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STUDY THE EFFECT OF CONSTRUCTION SEQUENCE ANALYSIS ON R.C.C. FRAMED STRUCTURE USING STAAD PRO

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Abstract: In this paper we have considered a multi-storey residential building (G+15) with different bay width. The building model is situated in seismic zone-IV for seismic parameters we have considered the Indian standard code (IS: 1893-2002) and analyzed it with STAAD Pro. The structure is a reinforced concrete frame with conventional beam slab system. Two cases have been considered for the study and comparison. Whereas in first case the model of building will be analyzed as a whole for the subjected loading and in second case the same model of building will be analyzed with reference to the construction sequence or staged construction for the subjected loading. Finally, a comparative study of axial forces, bending moments, shear forces was done at every storey for full frame model and construction stage model.

Keywords: Conventional analysis, construction sequence analysis, false work load, inspection live load, sequential gravity load, construction loads.

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INTRODUCTION

In conventional analysis or traditional analysis the building structure is analyzed in a single step using linear static analysis method the results obtained are linear in nature but during construction the loads may vary from the loads we have considered at the time of conventional analysis. Such variation in load may affect the serviceability of building. So that building should be analyzed at each stage of construction. The method to perform such analysis is known as construction sequence analysis or stage analysis. In this method the structure is analyzed at each stage of building. The results obtained from construction sequence analysis are different than the results of conventional analysis. Separating the results of earthquake shaking due to sustained loading was an immensely complex problem that required a critical seismological study and materials-based investigation, including evaluation of floor response spectra and contents damage, with an unusually in-depth nonlinear time-dependent analysis phase.[1]

Which is one of the type of construction sequence analysis. Construction sequential analysis is becoming an essential part during analysis as many well recognized analysis software included this facility in their analysis and design package

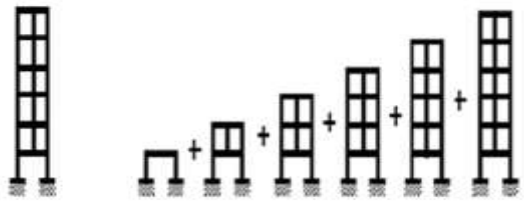


Fig 1.Conventional Vs Construction Sequence[5]

However this nonlinear static analysis is not so popular because of lack of knowledge about its necessity and scope. Like so many other analysis, construction sequential analysis have specific purposes in design phase of the structures. As it is mentioned earlier, it deals with nonlinear behavior under static loads in the form of sequential load increment and its effects on structure considering the structural members are started to react against load prior of completing the whole structure.[2] Construction Sequence analysis allows selectively application of load to the member of the building as the structure progressed in construction and considering the variation in forces in structures like axial force, shear force and moments. Two cases have been considered for the study and comparison. Whereas in Case 1 the building will be analyzed as a whole for the subjected loading (DL, LL, EQ) by using STAAD Pro software and in Case 2 the building will be analyzed with reference to the construction sequence or staged construction

for the subjected loading by using STAAD Pro software.[3] At last comparison of results for axial load ,moments. displacement from both the cases.

LITERATURE REVIEW

Sr. No.	References	Evolution Approach
1	Rosenboom O.A., Paret T.F.And Searer G.R (2012)	The detailed approach about the creep and shrinkage formation due to lateral load during construction stages
2	Yousuf Dinar, Munshi Md. Rasel, Muhammad Junaid Absar Chowdhury, Md. Abu Ashraf (2014)	The variation in steel and RCC frames while analyzing with construction sequence analysis.
3	K M Pathan, Sayyad Wajed Ali, Hanzala T Khan, M S Mirza, Mohd Waseem, Shaikh Zubair (2014)	Very good paper and gives detailed about constructional sequence loading pattern as specified in IS 14687:1999 and analysis is done by STAAD Pro.
4	B Sri Harsha & J Vikranth (2014)	This paper is concluded on the variation of forces due to construction sequence analysis and analyzed structure with Etabs.
5	R. Pranay, I. Yamini Sreevalli, Er. Thota. Suneel Kumar (2015)	The damages come in knowledge while analyzing with construction sequence analysis in this paper analysis is done by Etabs and check the effect on plinth beam.
6	Sagupta R. Amin, S.K. Mahajan (2015)	In this paper the approach of loading pattern and the methodology terms are very nice approachable for the actual construction loads which have to be considered while doing construction sequence analysis.

DETAILS OF STRUCTURE

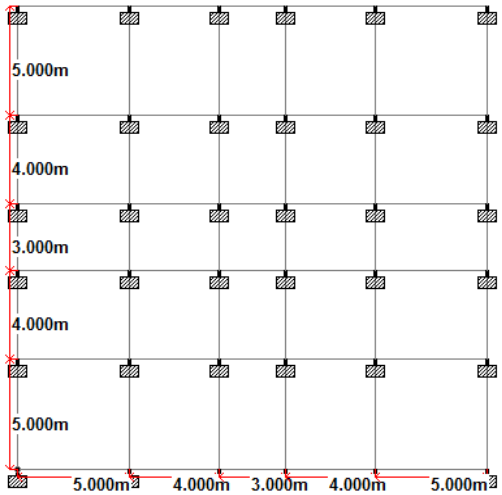
Structure	G+15
Beam Size	(500 X 500)mm
Column Size	(550 X 550)mm
Slab Size	200 mm
Material	M25 Fe415
Seismic Zone	IV
Importance Factor	1
Frame Type	SMRF (R=5)

DESIGN CODES

- IS 456:2000 - Code of practice for plain and reinforced concrete[6]
- IS 875:1987 (Part 1) - Code of practice for design loads (Dead Load)[7]
- IS.875:1987 (Part 2) - Code of practice for design loads (Live Load)[7]
- IS 1893:2002 - Criteria for earthquake resistant design of structures[8]
- IS 14687:1999 – False work for concrete structures – guidelines[9]

MODELING OF STRUCTURE

In this paper, models of G+5 G+10 and G+15 RC buildings frames with bays of different length and width are analyzed using STAAD pro



Fig(2) Plan View Building

Various stiffness governing factors such as bay width/length, storey height, etc. are decided as basic parameters. Three frames of G+5 G+10 and G+15 RC buildings of bay width/length 5m, 4m and 3m and storey height 3m were modeled and analyzed with conventional analysis method and by construction sequence analysis method. These models were used for the comparison of responses of various forces in terms of axial forces, bending moments, shear forces and displacements shows the typical floor plan of the models.[3]

LOADING OF STRUCTURE

Conventional Analysis

1) Dead Load(DL)

Self weight of columns and beams

Self weight of dry concrete slab (Density = 25 KN/m3)

Floor Finish = 1 KN/m2(refer IS 456:2000)

2) Live Load(LL)

3 KN/m2 (refer IS 875:1987 Part II)

Roof Live = 1.5 KN/m2(refer IS 875:1987 Part II)

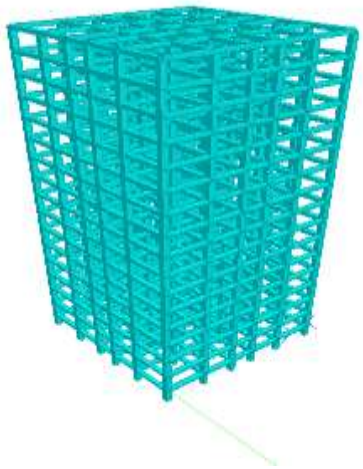


Fig 3- 3-D Model of Whole Building

3) Seismic Load(EQ)

Earthquake Loads and different load combinations as per I.S. 1893-2002 Part II in Earthquake Zone IV considering ductile detailing.

Z	**0.24**
I	1
R	5
Soil Type	II

4) Load Combination

1.2(DL+LL+EQ)

Construction Sequence Analysis

1) Dead Load(DL)

i) Self-weight of columns and beams;

ii) Self weight of dry concrete slab (Density = 25 KN/m3)

iii) Self weight of wet concrete slab (freshly poured) Density = 26 KN/m3 (refer IS 14687:1999)
iv) False work dead load 500 N/m2 (refer IS 14687:1999)

2) Live Load(LL)

i) Inspection live load on *Constructed* floor slab 750 N/m2 (refer IS 14687:1999)

ii) Construction live load on floor slab being constructed [assumed adequate to be equal to inspection live load i.e. 750 N/m2 (refer IS 14687:1999)

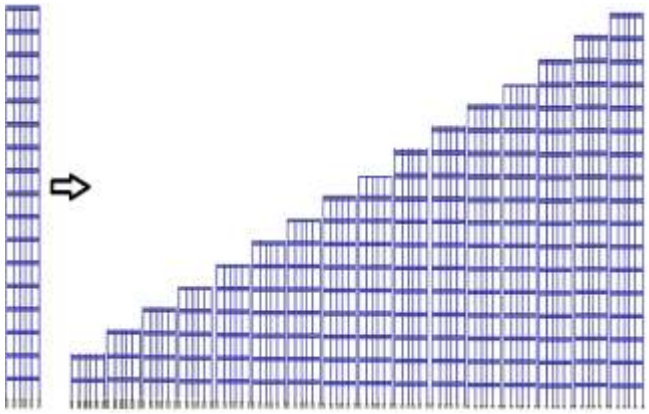


Fig 4 - Conventional analysis Vs Construction Sequence Analysis

3) Seismic Load(EQ)

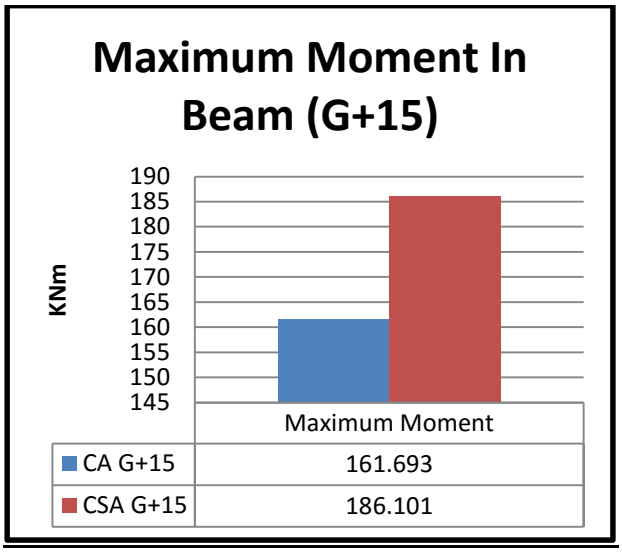
Earthquake Loads and different load combinations as per I.S. 1893-2002 Part II in Earthquake Zone IV considering ductile detailing.

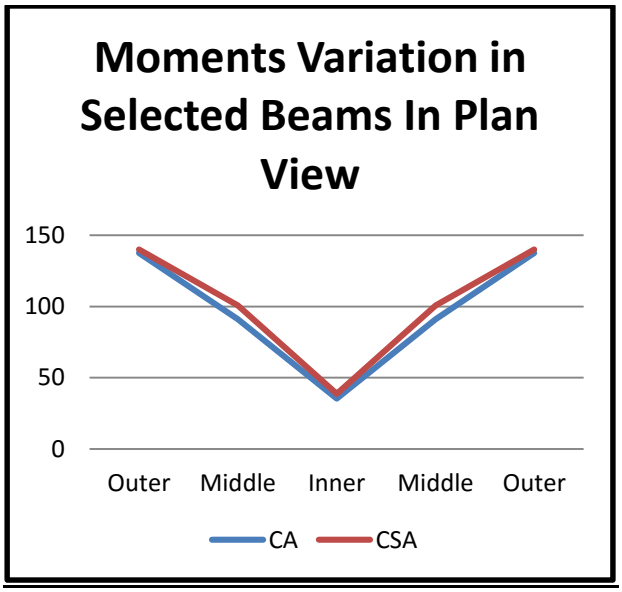
Z	**0.24**
I	1
R	5
Soil Type	II

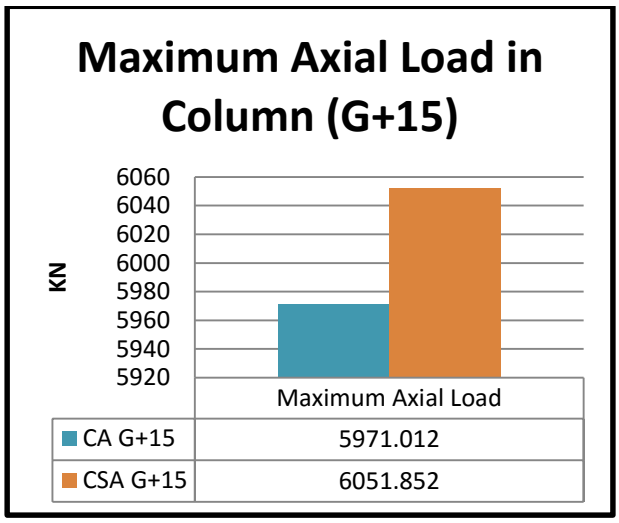
4) Load Combination

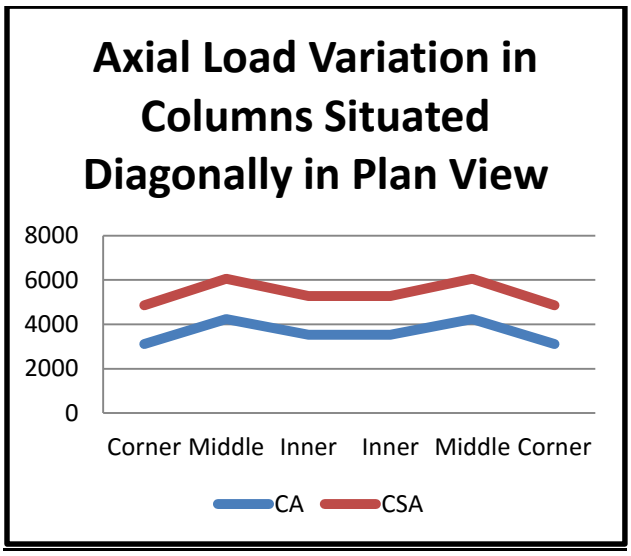
1.2 (DL+LL+EQ)

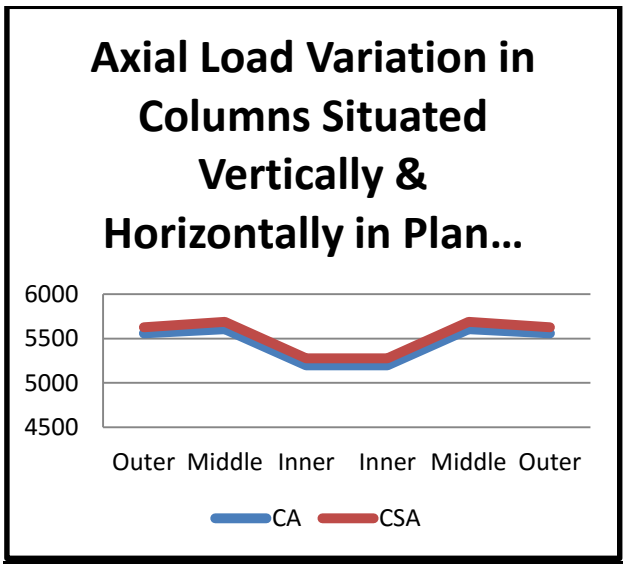
RESULTS

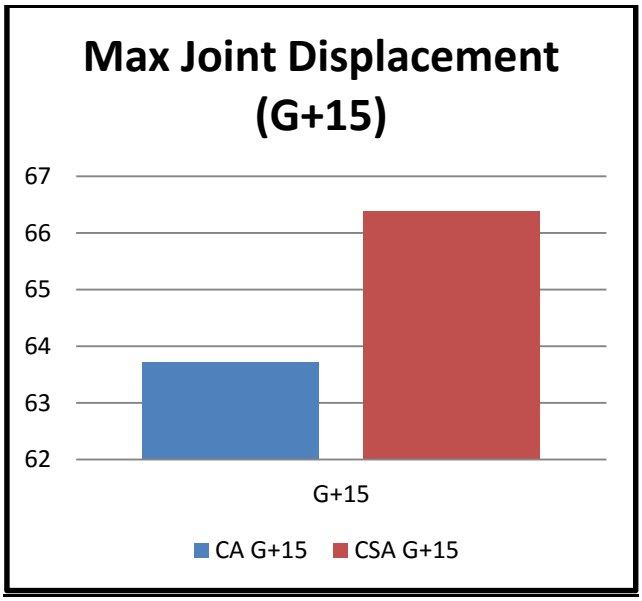

Maximum Moment In Beam (G+15)
KNm
190
185
180
175
170
165
160
155
150
145
Maximum Moment
CA G+15
161.693
CSA G+15
186.101

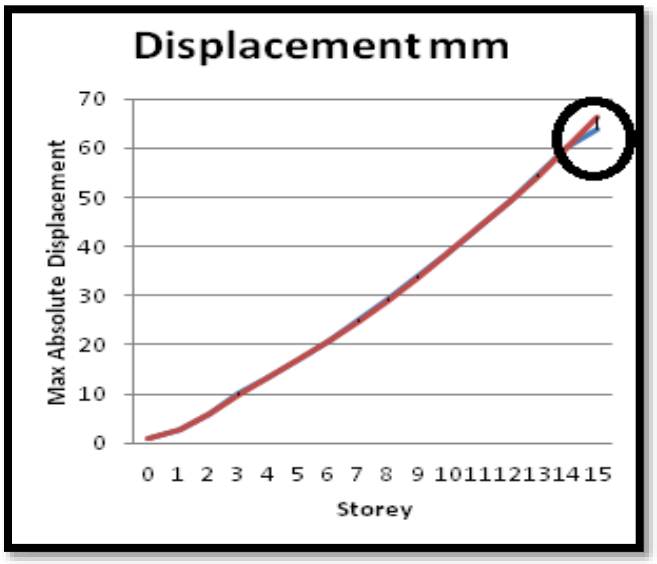

Moments Variation in Selected Beams In Plan View
150
100
50
0
Outer
Middle
Inner
Middle
Outer
CA
CSA

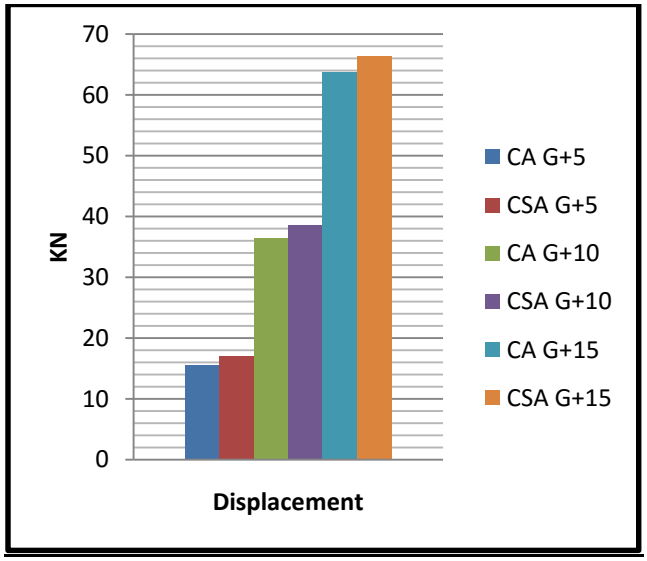

Maximum Axial Load in Column (G+15)
KN
6060
6040
6020
6000
5980
5960
5940
5920
Maximum Axial Load
CA G+15
5971.012
CSA G+15
6051.852

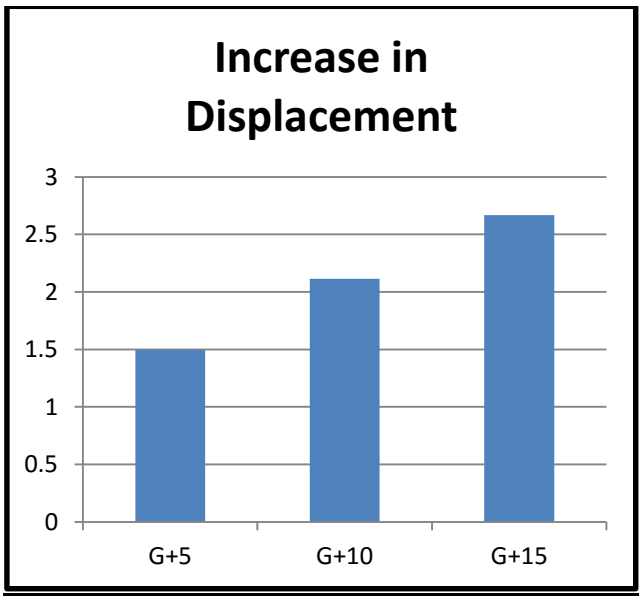

Axial Load Variation in Columns Situated Diagonally in Plan View
8000
6000
4000
2000
0
Corner Middle Inner Inner Middle Corner
CA
CSA


Axial Load Variation in Columns Situated Vertically & Horizontally in Plan…
6000
5500
5000
4500
Outer Middle Inner Inner Middle Outer
CA
CSA


Max Joint Displacement (G+15)
67
66
65
64
63
62
G+15
CA G+15
CSA G+15


Displacement mm
Max Absolute Displacement
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 101112131415
Storey


KN
70
60
50
40
30
20
10
0
Displacement
CA G+5
CSA G+5
CA G+10
CSA G+10
CA G+15
CSA G+15



DISCUSSION ON RESULTS

While comparing the moments induces in selected beams are observed greater in construction sequence analysis. The graph indicate, in our structure the middle selected beams are showing higher difference in results of construction sequence analysis and conventional analysis.

After observing the results for max axial load on column at different positions of building, obtained higher value of axial load in construction sequence analysis .The graphs shows that the difference in conventional analysis and construction sequence analysis are varying diagonally and perpendicularly and shows higher variation result in mid corner column.

In construction sequence analysis, main area to be observed is displacement and while comparing the results of displacement in conventional analysis and construction sequence analysis, construction sequence analysis gives higher value of displacements and the graph shows the result of floor to floor comparison with respect to joints the results are near about same till the roof to be constructed but at the roof level sudden change in values of displacement are observed. In addition to this as we constructing higher buildings we are getting the difference in values of displacement in conventional analysis and construction sequence analysis are increasing.

CONCLUSION

It is concluded that simulation of sequence of construction in the construction sequence analysis leads to considerable variations in deformations and design loads observed by conventional analysis.

As the height of structure increasing the difference in results of conventional analysis and construction sequence analysis is also increasing.

Therefore it is necessary that for Multi storey building frames the construction sequence effect shall be taken into consideration.

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