Review on Analysis of Masonry Infill in Multi Story Structure

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Abstract- *The rapid growth of urban population and limitation of available land, scarcity and high cost of available land, the taller structures are preferable now days. The tallness of a building is relative and cannot be defined in absolute terms either in relation to height or the number of stories. But, from a structural engineer''s point of view the tall building or multistoried building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. Tall structures have fascinated mankind from the beginning of civilization. The Egyptian Pyramids, one among the seven wonders of world, constructed in 2600 B.C. are among such ancient tall structures. Such structures were constructed for defense and to show pride of the population in their civilization. The growth in modern multi-storied building construction, which began in late nineteenth century, is intended largely for commercial and residential purposes. The design of tall buildings essentially involves a conceptual design, approximate analysis, preliminary design and optimization, to safely carry gravity and lateral loads.. Flat slab buildings have low lateral stiffness, and hence swing by large amounts of elastically even during low level earthquake shaking owing to little rotational flexibility offered by the thin slabs interconnection the columns. Since the column- slab system has small lateral stiffness and lateral load resistance, this large overall lateral drift of the flat slab building makes the columns incapable of accommodating the additional secondary moments generated by the lateral deformations. Thus, there are serious concerns on the use of flat slab buildings in earth quake zones III and IV.*

I. INTRODUCTION

The design of tall buildings essentially involves a conceptual design, approximate analysis, preliminary design and optimization. The design criteria are strength, serviceability, stability and human comfort. Tall structures have fascinated mankind from the beginning of civilization. The Egyptian Pyramids, one among the seven wonders of world, constructed in 2600 B.C. are among such ancient tall structures.

Recent major earthquakes have caused sever social disruption in the territory of the epicenter, especially due to structural failures causing damage to the people and properties. It is neither practical nor economically viable to design structures to remain within elastic limit during earthquake. A flat slab is a type of reinforced concrete construction in which a reinforced slab is built monolithically with the supporting columns and is reinforced in two or more directions without any provision of beams. Flat slab structures in areas of low seismicity (Zone II) can be designed to resist both vertical and lateral loads. Flat slabs are preferential by both architects and clients because of their aesthetic and economic advantages.

The performance of flat slab building under seismic loading is poor as compare to framed structure due to lack of frame action. Infill wall is the supported wall that closes the perimeter of a building constructed with a three-dimensional framework structure. The infill wall has the unique static function to bear its own weight. Infill walls are easy to build, attractive for architecture and has a very efficient cost-performance. Today, masonry enclosures and partition walls are mainly made of clay units, but also aggregate concrete units (dense and lightweight aggregate) and autoclaved aerated concrete units are used.

The use of masonry infill walls, and to some extent veneer walls, is common in many countries. Masonry walls are provided in multistory RCC buildings for functional and architectural requirements. It has been accepted that infill materials significantly effects on the seismic performance of the in filled framed structures. Clay bricks, RCC, Cement bricks are considered for seismic analysis.

II. LITERATURE REVIEW

Sharad P. Desai, Swapnil B. Cholekar (2013) [1] in their paper summarized that the Dynamic response of Flat slab with drop and without drop and Conventional Reinforced Concrete Framed Structures, for different height with and without masonry infill wall. Dynamic analysis for different types of building is done by using Response Spectrum method for earthquake zone III as per Indian Standard code. The effect of Flat slab with drop and Flat slab without drop considering with and without masonry infill wall is evaluated. It was found a significant change in the seismic parameters such as Fundamental Natural Period, Design Base Shear, Displacement and Axial Force of the structure.

Kumar Vanshaj, Prof. K Narayan (2017) [2] in their paper investigated that be the behavior of flat slab multistory G+19 building in four different cases as I) flat slab structure without shear wall. II) Flat slab structure with shear wall at core of the building. III) Flat slab structure with shear wall at corners of the building IV). Flat slab structure with shear wall at side centers of the perimeter boundary of the building. The lateral behavior of a typical flat slab building is evaluated by means of dynamic analysis through linear time history analysis method using ETABS software.

Dr. Uttamasha Gupta, Shruti Ratnaparkhe, Padma Gome (2012)[3] in their paper compared the behaviour of multi-storey buildings having flat slabs with drops with that of having two way slabs with beams and to study the effect of part shear walls on the performance of these two types of buildings under seismic forces. Present work provides a good source of information on the parameters lateral displacement and storey drift. For all the cases considered drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey.

C.Rajesh , Dr Ramacharla Pradeep Kumar , Prof. Suresh Kandru (2014) [4]Presented in their paper performance of RC frame buildings with and with-out infill walls. Here analyses and designs the masonry infill walls using equivalent diagonal strut concept in-order to assess their involvement in seismic resistance of regular reinforced concrete buildings. Modeled the two different buildings with and without infill walls and designed it and analysis done for gravity and seismic loads using software (SAP2000). Compare the results from the computerized model analyses for with and without infill structures as bare-frame and single strut models respectively.

Priyanka Vijaykumar Baheti , D.S.Wadje, G.R.Gandhe (2017) [5] The main objective of this paper is to study the behavior of flat slab structure under equivalent static analysis and compare the behaviour with a shear wall panel and infill wall panel provided at center and corner of building. The analysis is carried out in E-tabs software.

Ioana Olteanu , Vladut Iftode and Mihai Budescu (2014) [6] in their paper presented the influence of the infill material on the overall behavior of the structure. Numerical simulation in two different computer software is performed. The main conclusion is that the behavior of reinforced concrete frame structures can be improved by changing the material characteristics of the infill.

Vishesh P. Thakkar, Anuj K .Chandiwala, Unnati D. Bhagat (2017) [7] in their paper presented work to compare the seismic behavior of multi store buildings having conventional RC frame, flat slab with drop and flat slab without drop in seismic zone III with type II medium soil and to study the effect of height of building on the performance of these types of buildings under seismic forces. Linear dynamic response spectrum analysis was performed on the structure to get the seismic behavior.

R. P. Apostolska, G. S. Necevska-Cvetanovska, J. P.Cvetanovska and N. Mircic(2008) [8] In their paper presented the analysis for few types of construction systems to show that flat slab system with certain modifications (design of beam in the perimeter of the building and/or RC walls) can achieve rational factor of behaviour considering EC8 and can be consider as a system with acceptable seismic risk. Modifications with additional construction elements improve small bearing capacity of the system and increase strength and stiffness, improving seismic behavior of flat-slab construction system. Selected result from the analysis is presented in the paper.

DattatrayaL.Bhusnar,Dr.C.P.Pise,D.D.Mohite,Y.P.Pa war,S.S.Kadam,C.M.Deshmu kh(2016) [10] in their paper presented on the study of different infill materials on the seismic behaviour of multi-storey building with soft stories is carried out. For that, G+12 (Reinforced cement concrete) RCC model is selected. Different infill materials like siporex and clay brick are used. Different location of soft stories is considered for the analysis.

M.Danish, Zaid M, M. Shariq, A. Masood and A. Baqi (2013) [11]have presented a study on the finite element analysis of RC frame models viz. a bare frame; a frame with shear wall considering infill; a bare frame with shear wall has been carried out and the number of storeys vary as G+3, G+5, G+7 and G+9. Linear analysis of all RC frame structures has been performed as per IS: 1893 (Part 1) -2002 and IS: 456 - 2000. In this study only in-plane stiffness of masonry wall has been considered and infill panels modelled as equivalent diagonal strut elements.

Shubham Gupta, Lavina Talavale, Utkarsh Jain (2018) [12] have presented study on analysis of multistoried beam-slab buildings & flat slab buildings under DL, LL & EQ loads and to study the effect of shear walls on the above four types of buildings in terms of storey drift, lateral displacement and column forces. Effect of shear walls on drift values 1) In buildings without shear walls: a) The variation in drift values with height is parabolic having maximum ordinate at about one-third of the building height. b. The drift values in zone III is within permissible limits. 2) In buildings having shear walls: a) The variation in drift values with height is almost linear. b) The drift values get reduced by 6 to 7 times. Effect of Earthquake forces on columns carrying maximum forces 1) In buildings having shear walls: In 9 storied buildings, the axial forces in flat slab buildings are 14 to 20% more than in beam slab buildings.

M.K. Devtale, S.S. Sayyed, Y.U. Kulkarni, P.G. Chandak(2016) [13]in their paper presented the Comparison of Seismic Response between Flat Slab Building and Regular Frame Building . In the present study, the seismic behaviour of flat slab building is carried out. For this purpose linear analysis of flat slab building and regular framed structure building has been carried out. The comparison shows that the flat slab buildings have low base shear capacity and large deflection. Also linear analysis of flat slab building with shear wall and regular framed structure building with shear wall has been carried out.

Dr.P. Mallesham, S.B.Sankar Rao , Yerra Saritha (2016) [14]in their paper presented the comparison of an earthquake resistant building with & without infill’s in Zone II &Zone IV by using ETABS software for analyzing & Designing of the Building. The following conclusions are drawn based on the analysis and design of RC building designed for gravity loads and earthquake forces in II & IV zone. Almost every multi-storey building is made up of moment resisting RC frames in most of the developing countries. Brick infill masonry or concrete masonry are mostly used to infill the vertical space created by the beams and columns in the frame. These infill panels are generally not the intrinsic part of the moment resisting frame and usually they have openings in them for the utilitarian demand of doors, windows etc. There are advantageous and disadvantageous effect of infill masonry according to the previous studies and experience obtained during earthquake.

K.Sarath Kumar, Dr.Dumpa Venkateswarlu, Dr.D.V Rama Murthy (2017) [15]this paper deals with the behavior of multi storied flat slab building due to lateral forces with and without shear walls . so will study the analysis and design and about the behavior of building with shear wall and another with flat slab without shear wall. Based on the analysis and discussion shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls.

Basavaraj H S, Rashmi B A, (2015) [16]in their paper presents on the Seismic Performance Of R C Flat-Slab Building Structural Systems In the present work the G+4 and G+8 storied building models are considered. The vulnerability of purely frame and purely flat slab models under lateral loads and ground acceleration were studied. Further the flat slab models are strengthened by perimeter beam, infill walls, shear walls and increasing the cross sectional area of columns and the effect of positioning of infill walls and shear walls on performance of flat slab building models were analyzed.

P.M.B.Raj Kiran Nanduri,B. Suresh, SK.Nagaraju, MD.Ihtesham Hussain,(2013) [17]in their paper presents the Critical comparison of flat plate multistoried frames with and without R.C in filled walls under wind and earthquake loads. In the present investigation numerical studies for 20,40,60,80 storied frames with normal conventional beam supported slab system, flat plate floor system, flat plate floor system with R.C. In-filled walls against wind & earthquake loading has been conducted. A Comparison of the Critical Column Axial Forces, Critical Column moments, Lateral Drift (in mm) due to static, wind & Earthquake loads on the structures located at Hyderabad has been observed. In the case of tall multi story frames consisting of flat plate floor system with R.C. in filled external peripheral wall (F.P.F.S+R.C.I) the column axial forces are very much reduced by nearly 36% in all the frames. Hence the design of column becomes economical

Pradip S. Lande, Aniket B. Raut (2015) [18]In their paper presents a parametric investigation was carried out in order to identify the seismic response of systems a) flat slab building b) flat slab with perimetric beams c) flat slab with shear walls d) flat slab with drop panel. e) Conventional building the aforementioned hypothetical systems were studied for two different storey heights located in zone v. and analyzed by using ETABS Nonlinear version 9.7.3. Linear dynamic analysis i.e. response spectrum analysis is performed on the system to get the seismic behaviour. This paper presents a summary of the study, for conventional R.C.C building and flat slab building with and without shear wall, flat slab with drop panel and building with beam at periphery for seismic zone v. The effect of seismic load has been studied for these five types of buildings. On the basis of the results following conclusions have been drawn: The storey displacement is found maximum for the flat slab building as compared to conventional RC building and flat slab with shear wall the maximum displacement of the flat slab building is due to the absence of lateral load resisting system. The maximum storey drift found for G+6 building having a flat slab (As compared to its maximum limit i.e. 0.04% of height) For all the cases considered drift values follow a parabolic path along storey height with maximum value lying somewhere near the middle storey. It is found that flat slab structures exhibit higher flexibility compared to traditional frame structures. In order to limit deformation demands under the seismic excitations, combination with other stiffer structural systems as shear-walls is advisable. The maximum storey drift also found for flab slab. Min displacement found for flat slab with shear wall. Flat slab displacement is found 28% more than of conventional building for G+ 6. and 49.49% for G+12 building. Therefore it is advisable for tall building to use the shear wall.

Renuka Ramteke, Manish Chudare, Amey Khedikar (2017) [19]in their paper presented Study of Multistoried RCC Flat Slab Structure, Under Seismic Effect. In the present work dynamic analysis of 15 models of multi-storied RCC Flat slab structure is carried out by response spectrum analysis. Based on the work done in this dissertation following conclusions are drawn: Limiting plan aspect ratio is L/B =5 and slenderness ratio is 3.32. In earth quake prone area narrow and tall structure are not recommended, having aspect ratio more than L/B = 4 and slenderness ratio 2.88 without infill elements. Structure with aspect ratio more than 3 has higher magnitude of design base shear along both X and Y direction though their seismic weight is lesser than structure with aspect ratio 3. Curtailment in column size reduces the seismic weight of structure, hence less seismic weigh and less base shear. Buildings having square plan shape i.e. aspect ratio 1, is safest because: Lower and equal amount of base shear is acting along both X and Y direction. Fundamental time period for square plan structure is comparatively lesser than rectangular plan building. Hence it will perform well during earthquake with higher frequencies.

Dr. M Rame Gowda, Techi Tata(2016) [20]in their paper presents Study of seismic behaviour of buildings with flat slab. Two models are prepared. First model is a commercial building consisting of flat slab with drop and second model is a commercial building consisting of slab without drop. Firstly, the behavior of both buildings were studied and analyzed separately for all seismic zones and then finally, a comparison between both structures was made. Analyses were carried out using Response Spectrum method with the help of ETAB version 15.2.0. In order to study the behaviour, only maximum values were considered for the parameters like Storey Displacement, Storey Shear, Storey Drift, Storey Acceleration and Overturning Moment. From the results generated, it is quite clear that the building consisting of flat slab with drop shows better seismic performance. The storey displacement is less for the flat slab with drop as compared to the flat slab without drop with an average of 2mm displacement variation in each zones.

Santiago Pujol1,Amadeo Benavent-Climent2, Mario E Rodriguez3, and J. Paul Smith-Pardo4 [21] :-In their paper presented study on Masonry infill walls, an effective alternative for seismic strengthening of low-rise reinforced concrete building structures. Masonry infill walls are widely used as partitions worldwide. In this study, a full-scale three-story flat-plate structure was strengthened with infill brick walls and tested under displacement reversals. The results of this test were compared with results from a previous experiment in which the same building was tested without infill walls. In the initial test, the structure experienced a punching shear failure at a slab-column connection. The addition of infill walls helped to prevent slab collapse and increased the stiffness and strength of the structure. The measured drift capacity of the repaired structure was 1.5 %. A numerical model of the test structure was calibrated to match experimental results.

Elouali T (2000) [22]performed experimental cum analytical investigation on behavior of frame with masonry infill panels subjected to cyclic loading. Two types of masonry frequently used were tested. The effects of the infill panels on the seismic response of frame buildings were evaluated. The experimental results have been used to develop an analytical model for the determination of the stress-strain relationship to predict the inelastic behavior of each type of infill. A linear and nonlinear analysis have been carried out on the used prototype frames.

Shahabodin.Zaregarizi (2008) [23]carried out an investigation on the seismic rehabilitation of a five storey building damaged due to an earthquake in Iran, he compared the use of shear wall and infill to improve seismic performance of the structure and concluded the following: Concrete infills has considerable strength while brick one has lower, on contrary large displacement acceptance capability in brick infills are higher than concrete infills. So, combination of both concrete and brick infill can reduce negative effect of brick and concrete infills. Masonry infills as lateral resisting elements have considerable strength and can prevent collapse of buildings in moderate earthquakes. In shear wall neglecting effects of existing URM infills may lead to wrong results. Due to high stiffness of infills, only a limited number of shear walls are required in a structure.

Riza Ainul Hakim (2013) [24]This paper presented the behavior of a building in low to moderate seismic regions of Saudi Arabia. The building was designed for gravity loading and was poorly detailed and no ductile detailing was accommodated in the structure. Later on, the building designed for gravity loading has been investigated by performing nonlinear static analysis according to ATC 40 in SAP2000.

D.Gouse peera, Mohammed Rizwan Sultan (2015) [25]:-In their paper presented study on Dynamic analysis of multistory building for different shapes. This study is to grasp the behaviour of the structure in high seismic zone and also to evaluate Storey overturning moment, Storey Drift, Displacement, Design lateral forces. During this purpose a 15 storey-high building on four totally different shapes like Rectangular, L-shape, H-shape, and C-shape are used as a comparison. The complete models were analyzed with the assistance of ETABS 9.7.1 version. In the present study, Comparative Dynamic Analysis for all four cases have been investigated to evaluate the deformation of the structure. The results indicates that, building with severe irregularity produces more deformation than those with less irregularity particularly in high seismic zones. And conjointly the storey overturning moment varies inversely with height of the storey. The storey base shear for regular building is highest compare to irregular shape buildings.

NEED OF THE STUDY

The Flat slab building has a column-slab system, which is expected to resist both gravity loads and earthquake induced lateral inertia loads. Flat slab buildings have low lateral stiffness, and hence swing by large amounts of elastically even during low level earthquake shaking owing to little rotational flexibility offered by the thin slabs interconnection the columns. Since the column- slab system has small lateral stiffness and lateral load resistance, this large overall lateral drift of the flat slab building makes the columns incapable of accommodating the additional secondary moments generated by the lateral deformations. Thus, there are serious concerns on the use of flat slab buildings in earth quake zones III and IV. A System consisting of Shear walls, R.C. Infill Walls and flat Plate-frames may be provided as an appropriate lateral bracing system.

In many cases, the existing concrete skeleton is stiffened by filling in the space between the beams and columns with masonry of cast-in-place concrete. These infill walls can be a cost- effective method of increasing the lateral strength and rigidity of the building.]

OBJECTIVE OF THE WORK:-

The present work aim at following objective

- To evaluate the seismic performance of multistory flat slab building with L shape having different heights, in two different earthquake zones, with different infill materials, parameters like storey drift, base shear and displacement of these different flat slab buildings with and without infill wall are to be studied.
- To do the comparative study for determining reduction in base shear, displacement and storey drift for these various buildings due to the provision of infill wall with flat slab.

SCOPE OF THE WORK:-

Flat slabs with infill walls are commonly used in many parts of the country irrespective of seismic zone in India; Though minute details of infill are neglected the effect of their damage is very high during earthquakes.

This work focuses on understanding the behavior of flat slab structure with infill wall and without infill wall. For this purpose, the performance of buildings with infill wall is compared with same building without infill wall. This work will be taken up in following there phases.

Phase I: - Modeling of L shaped flat slab building with height varying G+7, G+13, and G+ 20 with and without infill wall using ETABS software.

Phase II: - To determine the parameters (storey drift, storey displacement, base shear) for these different modeled buildings and to do the comparative study of the above parameters (storey drift, displacement, base shear).

Phase III: - To do the comparative study and to prepare graphs and charts showing the performance of modeled buildings.

III. CONCLUSION

This paper focuses only on the literature review of the evaluate the seismic performance of multistory flat slab building.

The design of tall buildings essentially involves a conceptual design, approximate analysis, preliminary design and optimization. The design criteria are strength, serviceability, stability and human comfort. It is neither practical nor economically viable to design structures to remain within elastic limit during earthquake. Flat slabs are preferential by both architects and clients because of their aesthetic and economic advantages. Flat slab multistory G+19 building in four different cases as I) flat slab structure without shear wall.
II) Flat slab structure with shear walls at core of the building.
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boundary of theBuilding. Flat slab system with certain modifications (design of beam in the perimeter of the building and/or RC walls) can achieve rational factor of behaviour considering EC8 and can be consider as a system with acceptable seismic risk.

In 9 storied buildings, the axial forces in flat slab buildings are 14 to 20% more than in beam slab buildings. Flat slab buildings have low base shear capacity and large deflection. Almost every multi-storey building is made up of moment resisting RC frames in most of the developing countries. Brick infill masonry or concrete masonry are mostly used to infill the vertical space created by the beams and columns in the frame. In the present investigation numerical studies for 20,40,60,80.storied frames with normal conventional beam supported slab system,. flat plate floor system, flat platefloor system with R.C. in-filled walls against wind & earthquake loading has been conducted. A Comparison of the Critical Column Axial Forces, Critical Column moments, Lateral Drift (in mm) due to static, wind. & Earthquake loads on the structures located at Hyderabad has been observed.

In earth quake prone area narrow and tall structure are not recommended, having aspect ratio more than L/B = 4 and slenderness ratio 2.88 without infill elements. Buildings having square plan shape i.e. aspect ratio 1, is safest because lower and equal amount of base shear is acting along both X and Y direction. Two types of masonry frequently used were tested. The effects of the infill panels on the seismic response of frame buildings were evaluated. Concrete infills has considerable strength while brick one has lower, on contrary large displacement acceptance capability in brick infills are higher than concrete infills.

In shear wall neglecting effects of existing URM infills may lead to wrong results. Flat slab buildings have low lateral stiffness, and swing by large amounts of elastically even during low level earthquake shaking. This large overall lateral drift of the flat slab building makes the columns incapable of accommodating the additional secondary moments generated by the lateral deformations. There are serious concerns on the use of flat slab buildings in earth quake zones III and IV. Phase III:

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