EFFECT OF PATTERN LOADING ON SEISMIC BEHAVIOUR OF STRUCTURES BY CONSIDERING INFILLED EFFECT

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Abstract: **The accurate estimation of design actions on the structure is very important in structural design as it significantly affects the final design and objectives. Any error in the estimation of design actions may lead to wrong results of structural analysis on the structure and lead to the unrealistic sizing of its structural members or even collapse of the structure. Therefore it is important to account for the most adverse effects of live loads on the structure. The consideration of pattern loading depends on the ratio of dead to live load and the type of structural member.**

These days most of the engineers are not considering the different live load patterns to get the adverse effect of the structure. Considering the live load to all the slab panels may not appropriate to estimate the design parameters. In this context, an attempt is required to see the effect of pattern live load on the structure under seismic loads. The effect of pattern load may be different from bare frame structure and also infill structures. For the present work a regular symmetrical building will be chosen and the structure is loaded with different pattern live loading is analyzed for seismic load case with and without infill walls. Different dead loads to live load ratios are also considered as a parameter.

***Keywords*:Intercloud,Framework,protocol,Innovative**

1.INTRODUCTION

In structural engineering practice, individual structural members are designed for the critical scenarios. Conventionally such critical scenarios are being identified using structural analysis for different load combinations. Live loads such as human occupancy floor loads can be placed in various ways, some of which will result in larger effects than others. Hence, from a live load point of view we need to analyze a given structure for all possible placements of loads. Such placements of loads are known as load patterns. It is easy to see that the number of live load patterns needed in order to find the true critical response of the structure increases exponentially with an increase in the number of structural elements. Hence, the analysis of structures under all possible live load patterns becomes increasingly difficult or impossible for complex multidimensional systems. Conventionally dead loads, live loads, earthquake loads and wind loads are the primary load types used to analyze a structure for various parameters like span moments, end moments, shear, thrust or deflections. The Muller Breslau Principle for influence lines is an effective way to obtain critical load patterns. Realizing the fact that the efforts required in solving large structures is too much and such efforts further increase as design demands multiple analysis of the structure. In a way, such conventional analysis tools prove to be realistic only in a qualitative sense. Further, combining load combinations and load patterns requires the engineer to do multiple iterations of structural analyses in order to capture the critical scenario. Apart from being an impractical task in most situations, it is impossible at times. In fact for Simplicity standard structural engineering codes of practice have suggested several critical load patterns. In practice, engineers have limited themselves to suggested critical load patterns (ASCE02/ACI02/UBC/IBC). It is important to emphasize that these load combinations are just an effort in order to avoid large number of structural analysis and critical scenarios need not necessarily occur 2 under such load combination and load patterns. In such cases engineers are supposed to make their own judgment and they have to take the risk of missing such critical cases. The present work is an effort to show structural problems of all sorts of complexities under all possible load patterns and load combinations

2.LITERATURE SURVEY

A structure will subjected to different types of loadings. Some loads are permanently constant and some loads are variable. Generally, self-weight of different elements in a structure is permanently constant whereas live loads or imposed loads differ time to time and also position to position. In practice designers consider all floors are subjected to dead load and live loads fully. But it is evident that in structural analysis maximum resultant values such as bending moments, shear forces depends on position of live loads. In this chapter a literature review is presented to know the importance of considering live load patterns in analysis and design of structures

ASCE 7-05 Section 4.6 states "The full intensity of the appropriately reduced live load applied only to a portion of a structure or member shall be accounted for if it produces a more unfavorable effect than the same intensity applied over the full structure or member." What this means is that you need to arrange the live load so as to cause maximum effect in your members. You must design your structural elements so that they have sufficient strength to support all possible arrangements of live load. Consequently your analysis needs to provide you with envelope diagrams for each member. Envelope diagrams are internal force diagrams that envelop all the possible values of force at each location along the member. So examples are used below to explain method for determining envelopes. This can seem daunting task as you need to do multiple load cases to account for the various loadings on your structural system. For statically determinate structures, it is often easy to establish critical loading scenarios for shear, moment, reactions, and deflection. Unfortunately for continuous, statically indeterminate structures this is not so obvious and the use of influence lines becomes extremely useful. Ugur Ersoy (1992) worked on live load arrangements for multi-story frame analysis. He mentioned that 'Code require analyses based on live load arrangements producing the most unfavorable effects. This requirment leads to hundreds of cases in the analysis of multi-story structures which is neither feasible (even with the use of computer) nor sensible (due to the approximations involved). A reasonable number of cases should be analysed to obtain sufficiently accurate results'. In his work he proposed an apporach which requires the analyses of five cases irrespective of the number of stories and bays. Numerical comparisons indicated that proposed approach is 27 simpler and it leads to more accurate results than those proposed earlier. From his work he concluded that the live load arrangement proposed in general seem to yield greater moments as compared to the other practical methods. Furlong R.W (1981) worked on rational analysis of multistory concrete structures. Problems to be faced in analysis of structures considering effect of live load patterns. In the work furlong approached the problem of solving the structures for different live load patterns as a practical designer and claimed that all possible live load combinations do not have to be considered for the following reasons. 1. As the number of load cases increases, the probability of occurrence of the most critical combinations decreases. 2. Member forces are not very sensitive to loading not adjacent to such members. 3.Linear elastic analysis is just an approximation for reinforced concrete structures in which I and E change due to cracking and creep. Considering these important points, Furlong proposed simple live load arrangements which he claimed would yield reasonable values for shear and bending moment in beams and columns. The live load patterns considered in the study by furlong.

3. MODELLING AND ANALYSIS

Generally structures are subjected to dead and live loads. Dead loads are constant through out of the life of the structures where as imposed loads or live loads 32 vary time to time and position to position within the structure. Live loads position influences the design forces in different elements of the structure. In the present study a G+9 floors symmetrical building is chosen as shown in figure 3.1, 3.2 and 3.3 plan, elevation and isometric view respectively. Building is having plan dimension of 30 m ×30m , Six bays in each direction and each bay of 5 m. In all the models dead is considered full which includes self weight of the slab, beams, columns, floor finishes and wall loads. There are Eight different live load patterns are considered for the study viz., loading is in alternate bays, chess board kind of pattern, live load only at the corners panels, loading is only in central panels, full live load in all panels etc. In this chapter a detailed report is given which includes models, loading patterns, identified columns, beams bars for the study, parameters considered for the design. The study is conducted in three phases. In the first phase the models are analyzed for static load condition, in the second phase study the models are analysed for seismic load conditions without considering infills. In the third phase study the models are analysed for seismic load by considering infills. In seismic analaysis response spectrum method has been used in phase 2 and phase 3 study. Columns and beams are identified for the study. A finite element software ETABS is used for the analysis.

3.1 Properties considered in the models: The following properties are considered for the analysis. *3.1.1 In the first phase study Type of frame:* Ordinary RC moment resisting frame fixed at the base. Number of storey: 10 story (G+9). Floor height: 3.0 m. Depth of Slab: 175 mm. Size of beam: (300 × 550) mm. Size of column: (600 × 600) mm. Spacing between frames: 5 m along X direction and 5m along Y-directions. Materials: M 30 concrete, Fe 415 steel Material. Thickness of wall: 230 mm. Unit weight of Concrete 24 kN/m333 Unit weight of RCC: 25 kN/m3 Unit weight of in fill : 19 kN/m3 Loadings: The loads are considered as per IS 875 (part-1) for dead loads, IS 875 (part-2) for live loads Live load on floor: 3 kN/m2 (Commercial building) Wall load: 12 kN/m (assuming 0.23 thick walls) Parapet Wall load: 4 kN/m (Applied only on roof) Dead load from slab : 0.175×25=4.375 kN/m2 Floor finish : 1.0 kN/m2 Approximate udl from wall load : 4.8 kN/m2 (12*(5+5)/25) Total Dead Load = 10.175 kN/m2 Ratio of Dead Load to Live load = (10.175/3) =3.39 *3.1.2 In the second phase study* :In the second phase,

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in addition to the phase 1 study properties the following seismic parameters are considered. Seismic zone (Z5): V, Seismic Zone factor, Z = 0.36 Soil type = III (Soft soil) Importance factor, I = 1 Response Reduction factor, R = 3 (Ordinary moment resisting frame) Damping of structure: 5 percent (Concrete) *3.1.3 In the third phase study*: In addition to the phase I and II study properties the additional property considered is infill property. Infill is modelled as a compressive strut between a panel. The width of the infill is considered based on Paulay and Priestly infill model. Width of infill is W=0.25 dz, where dz is the diagonal length of infill strut. In our models dz is 4.94m therefore width of strut is 0.25×4.94 =1.23 m. Thickness of infill is 0.23m.

4. RESULTS AND DISCUSSION

The effect of pattern loading needs to be studied for every structure to design the elements for their worst design forces. In this project an attempt is given byconsidering Eight different live load patterns in a G+9 structure, which is having 6 bays of each 5m in each direction. In each model eight live load patterns are considered uniformly in all floors of the structure. The dead load to live load ratio is considered 3.39.

The study is conducted in three phases. In the first phase study, for all considered live load patterns models are analyzed for static load condition. The absolute maximum bending moments and absolute maximum shear forces in different chosen columns are tabulated and studied. Similarly the absolute maximum bending moments in chosen beam bars are studied. In the second phase study, for all considered live load patterns models of bare frame are analyzed for seismic loads. The absolute maximum bending moments and absolute maximum shear forces in different chosen columns are tabulated and studied. Similarly the absolute maximum bending moments in chosen beam bars are studied.

In the third phase study, for all considered live load patterns models of infilled frame are analyzed for seismic loads. The absolute maximum bending moments and absolute maximum shear forces in different chosen columns are tabulated and studied. Similarly the absolute maximum bending moments in chosen beam bars are studied.

4.0.Base shear :

Table 4.1: Base shear in kN for different pattern loading

Patterns	**Without infill**	**With infill**
P1	5658.6	12455.22
P2	8704	**18722**
P3	9332.4	17588.3
P4	9421.3	17453.19
P5	9288.8	17398.81
P6	9332	16766
P7	9455.7	17702.69
P8	**9582.63**	17784.07

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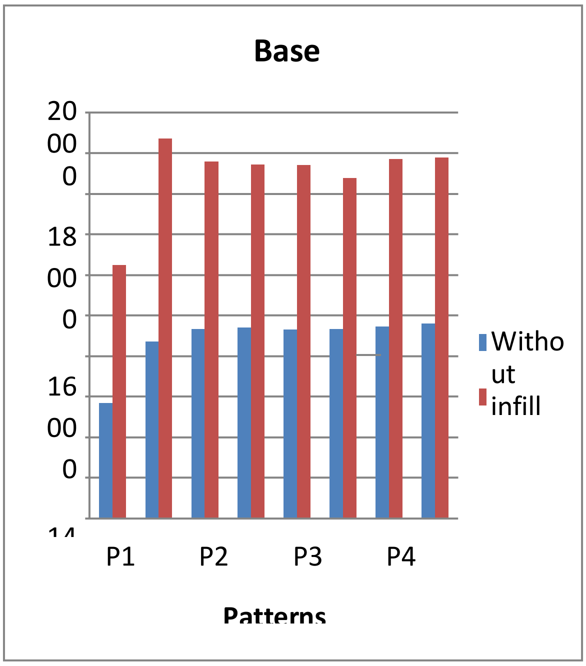

4.1: Base shear values in phase 2 and phase 3 studies

The base shear values of considered structure with and without infill walls are presented in table 4.1 and depicted in figure 4.1. In the model without infill the maximum shear is in pattern 8, i.e. live load in all panels. In this, full load is considered in all panels therefore the total mass of the structure increased in turn base shear also increases. Thebase shear values are higher in structure with infills and lower in without infill structure. If infills are considered, the structure time period will be decreased and S_a/g value increases (depending upon time period in response spectrum). In this case the variation is almost two times from without infill structure to with infilled structure. In thestructure with infill, the maximum base shear is in pattern 2.

4.2 Time periods

In dynamic analysis of bare frame structure (phase 2 study) and infill frame structure (phase 3 study) , time periods are presented in Table 4.6 and figure 4.6.Time periods are more in bare frame compared to infill frame structure as the stiffnessincreases time period of the structure decreases. In bare frame structure, pattern 1 loading model having more time period than pattern 8 loading model. In case of infill frame structure, pattern 6 loading model having more time period than pattern 8 loadingmodel.

Table 4.2: Time periods in phase 2 and phase 3 study

Patterns	Without infill	With Infill
P1	**1.947**	0.885
P2	1.366	0.961
P3	1.793	0.969
P4	1.861	1.011
P5	1.784	0.956
P6	1.793	**1.016**
P7	1.824	0.963
P8	1.841	0.962

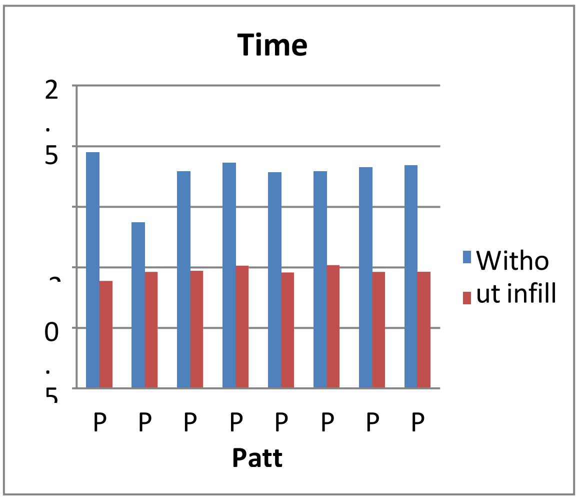

Fig 4.2: Time periods in phase 2 and phase 3 study

CONCLUSION

A ten story building is considered and analyzed for eight different live load patterns. Two different models bare frame and infill frame are used for the study. The study conducted in three phases. In the first phase bare frame analyzed for static loading, in the second phase study bare frame analyzed for seismic loading and in the third phase study infill frame analyzed for seismic loading. The results and presented and discussed in the chapter 4. Based on the results the following conclusions are drawn.

1. Phase 2 model (bare frame) is not influenced by pattern loading where as phase 3 model influenced and the variation is 5% when compared to full loading pattern. This is due to stiffness variation in the structure.

2. The stroey shears are more in phase 3 models when compared to phase 2 models. The values are increased more than 60%. There is no influence of pattern load for storey shear in phase 2 model but it is influenced by pattern loading in phase 3 model.

3. Storey drifts are influenced in both phase 2 and phase 3 models. Storey drifts values are considerably decreased in phase 3 model. As infills increases the stiffness the deformations and drifts decreases.

4. Time periods are also influenced by pattern loading. The variation is about 5 % compared to full loading i.e. pattern 8. Time periods depends on mass and stiffness of the structure, therefore infill structures have less time period when compared to bare frame structures.

5. The columns absolute maximum bending moments are not influenced by pattern loading inphase 1 study (static analysis of bare frame).

6. Interior columns of absolute maximum bending moments are influenced by the pattern loading in phase 2 study, where as exterior columns have very minimal influence of pattern loading on absolute maximum bending moments.

REFERENCES

1. *Ali Bakshi, Hamed Nikbakht, "Loading Pattern And Spatial Distribution Of Dynamic Wind Load And Comparison Of Wind And Earthquake Effects Along The Height OfTall Buildings", Proceedings of the 8th International Conference on Structural Dynamics, EURODYN, Belgium,4-6 July,2011, pp-1607-1613.*

2. *Amin Ghali, Adam Neville, T G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", A text book, fifth edition, Spon press, 2003*

3. *A. Madan, and M. Reinhorn, " Modeling of masonry infill panels for structural analysis" Journal of Structural*

4. *ASCE 07-5, A code of practice on " Minimum design loads for buildings and other structures" , Published by the Americal Society of Civil Engineers, 2006*

5. *Castro, P.T Laursen, D.C Jansen, "Performance of interlocking compressed earth block infill in confined masonry construction" Journal of Earthquake Engineering, July 2014*

6. *Cemalettin Dönmez and M. Alper Çankaya "Effect of Infill Walls on the Drift Behavior of Reinforced Concrete Frames Subjected to Lateral-Load Reversals", Journal of Earthquake Engineering, Volume 17, Issue 5, 2013*

7. *I.S. 456-2000, Indian standard code of practice for plain and reinforced concrete (fourth revision), Bureau of Indian standards, New Delhi.*

8. *I.S. 1893(Part 1)-2002, Criteria for earthquake resistant design of structure, general provision and building, Bureau of Indian standards, New Delhi.*

9. *IS 875-1987, Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures- part1. Dead loads, second revision, Bureau of Indianstandards, New Delhi.*

10. *Kashif Mahmud, Rashadul Islam and Al-Amin "Study of the Reinforced Concrete Frame with Brick Masonry Infill due to lateral loads", International Journal of Civil and Environmental Engineering, Volume 10, Issue 4, August 2010*

11. *Kulkarni J.G., Kore P.N., S.B.Tanawade, "Analysis of Multi-Storey Building Frames Subjected to Gravity and Seismic Loads with Varying Inertia", International Journal of Engineering and Innovative Technology, Volume.2, Issue 10, April 2013.*

12. *Vishal Saxena," Interval Finite Element Analysis for Load Pattern & Load Combination", A theses submitted to M.S.Program at Georgia Institute of Technology,August 2003.*

13. *Robert Park, William L.Gamble, "Reinforced concrete slabs",Second edition, John Wiley &Sons, Inc,2000.*
14. *R. W. Furlong, "Rational analysis of multistory concrete structure," ACI Concrete International, vol. 3, no. 6, pp. 29–35, 1981*

15. *S. Pujol and D. Fick, "The test of a full-scale three-story RC structure with masonry infill walls", Science Direct, Volume 32, Issue 10, October 2010*

16. *Technical note on "Composite beam design-Design load combinations", published by Computers and Structures, Inc, Berkeley, California, December 2001.*
17. *Ugar Ersoy, "Live Load Arrangements for Multi-Story Frame Analysis", Digest 92, Teknik Dergi, December 1992, pp-163-17*