Pushover Analysis For Seismic Assessment Of High Rise Building Using Etabs

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Abstract:

Earthquake load is becoming a great concern in our country as because not a single zone can be designated as earthquake resistant zone. One of the most important aspects is to construct a building structure, which can resist the seismic force efficiently. Study is made on the different structural arrangement to find out the most optimized solution to produce an efficient safe earthquake resistant building.

In the present analysis, a commercial building is analyzed with columns, columns with infill's under non linear static analysis. The building is analyzed and the results of Displacement, Base shear vs displacement, soft storey results were also compared after providing the infill's at each elevation.

A commercial package of ETABS 2013 has been utilized for analyzing commercial building. The result has been compared using tables & graph to find out the most optimized solution. Concluding remark has been made on the basis of this analysis & comparison tables.

KEYWORDS-

Plastic hinges,control node,developing the pushover curve estimation of displacement demand

I.INTRODUCTION

Earthquakes are naturally occurring devastating events due to the sudden release of energy from deep underground creating seismic waves which travels throughout the globe. Recent earthquakes in India have demonstrated the power of nature and the catastrophic impact of such power on normal life. There area unit several reasons tributary to structural injury and collapse of buildings thanks to earthquakes. These embody inappropriate land use choices, caliber concrete, inadequate engineering particularly at floor-column junctions, incorrect construction techniques, poor description and inadequate construction direction.

The higher than area unit all proverbial reasons for issues related to the buildings experiencing earthquake incidents.However, earthquake observations reveal that the presence of masonry in-fills within the frame structure and their influence on structural behavior is always overlooked in the design and construction practice. Unreinforced Masonry (URM) in-fill walls are commonly used as exterior and internal partition elements in most residential, and sometimes commercial, reinforced concrete (RC) moment resisting frame buildings. These in-fills are considered as non-structural or non-load bearing members in gravity load design. However, this practice of considering these in-fills as non-structural elements is wrongfully extended to seismic design of such buildings. Detailed investigations and studies of buildings damaged in past earthquakes have led researchers to consider the influence of masonry in-fills on seismic behavior of buildings. Consequently numerous experimental and numerical investigations have established the fact that the URM in-fills participate significantly in carrying in-plane forces when subjected lateral loads, particularly during seismic shaking.

Reinforced concrete (RC) building frames with in-fill walls ar typically analyzed and designed as clean frames, while not considering the strength and stiffness contribution of the in-fills. However, throughout earthquakes, these in-fills contribute to the response of the structure and also the behavior of in-filled frame buildings is totally different from that foreseen for clean frame structures. The presence of masonry in-fills may result in higher stiffness; but unexpected reduction of stiffness because of harm of infill walls will cause the formation of a soft floor mechanism, which, because of the introduction of joint harm, will occur at any floor level and severally of the distribution of the in-fills on the elevation.

II. MECHANISM

2.1 MECHANISM OF MASONRY INFILLS:

The addition of masonry infill panels to associate originally vacant moment resisting frame will increase the lateral stiffness of the structure, therefore shifting the natural amount of vibration on the earthquake response spectrum within the direction of upper seismal base and story shears, and attracting earthquake forces to elements of structures not designed to resist them. moreover, if the structure is intended to act as an instant resisting frame with a ductile response to the look level earthquakes, neglecting the contribution of in-fills, the stiffening result of the in-fills might increase the column shears leading to the event of plastic hinges at the highest of columns that area unit to bear with the infill corners.

During associate earthquake, these infill walls are broken untimely, developing diagonal tension and compression failures or out-of-plane failures. The degree of lateral load resistance depends on the number of masonry infill walls used. However, for the explanations explained higher than, masonry in-fills area unit ordinarily employed in internal partitioning and external enclosure of buildings, increasing wall-to-floor space ratios. Therefore, in spite of the lower strength and expected breakableness of this kind of masonry walls, the frames get pleasure from the intensive use of masonry walls till the brink of elastic behaviour has exceeded.

Beyond the premature failure of brittle masonry, the sudden loss of great stiffness against lateral drift should be remunerated by the slab/beam-column junction of the frame structure. This behaviour causes a high drift demand on the frame members, therefore inflicting exaggerated injury to the structure if there have been no masonry in-fills. The sudden loss of stiffness within the lateral load resistance mechanism causes a awfully high concentration of loading. This exaggerated magnitude of loading causes vital injury or maybe the collapse of slab/beam-column joints. If one or 2 joints collapse others can follow, inflicting premature failure of the whole structure.

If the frame structure joints square measure asked to perform satisfactorily underneath the abovementioned behaviour, it'll be very exhausting to satisfy the joint behaviour needs while not exploitation important sized beams in each directions at the highest of the columns in role of flat slabs while not beams.

The earthquake expertise with frame structures and masonry infill shows a lot of bigger injury at the locality of the primary and last column of the frame structures. this is often the rationale why earthquake prone countries use beams to extend joint resistance.

2.2 MODELLING OF MASONRY INFILLS:

Effects of masonry in-fills on building behaviour have been observed from experience of past earthquakes. Since then, a lot of experimental and numerical research work has gone to understand the behaviour of masonry fills under seismic loads to come up with numerical models to account for their effect. Another important aspect of masonry in-fills is that unlike other materials such as concrete, steel etc.., masonry properties vary highly across the geography depending on many factors. This makes it very difficult to come up with a single model to represent masonry in-fills. Hence, many models are available in literature for numerical studies of the effects of masonry in-fills. These different modelling techniques can be broadly classified as macro modelling and micro modelling.

Micro modelling is a finite element technique to model the masonry in-fills. This requires a lot of input data such as stress-stain relationship for masonry unit, stress-strain relationship for joint material, frame and masonry interaction relation etc. This leads to complexity in modelling, given the fact that masonry is highly non-homogeneous, highly non-linear, and brittle and its highly variable characteristics. All this makes micro modelling very complex and cumbersome and makes for a non-friendly tool for industry. On the other hand, macro models are based on a physical understanding of the global behaviour of masonry in-fills under seismic loads. The physical behaviour of masonry panel is best represented by compression struts when subjected to in-plane lateral loads. This is depicted in figure. This shows that force flow-patterns change in presence of masonry in moment frames where in it is essentially considered that force flow is through flexural action. This physical understanding helps in replacing infill panel by a simple compression strut member to mimic the behaviour of buildings. This method is called Equivalent strut width approach is depicted infig.1.1. Later researchers have developed multi strut models

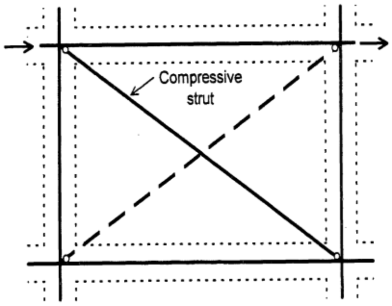

Fig.2.1. Diagonal strut model for In-filled frame

When the structure is subjected to dynamic loading, the utilization of only 1 diagonal strut resisting compressive and tensile forces cannot describe properly the inner forces evoked within the members of the frame. during this case, a minimum of 2 struts following the diagonal directions of the panel should be thought-about to represent more or less the impact of the masonry in-fills. it's typically assumed that the diagonal struts area unit active once compressive forces develop in them.

Pushover analysis could be a static, non-linear procedure during which the magnitude of the structural loading is incrementally accrued in accordance with a particular predefined pattern. This chapter presents the steps utilized in performing a Pushover analysis of an easy three- dimensional building in an exceedingly pre-defined manner

2.3 RETROFIT TECHNIQUES USED IN PAST IN EARTHQUAKES:

Retrofitting method is a technique that used to repair affected buildings during past earthquakes. Various retrofitting methods are using now-a-days to repair the affected buildings. The figures are showing the retrofitted buildings which were damaged during past earthquakes. Fig.2.1. shows the building which was retrofitted with concrete chevron infillss and fig.2.2. shows that the building retrofitted with concrete diagonal infillss. Fig.2.3. shows that the concrete framed building which is listed on the national register of historic places added concrete frames to minimize the soft story effect. Fig.2.4. represents the Baker Hamilton, conversion and rehabilitation of historic URM and wood framed building to which shotcrete walls and concrete frames added.


Fig.2.1. Chevron infills
Fig.2.2. X infills


Fig.2.3. Half in `fill

Fig.2.4. Concrete chevron infills

Various retrofitting methods are used to repair the damaged buildings. Fig.6.3. shows that the building consists of infill's in half portion. This method is used to reduce the economic losses because brick is cheaper than the concrete. It is also increases the lateral stiffness of the ground storey which is required to minimize the soft storey effect.

III. BUILDING DIMENSIONS

The building is 25m x 25m in plan with columns spaced at 5m from centre to centre. A floor to floor height of 3.0m is assumed.

Size of Structural Members

Column Size for nine storey building:

From ground floor to fifth floor: 600 mm X 900 mm.

From sixth floor to ninth floor: 450 mm X 600 mm.

Column Size for fifteen storey building:

From ground floor to seventh floor: 600 mm X 950 mm.

From sixth floor to fifteenth floor: 450 mm X 750 mm.

Beam Size for two different heights is: 400 mm X 600 mm.

Slab Thickness: 120 mm.

Brace Members Size: 230 mm X 230 mm.

Grade of Concrete and Concrete: M30; Fe 415 Concrete.

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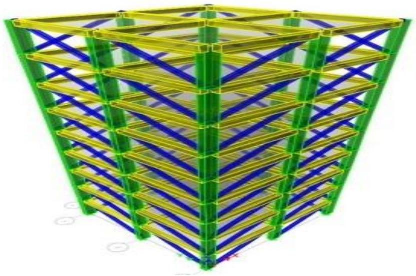


Fig 3.1:3d view of 9 storey building after providing infills

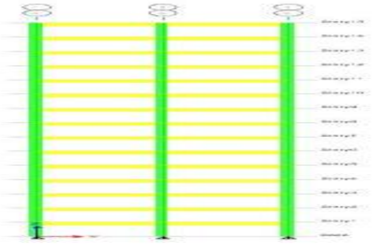


Fig 3.2:Elevation view of 15 storey building

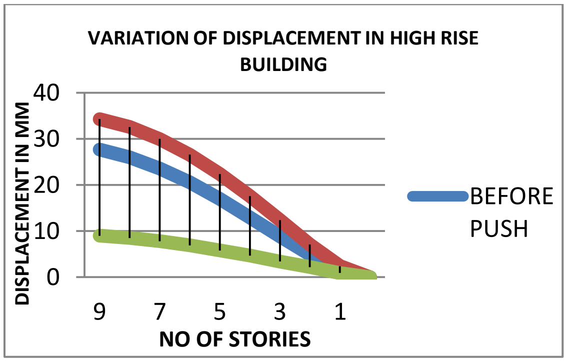
VI RESULTS

results of displacement, shear, moment & vertical irregularity is observed in three models that is when the building is in normal condition & when the model with push over analysis & when the model is with infill's at each elevation.

Case: 1 Comparison of displacement in 9 storey & 15 storey building

Comparative values of displacement for 9 storey building

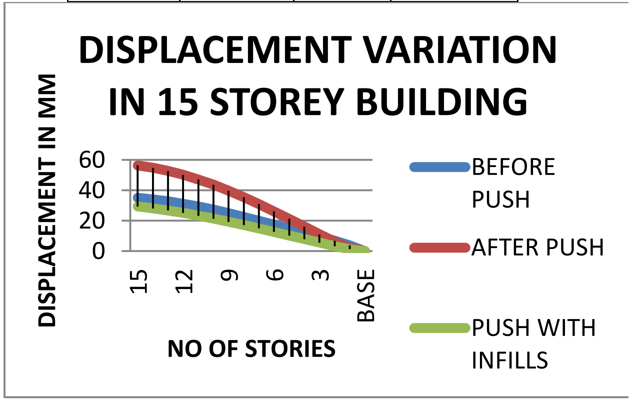
Stories	BEFORE PUSH	AFTER PUSH	PUSH WITH INFILLS
9	27.7	34.3	9
8	26	32.6	8.5
7	23.6	30	7.8
6	20.6	26.6	6.9
5	17	22.4	5.8
4	13	17.6	4.7
3	8.9	12.4	3.4
2	4.9	7.1	2.2
1	1.6	2.4	0.9
BASE	0	0	0



GRAPH 1 Displacement variation in nine storey building

TABLE 1:Comparative values of displacement for 15 storey building

STOREY	BEFORE PUSH	AFTER PUSH	PUSH WITH INFILLS
15	35	56.4	29.3
14	34	54.8	28.1
13	32.7	52.7	26.7
12	31.1	50.2	25.1
11	29.3	47.1	23.3
10	27.2	43.6	21.4
9	24.9	39.7	19.3
8	22.5	35.5	17.2
7	20	30.9	14.9
6	17.5	26.1	12.6
5	14.8	21.2	10.2
4	12.2	16.1	7.9
3	9.6	11	5.6
2	6.8	6.2	3.3
1	3.8	2.1	1.3
BASE	0	0	0

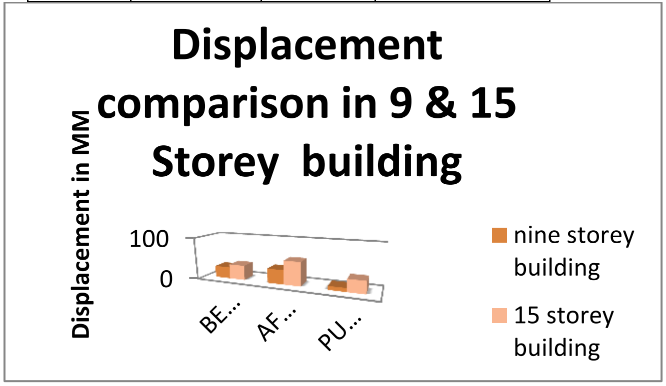


GRAPH 2 Displacement variation in fifteen storey building

Case: 2 Comparison of Displacement in 9 storey & 15 storey building

Displacement comparison values of 9 storey & 15 storey building

Stories	BEFORE PUSH	AFTER PUSH	PUSH WITH INFILLS
9	27.7	34.3	9
15	35	56.4	29.3

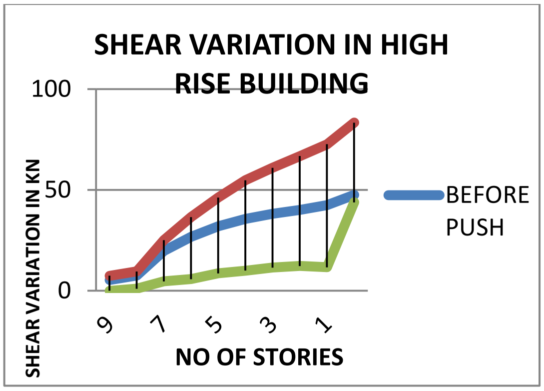


Graph 1 Displacement variation in nine & fifteen storey building

Case: 3 Comparison of shear in high rise building in three models

TABLE 1Comparative values of shear for 9 storey building

Stories	BEFORE PUSH	AFTER PUSH	PUSH WITH INFILLS
9	5.3	7.4	0
8	7.54	9.58	1
7	19.7005	25.15	4.69
6	26.69	36.5444	5.76
5	32.01	46.25	8.59
4	35.65	54.8	9.97
3	38.166	61	11.51
2	40.121	66.766	12.27
1	42.42	72.65	11.62
BASE	47.55	83.39	43.9



Graph 2Shear variation in nine storey building

V CONCLUSION

1.Displacement is analyzed in 9 storey high rise building it is observed that 50 % of displacement is reduced when infills are provided at each elevation.

2.Displacement is analyzed in 15 storey high rise building it is observed that 50 % of displacement is reduced when infills are provided at each elevation.

3.Shear is analyzed in 9 storey high rise building it is observed that 60 % of displacement is reduced when infills are provided at each elevation.

4.Shear is analyzed in 15 storey high rise building it is observed that 30 % of displacement is reduced when infills are provided at each elevation.

5.Moment is analyzed in 9 storey high rise building it is observed that 70 % of displacement is reduced when infills are provided at each elevation.

6.Moment is analyzed in 15 storey high rise building it is observed that 40 % of displacement is reduced when infills are provided at each elevation.

7.So, any irregularities in the construction of reinforced concrete framed buildings are better to avoid or various retrofitting techniques can be used to repair the structure.

8.Retrofitting of reinforced concrete framed buildings using concrete infills is better to avoid the collapse or failure of structure.

9.Un Reinforced masonry infill's also can be used as a retrofitting material.

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