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# Concept Of Pushover Analysis On RCC And Composite Column Structure

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**ABSTRACT:** Due to increase in population High rise structure is needed but earthquake is most dangerous disaster. And force which occurs on a earth surface due to earthquake causes structural damage. Due to this structure must be able to stand with this forces .To study seismic performance of building pushover analysis is performed on both structure.In this paper four different models is considered for analysis. 5 storey and 10 storey building of RCC and composite column with RC beam is modelled and analysed by usingETABS software.The building selected for study was rectangular in plan. Column use in composite structure is Encased I-section with Rc beam.For carrying out nonlinear analysis both material as well as geometric nonlinearity is considered. And results are compare in terms of capacity curve ,storey displacement, storey drift, formation of hinges, performance point for all models. Resultsshow that composite column with Rc beam is good in resisting earthquake forces as compare to RCC structure.

**KEYWORDS:** Composite column ,RCC structure ,Pushover analysis, Pushover curve ,Hinge formation ,Nonlinear static

## I. INTRODUCTION

Pushover analysis is a static non-linear technique in which two type of methods is used first one is force controlled and displacement controlled.Pushover analysis gives information about progressive failure of building. And also it gives idea about retrofiting is needed for a structure.Performance point is decides the feasibility of structure.

RCC structures are not suitable for high rise structure therefore composite is best option for this.Composite columns are provided with RC beam and also steel beam.Composite column is a compression member consisting either concrete encased hot rolled steel section or a rolled steel section embedded in concrete. At present there is no Indian standard code covering the design of composite. IS 11384-1985 does not make any specific provisions to composite columns.AISC 360-10 gives certain provision for composite column .Composite column are various types encased sections partially or fully and concrete filled tube.

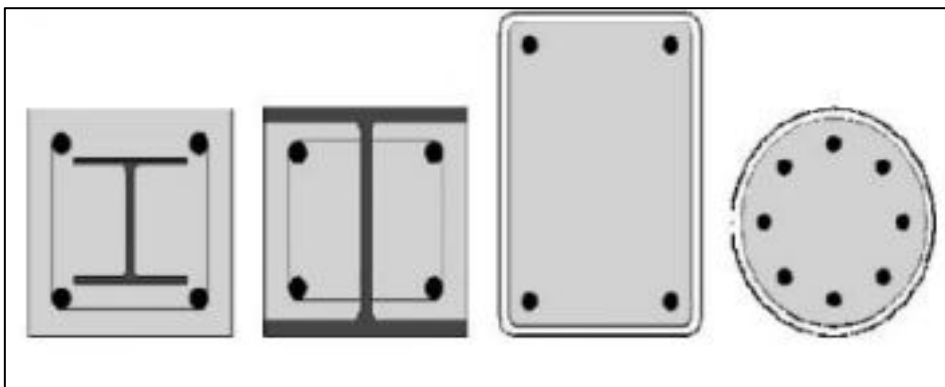


Fig1:Various composite columns

## II. RELATED WORK

[1].Non-linear pushover analysis of Rcc and steel-concrete composite frame”, A. S. Boke, Shrikant Suta, In this paper is studied of non- linear analyses using different residential building frames as a CIS-RC, CISSB, CFT-RC, CFT-SB, EIS-RC, EIS-SB, Steel and compared with RCC using ETABS software, assuming the linear material property and performing nonlinear static analysis. This non-linear static analysis is carried out and various parameters like story displacement, storey drift, base shear, Pushover curve, Capacity spectrum, Capacity curve Performance point value are studied. Generally it is found that in case of RCC construction areas of structural members are comes out very heavy with large amount of essential material such as steel & concrete, which takes large space in construction of multistory building. It is concluded that composite structure is one of the suitable alternatives, which not only takes care for earthquake forces but also gives less cross sectional area of structural member and provides large space for utilization in economical way.

[2]Pushover analysis of G+15 Steel and Steel-Concrete Composite Frame Structure”, Sudarshan Bhutekar, Mohammed Ishtiyaque, In this paper comparison of Steel and RCC-steel composite frame structure when they are subjected to similar lateral loading by nonlinear static pushover analysis in which it compares performance of G+ 15 storey for steel and composite (steel-concrete) when earthquake load incrementally increases on the structure. Composite construction combines the best of both steel and concrete along with lesser cost, speedy construction, fire protection etc. whereas steel has high strength to weight ratio. It is observed that the performance of steel structure is on higher side than that of the steelconcrete composite frame structure. In this focuses on how steel frame structure can be veteran and most economical over the RCC at its seismic performance.

[3]Comparative pushover analysis of RCC, steel and composite high rise building frame (G+11) by using Etabs, Sunil Rathod, Swati Bhokare, Aniket Shivatare, Pradip Dhiwar, Swapnil Sathe, Rajesh Shinde, In this paper a residential building of G+11 multi-story building is studied for Pushover Analysis using ETABS, assuming that material property linear, static and dynamic analysis is performed. These non-linear analysis are carried out and different parameters like displacement, storey drift, Performance point, base shear are plotted. But generally it is found that the cross sectional area of RCC structural member comes out very heavy with large amount of constituent material such as steel & concrete, which takes large space in construction of multistory building. Under such circumstances composite structure is one of the best options, which not only takes care for earthquake forces but also gives less cross sectional area of structural member and provides large space for utilization in economical way.

## III. METHODOLOGY

1. Forming a model of 5,10 storey building of RCC and composite structure in ETABS software. 4 Models are formed..
2. Assigning beam and column section and slab section and assigning all load to this structure.
3. Run the analysis and design the building in ETABS software. and check all member are passed.
4. After that define load case gravity by considering 100% dead load and 25% live load.
5. Also define push-x and push-y load case in a displacement controlled manner.
6. Assigning auto hinges to beam and column as per ASCE41-13.
7. Analyse all models .conclude the result.

**Table 3.1.Data for Analysis of RCC and Composite ColumnStructure used in ETABS Software**

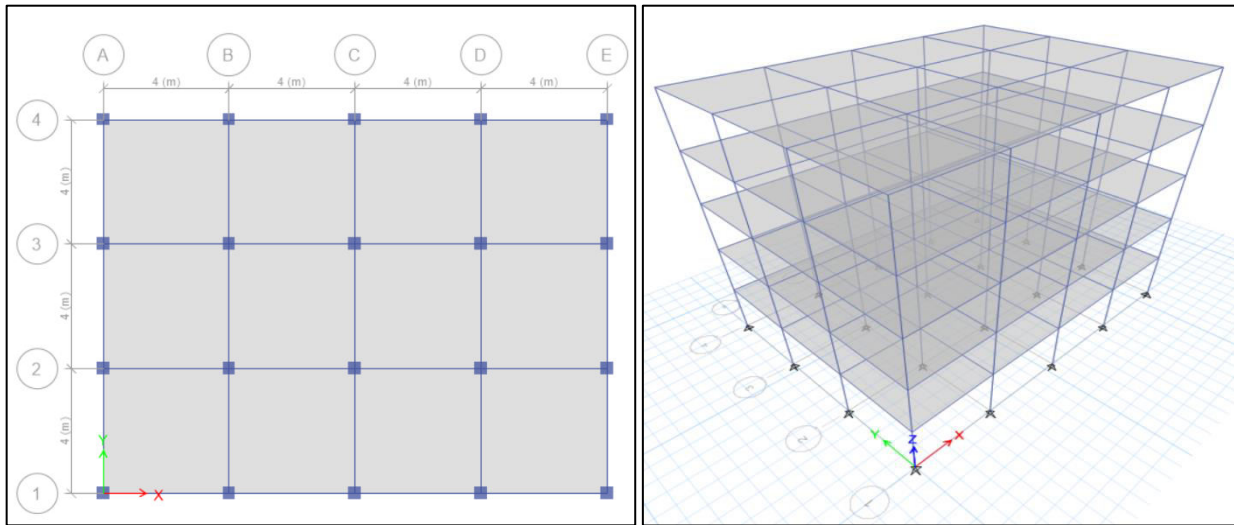
Plan dimension		16m x12m
Total Height of building	5 storey	15m
	10 storey	30m
Slab thickness		150mm
Height of parapet		0.9m
Thickness of wall		0.15m
Seismic Zone		III
Soil condition		Medium
Response Reduction factor		5
Importance factor		1.2
Zone Factor		0.16
Beam Size For 5 storey		230mmx450mm
Beam Size For 10 storey		300mmx600mm
Wall Load For 5Storey		7.65 kN/m
Wall Load For 10 storey		7.2 kN/m
Parapet wall Load		2.7 kN/m
Live load		3 KN/m <sup>2</sup>
Floor finish		1 KN/m <sup>2</sup>

Table.3.2.Size of column used in RCC structure:

RCC building	Model-1 5 storey	Model-2 10storey
1st to 5th floor	400mmx400mm	500mmx500
5th to 10th floor		400mmx400mm

Table3.3.Size of column used in composite structure

Composite building	Model-3 5 storey	Model-4 10storey
1st to 5th floor	Encased ISMB100 300mmx300mm	Encased ISMB200 400mmx400mm
5th to 10th floor		Encased ISMB100 300mmx300mm



Similarly 10 storey of RCC and composite is modelled.

#### IV. EXPERIMENTAL RESULTS

##### 4.1. Maximum Displacement of RCC and Composite Structure OF 5 Storey:

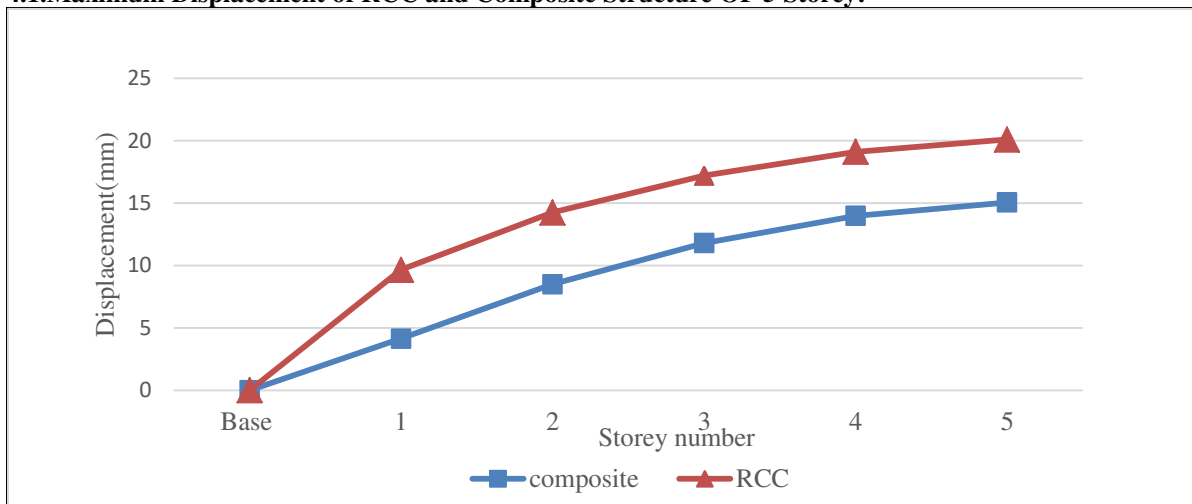


Figure 4.1: Maximum Story Displacement

It can be observed that maximum top storey displacement is seem to be maximum in case of RCC structure as compare to composite structure.

The storey displacement is reduced for composite column structure is about 25% as compare to RCC structure.

**4.2 Maximum Storey Drift of RCC and Composite Structure OF 5 Storey:**

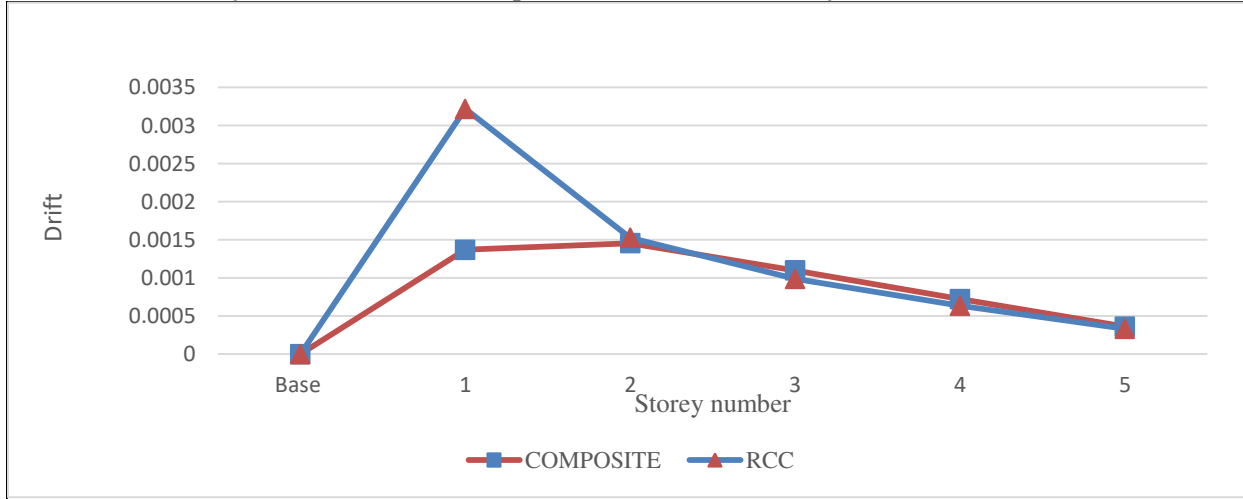


Figure 4.2: Maximum Storey Drift

The result shows the storey drift for composite column structure is comparatively less than RCC structure. The storey drift is reduced by 54.75% in composite column structure.

**4.3. Performance Point of structure of 5 Storey:**

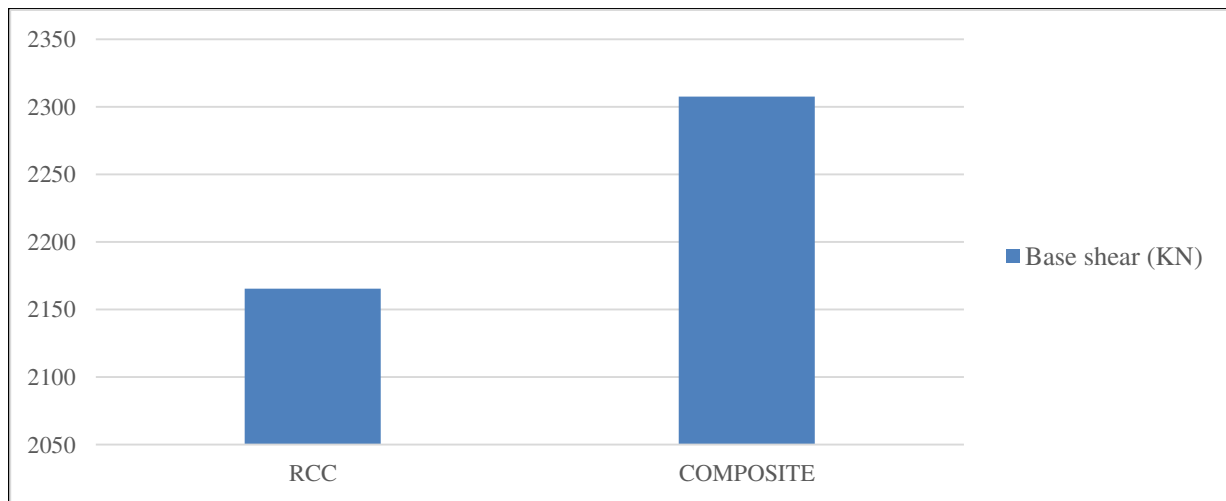


Figure 4.3.1: Base shear at performance point

The performance Point of structure is the point where demand spectrum and capacity spectrum of the structure intersects each other. As we can observe base shear is maximum in composite structure as compare to RCC structure.

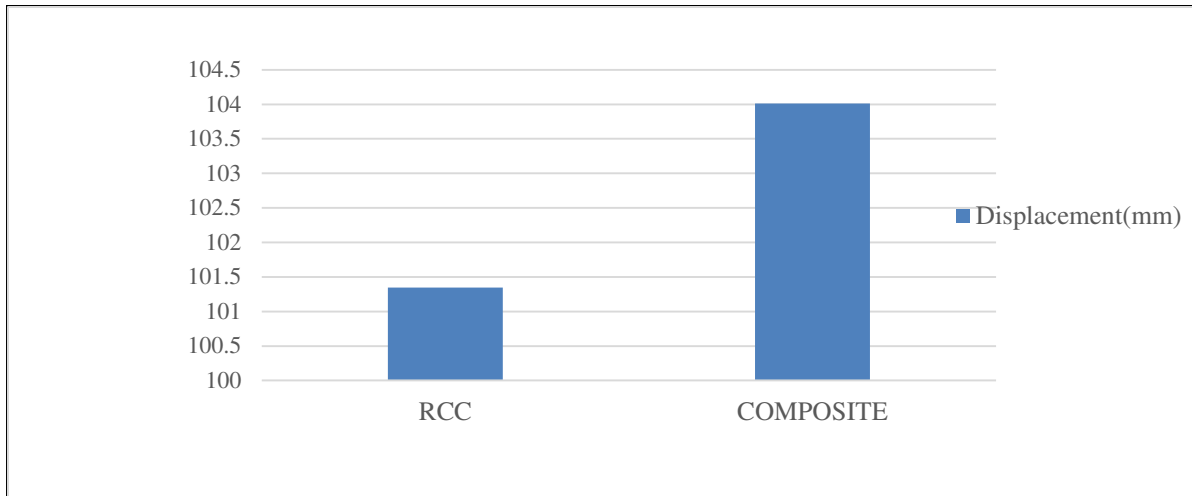


Figure 4.3.2: Story Displacement at performance point

As we can observe there is no significant variation of RCC and composite column structure in displacement only 2% displacement is more and Base shear is maximum in composite structure.

**4.4. Formation of Plastic Hinges of 5 storey:**

First hinge formation in RCC is takes place at 41.11 mm displacement and last hinge formation is takes place at 212mm displacement.

First hinge formation in Composite 46mm is takes place at 41.11 mm displacement and last hinge formation is taken place at 135mm displacement.

**4.5. Pushover curve for PUSH -X For RCC structure of 5 storey:**

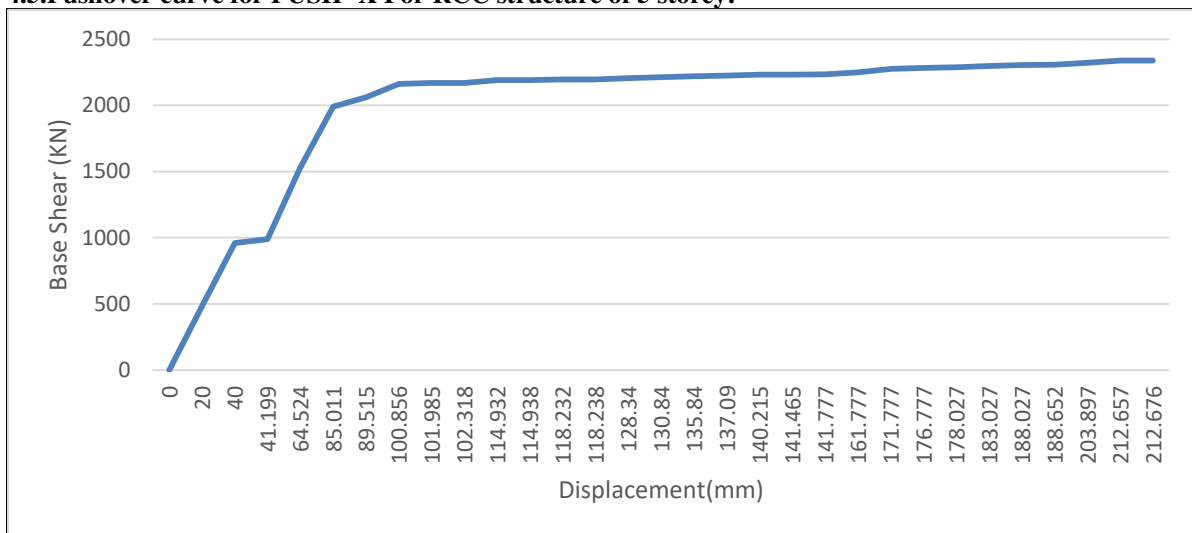


Figure 4.5. Pushover curve for Push-x of RCC model

After running the analysis pushover curve is obtained .the global behaviour of frame in terms of stiffness and ductility are presented by this curve ,Under a incremented lateral loading the element may yield sequentially. At every step the structure experiences loss in stiffness .Therefore slope of curve gradually decreasing.

**4.6 Pushover curve for PUSH -X For composite column structure of 5 storey:**

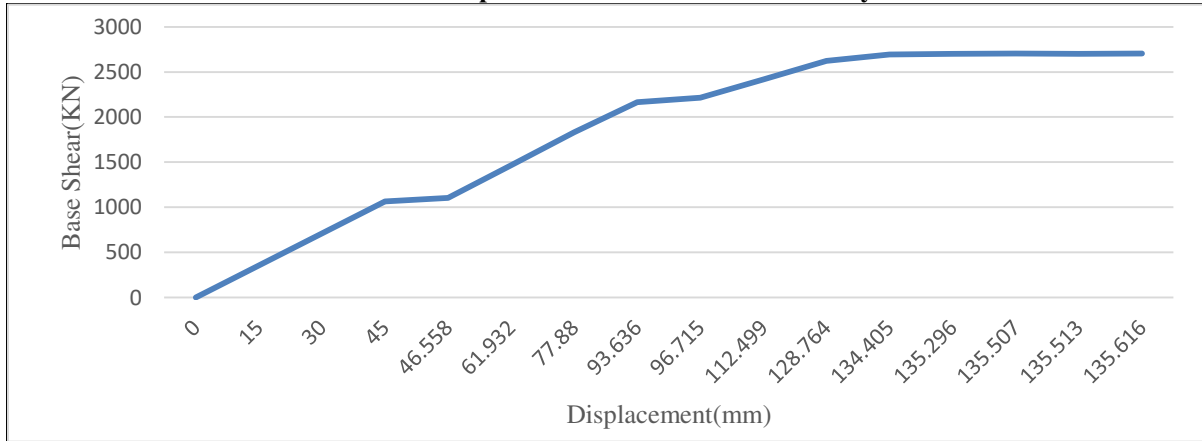


Figure 4.6 Pushover curve for push-x in composite model

Under a incremented lateral loading the element may yield sAfter running the analysis pushover curve is obtained .the global behaviour of frame in terms of stiffness and ductility are presented by this curve ,Under a incremented lateral loading the element may yield sequentially. At every step the structure experiences less loss in stiffness .Therefore slope of curve gradually less decreasing. As compare to composite.

**4.7 Maximum Displacement of RCC and Composite Structure OF 10 Storey:**

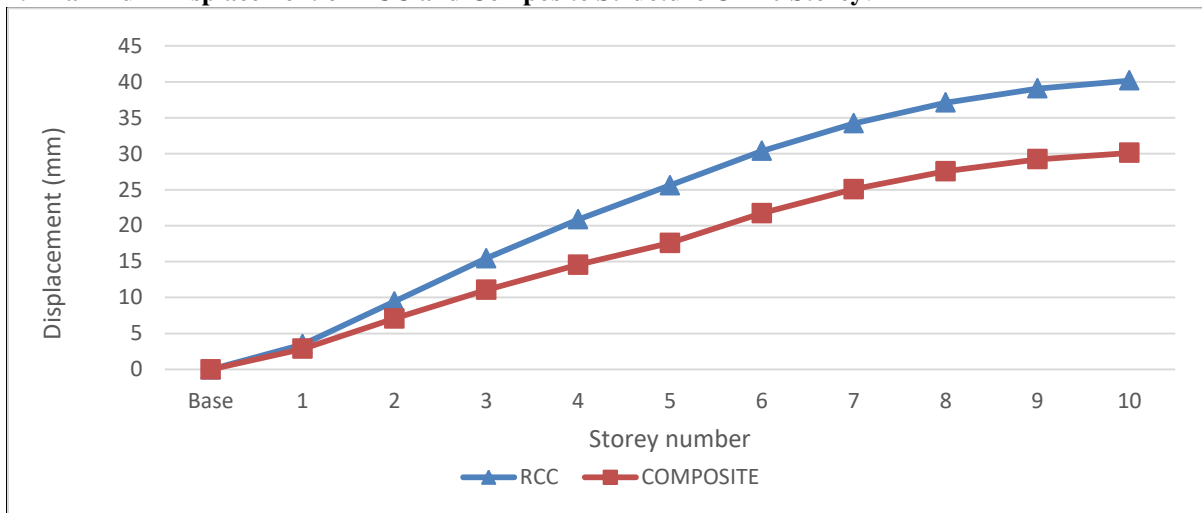


Figure 4.7: Maximum Story Displacement

It can be observed that maximum top storey displacement is seem to be maximum in case of RCC structure as compare to composite structure.

The storey displacement is reduced for composite column structure is about 25% as compare to rcc structure.



**4.8 Maximum storey Drift of RCC and Composite Structure OF 10 Storey:**

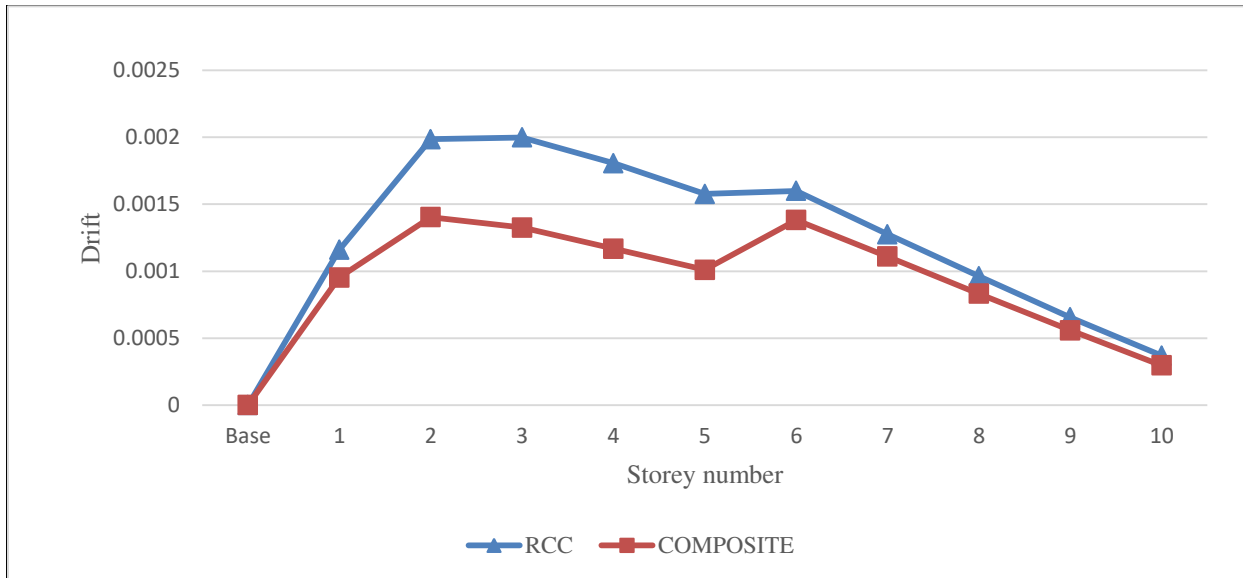


Figure 4.8: Maximum Story Drift

The result shows the storey drift for composite column structure is comparatively less than RCC structure. The storey drift is reduced by 33% in composite column structure .

**4.9.Performance Point of structures of 10 Storey:**

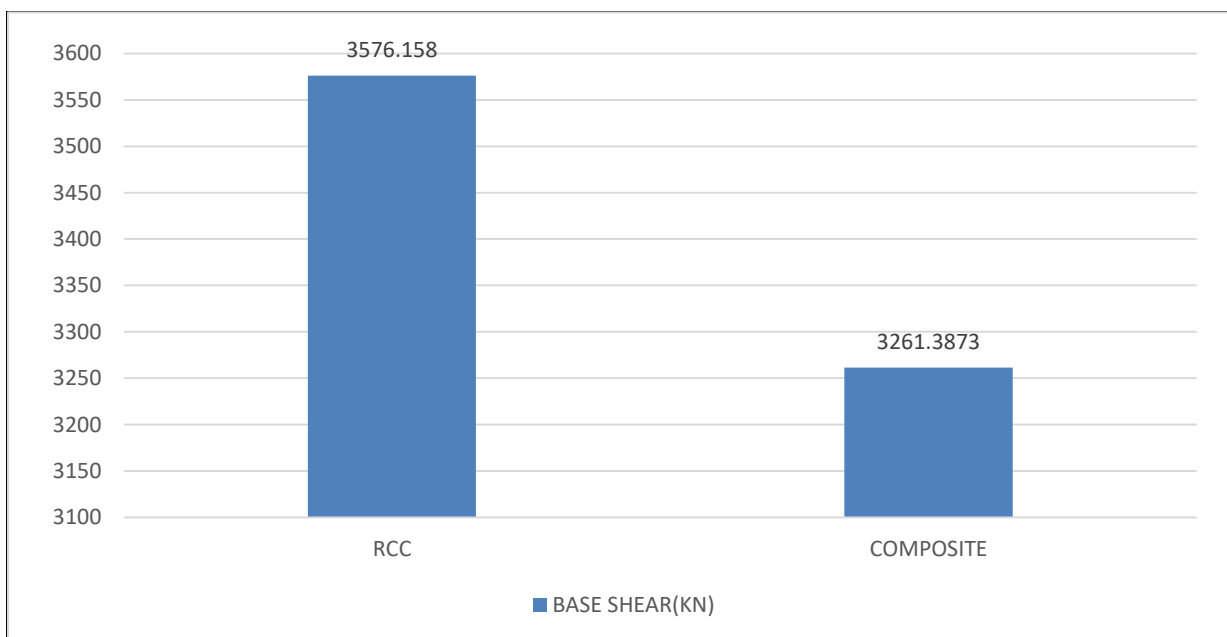


Figure 4.9.1: Base shear at performance point

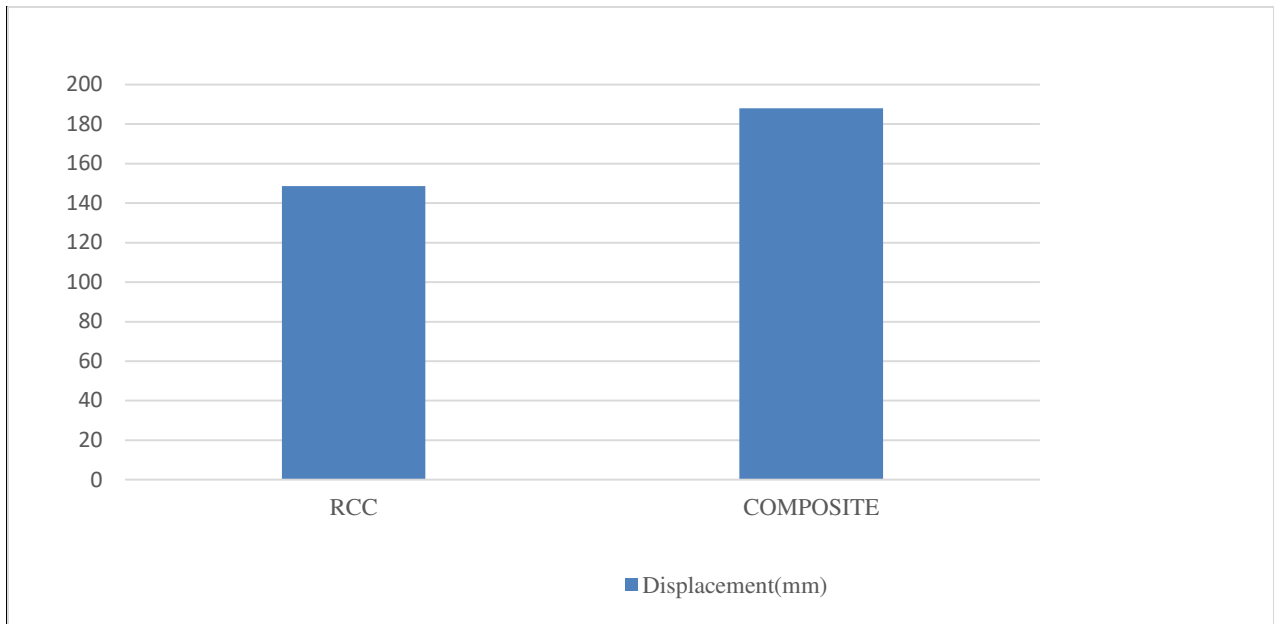


Figure 4.9.2. Story Displacement at performance point

The performance Point of structure is the point where demand spectrum and capacity spectrum of the structure intersects each other. Composite column structure shows maximum variation of displacement as compare to RCC. As we can observe and composite column structure is 26% displacement is more than RCC structure and Base shear is maximum in RCC structure. Base shear of composite 8% reduces seismic effect on structure as compare to RCC.

**4.10. Formation of Plastic Hinges of 10 storey:**

First hinge formation in RCC is takes place at 77 mm displacement and last hinge formation is takenplace at 216 mm displacement.

First hinge formation inComposite46mm is takes place at 83 mm displacement and last hinge formation is taken place at 343mm displacement.

**4.11. Pushover curve for PUSH X For RCC of 10 storey:**

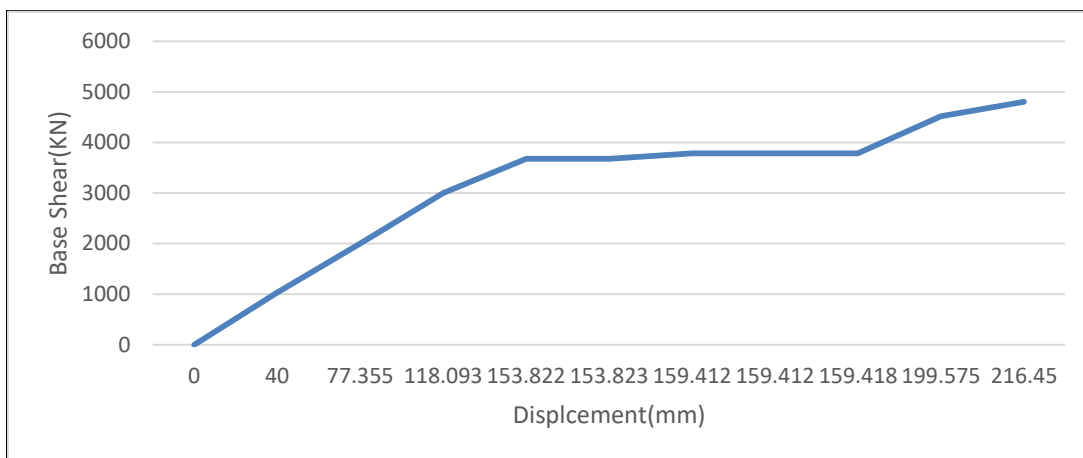


Figure 4.11. Pushover curve for Push-x of RCC model

Under a incremented lateral loading the element may yield sequentially. At every step the structure experiences loss in stiffness .Therefore slope of curve gradually decreasing..

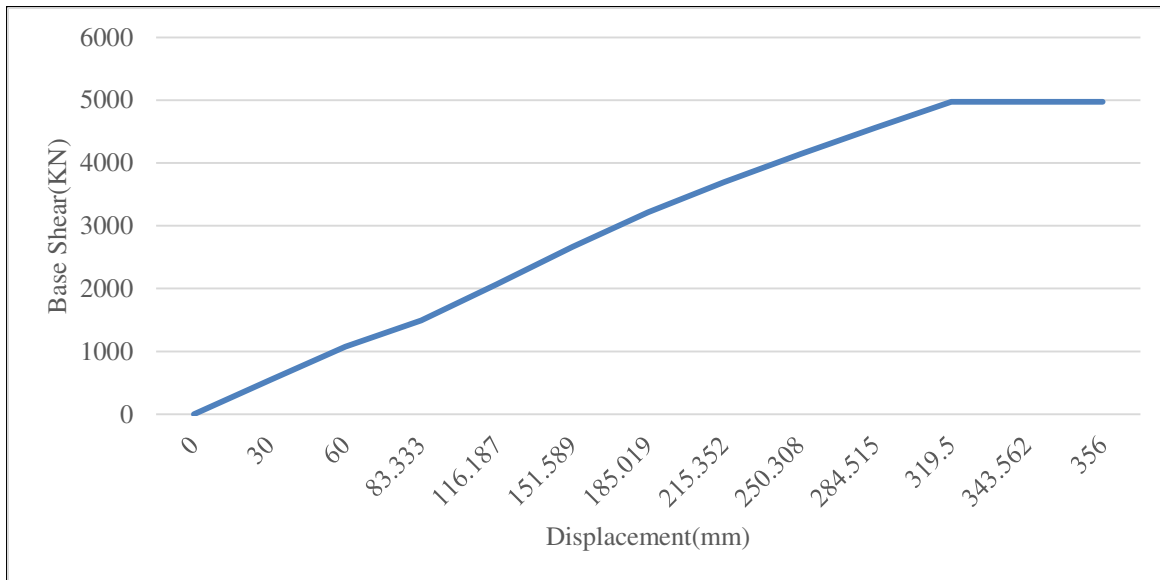


Figure 4.12. Pushover curve for Push-x of Composite model

At every step the structure experiences less loss in stiffness .Therefore slope of curve gradually is less decreasing as compare to RCC structure.

## V. CONCLUSION

- 1.The sizes of column for composite structure is smaller as compare to sizes of column in RCC structure.
- 2.For a all composite column structure base shear is minimum as compare to RCC structure.except 5 story structure at a performance point.
- 3.As we know that performance point decides feasibility or stiffness of structure .Composite structure is maximum displacement with less base shear. As compare to RCC frame.
- 4.Maximum Storey displacement of composite column structure is reduce as compare to RCC.
- 5.Maximum Storey drift of composite column structure is also reduced as compare to rcc structure.
- 6.Pushover curve for RCC structure reach yield point earlier as compare to Composite column structure.
- 7..Loss of stiffness is occurring in RCC structure as compare to Composite column structure,
- 8.For all structure monitored displacement of 600mm is used but Etabs programme does not reach this target displacement.
- 9.In case of composite column structure first hinge between B-c is occurs at a maximum displacement as compare to RCC.
- 10.Finally I conclude that the average story drift observed in both building are less than 4% of storey height.which is maximum storey drift allowed for collapse prevention level.Hence it is concluded that the building s ie RCC and composite is overall safe.
11. Also composite column structure is better suitable for structure greater than 5 story because 5 storey structure does not give performance point of structure as compare to 10 storey structure.

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