EARTHQUAKE RESISTANT DESIGN OF OPEN GROUND STOREY LOW RISE BUILDING

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ABSTRACT

Open ground storey building have infill wall in all the storey except ground storey of the building. due to irregularities of the structure of the building have altered under the lateral loads toward the building. for the designing of the building engineer ignores the stiffness and strength of the infill wall because it is believes that it is conservative design. And for the open ground storey beam and column is used the 2.5 multiplication factor to all the beam and column for ground storey is recommended by Indian slandered code IS1893:2002. In the design offices engineer experienced that the multiplication factor 2.5 is not realistic for the open ground storey low rise building and required critical assessment of the multiplication factor for open ground storey building. therefore, in this thesis the objective is to assess the effect of infill wall, check the multiplication factor and effect of support condition of the building.In this analysis, the multiplication factor 2.5 is seen that too high for the open ground storey low rise building. the problem the problem of open ground storey low rise building cannot be properly identified through the elastic analysis as the stiffness of open ground storey building and similar bare frame is same. According to the nonlinear analysis of the OGS low rise building fails through the soft storey mechanism at a comparatively low base shear and displacement and the mode of failure is found to be brittle. In this analysis shows that the support condition of the building influence the considerable and important parameter for the multiplication factor.

Keywords:Infill wall,Lateral Displacementopen ground storey, parking provisions, Seismic loads.

I. INTRODUCTION

With the increasing population of world there is a necessity of the use of the shelter and vehicle parking. For fast growing country like India there is arising lots of problem for the men and vehicle parking is used as a parking space for the multi-storey building. and these type of building is also known as open ground storey building or open first storey building. There is lots of advantages of these type of building but from the earthquake point of view these types of buildings are much vulnerable.

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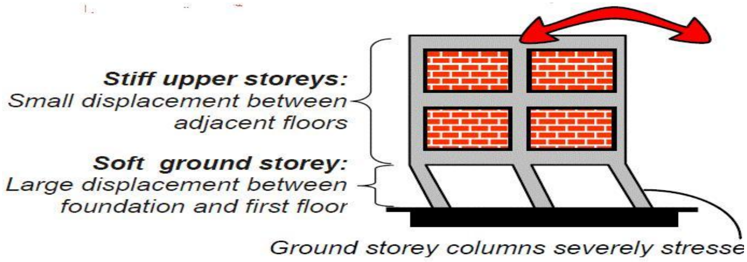
Figure: example of an open ground storey building

In the open ground storey building walls are present at the all the storey rather than ground storey and during the time of earthquake or dynamic loading the upper storey except ground storey columns are heavily stressed. These phenomenon is occurring due to stiffness discontinuity present on the open ground storey building here all the upper storey are have higher stiffness than the ground storey of the building. these phenomenon works



like a vibration of inverted pendulum.

In the conventional design practice code the strength and stiffness of infilled walls are ignored and the frames strength only designed. In the design practice code, there is no provision for the design of the frame is bare frame design. With the infill the strength and stiffness of bare frame is increases but at the open ground storey is not, then the fundamental time period component to bare frame and consequently increases the base shear demands in the ground storey beams and column.

In the past earthquake, the failure patterns are observed in bhuj earthquake and Jabalpur earthquake there is in the open ground storey building. the infill part is at other side and open ground storey is other side effected by earthquake.

After the bhuj earthquake Indian code IS 1893:2002 are revised and give some recommendation. In clause 7.10.3. (a) stats that, "the column and beams of the shoft storey are to be designed for 2.5 times the storey shear and moment calculated under seismic loads of bare frames ". The value 2.5 is used as multiplication factor for the open ground storey beam and column. the objective of this thesis based on the study about the literature present in open ground storey building.

1. effect of the strength and stiffness of the infill wall in the seismic analysis of the building.
2. To check the effect of the support condition of the building.
3. Assess the multiplication factor 2.5 which is given by 1893:2002

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II. METHODOLOGY

For the study of the various methods of the linear and nonlinear analysis following steps should be followed.

1. Select the building for the study of the building which is open ground story building(G+4).
2. Review and detail study of the previous researches, study and literature of the effect of OGS building and infill wall as per code recommended.
3. The model was developed with infill masonry and without infill masonry and different support condition.
4. The models are analyzed based on linear and nonlinear methods.
5. Observation and results of the study were discussing.

Literature review:- This part is present a study about the summery of the literature review. This is divided on the two parts. One part is about seismic effect on the open ground storey building and other one is about previous work carried out in the modelling of infill wall. The concept of seismic behavior of open ground storey building is first introduced by **Holmes** during the time of dynamic loading on frame, and infill wall are intact initially and when lateral load increases then the infill wall started separating from unloaded corner and still intact at the compression corner infill wall is act as the imaginary diagonal strut. At a time only one corner will be act as a diagonal strut. and the length of the wall and frame on which is in contact is known as contact length. During the time of loading the loads will be transfer through te diagonal struts because the behavior of infill wall. The infill wall is modelled as diagonal struts. And the struts are active only when subjected to compressive loads.

Using the effect of slip and interface between frame and infill wall was studies by the Mallick and Severn (1967). The infill wall between the frame as simulated by means that of linear elastic rectangular finite component with 2 degree of freedom at the all four corner nodes. The contact length between the infill wall and frame is calculated and modelled. Using the link element between frame and infill was considered by considering frictional shear force. All the node has two translational degree of freedom. The infill elements are able to transfer the compressive forces but not able to transfer the tensile forces. **Rao et. Al (1982)** studies infill frame by theoretically and experimentally with opening strength by opening beams. And concluded that the effect of lintel lateral stiffness of an infilled frames.

The effect of the opening and their location on the behavior of the one storey reinforced concrete frames with brick infill walls was investigated by Karisiddapa and Rahman (1988)

Choubey and Sinha studied about the various parameter of the infill wall such as separation of infill wall from frames, plastic deformation, stiffness and energy dissipation of infilled wall under cyclic loading

Arlekar et al (1997) conducted and studied about the behavior of reinforced concrete frames open ground storey building when subjected to seismic loads. A four storey frames analyzed using static analysis and response spectrum analysis and to find displacement and resultant forces. It shows that the bare frame is different from the open ground storey frames.

Riddington and smith (1997) studied about the effect of different parameter such as plan aspect ratio, relative stiffness and number of bays was studied.

Scarlet (1997) studies the earthquake force in the open ground storey building and the multiplication factor for base shear of open ground storey building was proposed. The qualification of seismic forces in the open ground

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storey building requires modelling the stiffness of the infill wall in the analysis. It is proposed the multiplication factor ranging from 1.86 to 3.28 as the number of storey increases from 6 to 20

The effect of brick masonry as infill frames are included to non-structural and they have a considerable influenced on the lateral response to the structure was pointed out by **Deodhar and Patel (1998).**

Davis and Menon (2004) ended that the presence of masonry infill panels modifies the structural force distribution considerably in associate degree OGS building. the whole construction shear force will increase because the stiffness of the building will increase within the presence of masonry infill at the higher floor of the building. Also, the bending moments within the ground floor columns increase (more than 2 fold), and also the mode of failure is by soft construction mechanism (formation of hinges in ground floor columns).

Das and Murthy (2004) ended that infill walls, once gift during a structure, generally bring down the harm suffered by the RC framed members of a completely infilled frame throughout earthquake shaking. The columns, beams and infill walls of lower stories are a lot of prone to harm than those in higher stories

Asokan (2006) studied however the presence of masonry infill walls within the frames of a building changes the lateral stiffness and strength of the structure. This analysis planned a plastic hinge model for infill wall to be employed in nonlinear performance primarily based analysis of a building and concludes that the last word load (UL) approach in conjunction with the planned hinge property provides a higher estimate of the non-resilient drift of the building.

Hashmi and Madan (2008) conducted non-linear time history and pushover analysis of OGS buildings. The study concludes that the radio frequency prescribed by IS 1893(2002) for such buildings is adequate for preventing collapse

Sattar And Abbie (2010) in their study over that the pushover analysis showed an increase in initial stiffness, strength, and energy dissipation of the infilled frame, compared to the clean frame, despite the wall's brittle failure modes. The better collapse performance of fully-infilled frames was related to the larger strength and energy dissipation of the system, related to the value-added walls.

There are a unit various analysis efforts found on the unstable behavior of OGS buildings and on the modelling infill walls for linear and nonlinear analysis. However, no printed literature found on the look criterion given in IS 1893:2002 (Part-1) for OGS low rise buildings. this can be the first motivation behind the current study.

Devendra Dohare andDr.Savita Maru(2014) are studied about the seismic behavior of soft storey building RC frame buildings with soft story are known to perform poorly during in strong earthquake shaking. Because the stiffness at lower floor is 70% lesser than stiffness at storey above it causing the soft storey to happen. For a building that is not provided any lateral load resistance component such as shear wall or bracing, the strength is considering very weak and easily fail during earthquake. In such a situation, an investigation has been made to study the seismic behavior of such buildings subjected to earthquake load so that some guideline could be developed to minimize the risk involved in such type of buildings.

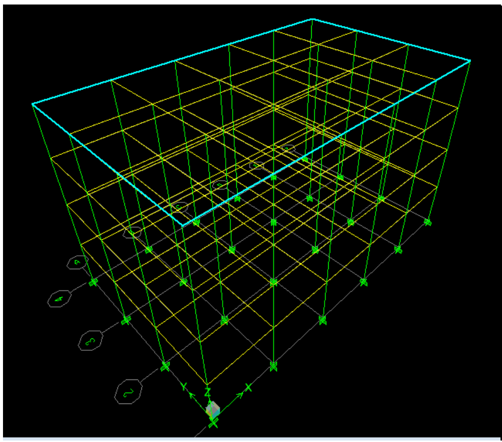
Vipin V. Halde and Aditi H. Deshmukh(2015) are studied the Review on Behavior of Soft Storey Effect in Building and concluded the behavior of the soft storey is different during a quake, the structural member undergoes damage and to provide member to withstand that additional forces due to soft storey heavy or bulky member need to be provided.

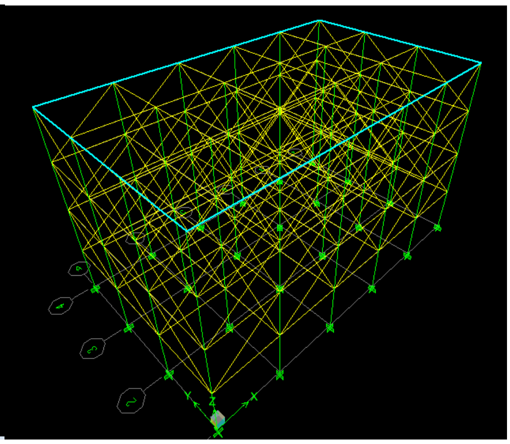
AshitoshC.RajurkarandNeetaK.Meshram(2016) are concluded as the Maximum axial force is found in bare frame model. In interior columns, with considering infill wall effects and open ground storey the value of shear force is maximum. In interior columns, without considering infill wall effects and stiffer size column the value of moments is maximum. Soft storey building exhibits deficient performance during earthquake. Damage induced for ground floor columns and ground storey are very large for soft storey building. Soft storey at ground level in RC frame building shows deficient performance during earthquake as the stiffness of soft storey is less.

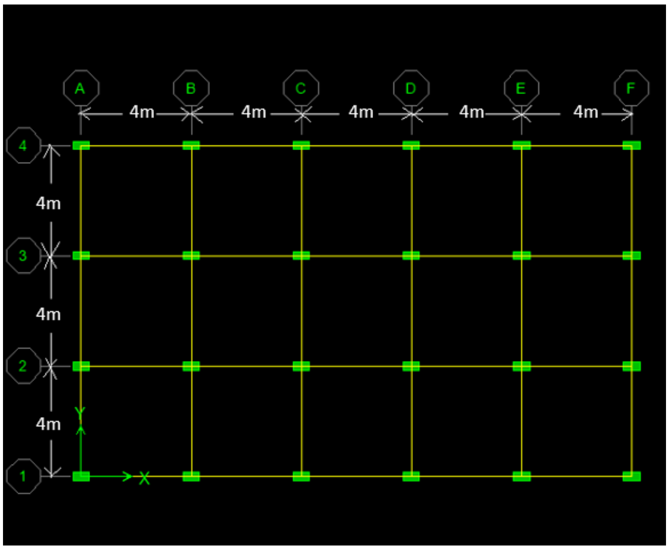
III. STRUCTURAL MODELLING

An existing building located at Gorakhpur Uttar Pradesh in seismic zone IV is selected for the study. this is the symmetrical building from the structural point of view in plan and elevation.

The building is G+3 open ground storey building made with reinforced concrete the slab thickness is 150 mm at each floor and the wall thickness is 120 mm. for dead load is concern with building dead load itself and live load is concern to the 3 kn/m^2 .and floor finish and partition loads are taken as 1 kn/m^2.the correction of the beam is 600mm*300mm and columns are also like beam 600*300mm.







Results and discussion: - the selected building structure is subjected to two different study which is linear analysis and nonlinear analysis the firstly for the linear analysis the base shear and time period calculation table is shown

	With infill		Without infill	
	Vx(KN)	*Vy*(KN)	*Vx*(KN)	*Vy*(KN)
Equivalent static (V_B)	641	641	635	635
Response spectrum analysis (V_b)	609	637	516	539
V_B/V_b	1.05	1.006	1.23	1.17

The base shears for the equivalent static method and the response spectrum methods are given in Table. This table indicates that there is no considerable difference between two models with regards to the global stiffness and design forces.

Calculation of shift in period

The effect of infill wall in open ground storey building increased the total stiffness of the building and reduced the fundamental time period of the building. The difference between bare frame building and infilled wall building is the reduced time period and this causes reduction may attract additional seismic forces. Time period is an important parameter that influence the consideration of infill wall and stiffness. And these are the values of the time period of he selected model of building.

` Fixed end	Empirical formula		Computational formula	
	With infill	Without infill	With infill	Without infill
Tx(s)	0.24	0.24	0.13	0.20
Ty(s)	0.31	0.31	0.13	0.20
(Sa/g)x	2.5	2.5	2.5	2.5
(Sa/g)y	2.5	2.5	2.5	2.5

Table:- shift in period for fixed end support

` Pined end	Empirical formula		Computational formula	
	With infill	Without infill	With infill	Without infill
Tx(s)	.24	.24	.21	.26

Ty(s)	.31	.31	.21	.26
(Sa/g)x	2.5	2.5	2.5	2.5
(Sa/g)y	2.5	2.5	2.5	2.5

Table: - shift in period for fixed end support

Comparison of maximum storey drift: - For the study about the how much effect of the infill wall and bare frame is given by maximum storey drift. for the maximum storey drift we can see in the following curves which is show between the storey and the corresponding drift there is clear that the effect of response spectrum analysis is shown and the maximum is found in the global y direction.

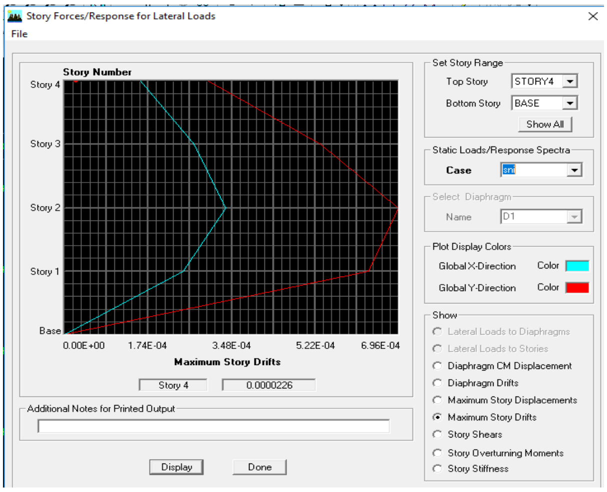


Fig. Maximum storey drift for without infill wall

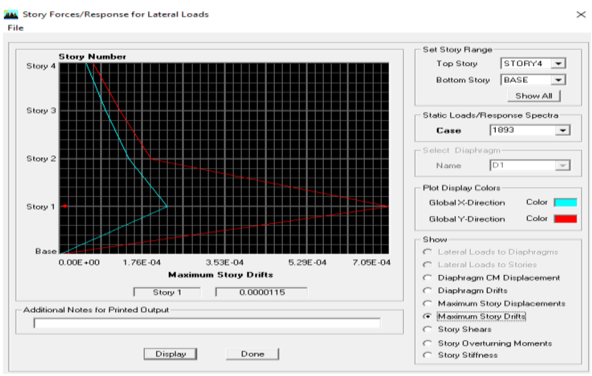


Fig. Maximum storey drift for without infill wall

Results from nonlinear analysis: - for the nonlinear analysis

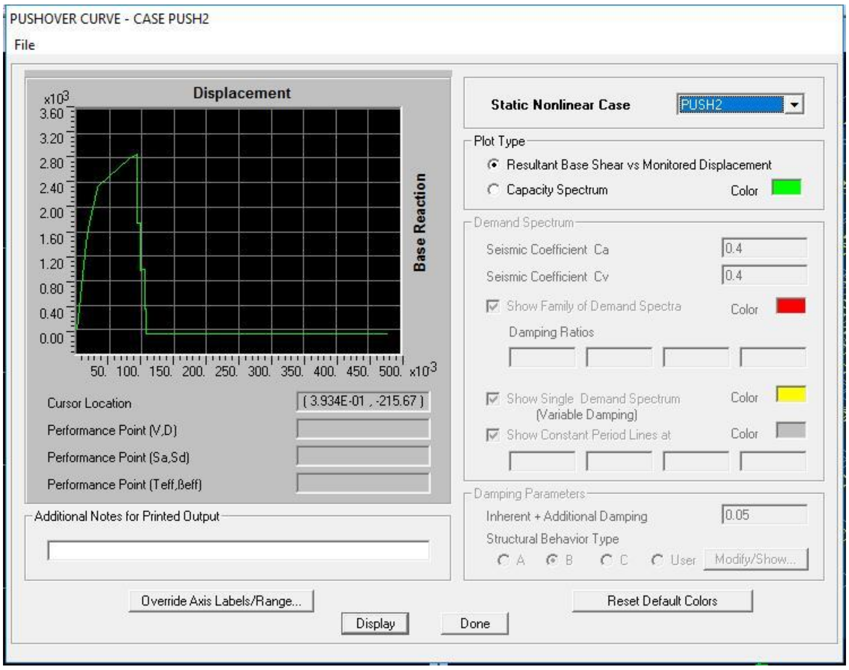


Fig.: The pushover curves, in term of Base Shear-Roof Displacement in directions X for bare frame with fixed end support.

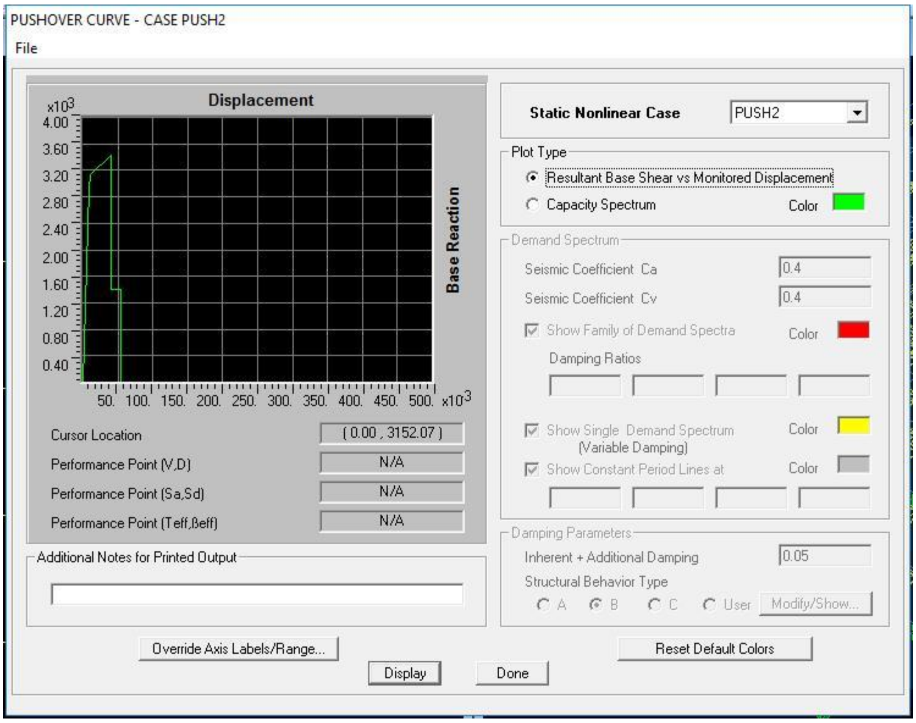


Fig: The pushover curves, in term of Base Shear-Roof Displacement in directions X for building with infill wall

From the above two pushover curves we see that the yielding zone of the building in case of infill wall is small in comparison with bare frame case and forces require for displacement is more in infill case.

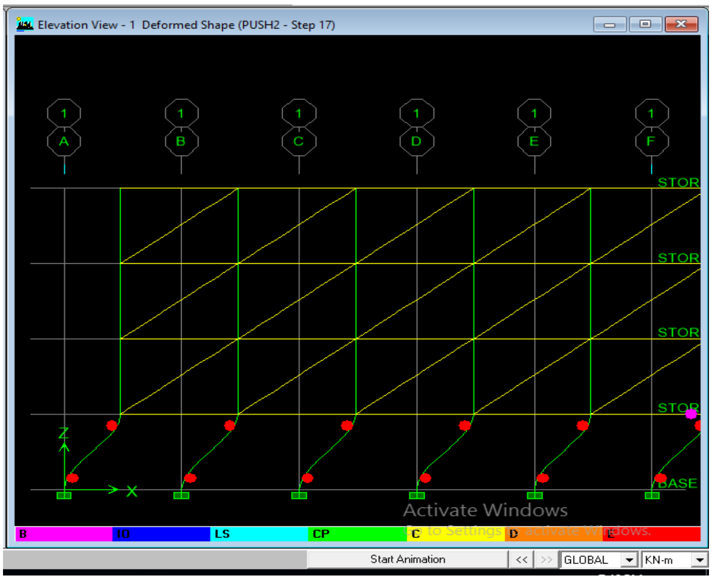


Fig.: Hinge distribution in bare frame

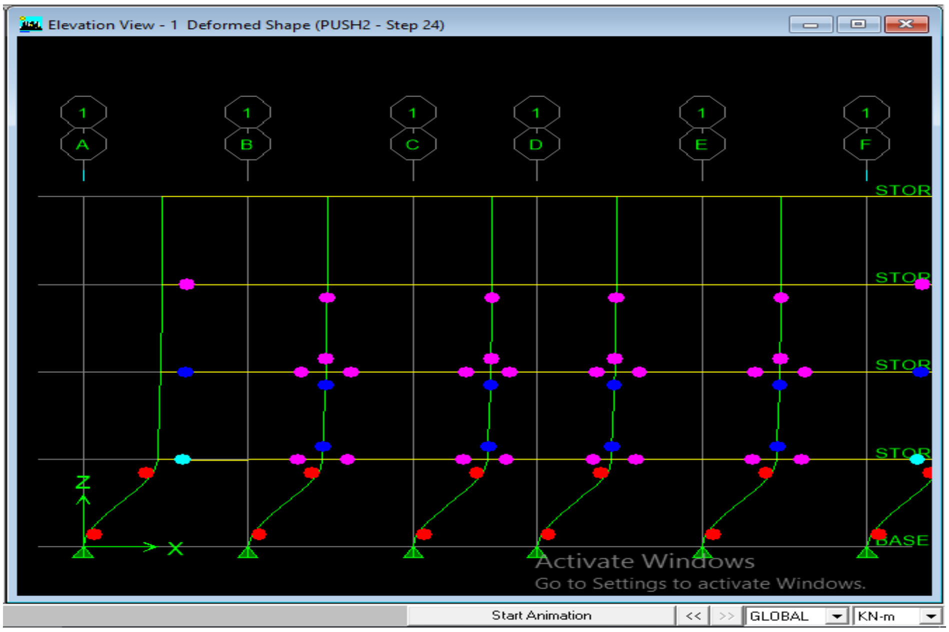


Fig : Hinge distribution in frame with infill wall

We can see that the above two hinge distribution figure in which the bare frame utilize full capacity of the building where the frame with infill has not utilize his full capacity at ultimate push.

IV. SUMMERY AND CONCLUSION

The open ground storey building are consider to be vulnerable as compare to the fully infill wall. the open ground storey building re assumed to be irregular as per IS1893:2002 which is require for the dynamic analysis of the structure considering infill strength and stiffness. According to IS1893:2002 the building is designed based on the ignoring infill stiffness and designed and 2.5 multiplication is used for the ground storey beam and column strength. In this thesis, this approach is reviewed. For the review of this we selected a G+3 open ground storey building for two type of support condition that is fixed end support condition and pinned end support condition and for bare framed and without infill frame. And the infill wall is modelled as a diagonal strut. And only one strut is active at a time and compression strut is active at a time.There is three analysis is carried out that is equivalent static analysis, response spectrum analysis and pushover analysis is carried out on the selected model the code specified multiplication factor is compare with ratio of the force demand.In this thesis the multiplication factor for the all beam and column was checked for open ground storey building. The value of interaction ratio and demand to capacity for beam and column for both support condition the value 2.5 is too high to be multiplied to beam and column of OGS low rise building. This is true for the selected building. In the nonlinear analysis of the building it is found that OGS low rise building fails through a ground storey mechanism at a comparatively low base shear and displacement. And brittle mode of failure is to be found.Both elastic and inelastic analyses show that the beams forces at the ground storey reduce drastically for the presence of infill stiffness in the adjacent storey. And design force amplification factor need not be applied to ground storey beams.From the linear analysis (equivalent static analysis and response spectrum analysis) we can see the results and concluded that the effect of infill wall increases the forces at the ground storey column. But the code given multiplication factor 2.5 for the low rise OGS building much high than the required. It is found from the literature the support condition taken for the study is not given as much important but from this present study we can see that the effect of the support condition play considerable role in the analysis of the buildings. from the nonlinear analysis (pushover analysis) results show that the frame with infill wall is have brittle mode of failure where bare frame is had ductile mode of failure.

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