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PROGRESSIVE COLLAPSE ANALYSIS OF RC STRUCTURES

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Abstract – Progressive collapse is the spread of initial failure from component to component leading whole collapse of a structure. It is because of vehicle impacts, fire, earthquakes and regular or manmade dangers. Collapse leads huge proportions of impropriate triggers in the structures which make structures unequipped for withstanding loads and it prompts collapse of the structure. In this examination Special moment resisting frame of G+5 story building is displayed utilizing FEM based programming (ETABS). The examination is conveyed according to GSA guidelines in zone V having medium soil by linear dynamic and non linear analysis. The story drift and story shears are as calculated to know the potential for progressive collapse of a structure. It is seen that the outcomes from non linear static examination are substantially more significant than straight powerful investigation.

Key Words: Progressive collapse, GSA, linear dynamic analysis, non static analysis.

1. INTRODUCTION

Progressive collapse means the initial local failure is Spreaded from Element to Element. The local failure results in the Redistribution of Loads in the Structures, Which finally Leads to Failure of entire structure. This occurs due to the redistribution of loads in the surrounding elements the structure is not able to find an alternative equilibrium state so collapse of structure will takes place. The collapse of whole structure or large part of structure is preceded by the failure or damage of a relatively small part of structure.

The best-known progressive collapse situations in late history have frequently been a consequence of psychological militant assaults. Progressive collapse which occurs in different situations, for example, normal risks or incidental activities (gas blasts, earthquakes) may likewise be the activating occasion prompting an unbalanced incidental collapse. Buildings are susceptible to progressive fail analysis. And it is performed by instantly removing one/more vertical loads due to excessive loadings and analyzing the building elements remaining capability to absorb the failure.

The incomplete collapse of the 22-story Ronan Point condo tower in Newham (east London) in 1968 drew the enthusiasm of the exploration group towards this wonder surprisingly. A gas blast in a side of the eighteenth floor extinguished a load bearing wall,which inturn caused the collapse of the upper floors because of the loss of help. The effect of the upper floors on the lower ones prompted a successive disappointment the distance down to the ground level. Therefore, the whole corner of the building collapsed, as can be seen in Fig.1. This incomplete collapse was recognized to the failure of the structure to distract loads after the passing of a load conveying element. It is an especially illustrative case since the extent of the collapse was totally out of extent regarding the activating circumstance.

Fig-1: Ronan Point building after collapse, London 1968

1.1 GSA Guidelines

The General Service Administration (GSA) investigation includes elimination of one column at a point in time from the story 1 above the ground floor. GSA provides criterion for column removal for static analysis case. According to that a column is removed below for representative structures.

1. Column in the middle of longer side of building.
2. Column in the middle of shorter side of the building.
3. Corner column

1.2 Objectives

1. To estimate different results such as story shear and story drift for bare frame model & model with removal of column in the different stories.
2. To estimate the probable for progressive collapse of six story symmetrical reinforced concrete building using the dynamic analysis & push over analysis for column removal conditions.
3. To find the elastic performance of the building by plotting push over curve & Performance point of the structure

1.3 Methodology

1. To achieve the objectives of the research work by carrying extensive literature review.
2. In this learning special moment resisting frame of 6 story building is modeled using FEM based software.
3. ETABS software is used for the modeling & analysis of the structure.
4. The beam and column member sizes are assumed.
5. Analysis of each building models, response spectrum analysis& pushover analysis procedures.
6. Conclusions are made based on the performance of each structural system.

1.4 Methods of Analysis

1.Linear dynamic analysis
2.Non linear static analysis(Pushover analysis)

Pushover analysis

1. A three dimensional structural model is created.
2. Modeling of structure is done by ETABS software
3. Assign the member properties
4. Assign the gravity load and dead load
5. Parameter is to be provided for pushover analysis
6. Iterative pushover analysis is carried out.
7) Pushover curve is drawn and performance point is marked.
8) Base shear v/s Displacement results are tabulated

2. MODELING OF STRUCTURE

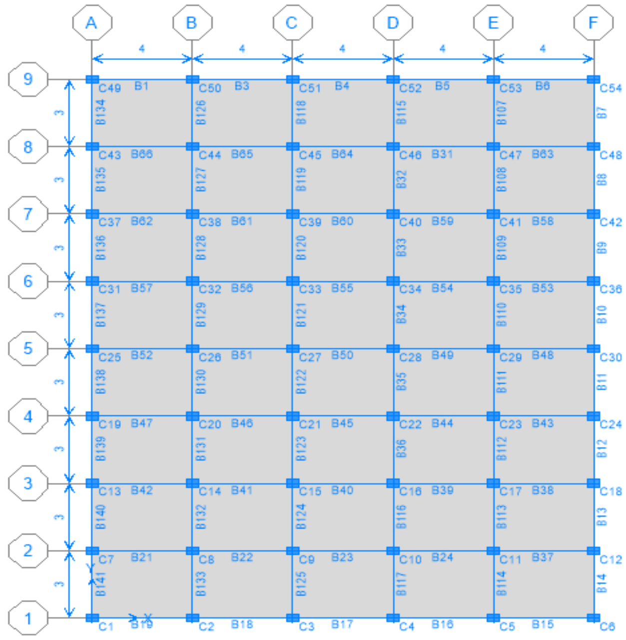

Fig-2: Plan of RC framed structure

The following exterior analysis cases should be considered.
1. Analyze for the bare frame model of the building
2. Analyze for the removal of a column located at corner of the short side of the building (C54)
3. Analyze for the removal of a column located at middle of the short side of the building (C52)
4. Analyze for the removal of a column located at the middle of the longer side of the building (C30)

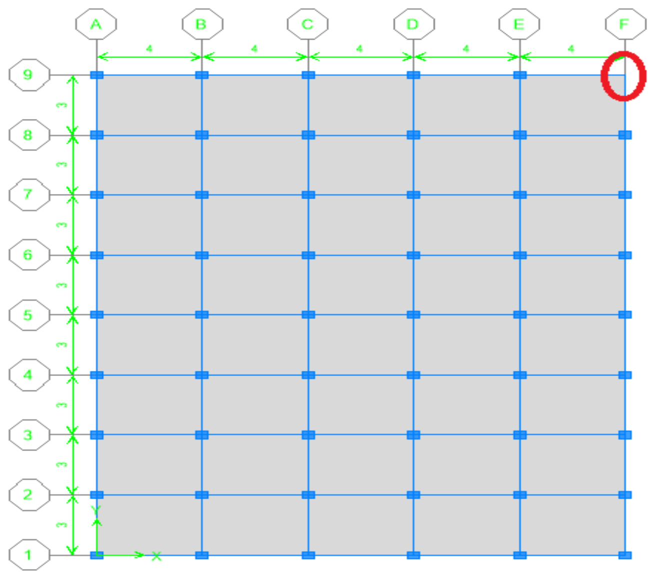

Fig-3: Removal of corner column

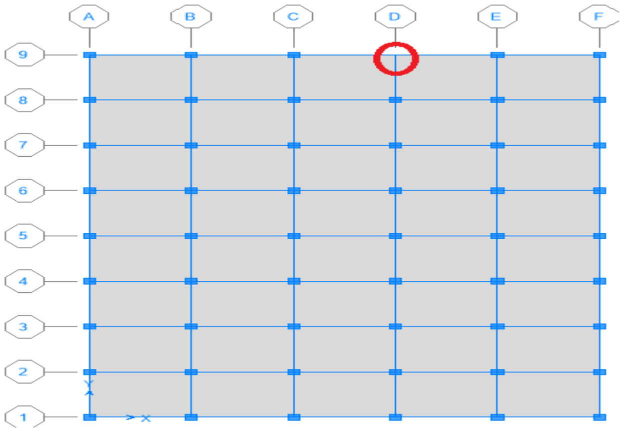

Fig-4: Removal of middle column in shorter direction

2.1 Properties

For the analysis of the building we used the ETABS software. The grade of concrete considered is M30 and that of steel is Fe415 for reinforcement used for the analysis, as per IS 456:2000 the material elastic properties are taken.

Table-1: General details of building

Number of story's	G+5
Building type	RC framed
Seismic Zone	Zone V
Soil type	Medium soil (type 2)
Story height	3.2m
Response reduction factor	5
Importance factor	1.5

Table- 2: Structural members of buildings

Thickness of slab	120mm
Beam	250X400mm
Column	350X450mm

Table- 3: Material properties of buildings

Grade of concrete	M30
Grade of steel	Fe415
Density of concrete	25 kN/m³
Young's modulus of concrete	31622x10 kN/m³
Poisons ratio of concrete	0.2

Table- 4: Assumed load intensities

Loads	Roof	Floor
Live load	3kN/m²	3kN/m²
Super dead	1.5kN/m²	

3. RESULTS

3.1 Bare Frame Results

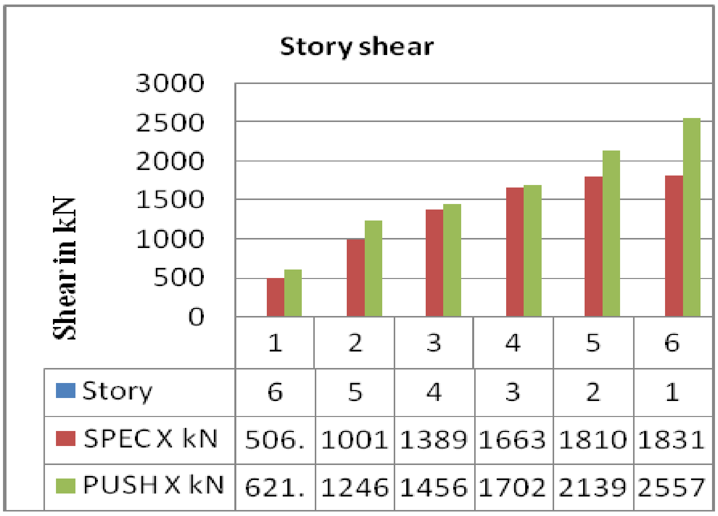

Fig-5: Story shear for bare frame model

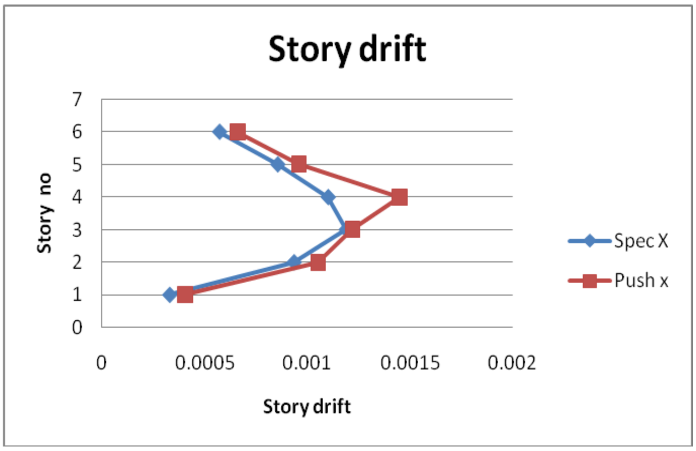

Fig-6: Story drifts for bare frame model

3.1.1 Results of removing corner column

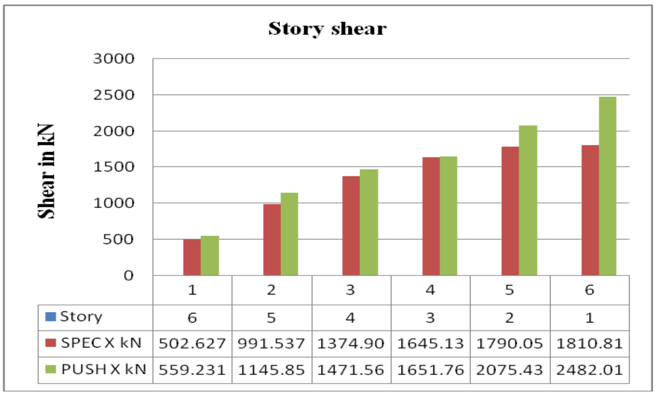

Fig-7: Story shear for corner column removal

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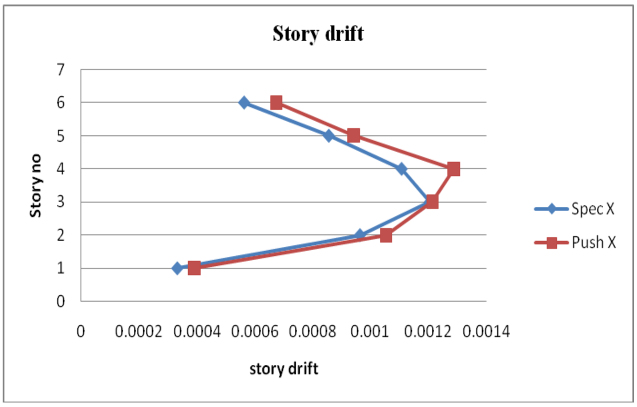

Fig-8: Story drifts for corner column removal

3.1.2 Results of removing mid column in shorter direction

Fig-9: Story shear for middle column removal in shorter direction

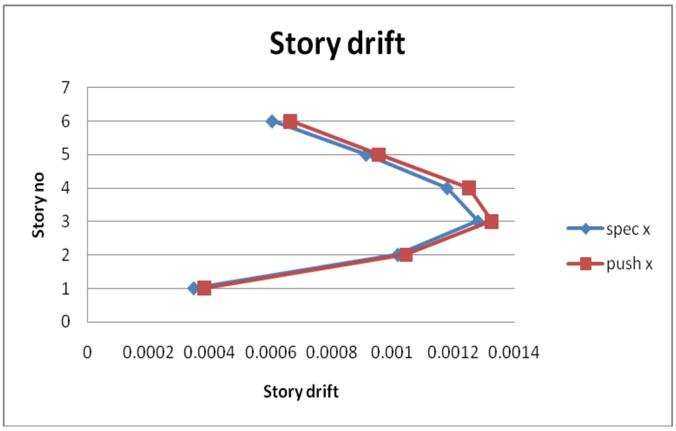

Fig-10: Story drifts for middle column removal in shorter direction

3.1.3 Results of removing mid column in longer direction

Fig-11: Story shear for middle column removal in longer direction

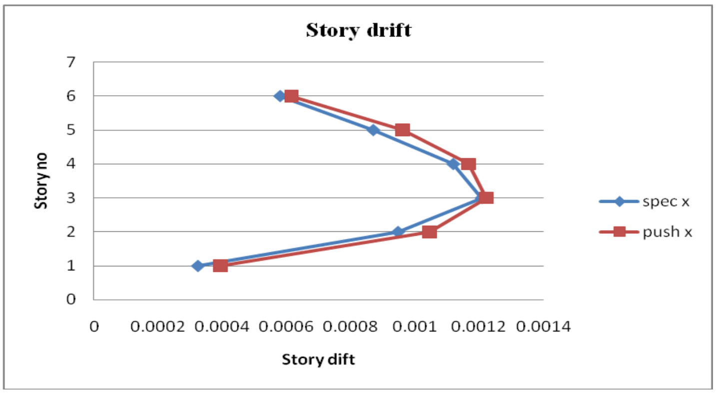

Fig-12: Story drifts for middle column removal in longer direction

3.2 BENDING MOMENTS

3.2.1 Bending moment in bare frame model

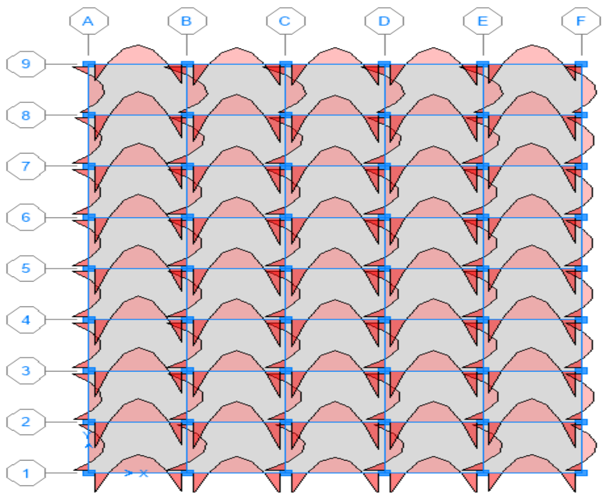

Fig-13: Moment for bare frame model

3.2.2 Bending moment in corner column removal

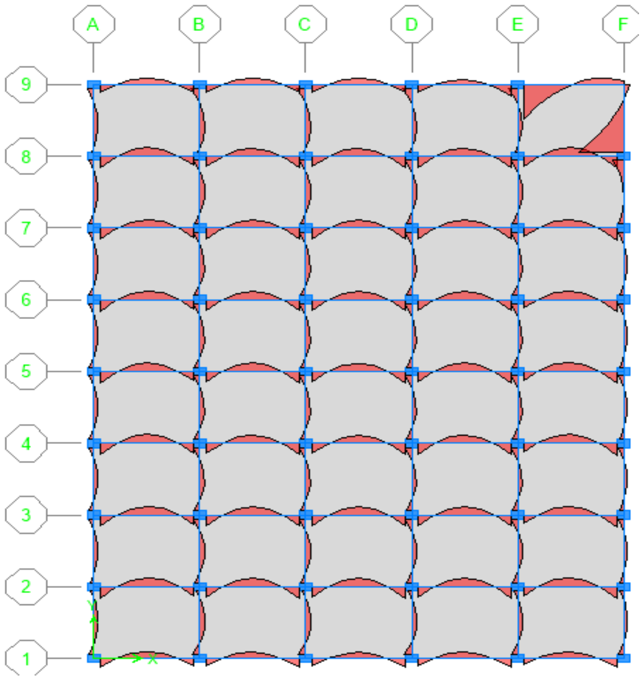

Fig-14: Moments for corner column removal

3.2.3 Bending moment in mid column removal in shorter direction

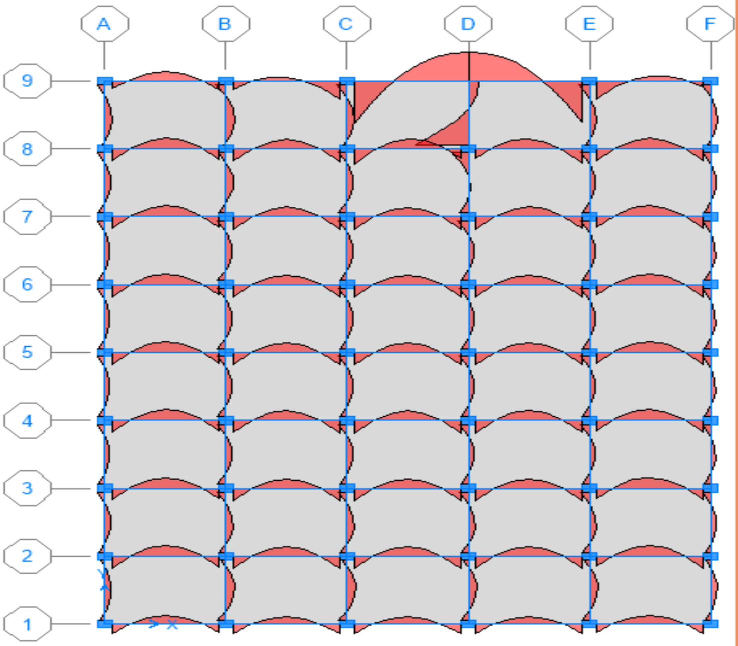

Fig-15: Moment for middle column removal in shorter direction

3.2.4 Bending moment in mid column in longer direction

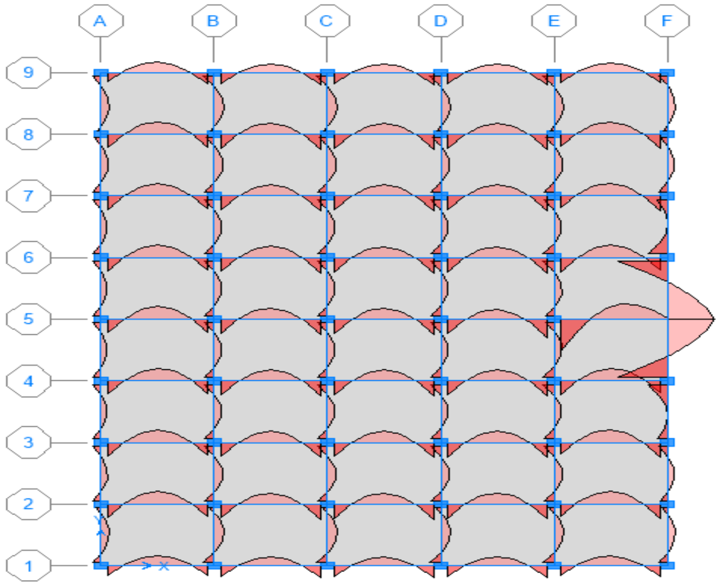

Fig-16: Moments for mid column removal in longer direction

3.3 Pushover analysis

3.3.1Pushover curve for bare frame in both X and Y direction

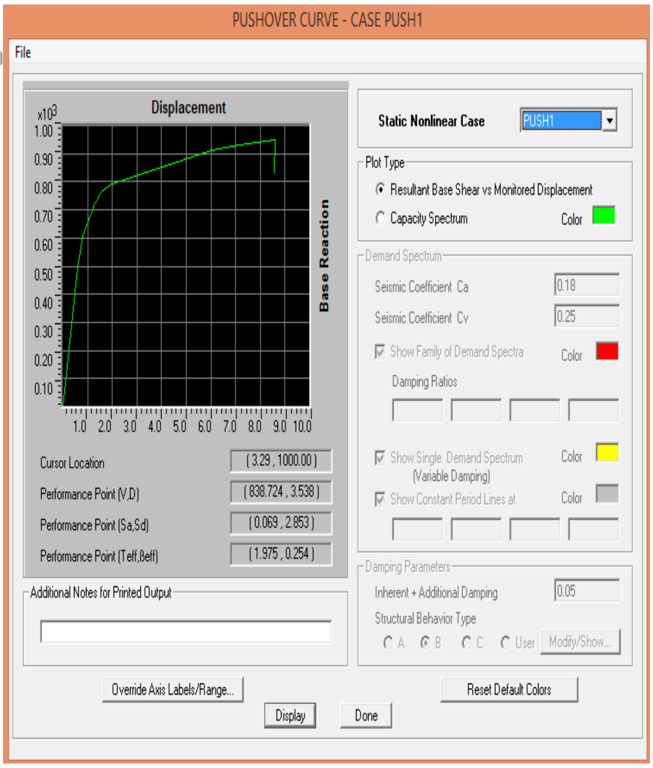

Fig-17: Pushover curve in X direction

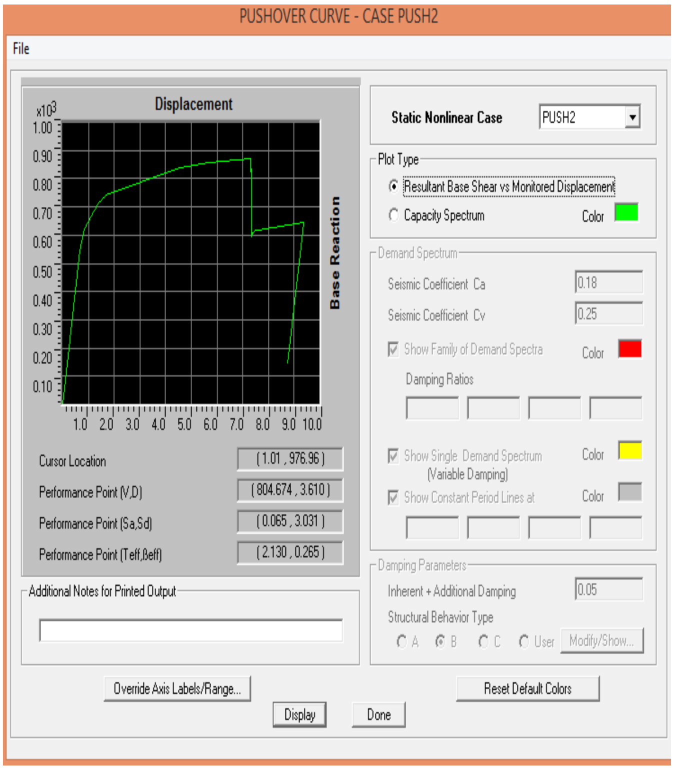

Fig-18: Pushover curve in Y direction

3.3.2 Pushover curve for removal of corner column in both X and Y direction

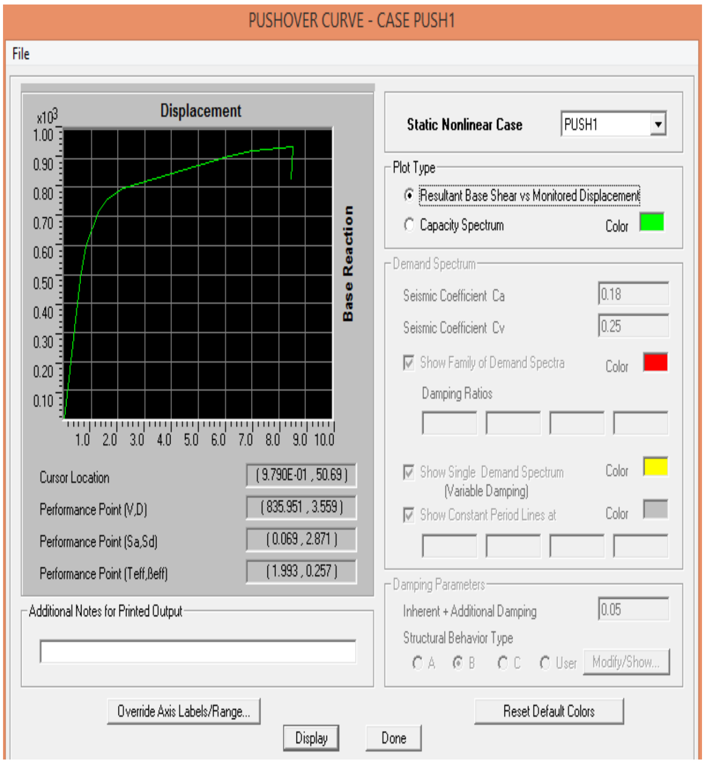

Fig-19: Pushover curve for corner column removal in X direction

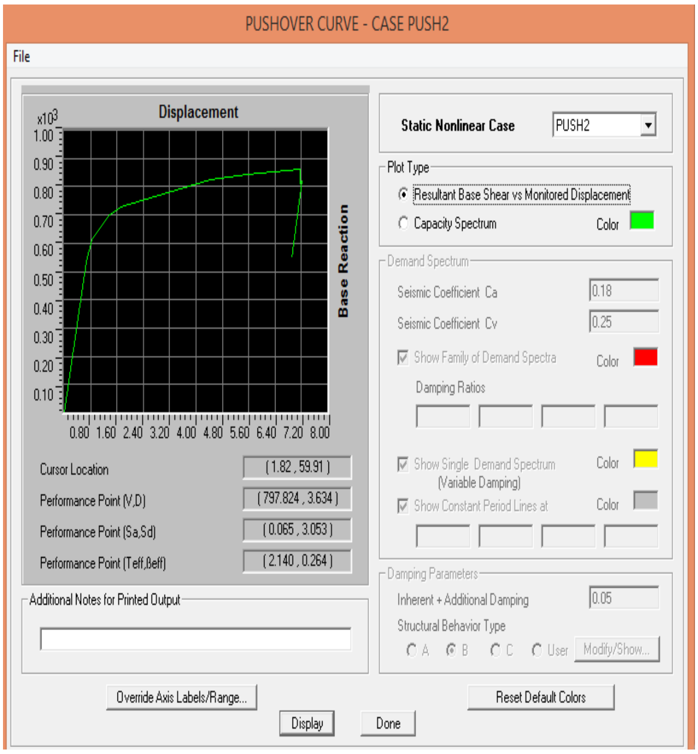

Fig-20: Pushover curve for corner column removal in Y direction

4. CONCLUSIONS

- As the weight of the structure increases the value of base shear also increases. The base shear value obtained from pushover analysis is more when compared to results obtained from response spectrum analysis for all types of models
- The rate of story drift increases as story height increases up to certain story & then decreases.
- The bending moments obtained after the analysis seen that the bending moments at where columns are removed are more when compared to other joints.
- Higher storey buildings are more sensitive to progressive collapse than low rise buildings.
- By using pushover analysis, structural engineer can design the frame to his option of performance level, which results in economy.
- Pushover curve is plotted for displacement and base shear for different column removal conditions in both X & Y directions.

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