OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

ANALYSIS OF SEISMIC BEHAVIOUR OF INFILL FRAME STRUCTURES WITH SHEAR WALL BY E-TAB SOFTWARE

Akanksha Balkrishna Kantale[1], Prof. L.G. Kalurkar[2]

PG Student, Jawaharlal Nehru Engineering College, Aurangabad.
Ass. Professor Jawaharlal Nehru Engineering College, Aurangabad.
akankshakantale@gmail.com

Abstract: Seismic performance of RC frame structures was investigated by creating 3-D models of the frame for high rise building. The types of building are investigating are Masonry infills and shear wall. The result shows that the Masonry infills and shear wall increase the stiffness and strength of the structure and reduce damages and drift capacity. The performance of the structure improved from collapse prevention to immediate occupancy.

The Non-linear static Pushover analysis has performed with the help of computer software E-TAB v9.7.2 for three different models of RC frame. Results of the analysis for hinge formation, drift, displacement and performance where compared.

Keywords: *RC frame; RC infill wall; Hinge formations, Pushover analysis, drift, displacement.*

I INTRODUCTION

Amongst the natural hazards, earthquakes have the Potential for causing the greatest damage, safety against seismic hazard is one of the goal of design and construction of multi-story buildings in seismically active region. Since Earthquake forces are random innatureand unpredictable. The engineering tools need to be sharpened for analyzing the structures under the action of these forces. The use of RC walls as shear wall, infill wall or wing wall have been reported as effective to improve the overall capacity of RC frame structures including strength, stiffness and performance. Earthquake loads are to be carefully modelled so as to assess the real behaviour of structure with a clear understanding that damage is expected but it should be controlled.

This paper is aimed at pushover analysis which is an iterative procedure shall be looked upon, as an alternative for the orthodox analysis procedures. This Study focuses on pushover analysis of multi-storey RC Framed buildings subjecting them, to monotonically increasing lateral forces with an invariant height wise distribution, until the pre-set performance level is reached.

II NEED FOR THE WORK:

From the effect of previous significant earthquakes, The brick masonry infill wall and shear wall are considered as non-structural element in analysis and design. Though they are considered as non-structural element, but they have their own strength and stiffness. So it is concluded that the seismic risk in urban areas are increasing. Hence there is a need to study and revise this situation. However, masonry infill wall and shear wall for lift may contribute remarkably in increasing the stiffness of reinforced concrete frame. This attracts part of the lateral seismic shear forces on buildings, so reducing the loads on the RC members. Hence there is a need for incorporating, shear wall and masonry infill wall for lift, while analyzing the structure against lateral loads viz. Seismic, wind load.

III SCOPE FOR THE WORK:

The building elements like slab, beams and columns are designed according to IS456-2000. The designed elements are then applied to the frame element of building. After modelling the buildings are analyze using response spectrum method and then design command is given to the software. As soon as the design procedure is complete the pushover analysis is carried out and the results came are compared according to the given .

IV OBJECTIVES OF THE ANALYSIS

The present study aims at following objectives,

4.1 To carry out Non-Linear Static Pushover Analysis of frames with following models,

1) RC Bare frame.

2) RC Frame with masonry infill.

3) RC Frame with masonry infill and shear wall for lift.

4.2 To compare the following results between the above mention frames as,

1) Pushover Curve i.e. base shear verses Displacement.

2) Storey Displacements.

3) Hinge formation locations.

4) Performance point.

5) Storey Drift and there checks according IS1893 (Part1):2002.

The analysis of frames is carried out by using E-TAB Software.

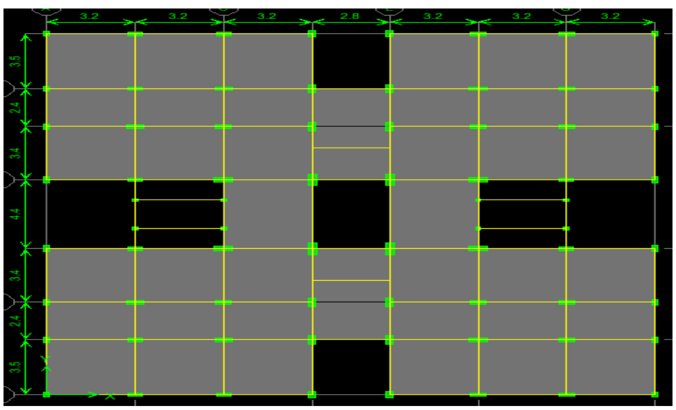

Fig.1 RC Bare frame

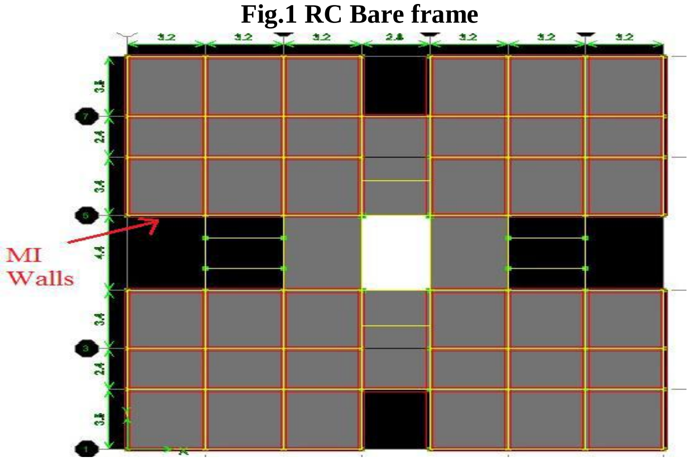

Fig. 2 RC Frame with masonry infill

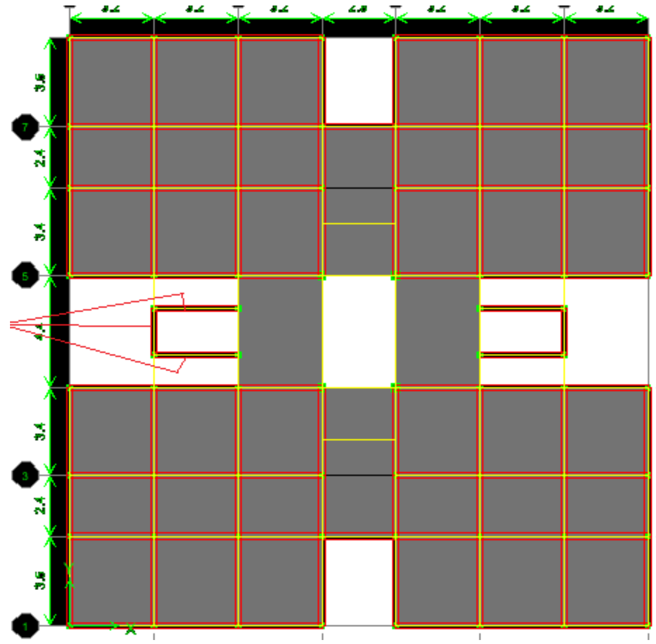

Fig.3 RC Frame with masonry infill and shear wall for lift

V METHODOLOGY:

Following are the steps for the analysis done for three different models shown in objectives,

- Prepared a grid for plan.
- IS456-2000 is defined to models.
- Give the properties to the slab, beams and columns.
- Define the static load cases and apply them to slab and beams only.
- Assign the support condition as a fixed support to the bottom of column.
- Apply diaphragm action to the slab for rigid condition.
- Define mass sources.
- Define response spectrum functions for IS1893-2002.
- Define response spectrum case data.
- Run the analysis and various results are obtained.
- Designs are carried out as per IS456-2000, and then select all the columns and beams to assign hinge properties. Moment and shear hinges are considered for beam element; and axial with biaxial moment hinges are considered for column elements.
- Defining static nonlinear load cases.
- Run the pushover analysis.
- Finally the results are obtained.

VI EXPERIMENTAL ANALYSIS

6.1 Base shear verses displacement results are shown graphically below for each model.

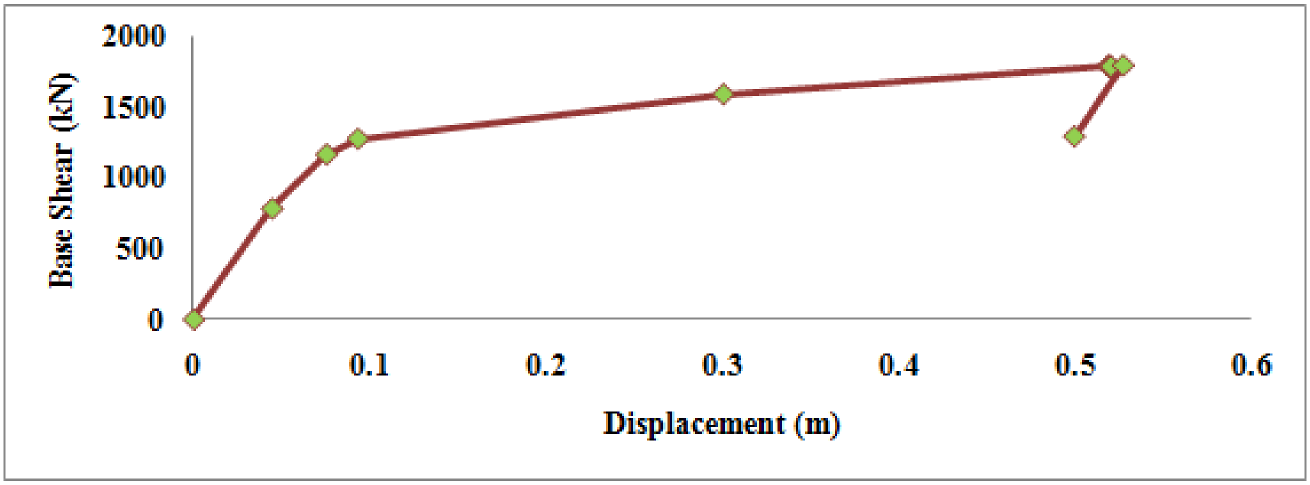

Fig.4Base Shear verses Displacement for Model 1

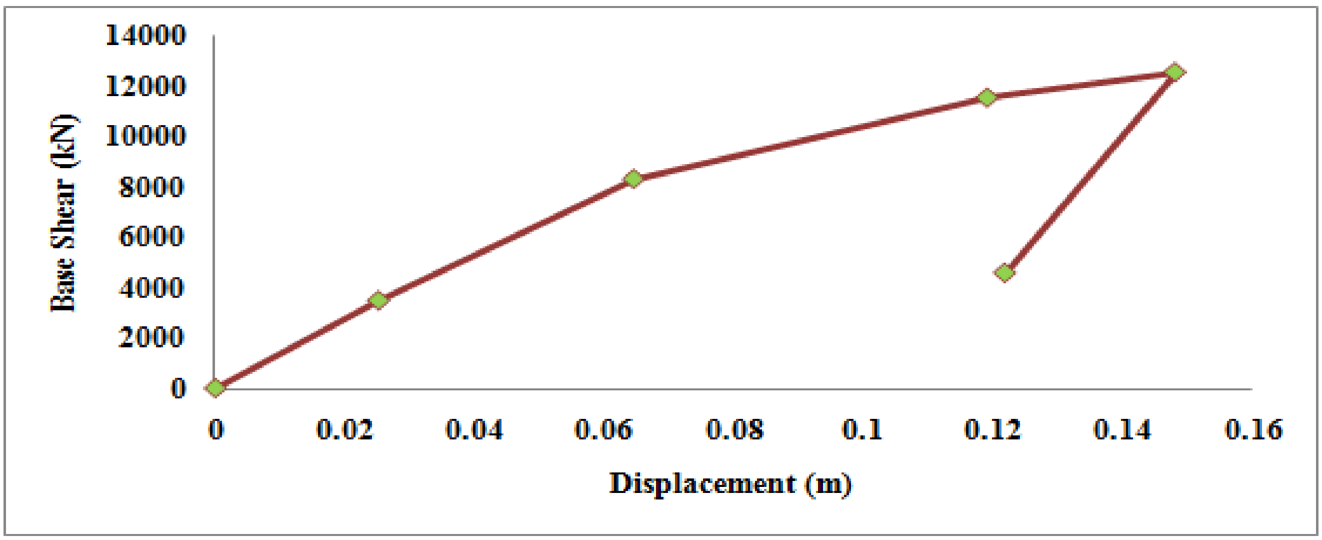

Fig.5Base Shear verses Displacement for Model 2

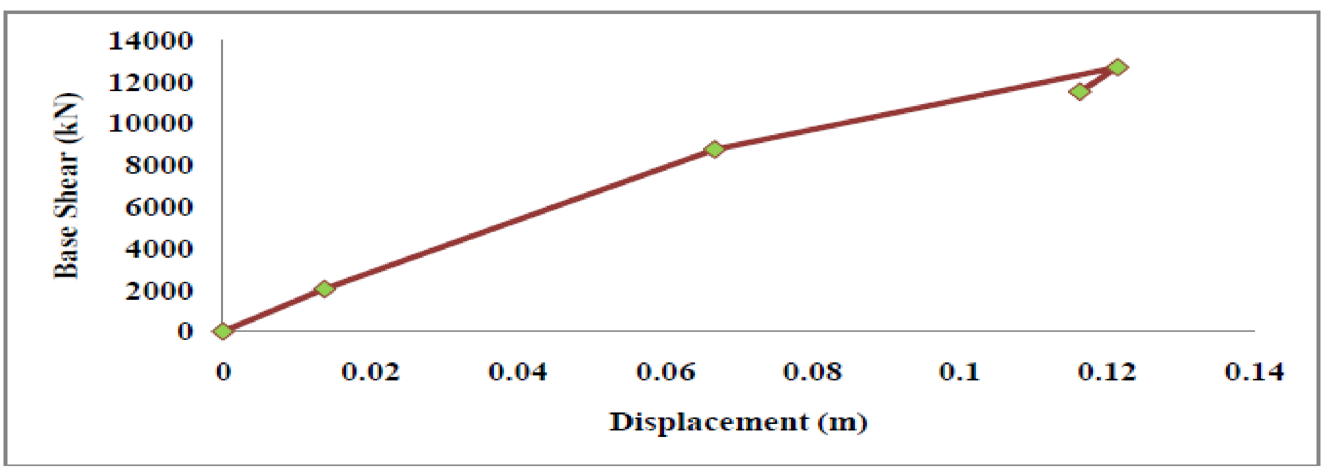

Fig.6 Base Shear verses Displacement for Model 3

6.2 Base shear and Displacement for all models result obtained from E-TAB.

The result obtained from Non-linear static pushover analysis, regarding base shear and displacement in case of Model 1 to Model 3, are shown in Table 1. Also their graphs are shown in Fig 4 to6. The value for maximum displacement for all models are shown in table no 1.

Table.1Maximum displacement values

Model No.	Displacement (mm)
1	527
2	148
3	121

The result shows that, the displacement for Model 1 i.e. bare frame is more compared to Model 2 and 3; this indicates the importance of masonry infill and shear wall for lift on the structure. Moreover from Model 2 and 3, the Model 3 i.e. RC frame with MI and shear wall for lift gives higher stiffness and strength.

Table.2 Storey displacement at top and stiffening factor all models

	Model No-1	Model No-2	Model No-3
Displacement at top floor (mm) Δ max	**527**	**148**	**121**
Linear behavior force (KN)	784.63	8330.567	8945.064
Collapse Limit force (KN)	1796.89	12583.17	12274.27
Stiffening Factor w.r.t Δ max of Model-1	-	71.89%	77.09%

6.3 Story wise Displacement and Drift for all three models.

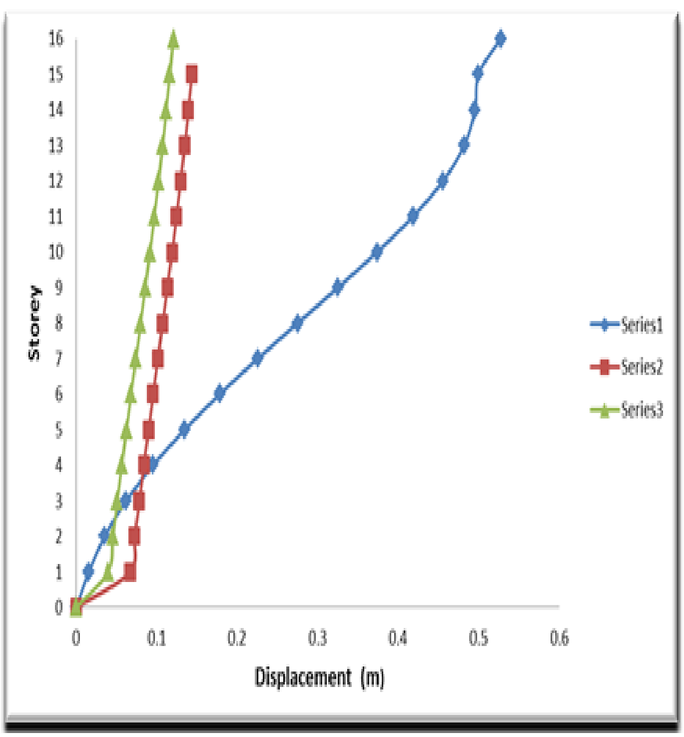

Fig.7 Storey verses Drift for all models.

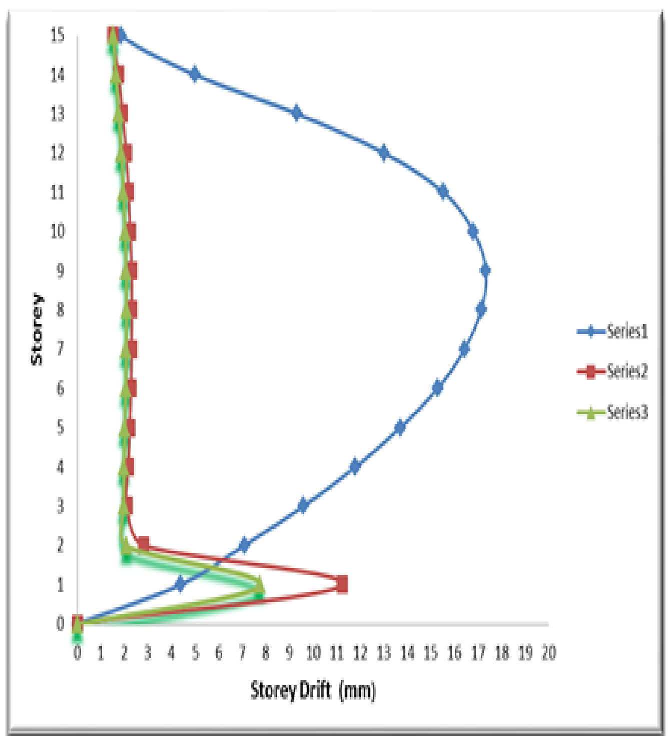

Fig.8 Storey verses Displacement for all models

Where, Series 1 = Model 1 (blue line), Series 2 = Model 2 (brown line), Series 3 = Model 3 (green line). Figure 7 indicates the displacement of all frame models at each floor level. The results are obtained by analysis, Model-1 i.e. bare frame is having large displacement at each floor than that of Model 2 & 3. Model-3 clearly shows the minimum displacement at each floor level than the other frames. Also from figure 7, the Storey wise drift obtained from E-TAB software for all Models are compared with the permissible drift according to **IS 1893(Part-I):2002, clause no. 7.11.1, Page No.27**.The storey wise drift is more for Model 1. The above Graph represented clearly, the storey drift and displacement is minimum for Model 3 at each floor level.

6.4 Demand - Capacity Pushover result

For determining the performance point of building frame, E-TAB software gives value of Teff, Beff, Sd capacity, Sd demand, Sa capacity and Sa demand. Where Teff = effective period, Beff= effective damping, Sd= Spectral displacement,Sa = Spectral acceleration. The full line curve is obtained by **Sa vs Sd capacity** for all models. The dotted line curve is obtained by **Sa vs Sd demand** for all models. Intersection of capacity and demand is shown by yellow circle, known as performance point.

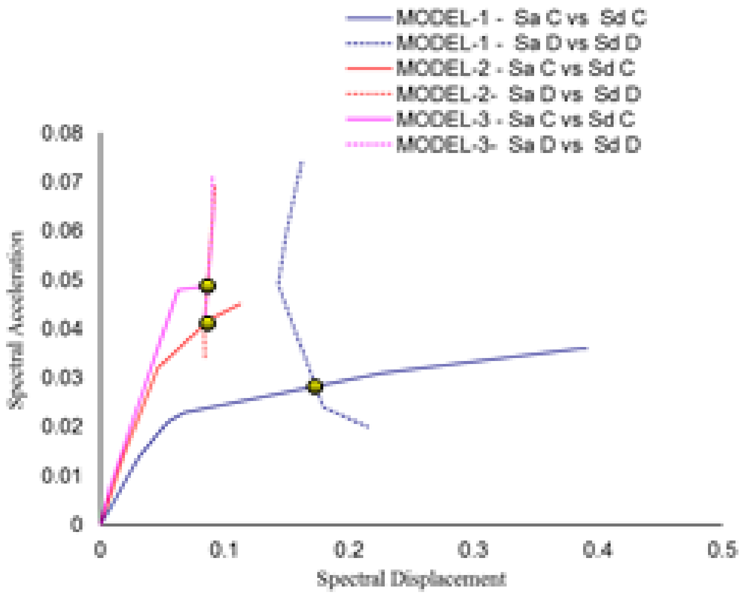

Fig.9 Performance point for all Models

From above fig.9 it shows that the demand is more important for Model-1 since it intersect the capacity curve near the event point between LS & CP (Life Safety & Collapse prevention). The Model-1 has significant risk of injury due to falling hazards from structural debris may exist. The structure may not be technically practical to repair and is not safe. In Model-2, the demand curve intersects the capacity curve near the event point between IO & LS (Immediate Occupancy & Life Safety). Which means that for Model-2, the risk of life-threatening injury of structural damage is low, and although some minor structural repairs can be done appropriately. Also in Model-3, the demand curve intersects the capacity curve near the event point between B & IO. This means that an elastic response and the security margin are greatly enhanced. Thus adding the masonry infill wall and shear- wall for lift arrangement will increase the level of safety since the demand curve tends to intersect the capacity curve near the elastic domain. Therefore, it can be concluded that the margin of safety against collapse for the R.C. frame without masonry infill wall is small, whereas providing by the masonry infill wall and shear wall in R.C. frame, there is sufficient strength and displacement is obtained.

Table.3 Performance point displacement demand

Frame Model	Sa (acceleration demand)	Sd (displacment demand)
Model 1	0.028	0.165
Model 2	0.041	0.084
Model 3	0.042	0.084

Displacement demand for Model 1 is more, than the other models; and Model 2 & 3 having least displacement demands than the Model-1. Acceleration demand is more for Model-3, and small for Model-1 comparing to other model.

6.5 Hinge formation locations.

Table.4 Hinge formation for Model 1

Step	Base Force (KN)	Displacement (m)	A to B	B - IO	IO - LS	LS-CP	CP-C	C-D	D-E	Beyond E	Total
0	00	0.00	10106	6	0	0	0	0	0	0	10112
1	784.643	0.0445	9500	612	0	0	0	0	0	0	10112
2	1168.11	0.0753	9156	956	0	0	0	0	0	0	10112
3	1278.02	0.0932	8528	526	925	133	0	0	0	0	10112
4	1593.64	0.3006	8444	244	379	1043	0	2	0	0	10112
5	1797.81	0.5192	8444	244	379	1043	0	0	2	0	10112
6	1790.78	0.5193	8444	244	378	1042	0	2	2	0	10112
7	1791.92	0.5198	8444	244	375	1042	0	0	4	0	10112
8	1787.69	0.5199	8444	244	375	1045	0	0	4	0	10112
9	1790.00	0.5205	8438	248	342	1045	0	14	4	0	10112
10	1796.90	0.5275	8438	248	342	1068	0	2	18	0	10112
11	1295.20	0.4998	10112	0	0	0	0	0	0	0	10112

Table.5 Hinge formation for Model 2

Step	Base Force (KN)	Displacement (m)	A to B	B - IO	IO -LS	LS-CP	CP-C	C-D	D-E	Beyond E	Total
0	0.00	0.00	6224	4	0	0	0	0	0	0	6228
1	3490.321	0.0252	5918	310	0	0	0	0	0	0	6228
2	8330.567	0.0646	5683	346	191	8	0	0	0	0	6228
3	11569.69	0.1192	5595	389	106	138	0	0	0	0	6228
4	12583.17	0.1482	5571	410	91	154	0	2	0	0	6228
5	4594.418	0.1219	6228	0	0	0	0	0	0	0	6228

Table.6 Hinge formation for Model 3

Step	Base Force (KN)	Displacement (m)	A to B	B - IO	IO - LS	LS-CP	CP-C	C-D	D-E	Beyond E	Total
0	0.00	0.00	6227	1	0	0	0	0	0	0	6228
1	2040.742	0.0138	5936	284	8	0	0	0	0	0	6228
2	8945.064	0.0668	5692	326	186	22	0	2	0	0	6228
3	12274.27	0.1215	5692	326	186	22	0	1	1	0	6228
4	11518.87	0.1164	6228	0	0	0	0	0	0	0	6228

VII. CONCLUSION

An analytical model for Bare Frame, Masonry infill and Masonry infill with Shear wall is proposed in this dissertation. The conclusion based on, the results of Nonlinear Static Pushover Analysis of Model 1, Model 2 and Model 3, as described in the previous chapters, are presented herewith.

1) Model-1 has very large displacement compared to Model-2 and Model-3.

2) The Stiffness of Model-3 i.e. (Masonry infill with shear wall for lift frame) increase up to 77.09%.

3) In Model-1, the demand curve intersects the capacity curve near the event point between LS & CP (Life Safety & Collapse prevention). This means that, there is significant risk of injury due to falling hazards from structural debris may exist. The structure may not be technically practical to repair and is not safe.

4) In Model-2, the demand curve intersects the capacity curve near the event point between IO & LS (Immediate Occupancy & Life Safety). This means that, the risk of life-threatening injury of structural damage is low. It indicates that elastic response and security margin is enhanced by providing brick work in the frame.

5) In Model-3, the demand curve intersects the capacity curve near the event point between B & IO. It indicates that the elastic response and security margin is greatly enhanced than Masonry infill frame, by providing masonry infill wall and shear wall for lift for high rise structure.

6) The storey drift are checked according to clause no. 7.11.1 IS 1893(Part-I):2002, Page No.27 and it is found that drifts for Model 2 & 3 are more safe.

7) The seismic analysis of RC frame for high rise building should be done by considering the infill walls and shear wall for lift in the analysis which reduces storey drift drastically than the bare frame.

8) The IS Code describes insufficient information about infill wall with shear wall for lift, design procedures. Software like E-TAB is used as a tool for analyzing the effect of infill wall and infill wall with shear wall for lift on the structural behavior.

VIII FUTURE SCOPE

As the performance based pushover analysis is very useful method to design the structure at required performance level, it can be applied in different structures.

1)In the present study full masonry infill and shear wall is taken in the frames, partial infill can be taken so as to consider the opening in the frame in case of doors and windows.

2)Optimization can be done for same.

REFERENCES

1.Ashok Thakur, Arvinder Singh; "Comparative Analysis of a Multistoried Residential Building with and Without Shear Wall using STADD Pro., International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 1, Issue 1, June 2014, pp. 54-57.

2.A. Shuraim and A. Charif, "Performance of Pushover procedure in Evaluating the Seismic Adequacy of Reinforced Concrete Frame" 7th Saudi Engineering Conference.

3.Chandrasekaran, Gupta, Varun; "Pushover Analysis of RC framed structures", International Journal of Nonlinear Dynamics & Chaos in Engineering System, Vol.4, No. 43, 2006, pp. 329-342.

4.Diptesh Das and C.V.R Murty, "Brick masonry infills in seismic design of RC frame buildings Part II – Behavior", The Indian Concrete Journal, July 2004, Vol. 78, No. 7, pp. 39-44.

5.Dhileep M, Trivedi A and Bose P R, "Behavior of high frequency modal responses in nonlinear seismic analysis", International Journal of Civil and Structural Engineering, Volume 1, No 4, 2011.

6.Diptesh Das and C.V.R Murty, “Brick masonry infills in seismic design of RC frame buildings Part II – Behavior”, The Indian Concrete Journal, July 2004, Vol. 78, No. 7, pp. 39-44.

7.Konuralp Girgin and Kutlu Darılmaz; “Seismic Response of Infilled Framed Buildings Using Pushover Analysis”, ARI The Bulletin of the Istanbul Technical University, VOLUME 54, NUMBER 5.

8.Subramanian and Jayaguru; “Behavior of Partial Infill R.C. frames in Shear”, Teresa, Garcia; “The Captive and Short column effect”, Earthquake Spectra, Vol. 21, No. 1, 2005, pp. 141-160.

9.Prof. Milind V. Mohod; “Pushover Analysis of Structures with Plan Irregularity”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 4 Ver. VII (Jul. - Aug. 2015), PP 46-55.

10.P. P. Chandurkar, Dr. P. S. Pajgade; “Seismic Analysis of RCC Building with and Without Shear Wall”, International Journal of Modern Engineering Research (IJMER) Vol. 3, Issue 3, May-June 2013, pp-1805-1810 ISSN: 2249-6645.

11.Vikas Govalkar, P. J. Salunke, N. G. Gore; “Analysis of Bare Frame and Infilled Frame with Different Position of Shear Wall”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-3 Issue-3, July 2014.