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Seismic Performance of Multistory Reinforced Concrete Buildings by Pushover Analysis

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Abstract: In this investigation the analysis of G+4, G+11 and G+21 building is situated in New Delhi (Zone IV. The seismic analysis of of G+4, G+11 and G+21 building as per IS 1893-2002. In this research pushover analysis was performed in SAP 2000 and after that is designed as per IS 456-2000 for different loads. This analysis gives better understanding seismic performance of building & also shows damage or failure of buildings. The building performance level is determined by pushover curve & demand curve. The result shows that the failure is noticed in the column of ground storey of the building. After that enlarged amount of reinforcement in the ground story the buildings have reached life safety performance level.
Keywords: Pushover curve, capacity spectrum, demand spectrum, IS 1893:2002, STAAD Pro, SAP2000

I. INTRODUCTION

The standard building codes define the significant design requirements to ensure the safety of residents in a sudden ground shaking events. We usually witness the natural disaster effects on buildings even designed based on building codes. Therefore it is important to analysis the building performance before physically constructing it. Before constructing the structure we have to check the story drift, nodal displacement at the roof level and the capacity before the building fails for certain ground motions. The safety of non-structural elements can be ensured through PBE with enhance in expenditure of the construction. Therefore, PBE is the method or approach used by design specialists to construct buildings that possess functionality and the continued availability of services.

The PBE methodology is not going to be the instant replacement for design to the traditional code methods. It will only help in enhancing the design criteria in determining the deformation based response.

II. OBJECTIVE OF STUDY

The objective of the present study is as follows:

1) Design G+4, G+11 and G+21 multistoried buildings in STAAD pro as per IS-456-2000 different loads.
2) The main objective is to perform pushover analysis in SAP2000 to get the seismic response of the structure.
3) The main objective is to check whether the building designed by standard codes is safe under earthquake loads.

III. MODELLING APPROACH

A. Modelling

The Building is designed as per IS 456-2000. The details of building are as follows.

The building is 24.5m to 18.5m. Its area is 453.25m2

Dimension of Beams: 600x800mm

Ground floor columns: 1000x1000mm

Other floors: 800x800mm

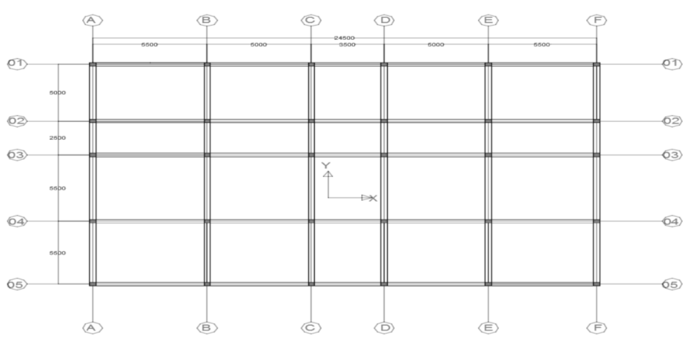

Figure 3.1 showing the plan the building

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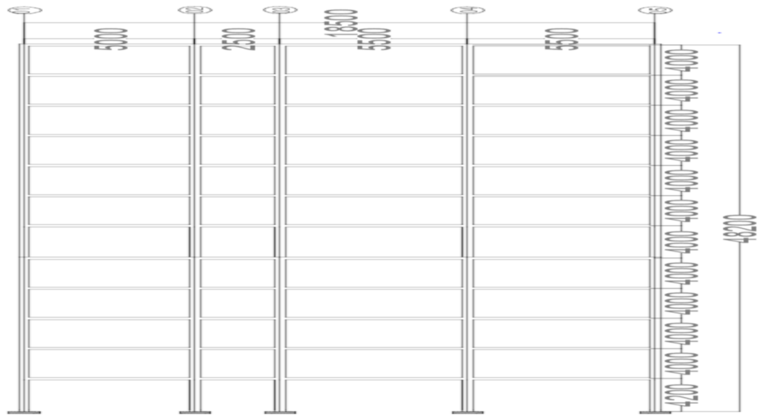

Figure 3.2 Section A-A of 12 Story Building

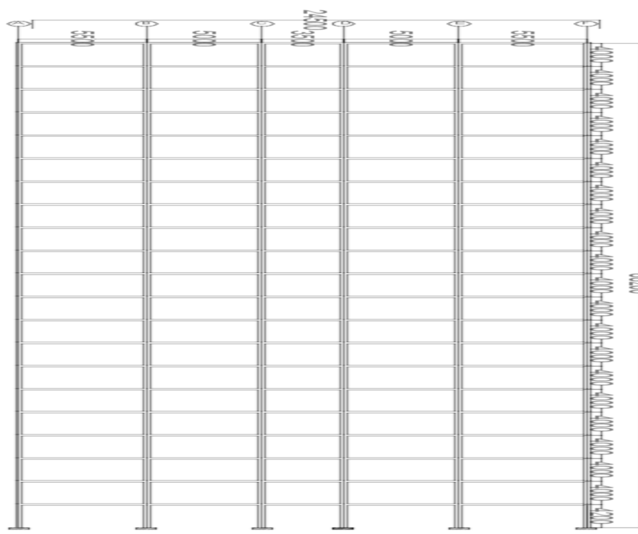

Figure 3.3 Section 1-1 of 22 Story Building

B. Loads on the Structure

As per IS 456-2000 & IS 1893-2002 the structure is analyzed and designed for live load, seismic load. The subsequent figures show the different loads acting on the building.

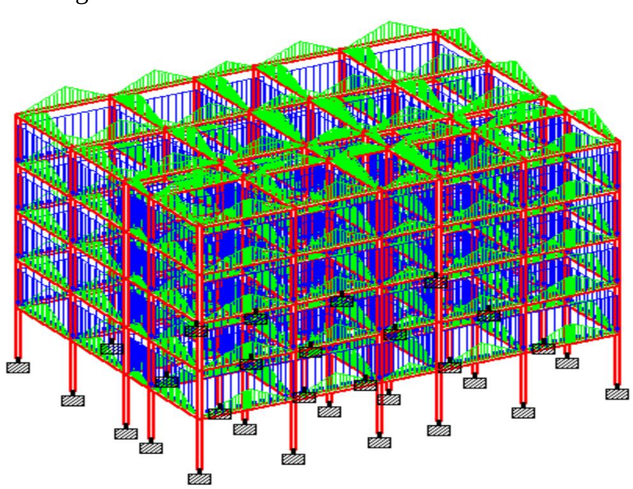

Figure 3.4 illustrating the brick infill load acting on the beams

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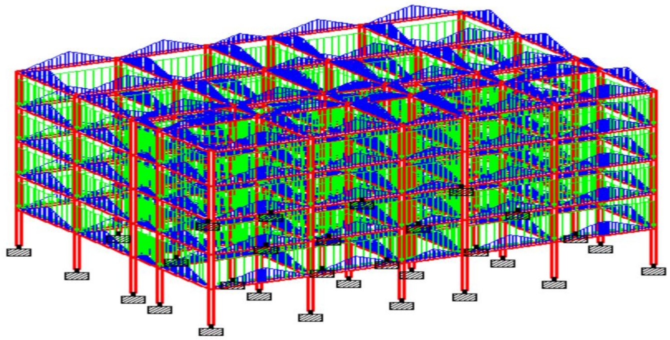

Figure3.5 Illustrating the floor load acting on the slabs

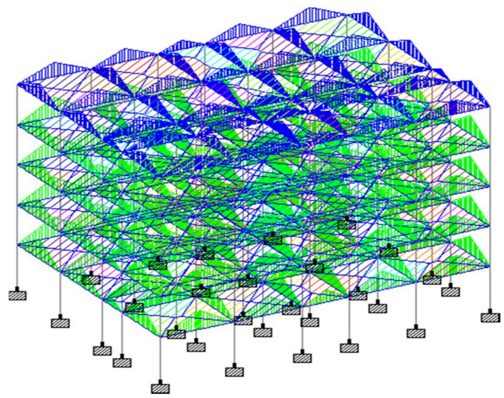

Figure3.6 Illustrates the Live Load acting on the Roof

IV. RESULTS

A. Results of RCC Design

1) RC Design of G+4 Building

The details of 5 story building are given below:
Beams=300mmx450mm
Columns=450mmx450mm
Concrete Grade=M30
Steel Grade=Fe415 HYSD bar

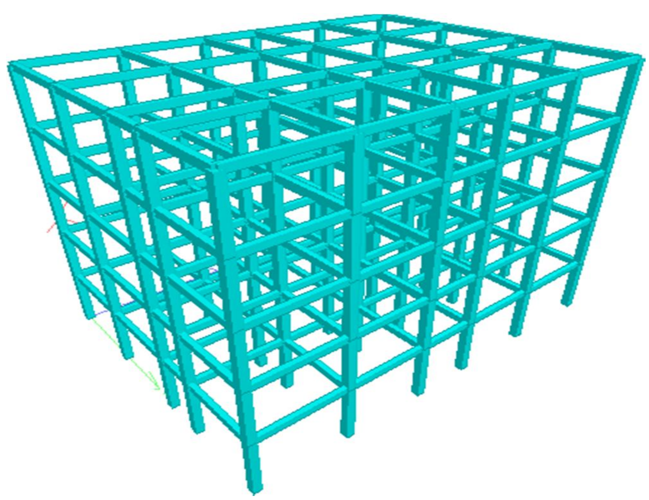

Figure 4.1 showing the 3D model of the building

Detailing of beams
Dimension of Beam= 450mmx300mm.
Grade of concrete= M-30
FE-415 Steel is used

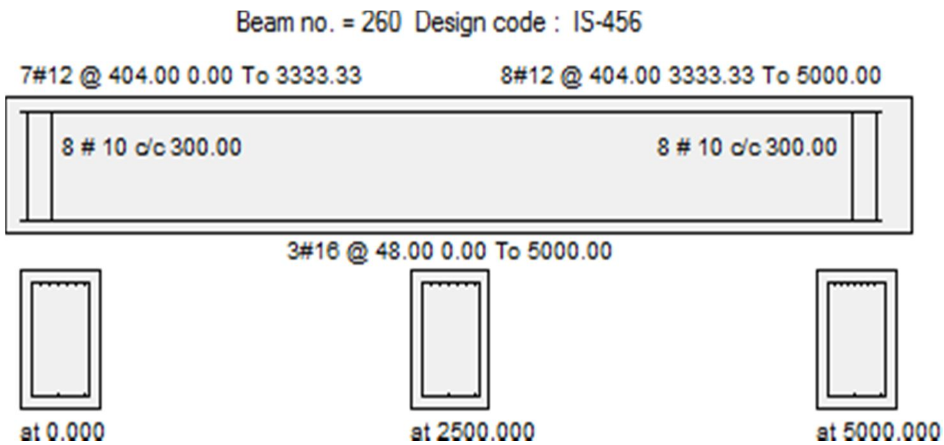

Figure4.2 showing the reinforcement detailing of beam of G+4

Detailing of columns
Dimension of Beam= 450mmx450mm.
Grade of concrete= M-30
FE-415 Steel is used

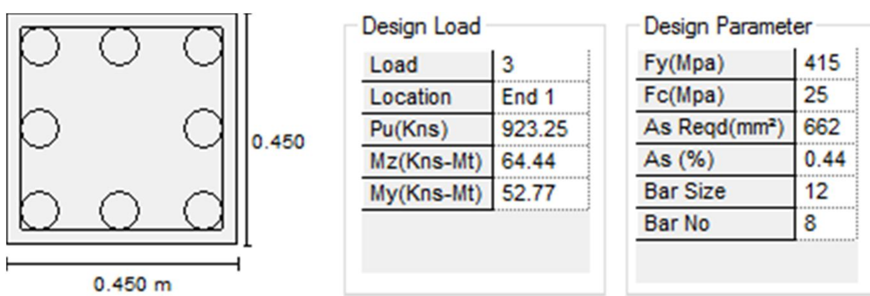

Figure4.3 showing the reinforcement detailing of column of G+4

2) RC Design of G+11 Building

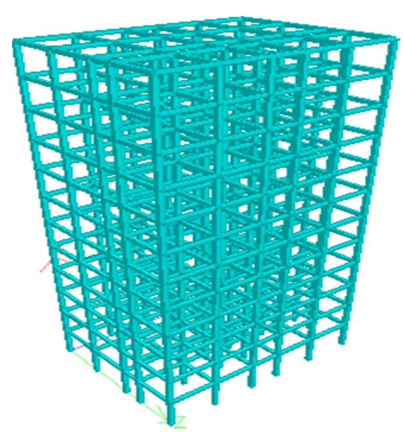

Figure4.4 Showing the STAAD pro Model of G+11

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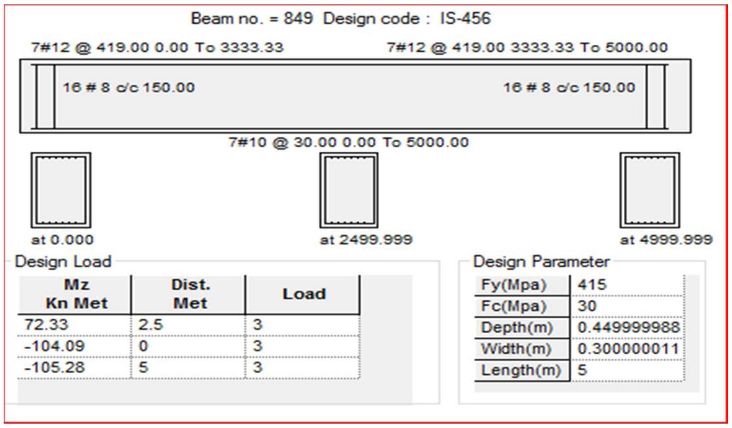

Figure4.5 showing the reinforcement detailing of beam of G+11

Detailing of columns
Dimension of Beam= 450mmx450mm.
Grade of concrete= M-30
FE-415Steel

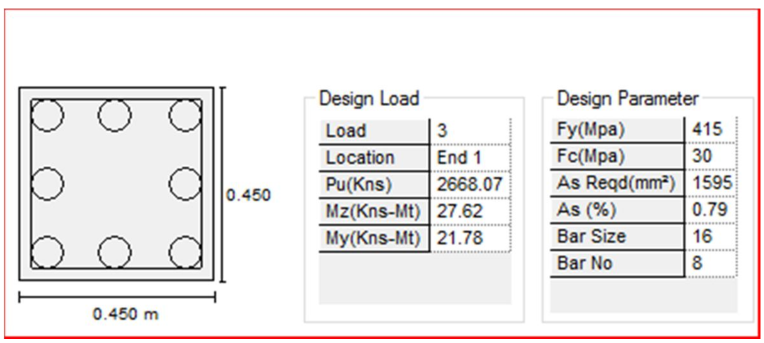

Figure4.6 showing the reinforcement detailing of column of G+11

3) RC Design of G+21 Building

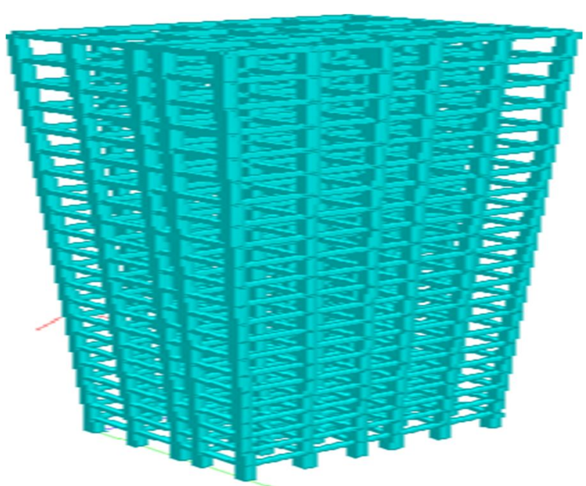

Figure4.7 Showing the STAAD Pro Model of G+21

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Detailing of beams
Dimension of Beam= 450mmx300mm.
Grade of concrete= M-30
FE-415 Steel is used

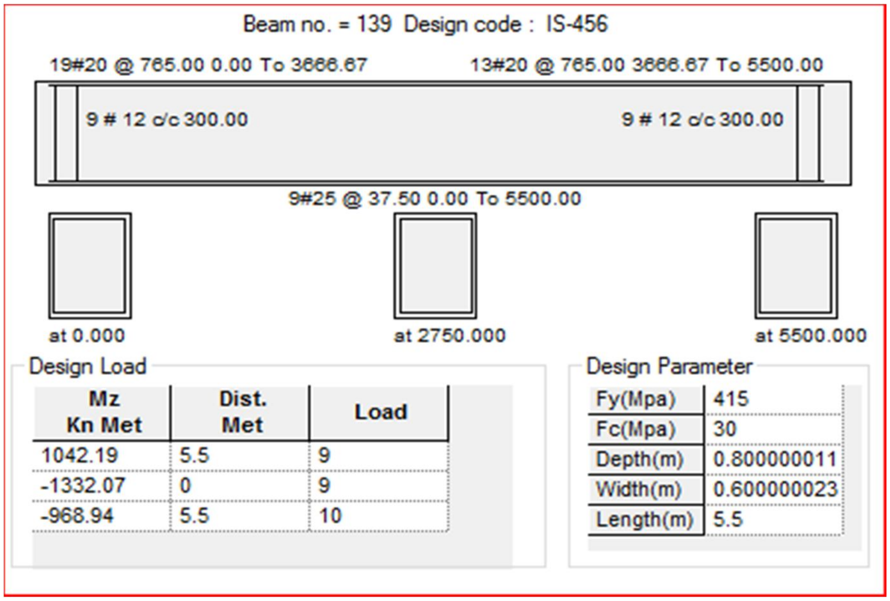


Figure4.8 showing the reinforcement detailing of beam of G+21

Detailing of columns
Rectangular columns of dimension 800mmx800mm are provided with M30 grade concrete and Fe415 grade of steel. The following figure shows the reinforcement details taken from STAAD Pro.
The following figure shows the column reinforcement for G+22 Building, this column developed the first plastic hinge.

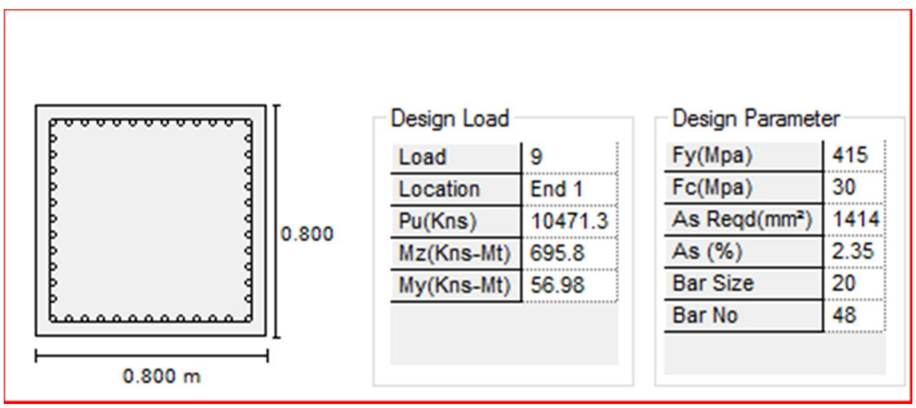
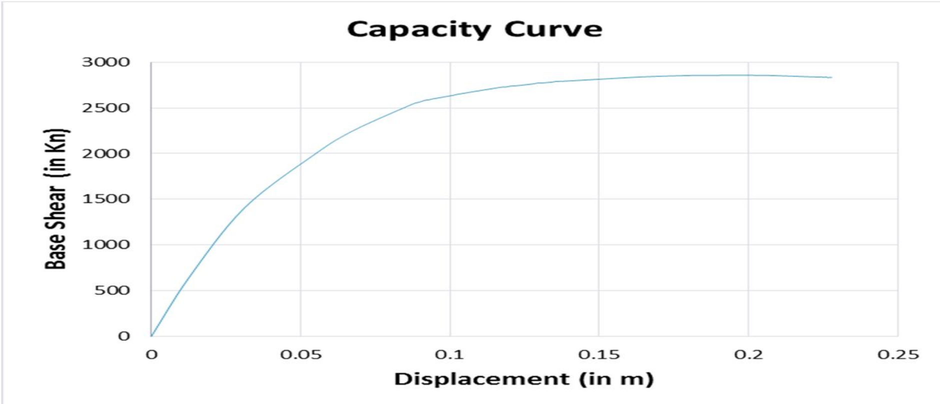


Figure4.9 showing the reinforcement detailing of column of G+21

B. Pushover Analysis Results

1) The Pushover analysis of G+4 RC Building

The graph plot between the Pushover curve base shear vs lateral displacement.
The Design base shear (VB) was found to be 1742 in chapter 3 and the capacity is 2900KNwhich is much higher, hence the building is safe for this level of earthquake.



Graph 4.1 shows the pushover curve

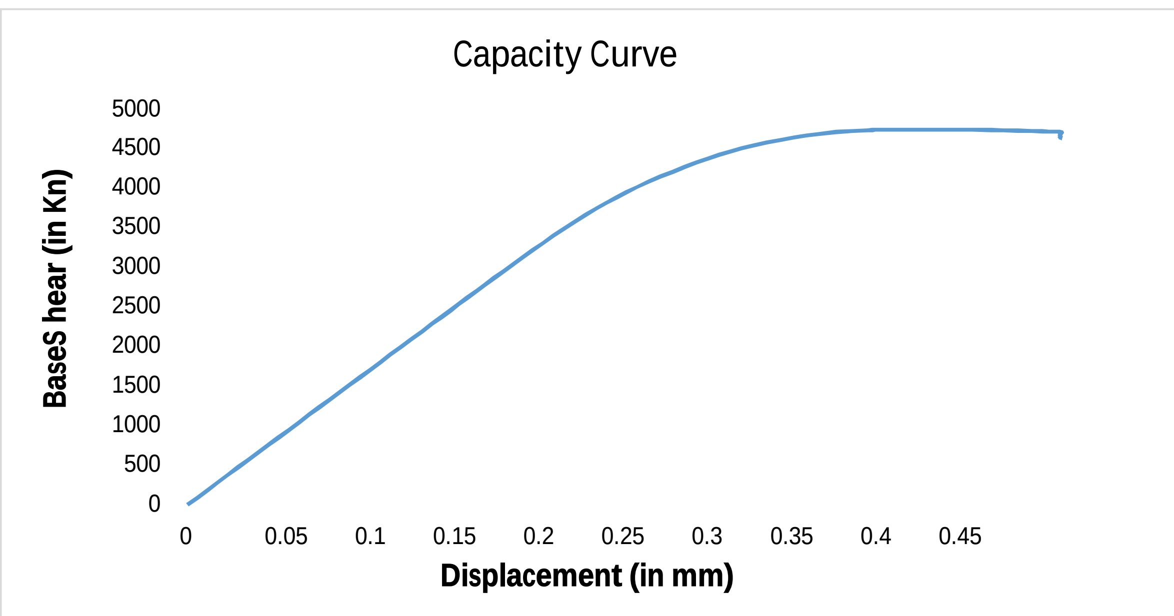
Table 4.1 the conclusion from Performance point of G+4

Base shear(KN)	2679.179	Roof displacement (m)	0.108
Spectral Acceleration, Sa (m/s)	0.488	Spectral displacement, Sd(m)	0.082
Effective time period, Teff(s)	0.823	Effective damping, βeff	0.189

2) The Pushover analysis of G+11 RC Building

The graph plot between the Pushover curve base shear vs lateral displacement.

From the graph value of base shear was found to be 4364KN and the capacity from the plot is 4800KN which is higher, hence the performance of the building for this level earthquake is acceptable.



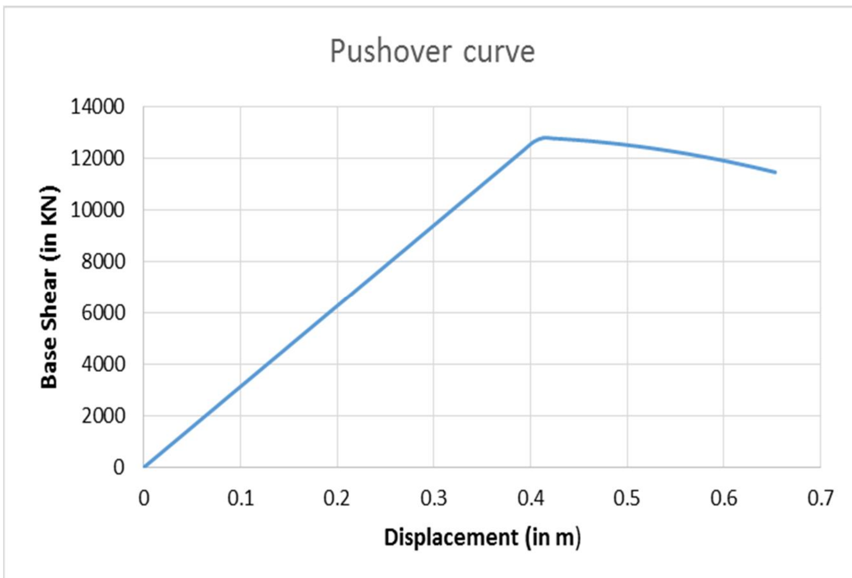
Graph 4.2 Pushover curve (base shear vs displacement) for 12 Story Building

Table 4.2 the conclusion from Performance point of G+11

Base shear(KN)	4415.444	Roof displacement (m)	0.166
Spectral Acceleration, Sa (m/s)	0.140	Spectral displacement, Sd(m)	0.137
Effective time period, Teff(s)	1.986	Effective damping, βeff	0.170

3) The Pushover analysis of G+21 RC Building

The graph plot between the Pushover curve base shear vs lateral displacement. From the graph the value of base shear was found to be 11421 KN and the capacity from the plot is 12382 KN which is higher, hence the performance of the building for this level earthquake is acceptable.



Graph 4.3 Pushover curve (base shear vs displacement) for 22 Story Building

Table 4.3 the conclusion from Performance point of G+21

Base shear(KN)	12021.25	Roof displacement (m)	0.381
Spectral Acceleration, Sa (m/s)	0.138	Spectral displacement, Sd(m)	0.236
Effective time period, Teff(s)	2.131	Effective damping, βeff	0.168

V. CONCLUSION

After analysis all the results the following conclusion has been drawn:

1) From the above results it is clear that the capacity of G+4, G+11 and G+21 RCC buildings are higher than design base shear
2) Considering three different RC building it was concluded if the buildings are designed with proper sections and reinforcement details as per standard codes will perform better under seismic forces.

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