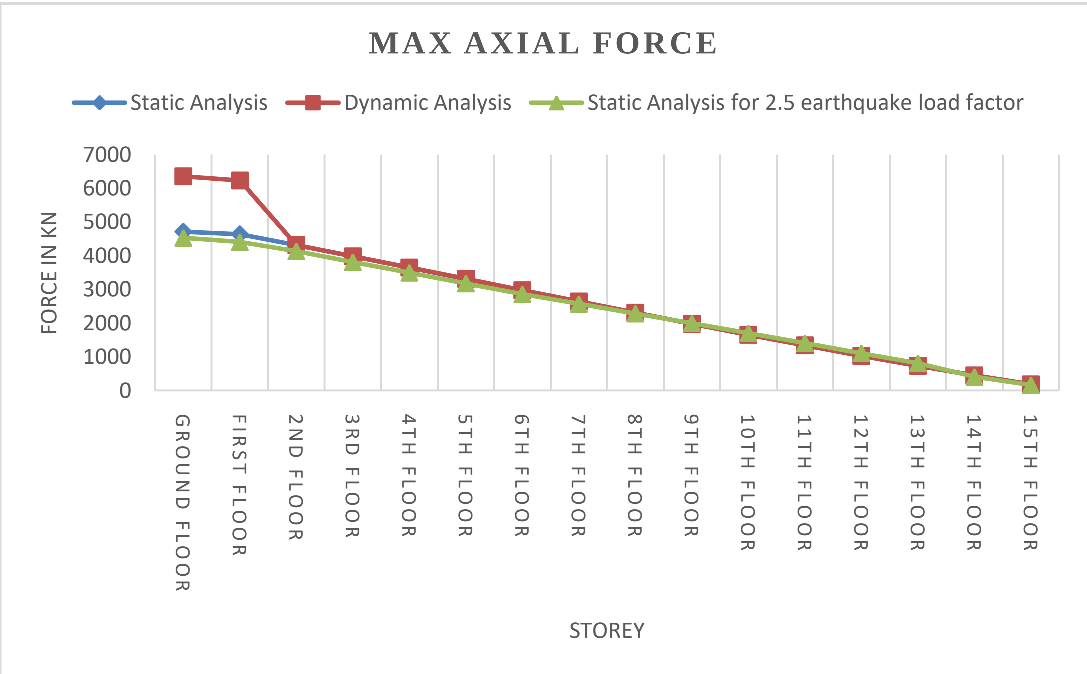
Storey	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
1st Floor	6.246	9.945	15.618
2nd Floor	6.422	6.026	16.056
3rd Floor	6.497	5.791	16.226
4th Floor	6.538	5.625	16.329
5th Floor	6.52	5.41	16.283
6th Floor	6.438	5.159	16.079
7th Floor	6.285	4.871	15.696
8th Floor	6.052	4.547	15.114
9th Floor	5.732	4.187	14.315
10th Floor	5.319	3.789	13.282
11th Floor	4.805	3.35	11.999
12th Floor	4.185	2.868	10.451
13th Floor	3.455	2.346	8.63
14th Floor	2.612	1.78	6.535



International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 5
May 2017

Table 6: Maximum Axial forces

Storey	Static Analysis	Dynamic Analysis	Static Analysis for 2.5 earthquake load factor
Ground Floor	4715.396	6354.006	4534.03
First Floor	4640.183	6225.87	4409.89
2nd Floor	4312.039	4312.039	4133.79
3rd Floor	3980.986	3980.986	3815.96
4th Floor	3647.382	3647.382	3497.61
5th Floor	3312.327	3312.327	3179.58
6th Floor	2976.841	2976.841	2862.39
7th Floor	2642.072	2642.072	2572.93
8th Floor	2309.322	2309.322	2286.13
9th Floor	1980.059	1980.059	1995.79
10th Floor	1655.916	1655.916	1702.41
11th Floor	1338.685	1338.685	1406.46
12th Floor	1030.302	1030.302	1108.35
13th Floor	732.814	732.814	808.46
14th Floor	448.442	448.442	408.17



IV. Conclusion

In the present study, an attempt has been made to compare the seismic behavior of high rise buildings with complexities and the following are conclusions are drawn.

The study focused on the seismic performance of reinforced concrete open ground storey, which are most commonly used in all over the world. The seismic performances were estimated through the comparison between displacement demand obtained by different method of analysis and displacement capacity obtained by static equivalent method and response spectrum method.

- The difference of value of displacement between static and dynamic analysis is insignificant for lower stories but the difference is increased in higher stories and static analysis given higher values than dynamic analysis including response spectrum method.
- The results of equivalent static analysis are approximately uneconomical because values of displacement are higher than dynamic analysis.
- The displacement of each storey at center of mass is lower compare to those at the joint of maximum displacement.
- Linear static /dynamic analysis shows that column forces at ground storey increases for the presence of infill wall in upper storey. But design forces multiplication factor found to be much less than 2.5.
- Seismic analysis of bare frame structures leads to under estimation of base shear. Under estimation of base shear leads to collapse of structures during earthquake shaking. Therefore the important to consider the infill wall in the seismic analysis of structures
- Drift and displacement results obtained by ESA are greater than the results obtained by RSA
- In ESA storey drift is maximum at 4th Floor where as in RSA it is maximum at 3rd floor.
- From the analysis result for both equivalent static analysis and response spectrum analysis the storey displacement and storey drift is more along the shorter span.

REFERENCES

1. Dr. VinodHosur “Eartquke Resistant design of building structures” ISBN No. 978-81-265-3859-1 Publisher Wiley Precise
2. Robin Davis, Praseetha Krishnan, DevdasMenon, A. Meher Prasad, Effect Of Infill Stiffness On Seismic Performance Of Multi-StoreyRc Framed Buildings In India, 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004 Paper No. 1198
3. Chieng, M. S. Jaafar, A. A. Abang Ali (2011), Effect of Soft Story on Structural Response of High Rise Buildings, IOP Conf. Series: Materials Science and Engineering 17 (2011) 012034 doi:10.1088/1757-899X/17/1/012034
4. P.B.Lamb and Dr R.S. Londhe(2012), Seismic Behaviour of Soft First Storey, IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) ISSN: 2278-1684 Volume 4, Issue 5 (Nov. - Dec. 2012), PP 28-33
5. Dr. SaraswatiSetia and Vineet Sharma, Seismic Response of R.C.C Building with Soft Storey, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012).
6. Dande P. S. and, Kodag P. B.(2013), Influence of Provision of Soft Storey in RC Frame Building for Earthquake Resistance Design, International Journal of Engineering Research.
7. N. Sivakumar and S. Karthik(2013), Seismic Vulnerability of Open Ground Floor Columns in Multi Storey Buildings, International Journal of Scientific Engineering and Research (IJSER)