Review on Dynamic Response of Building with RCC and AAC Infill Wall

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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. 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.**

1. INTRODUCTION

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. The design criteria are strength, serviceability, stability and human comfort.

Earthquakes have become a frequent event all over the world. It is very difficult to predict the intensity, location, and time of occurrence of earthquake. Structures adequately designed for usual loads like dead, live, wind etc may not be necessarily safe against earthquake loading. It is neither practical nor economically viable to design structures to remain within elastic limit during earthquake. The design approach adopted in the Indian Code IS 1893(Part I): 2002 'Criteria for Earthquake Resistant Design Of Structures' is to ensure that structures possess at least a minimum strength to withstand minor earthquake occurring frequently, without damage; resist moderate earthquakes without significant structural damage though some non-structural damage may occur and aims that structures withstand major earthquake without collapse. Structures need to have suitable earthquake resistant features to safely resist large lateral forces that are imposed on them.

A. INFILL WALL

The infill wall is the supported wall that closes the perimeter of a building constructed with a three-dimensional framework structure (generally made of steel or reinforced concrete). Therefore, the structural frame ensures the bearing function, whereas the infill wall serves to separate inner and outer space, filling up the boxes of the outer frames. The infill wall has the unique static function to bear its own weight. The infill wall is an external vertical opaque type of closure. With respect to other categories of wall, the infill wall differs from the partition that serves to separate two interior spaces, yet also non-load bearing, and from the load bearing wall. The latter performs the same functions of the infill wall, hygro-thermically and acoustically, but performs static functions too.

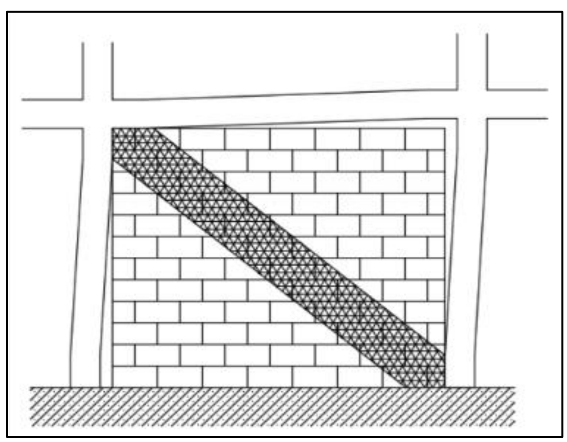

Fig 1 Infill Wall.

2. STATE OF DEVELOPMENT

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. The efficiency and serviceability under Indian standard code in seismic zone 'V' been observed for each defined model and compared the values with international codes Flat slab building without shear wall shows poor performance during earthquake excitation when compared to flat slab building with shear wall due less lateral stiffness. To increase the performance of the flat-slab structure under horizontal loads, particularly when speaking about seismically prone areas modifications of such system can be done by adding structural elements such as RC shear wall. Within the limitations of this study, it is recommended that the flat slab building with shear wall at side center should be preferred because of considerable difference in storey displacement, time period, base shear, storey drift and storey stiffness when compared to other models.

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 parameter's 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. Use of flat slabs with drop results in increase in drift values in shorter plans and decrease in larger plans, marginally in a range of 0.5mm to 3mm. Still all drift values are within permissible limits even without shear walls In zone III and IV use of flat slabs with drop in place of beam slab arrangements, though, alters the maximum lateral displacement values, however, these all are well within permissible limits, even without shear walls.

C.Rajesh, Dr Ramacharla Pradeep Kumar, Prof. Suresh Kandru (2014) [4] Presented in their paper performance of RC frame buildings with and without 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. From the observation of the results, it states that decrease in the time period will leads to increase in the base shear of the buildings and total weight of the building is less in strut model as compared to bare-frame model buildings. Strut model buildings show the less time period and total weight of the building and higher in the base shear of the building. As if we know time period is inversely proportional to stiffness, here it is seen that strut model buildings have less time period than bare-frame buildings which can say that strut model buildings are stiffer and safer during the earthquakes than the bare-frame models.

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. Static analysis is carried out study the behavior of flat slab with peripheral beam structures till collapse and identify the weaknesses under eismic loading. From the results and discussions, the L shape infill wall panel are best suitable for seismic analysis. The time period and deflection decrease with increase in the stiffness of the structure.

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. The proposed polyurethane brick has a flexible behavior, with good properties for thermal insulation and mechanical ones. The main advantage is the low unit weight, respectively the low load that is transmitted to the structural system.

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. Dynamic analysis for conventional RC frame building, flat slab with drop building and flat slab without drop building was done by using response spectrum analysis for earthquake zone III as per Indian standard code. The effect of height of building on these building is evaluated. There is significant change in seismic parameters like storey displacement storey drift, storey shear, time period and based shear is noticed

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. The purely flat-slab RC structural system is considerably more flexible for horizontal loads than the traditional RC frame structures which contributes to the increase of its vulnerability to seismic effects. The critical moment in design of these systems is the slab-column connection, i.e., the penetration force in the slab at the connection, which should retain its bearing capacity even at maximal displacements. The ductility of these structural systems is generally limited by the deformability capacity of the column-slab connection. To increase the bearing capacity of the flat- slab structure under horizontal loads, particularly when speaking about seismically prone areas and limitation of deformations, modifications of the system by adding structural elements are necessary. The realized investigations have shown that the flat-slab structural system with well-defined modifications can exhibit a favorable and rational factor of behavior compliant with Euro code 8 and can thus be treated as a system with acceptable seismic risk. The modification with certain structural elements improves the low bearing capacity and deformability of the system and leads to more adequate seismic behavior of the purely flat-slab structure.

Abhishek Arya and Lovish Pamecha (2017) [9] In their paper presented work to study and compare the behavior of multistory buildings having slabs with beams, flat slabs with and without drops and grid slab under seismic loading and observe the effect on the parameters as lateral displacement and storey drift. For this purpose, three cases of multi-storey buildings are considered having 10 storey, 15 storey and 20 storey. All the three cases are considered having conventional frame, flat slab with and without drops and grid slab systems and also analyzed for zone III, zone IV and zone V by using software Staad.Pro. For all the cases considered drift values follow approximately a parabolic path along floor height with maximum value lying somewhere near the third or fourth storey and displacement values follow around similar gradually increasing straight path along floor height. For all the models drift values and lateral displacements are less for lower zones and it goes on increases for higher zones. In all the models maximum drift values are near about 3 and 4 storey and lateral displacement is maximum at top storey and least at the base of structure. It is experienced in all the models that storey drift and lateral displacement of flat slab without drop building is slightly more than conventional frame and grid slab buildings, but highly more than flat slab with drop building in all the seismic zones.

DattatrayaL.Bhusnar, Dr.C.P.Pise,D.D.Mohite,Y.P.Pawar,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. To study of different infill material on the seismic behaviour of multistory building, linear dynamic analysis (Response spectrum analysis) in ETABs software is carried out. Different seismic parameters like time period, storey shear, storey displacement and storey drift are checked out.

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. The behaviour of buildings subjected to Gravity and Seismic loads with the help of Response Spectrum Analysis using FEM based software and the effect on Time Period, Mass Participation factor, and Storey Drift has been observed. Strength and Rigidity of RC bare frame structures is found increasing after the inclusion of infill panels and shear wall. Infill and shear walls considerably enhance the rigidity and strength of the frame structure therefore, neglecting them in analysis & design of structure will lead to failure due to stiffness irregularity. Symmetry in position of shear wall in plan is a key factor to obtain desirable performance of shear wall structure. Increment in number of storeys make the building frame more vulnerable and therefore shear wall becomes a necessity in high rise buildings to save damage due to earthquake.

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. However, moments in flat slab buildings are lesser than those in beam slab buildings by 20 to 40 %. 2) In buildings without shear walls: In 9 storied buildings, the axial forces in flat slab buildings are almost equal to those in beam slab buildings but moments in lower four storeys of flat slab buildings are almost doubled while these get almost equaled in the upper remaining storeys. Effect of shear walls on lateral displacement In zone III, lateral displacements of both the types of buildings are within permissible limits.

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. It is found that the performance of flat slab building under seismic load improves much better with the use of shear wall. Study of different models for seismic loads, by equivalent static analysis of flat slab and regular frame building gives, i. Performance of regular frame building is better than flat slab building. ii. Performance of flat slab building improves much more with the use of shear wall.

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. There is increase in overall lateral strength. Damping of the structure is also affected by the infill walls; increase in damping of the structure due to the effect of infill causes the increase in energy dissipation capacity of the structure. In addition to that the total horizontal displacement and the storey drift of the structure are greatly reduced by the introduction of infill in moment resisting reinforced concrete frame. However, there are disadvantageous effect of infill such as soft storey and short column effect

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. They can be made to behave in a ductile manner by adopting proper detailing techniques. Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear walls, floors, foundation walls, slabs or footings. For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall. VIII. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. X. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage. The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement. This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0). However, for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence, adequate vertical reinforcement should be provided for such 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. The infill walls are modeled as equivalent diagonal strut and the seismic analysis has been performed by Equivalent Lateral Force Method, response spectrum method as per code IS 1893:2002 and linear time history using Electro earthquake data. The results in form of fundamental time period, base shear, lateral displacement and inter storey drift results are compared for purely frame, purely flat slab and seismic strengthened flat slab models and the

3. SUMMARY OF LITERATURE AND GAP

From literature survey it is found that which work was done on 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. Most of the studies carried out for infill wall structure for flat slab and equal shape of building with the RCC infill materials. There is need to study on different infill material on the seismic behaviour of multistory building for different types of shape and for conventional slab system.

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