

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 4, April 2018

A Review on Non-linear Pushover Analysis of Flat Slab Building

Sayali Baitule¹, Tushar Dalawi²

Assistant Professor, Department of Civil Engineering, PRMIT & R, Badnera, Maharashtra, India¹

Assistant Professor, Department of Civil Engineering, PRMIT & R, Badnera, Maharashtra, India²

ABSTRACT: Flat slab systems in current construction practice are commonly used for relatively light residential loads and for spans from 4.5m to 6m. The flat slab type of construction provides architectural flexibility, more clear space, less building height, easier formwork, and consequently, shorter construction time. However, flat slabs are susceptible to significant reductions in stiffness as a consequence of slab cracking that can arise from construction loads, service gravity loads, temperature and shrinkage effects, and lateral loads. When subjected to earthquake action, the unbalanced moments can produce high shear stresses in the slab. Hence it is necessary to study the performance of flat slab when subjected to earthquake. Performance based seismic design (PBSD) is the modern approach to earthquake resistant design. The pushover analysis of a structure is a static non-linear analysis under permanent vertical loads and gradually increasing lateral loads. This paper will concentrate on various studies of evaluation of performance of flat slab by non-linear static (pushover) analysis.

KEYWORDS: Flat slab, Performance based seismic design, Pushover analysis.

I. INTRODUCTION

The construction of flat slab building is increasing rapidly as they have many advantages. Flat slabs are susceptible to significant reductions in stiffness as a consequence of slab cracking that can arise from construction loads, service gravity loads, temperature and shrinkage effects, and lateral loads. Flat slab systems experience excessive lateral drifts (displacement) when subjected to wind loads or seismic excitations. Therefore in regions of high seismic risk, modern seismic design codes prohibit the use of flat slab/plate as a lateral load resisting system, but allow its use as a vertical (gravity) load resisting system. When subjected to earthquake action, the unbalanced moments can produce high shear stresses in the slab. Hence it is necessary to study the performance of flat slab when subjected to earthquake.

The pushover analysis is becoming popular method of predicting seismic force and deformation demands for the purpose of performance evaluation of existing and new structures. This procedure is mainly used to estimate the strength and drift capacity of existing structure and the seismic demand for this structure subjected to selected earthquake. This procedure can be used for checking the adequacy of new structural design as well. The effectiveness of pushover analysis and its computational simplicity brought this procedure in to several seismic guidelines (ATC-40[3] and FEMA 356[4]) in last few years.

The flat-slab system, as shown in Fig.1, is a special structural form of reinforced concrete construction that possesses major advantages over the conventional moment-resisting frames. The former system provides architectural flexibility, unobstructed space, lower building height, easier formwork and shorter construction time.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 4, April 2018

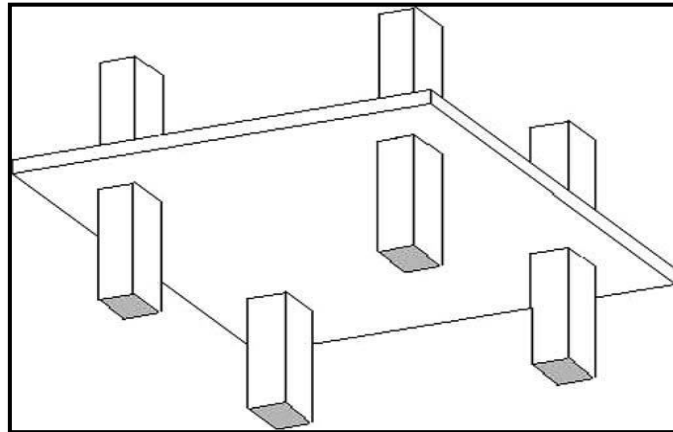


Figure 1: Illustration of a typical flat-slab structural form [7]

II. LITERATURE REVIEW

Farzad Naeim (2008) [1] Seismic Design Handbook presented performance based design is an attempt to predict buildings with predictable seismic performance. This chapter provides a basic understanding of the promises and limitations of performance based seismic engineering. The state-of-the-art methodologies and techniques embodied in the two leading guidelines on this subject (ATC-40 and FEMA 273/274) are introduced and discussed. Numerical examples are provided to illustrate the practical applications of the methods discussed.

Rizwan Bhina *et.al* (2015)[3] presented paper on Assessment of Different Aspects of R.C. Flat-Slab Building and Its Serviceability. In this paper the response of Flat-Slab building and a normal symmetric R.C. frame building of same dimension have been studied for varying seismic intensities and serviceability. Static analysis has been performed on the building to obtain the reinforcement of the structure by using different building codes for example IS 456, ACI 318, NZ code, EURO code. It can be concluded from the result that Indian code IS 456 suggest maximum amount of reinforcement.

A.E. Hassaballa, *et.al* (2014)[4] presented paper on Pushover Analysis of Existing Four Storey RC Flat Slab Building. In this paper a pushover analysis was performed on the four story building using SAP2000 software (Ver.14) and equivalent static method according to UBC 97. They have concluded that the structure will behave poorly during the imposed seismic excitation and need to be retrofitted to avoid future major damage or collapse.

M. A. Ismaeil[5] presented paper on Pushover Analysis of Existing Three Stories RC Flat Slab Building. This paper contains the study of seismic performance of the existing hospital buildings in the Sudan. Plastic hinge is used to represent the failure mode in the beams and columns when the member yields. The pushover analysis was performed on the building using SAP2000 software (Ver.14) and equivalent static method according to UBC 97.

K. S. Sable *et.al* (2012)[6] presented paper on Comparative Study of Seismic Behaviour of multi-storey Flat Slab and Conventional Reinforced Concrete Framed Structures. This paper investigates the comparison of conventional reinforced concrete building system i.e. slab, beam & column to the flat slab building. These results are compared for different heights of building. The analysis was carried out in STAAD Pro2007 software. Results of conventional R.C.C structure i.e. slab, beam and column and flat slab R.C.C structure for different heights are discussed.

Dhananjay D. Joshi *et.al* (2014)[8] presented a paper on Performance of Flat Slab Structure Using Pushover Analysis. In this paper a (G+7) frame having 5 bays is considered for analysis. The results obtained by performing pushover

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 4, April 2018

analysis on flat slabs by using most common software SAP2000. It is observed that the performance point of flat slab is more as compared to conventional building.

K. Soni Priya et.al (2012)[9] presented a paper on Non-Linear Pushover Analysis of Flat-slab Building by using SAP2000. In this paper, pushover analysis was performed on (G+2) building with flat slab and resulting pushover curve is plotted. It is concluded that curve is initially linear but start to deviate from linearity as the columns undergo inelastic actions.

Triandas Srikanth[10] presented report on 'Non-linear Pushover Analysis of Flat Slab Buildings with and without Seismic Retrofitting'. In this report the lateral behaviour of a typical flat slab building which is designed according to IS:456-1978 is evaluated by means of non-linear pushover analysis. The inadequacies of these buildings are discussed by comparing the behaviour with that of the conventional beam-column framing. The effect of retrofitting schemes is also studied.

Ravindra B N et.al.[13] presented paper on 'Dynamic Analysis of Soft Storey Building with Flat Slab'. For linear and nonlinear analysis 5, 10 and 15 storey buildings modelled by using ETABS software considering response reduction factor, importance factor, zone factor, damping ratio, base shear and hinge reactions are obtained

Rahiman G. Khan et.al.[14] presented paper on Pushover Analysis of Tall Building with Soft Stories at different Levels. In this paper the seismic vulnerability of building is shown with an example of G+20. Earthquake analysis is carried out on RCC moment resisting frame tall building without infill wall on different stories and best position for soft storey is suggested.

Dubey S.K. et.al. [2011] presented paper on Seismic Behavior Of Asymmetric RC Buildings. The main objective of this study is to understand different irregularity, and to analyze "T"-shaped building while earthquake forces acts and to calculate additional shear due to torsion in the columns. Additional shear due to torsional moments needs to be considered because; this increase in shear forces causes columns to collapse. So in design procedures this additional shear must be taken into account.

R.S.More, V. S. Sawant [2013] presented paper on Analysis of Flat Slab. This paper gives information about major issues associated with the flat slab and different method for analysis of flat slab use to confirm the behaviour of flat slab.

III. CONCLUSION

From the above literature review it is found that studies have been carried out for seismic evaluation of flat slab buildings using pushover analysis. Many experimental and analytical works has been done by many researchers in the area of the pushover analysis of the structural members. The concept of pushover analysis is rapidly growing nowadays. It is found that Standard pushover analysis and Capacity spectrum method are more popular for seismic evaluation but a very small work has been carried on modal pushover analysis method. The use of pushover analysis and behaviour of various flat slab structures has been studied extensively in previous studies.

REFERENCES

- [1] FarzadNaeim, "The Seismic Design Handbook" ,Second edition 2008
- [2] Dr. V. L. Shah, Dr. S. R. Karve, Limit State Theory An Design of Reinforced Concrete, Structures publication, India.
- [3] Mohd. Rizwan Bhina, Waseem Khan, and D.K.Paul, "Assessment of Different Aspects of R.C. Flat-Slab Building and Its Serviceability", International Conference on Architecture And Civil Engineering (ICAACE'14) Dubai, December 25-26, 2014.
- [4] A. E. Hassaballa, M. A. Isamaeil, A.N. Alzead, Fathelrahman M. Adam, "Pushover Analysis of Existing 4 Storey RC Flat Slab Building", International Journal of Sciences: Basic and Applied Research (IJSBAR)2014, Volume 16, No 2.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 4, April 2018

- [5] M. A. Ismaeil, "Pushover Analysis of Existing 3 Stories RC Flat slab Building", International Journal of Advances in Science and Technology (IJAST) ISSN 2348-5426(2013).
- [6] Prof. K S Sable, Er. V A Ghodechor, Prof. S B Kandekar, "Comparative Study of Seismic Behavior of Multistory Flat Slab and Conventional Reinforced Concrete Framed Structures", International Journal of Computer Technology and Electronics Engineering (IJCTEE) Volume 2, Issue 3, June 2012
- [7] Ali Demir, Hakan Basaran, MuhiddinBagci, "study of A Comparative Assessment of Existing Structure by Performance Based Analyses", American Journal of Engineering, Technology and Society", Vol. 1, No. 1, 2014.
- [8] Dhananjay D. Joshi, Dr. Pranesh B. Murnal, "Performance of Flat Slab Structure Using Pushover Analysis", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 8, Issue 3 (Sep. - Oct. 2013).
- [9] K. Soni Priya, T. Durgabhavani, K. Mounika, M.Nageswari, P.Poluraju, "Non-Linear Pushover Analysis of Flatslab Building by using SAP2000", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-1, Issue-1, April 2012
- [10] Triandas Srikanth "Non-linear Pushover Analysis of Flat Slab Buildings with and without Seismic Retrofitting", Thesis report, IITK, India, July 1999.
- [11] Mohd. Rizwan Bhina, Waseem Khan, and D.K.Paul, "Assessment of Different Aspects of R.C. Flat-Slab Building over normal R.C. frame building", Research gate 2015.
- [12] Altuntop, Mehmet Alper "Analysis of Building Structures with Soft Stories"
- [13] Ravindra B., Mallikarjun S. Bhandiwad "Dynamic Analysis of Soft Storey Building with Flat Slab", International research journal of Engg. And Technology, volume:02, july 2015.
- [14] Rahiman G. Khan, M. R. Vyawahare, "Pushover Analysis of Tall Building with Soft Stories at different Levels", International journal of engg .research and application, vol. 3, Aug 2013.
- [15] Sudhanshu Sood, Dr. Naveen Kwatra "Performance based seismic design of building" July 2010.