International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 294-305

Push Over Analysis of RC Frame with Linked Column Frame System

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Abstract
Pushover analysis, also known as non-linear static analysis, is a method that is frequently used to examine or evaluate the structural vulnerability to earthquakes.The increase in number of earth quakes in recent days necessitate the development of new methods to strength the structures.Linked column frame system is one such method which helps to reduce the damage caused to structures.This paper aims to study the push over analysis on a RC frame with and without linked column system.Push over curve and hinge formation is also discussed here.

Keywords: *Pushover analysis,Linked column frame system,Push over curve*

Date of Submission: 01-07-2022 Date of acceptance: 11-07-2022

I. INTRODUCTION

Pushover analysis is a static method for calculating seismic structure deformations using a streamlined nonlinear method[3]. When there is an earthquake, buildings remodel themselves. The dynamic forces on a structure are transferred to other components as individual ones give way or fail.Linked Column Frame system is a consist of a linked column system in which 2 couple columns are attached by a link beam and a moment resisting frame.The moment resisting frame acts as gravity load bearing structure.Linked column system is asteel frame and acts a main lateral load bearing system[1].The links in link beam serve as a structural fuse that makes a self-sacrificing sacrifice by yielding to provide ductility, energy dissipation, and nonlinear softening behaviour while minimising the relative damage and inelastic behaviour of the structural members of the surrounding moment-resisting frame.

1.1 MODELLING

1.1.1 Frame description

A 6 bay frame of total length 36m and each bay having length 6m is considered.The frame has 13 stories and each storey has a height of 3m.Figure 1 shows the frame pattern.

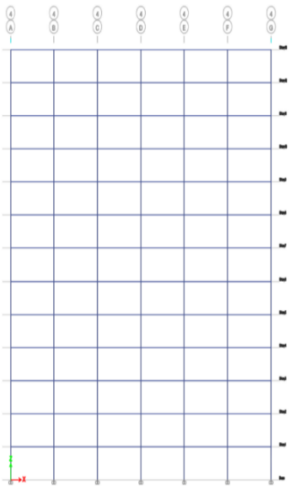

Figure1: Frame pattern

1.1.2Modelling of linked column system

Modelling is done using etaab section designer.Couple column ISWB 200 and link beam ISMB100 is used.The length of link beam is 500mm.Figure 2 shows the couple column property. Figure 3 shows the link beam section property. Figure 4 shows the linked column frame system.

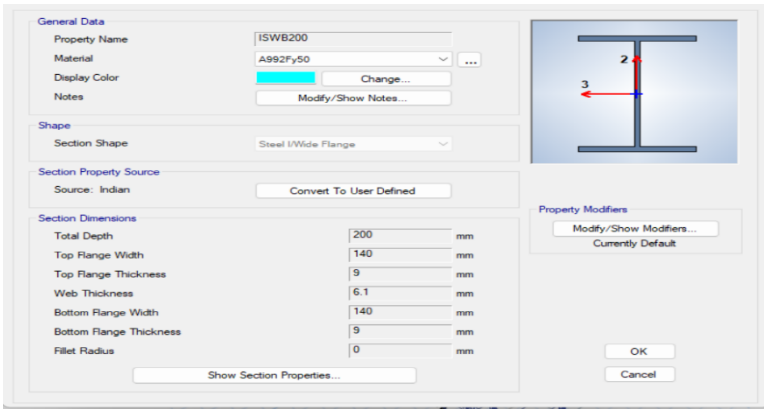

Figure 2: Couple column section property

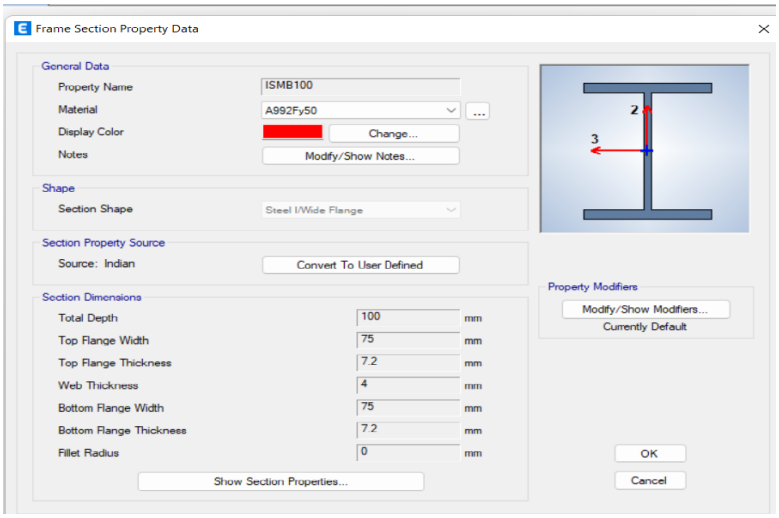

Figure3: Link beam section property

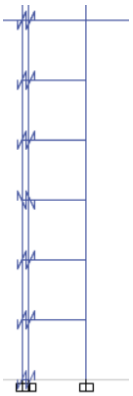

Figure 4: Linked Column Frame system

1.1.3 Modelling of patterns with linked column system

Different patterns are considered by placing linked column system in different manner and is shown below from figure 5 to figure 16.

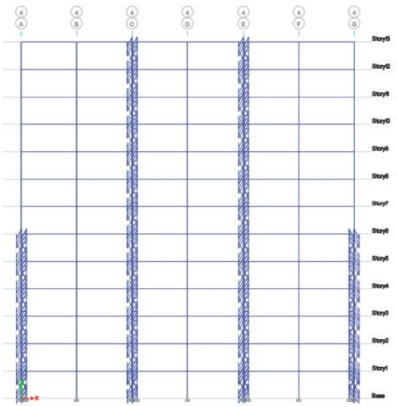

Figure 5: Pattern 1

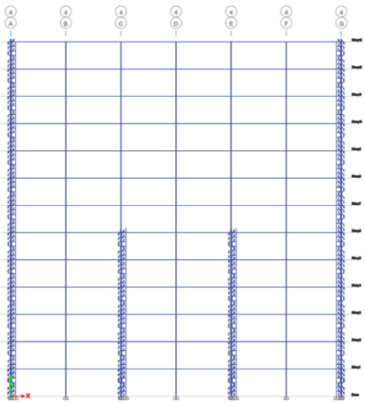

Figure 6: Pattern 2

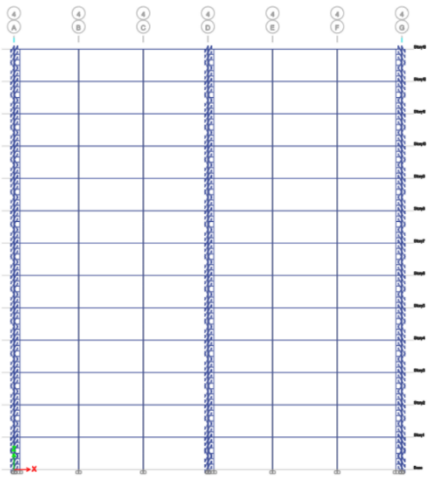

Figure 7: Pattern 3

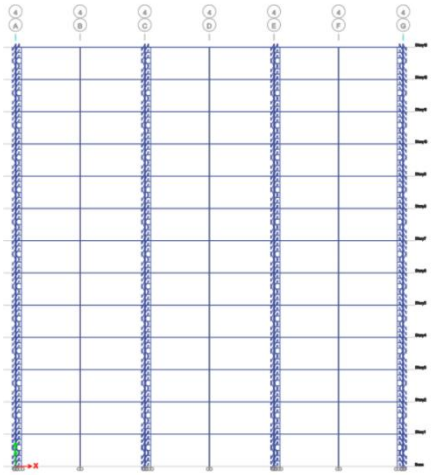

Figure 8: Pattern 4

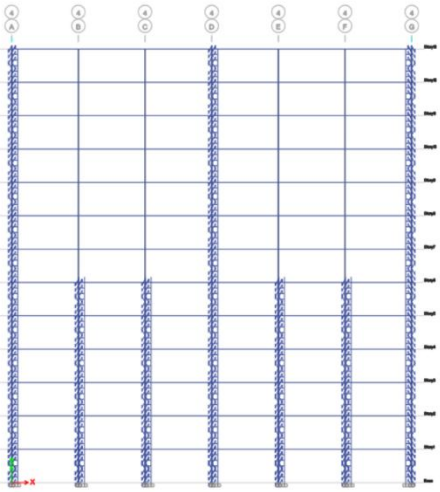

Figure 9: Pattern 5

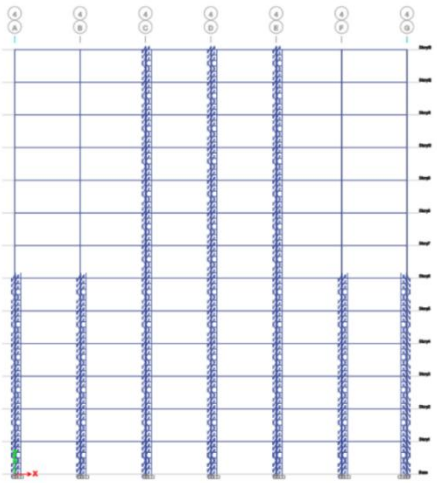

Figure 10: Pattern 6

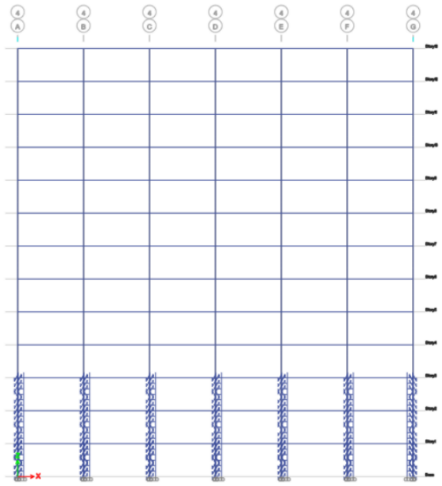

Figure 11: Pattern 7

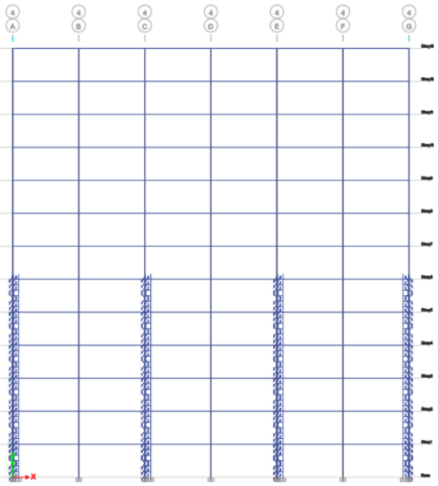

Figure 12: Pattern 8

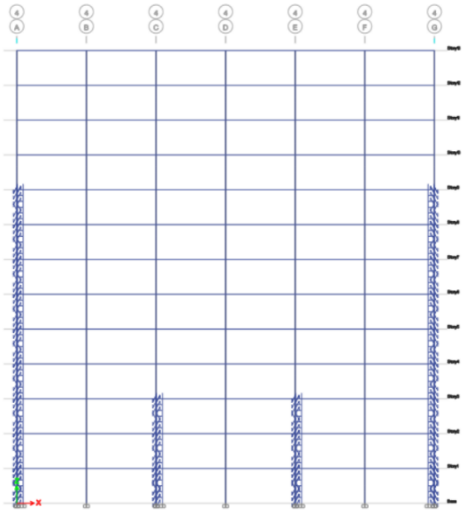

Figure 13: Pattern 9

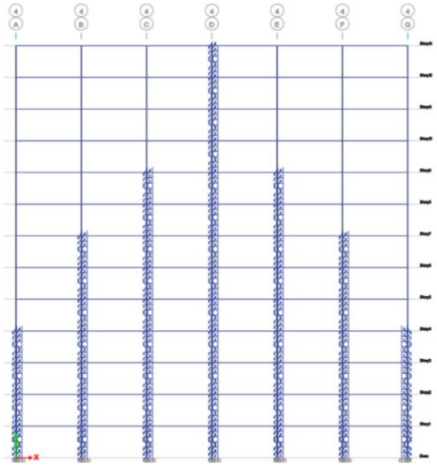

Figure 14: Pattern 10

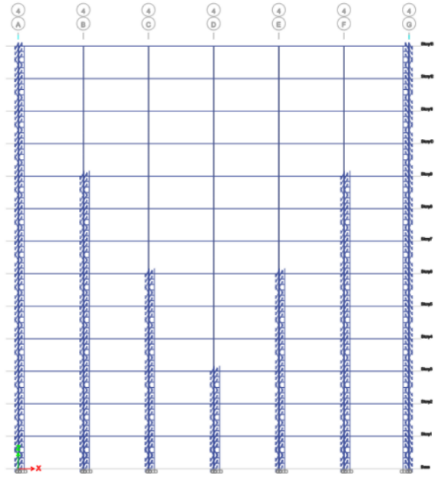

Figure 15: Pattern 11

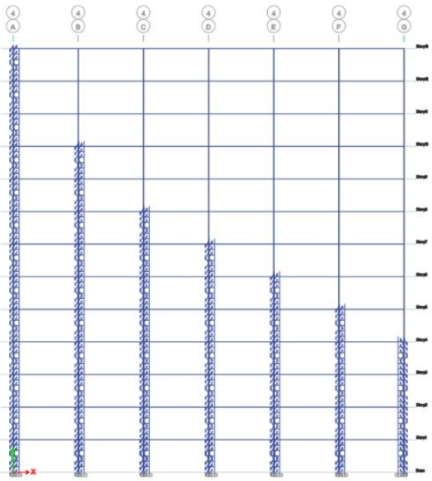

Figure 16: Pattern 12

II. RESULT AND DISCUSSION

Push over analysis is carried out on concrete frame and on all patterns.The result after analysis include pushover curve and sequence of formation of hinge and is discussed below.

2.1 Push over curve

Push over curve is also known as capacity curve is a plot in which displacement is shown in X axis and base shear is shown in Y axis.Figure 17 shows the push over curve.

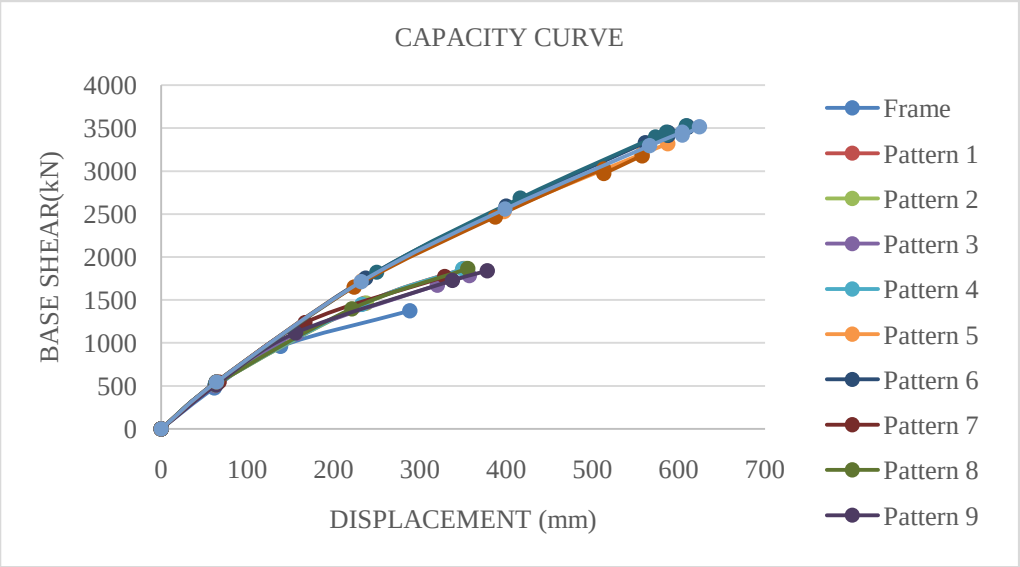

Figure 17: Push over curve

From the graph,it is understood that all patterns have greater displacement and base shear value than that of frame. The displacement is highest for pattern 6 and base shear is highest for pattern 6.

The maximum value of displacement and base shear of frame and all patterns are taken and a table is formed as shown in table 1.

Table 1: Result

Name	Displacement (mm)	Base shear (kN)	% difference in displacement	% difference in base shear(lateral load capacity)
Frame	288.243	1373.4182	1	1
Pattern 1	351.185	1864.2827	21.836	35.74
Pattern 2	353.685	1864.2121	22.704	35.735
Pattern 3	357.381	1783.7819	23.986	29.87
Pattern 4	349.736	1862.8364	21.33	35.63
Pattern 5	587.25	3317.5406	103.734	141.55
Pattern 6	610.403	3509.6165	111.766	155.538
Pattern 7	328.984	1772.4897	14.134	29.056
Pattern 8	355.485	1865.5279	87.689	35.83
Pattern 9	378.151	1838.2871	31.191	33.84
Pattern 10	609	3510.9109	111.28	155.633
Pattern 11	557.847	3177.2727	93.5335	131.34
Pattern 12	624.301	3514.1121	116.588	155.866

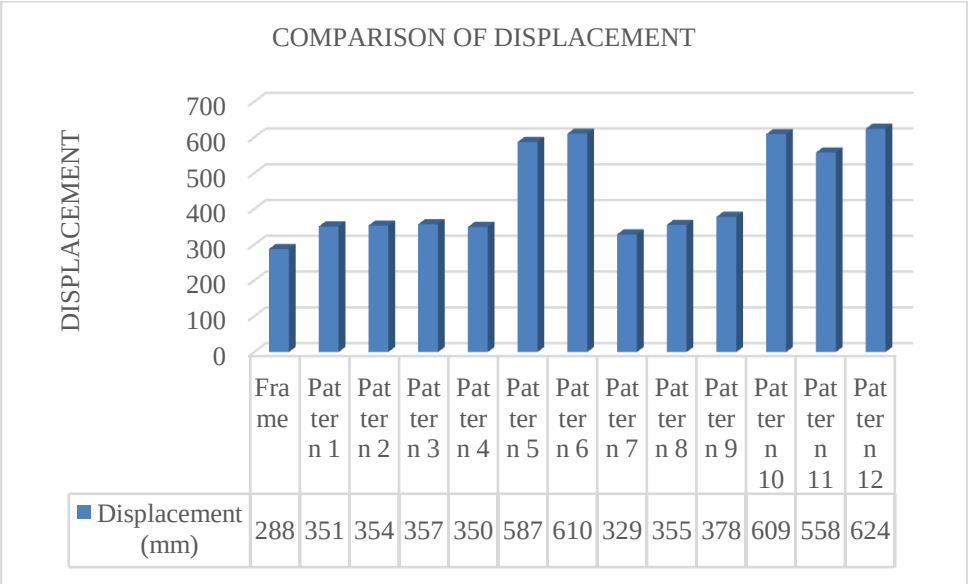

Figure 18: Comparison of displacement

Figure 18 shows the comparison of displacement of frame and other patterns.Pattern 12 has highest displacement and is about 624.Frame may fail when displacement is about 288 wheras pattern 12 may fail when displacement is about 624.

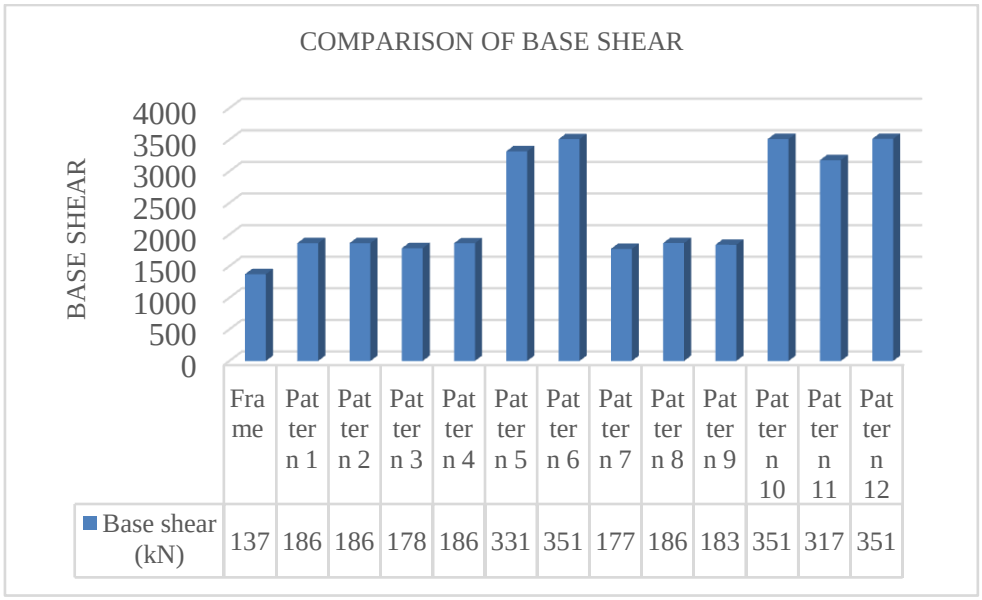

Figure 19: Comparison of base shear

Figure 19 shows the comparison of base shear of frame and different patterns. Pattern 12 has highest base shear and is about 3514kN. That means pattern 12 has highest lateral load capacity.

2.2 Plastic hinge formation

The sequence of plastic hinge formation of state of hinge is obtained after push over anlaysisand is shown in below figures from figure 20 to figure 31.The black ,green,sea green,purple,and red colour shown in colour bar from figure 20to figure 3 indicate the elastic, yielding, ultimate, failure, and breaking condition respectively.In the plastic hinge formation of frame, some of the hinges are in breaking condition which result in structure failure. The hinges are in yielding state in all the patterns in which linked column system are provided in different manners(figure 21 to figure 31).In the patterns in which linked column is provided,structure may fail only after the failure of linked column system.

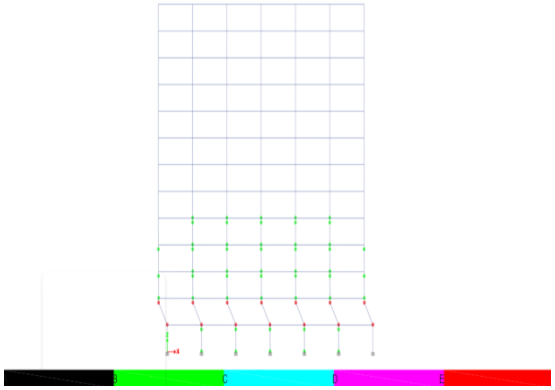

Figure 20: Plastic hinge formation of Frame

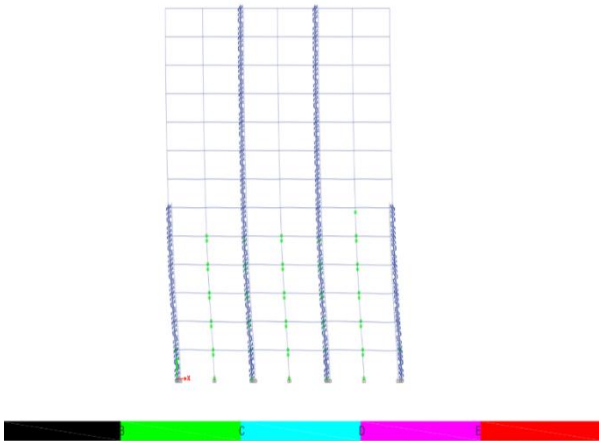

Figure 21: Plastic hinge formation of pattern 1

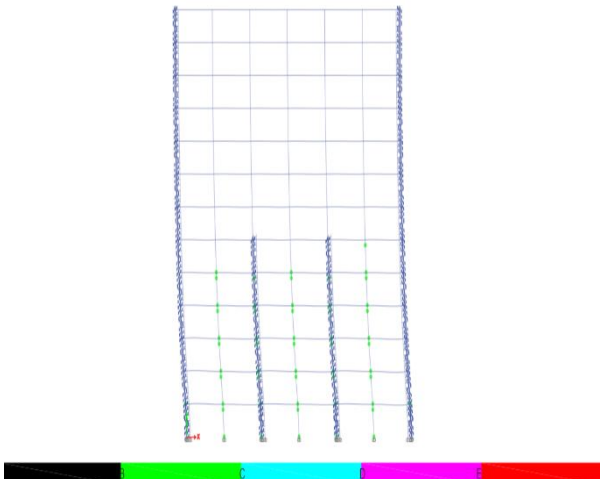

Figure 22: Plastic hinge formation of pattern 2

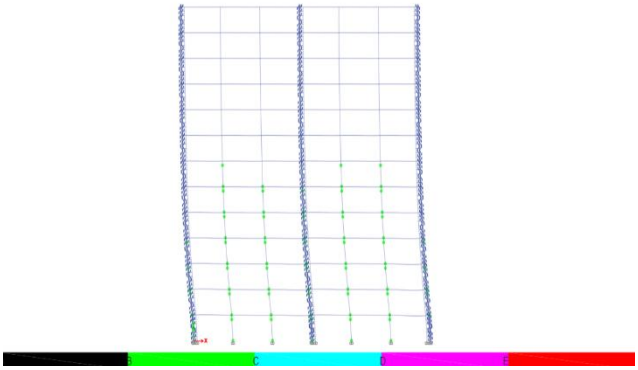

Figure 23: Plastic hinge formation of pattern 3

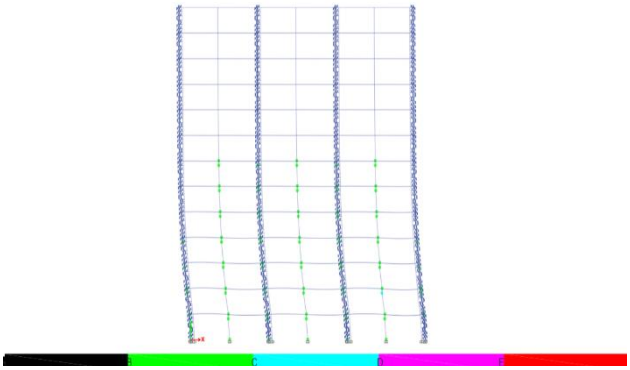

Figure 24: Plastic hinge formation of pattern 4

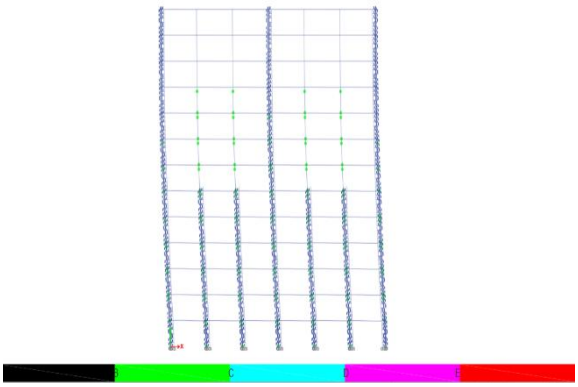

Figure 25: Plastic hinge formation of pattern 5

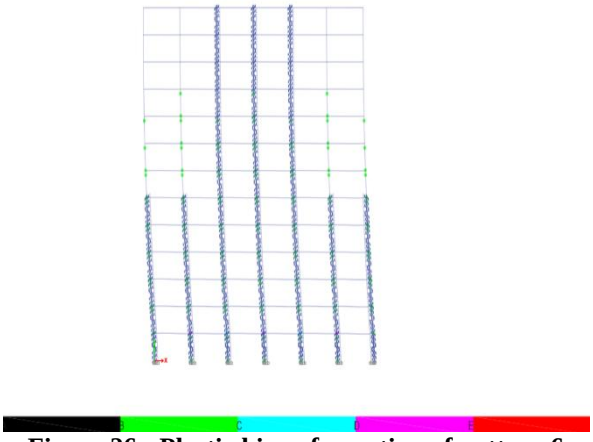

Figure 26: Plastic hinge formation of pattern 6

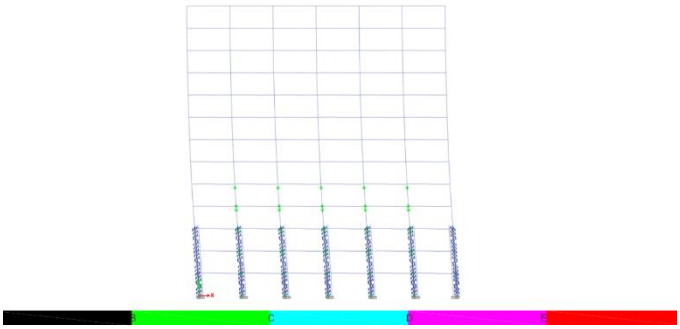

Figure 27: Plastic hinge formation of pattern 7

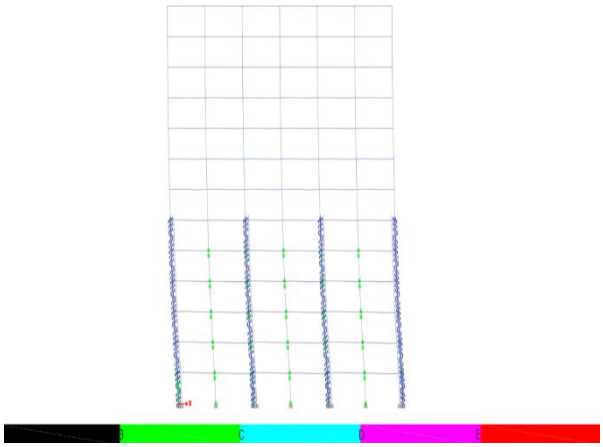

Figure 28: Plastic hinge formation of pattern 8

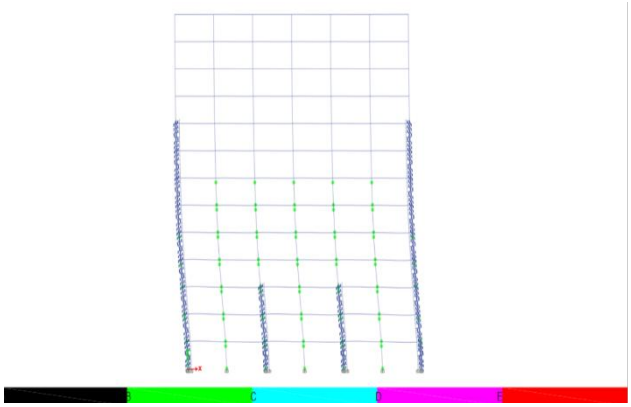

Figure 29: Plastic hinge formation of pattern 9

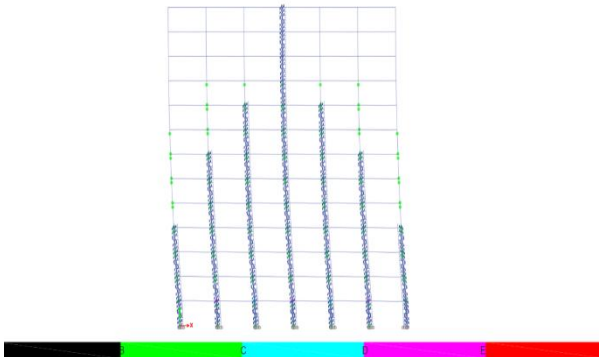

Figure 30: Plastic hinge formation of pattern 10

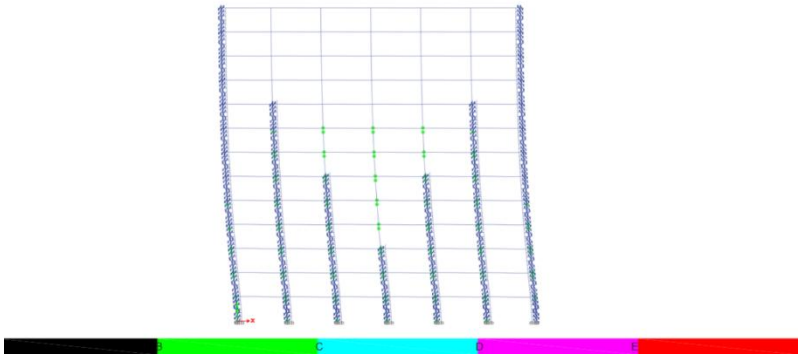

Figure 31: Plastic hinge formation of pattern 11

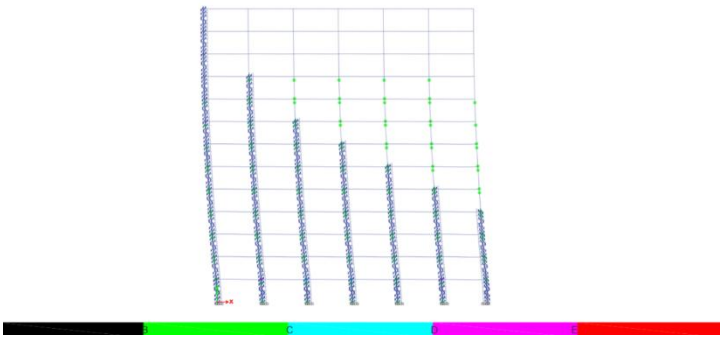

Figure 32: Plastic hinge formation of pattern 12

III. CONCLUSION

It was observed that displacement and base shear of pattern 12 has higher value than frame and all other patterns.By using linked column frame system the lateral load capacity can be improved. Also the failure of structure can be prevented by using linked column frame system.

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