Pushover Analysis of Building Using Soft Story at Different Levels by using ETABS

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Abstract-In India the enormous loss of life and property perceived in the last couple of decades, attributable to failure of structures instigated by earthquakes. Responsiveness is now being given to the assessment of the sufficiency of strength in framed RCC structures to resist solid ground motions. The seismic reaction of RCC building frame in terms of performance point and the earthquake forces on Reinforced building frame with the help of pushover analysis is carried out in this project. In this method of analysis a model of the building is exposed to a lateral load. Pushover analysis can afford a substantial insight into the weak links in seismic concert of a structure and we can know the weak zones in the structure. In this project effort has been made to investigate the effect of Shear Wall and Structural Wall on lateral displacement and Base Shear in RCC Frames. RCC Frames with G+13 are considered, one with soft storey and other with normal building in L-shape. The pushover analysis of the RCC building frame is carried out by structural analysis and design software ETABS..

Keywords: Pushover, ETABS, Soft Storey etc

I. INTRODUCTION

The term earthquake can be used to describe any kind of seismic event which may be either natural or initiated by humans, which generates seismic waves. Earthquakes are caused commonly by rupture of geological faults; but they can also be triggered by other events like volcanic activity, mine blasts, landslides and nuclear tests. There are many buildings that have primary structural system, which do not meet the current seismic requirements and suffer extensive damage during the earthquake. According to the Seismic zoning Map of IS: 1893-2002, India is divided into four zones on the basis of seismic activities. They are zone II, zone III, zone IV and zone V. Some industries usually make full-scale models and execute wide testing, before manufacturing thousands of identical structures that have been analysed and designed with consideration of test results. Unluckily, this choice isn't available to building industry so that economy of huge scale creation is unfeasible. In India many existing structure design as per Indian standard code 456:2000 but to make building earthquake resistant IS 1893-2002 should be used to avoid future building vulnerable in earthquake.

Generally, loads on these structures are only gravity loads and result in elastic structural behaviour. However, under a Strong seismic event, a structure may actually be subjected to forces beyond its elastic limit. Since. There cent earthquake in last 4 decayed in which many concrete structure have been harshly damaged or collapsed, it have indicated the need for evaluating the seismic suitability of present building or purposed building. Therefore structure vulnerable to damage must be determined. To make or attain this objective, simplified linear elastic methods are not suitable. Thus the structural designer has developed a new method of design and seismic procedure that include performance based structure towards nonlinear technique.

II. MATERIALS & METHODOLOGY

In the Present work three building models of G+13 has been developed for RCC, for different position of shear wall situated in zone V with subsoil Type medium -II were analyzed in ETAB software. All the buildings are subjected to same earthquake loading to check their seismic behavior for same storey and storey height. For the analysis of these models various methods of seismic analysis are available but for present work both linear static and non-linear static method is used. Details of the methods are as given below.

A. Push over Analysis

Pushover analysis which is an iterative procedure is looked upon as an alternative for the conventional analysis procedures. Pushover analysis of multi-story

RCC framed buildings subjected to increasing lateral forces is carried out until the present performance level (target displacement) is reached. The promise of performance based seismic engineering (PBSE) is to produce structures with predictable seismic performance. The pushover analysis is more convenient than full dynamic analysis because of computational time. With pushover analysis, results took considerably much lesser time than dynamic analysis. Thus, pushover analysis is more practical for use in a design office. After the structure has been designed or retrofitted using appropriate codes or design guidelines, is that it yields additional information on the limit states, the plastic hinge sequence and the force redistribution caused by a seismic event.

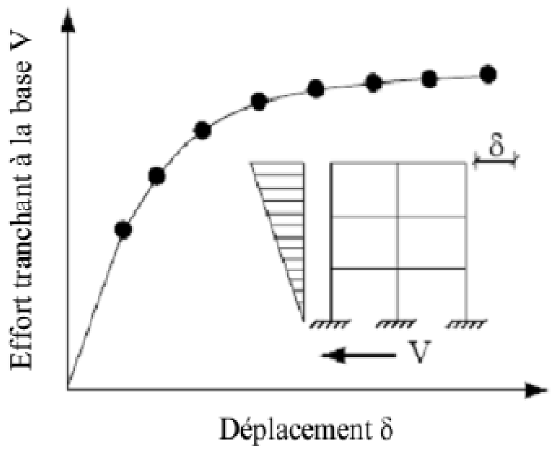


Fig 1: Pushover Curve

B. Models In ETABS 2016

Table 1 Model Details

Model 1	G+13 without soft storey
Model 2	G+13 with soft storey at 3rd floor
Model 3	G+13 with soft storey at 5th floor
Model 4	G+13 with soft storey at 8th floor

Model Details

- Bay Size: 40 x 40 m
- Storey: G+13
- Concrete: M25
- Steel: Fe500
- Column Size: 380 x 400 mm
- Beam Size: 250 x380 mm
- Slab Thickness: 150 mm
- Shear Wall: 200 mm

III. RESULTS AND OBSERVATIONS

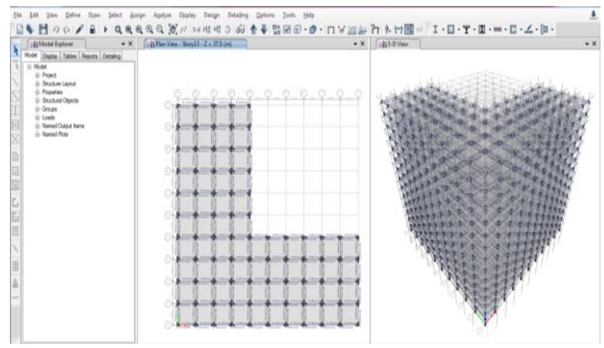


Fig 2 L shape building G+13 without soft storey

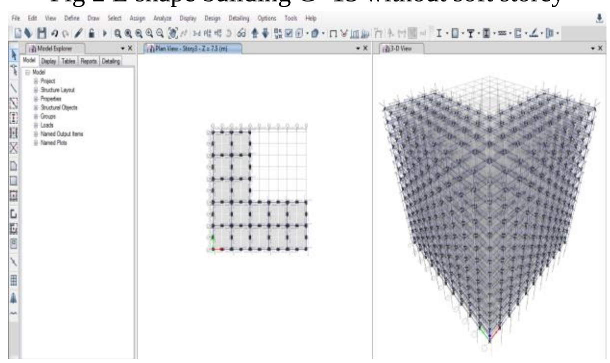


Fig 3 L shape building G+13 with soft storey at 3rd floor

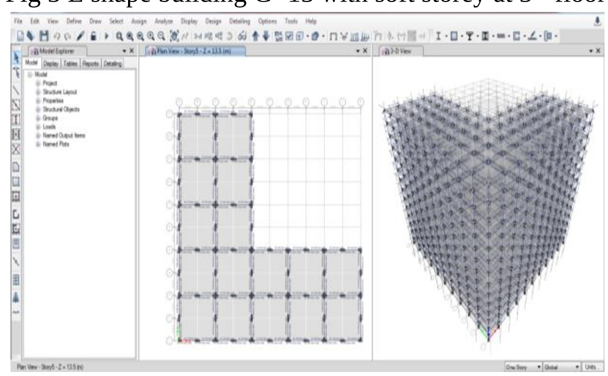


Fig 4 L shape building G+13 with soft storey at 5th floor

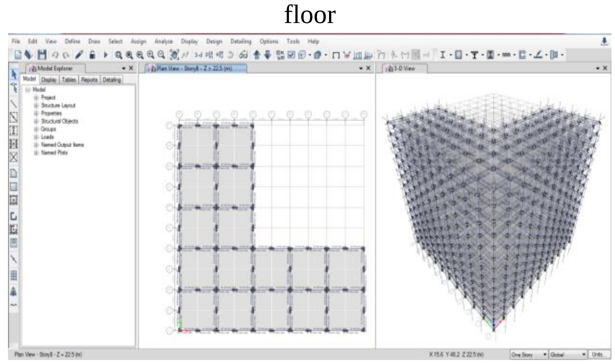


Fig 5 L shape building G+13 with soft storey at 8th floor

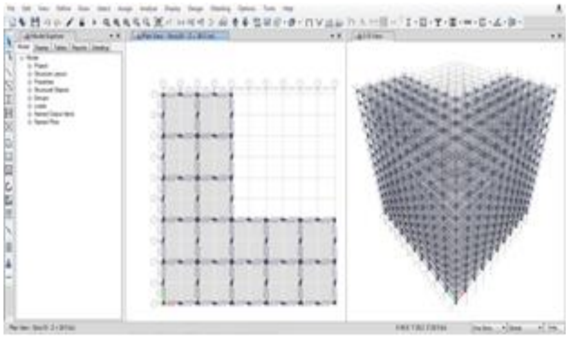
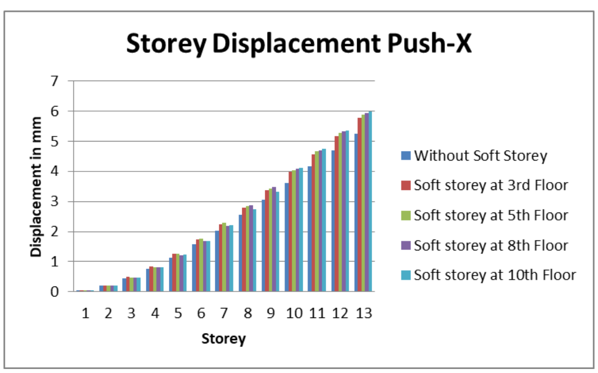


Fig 6 L shape building G+13 with soft storey at 10th floor

A. Results of The Models

Table 2 Storey Displacement PUSH-X

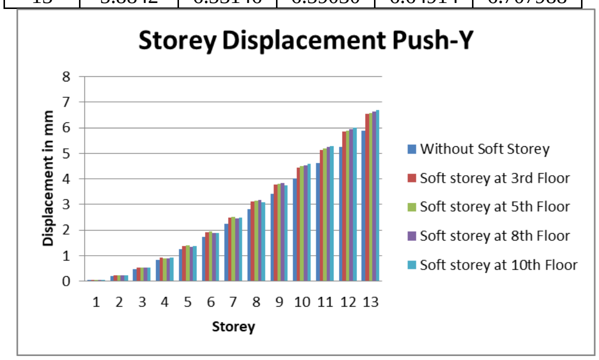
Story	Without Soft Storey	Soft Storey At 3rd Floor	Soft Storey At 5th Floor	Soft Storey At 8th Floor	Soft Storey At 10th Floor
1	0.0434	0.0455	0.0460	0.04643	0.04687
2	0.1977	0.2075	0.20956	0.21153	0.21351
3	0.44	0.484	0.4664	0.4708	0.4752
4	0.7573	0.8330	0.80273	0.81031	0.81788
5	1.1372	1.2509	1.27366	1.21680	1.22817
6	1.5685	1.7253	1.75672	1.67829	1.69398
7	2.0407	2.2447	2.28558	2.18354	2.20395
8	2.5441	2.7985	2.84939	2.87483	2.74762
9	3.0698	3.3767	3.43817	3.46887	3.31538
10	3.6097	3.9706	4.04286	4.07896	4.11505
11	4.1565	4.5721	4.65528	4.69684	4.73841
12	4.7039	5.1742	5.26836	5.315407	5.362446
13	5.247	5.7717	5.87664	5.92911	5.98158



Graph 1 Storey Displacement PUSH-X

Table 3 Storey Displacement Push-Y

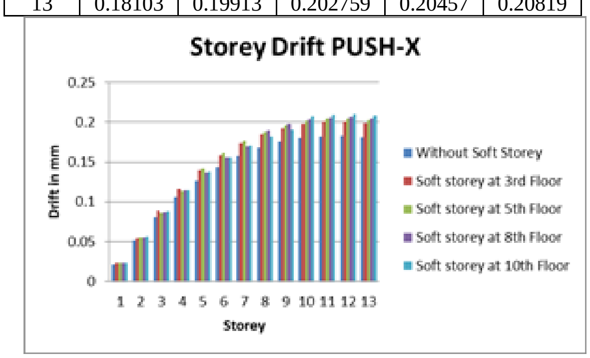
Story	Without Soft Storey	Soft storey at 3rd Floor	Soft storey at 5th Floor	Soft storey at 8th Floor	Soft storey at 10th Floor
1	0.0471	0.05039	0.05086	0.05133	0.05181
2	0.2135	0.22844	0.23058	0.23271	0.23485
3	0.4776	0.53013	0.51580	0.52058	0.52536
4	0.8256	0.91641	0.89164	0.89990	0.90816
5	1.2446	1.38150	1.39395	1.35661	1.36906
6	1.7227	1.91219	1.92942	1.87774	1.89497
7	2.2488	2.49616	2.51865	2.45119	2.47368
8	2.8123	3.12165	3.14977	3.17789	3.09353
9	3.4037	3.77810	3.81214	3.84618	3.74407
10	4.014	4.45554	4.49568	4.53582	4.57596
11	4.6353	5.14518	5.19153	5.23788	5.28424
12	5.2606	5.83926	5.89187	5.94447	5.99708
13	5.8842	6.53146	6.59030	6.64914	6.707988



Graph 2 Storey Displacement Push-Y

Table 4 Storey Drift Push-X

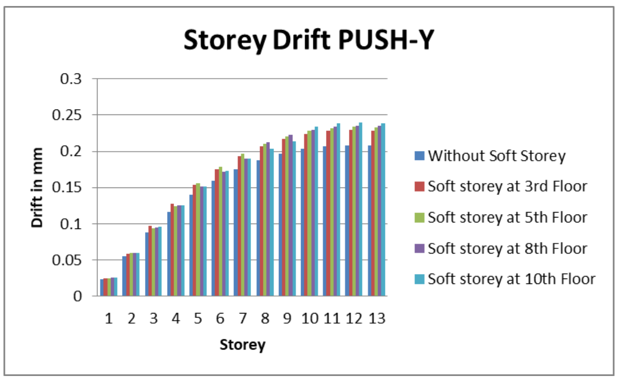
Story	Without Soft Storey	Soft storey at 3rd Floor	Soft storey at 5th Floor	Soft storey at 8th Floor	Soft storey at 10th Floor
1	0.02170	0.02300	0.02322	0.02344	0.02354
2	0.05142	0.05451	0.05502	0.05554	0.0558
3	0.08075	0.08883	0.08641	0.08722	0.08762
4	0.10577	0.11634	0.11317	0.11423	0.11476
5	0.12663	0.13930	0.14183	0.13676	0.13740
6	0.14375	0.15813	0.16100	0.15525	0.15597
7	0.15739	0.17313	0.17628	0.16998	0.17077
8	0.16780	0.18458	0.18794	0.18962	0.18207
9	0.17523	0.19276	0.19626	0.19801	0.19013
10	0.17995	0.19795	0.20155	0.20335	0.20695
11	0.18226	0.20048	0.20413	0.20595	0.20960
12	0.18248	0.20073	0.20438	0.2062	0.20986
13	0.18103	0.19913	0.202759	0.20457	0.20819



Graph 3 Storey Drift Push-X

Table 5 Storey Drift Push-X

Story	Without Soft Storey	Soft storey at 3rd Floor	Soft storey at 5th Floor	Soft storey at 8th Floor	Soft storey at 10th Floor
1	0.02356	0.02497	0.02521	0.02545	0.02556
2	0.05547	0.0588	0.05935	0.05991	0.06018
3	0.08800	0.09680	0.09416	0.09504	0.09548
4	0.11600	0.12760	0.12412	0.12528	0.12586
5	0.13967	0.15364	0.15643	0.15084	0.15154
6	0.15936	0.17530	0.17849	0.17211	0.17291
7	0.17534	0.19288	0.19639	0.18937	0.19025
8	0.18785	0.20663	0.21039	0.21227	0.20382
9	0.19712	0.21684	0.22078	0.22275	0.21388
10	0.20344	0.22378	0.22785	0.22988	0.23395
11	0.20709	0.22780	0.23194	0.23401	0.23815
12	0.20843	0.22927	0.23344	0.23552	0.23969
13	0.20786	0.22865	0.23280	0.23488	0.239045



Graph 4 Storey Drift Push-Y

B. Static Pushover results

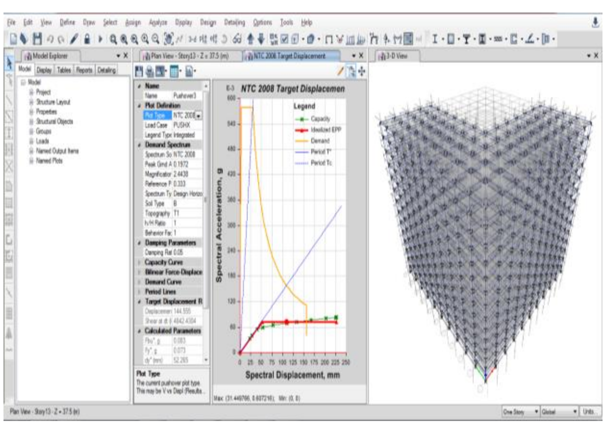


Fig 7 G+13 without soft storey Building Push X

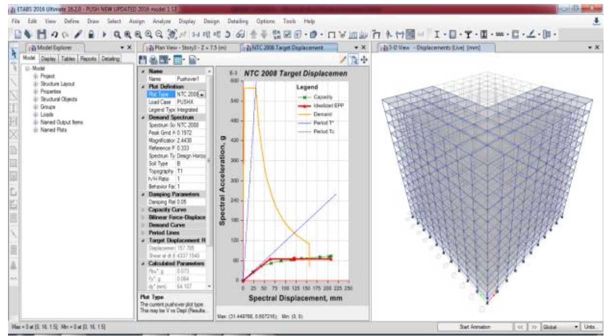


Fig 8 G+13 Building – (soft storey at 3rd floor) Push X

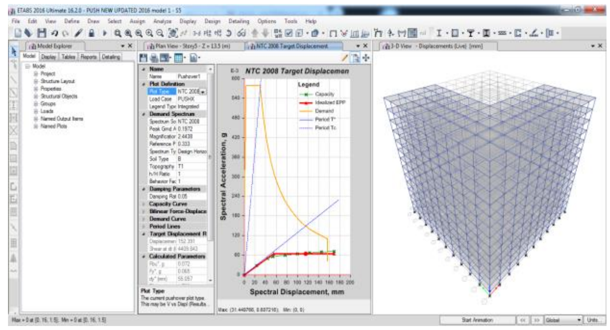


Fig 9 G+13 Building – (soft storey at 5th floor) Push X

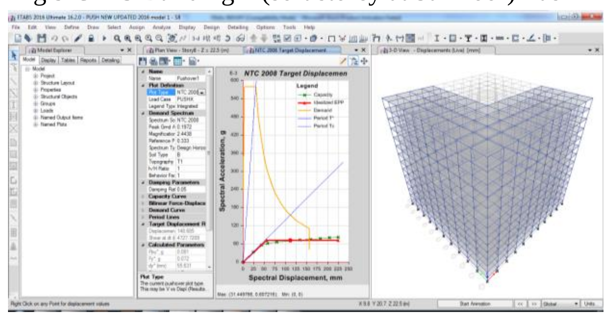


Fig 10 G+13 Building – (soft storey at 8th floor) Push X

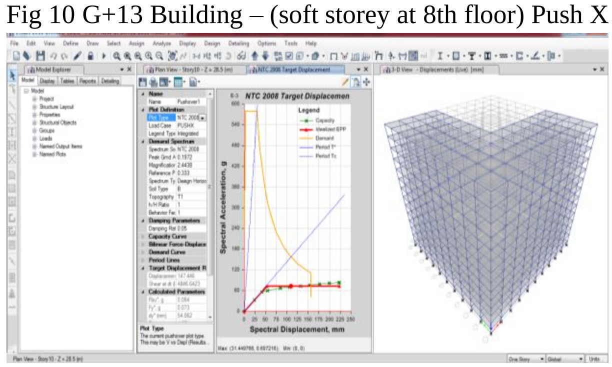


Fig 11 G+13 Building (soft storey at 10th floor) Push X

IV. CONCLUSION

Design Pushover analysis was carried out on 13 storey building models as per IS 1893: 2002 (part 1). 5 different models were selected and analysis was done using ETABs 2016. Storey displacement, storey drift, Storey stiffness and Base shear of each models are obtained as results and comparative study was carried out for finding model with better performance.

- Maximum yielding occurs at the soft storey, because of soft stories maximum plastic hinges are forming though the base force is increasing.
- As we shifted soft storey to higher level, yielding is less than lower level soft storey and lower intensity hinges are forming after maximum number of pushover steps.
- As we shift soft storey to higher level it can be seen from pushover and capacity spectrum curve that time period goes on reducing from 0.716 Sec. for 3rd floor soft storey to 0.446 Sec. at 10th floor soft storey.
- Which means soft storey is safer at higher level in high rise building. Most of the hinges developed in the beams and few in the columns.
- It is observed that plastic hinges are developed in columns of ground level soft storey which is not acceptable criteria for safe design.

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