ANALYSIS OF G+25 STOREY RESIDENTIAL BUILDING USING CONSTRUCTION SEQUENCE ANALYSIS WITH FLOATING COLUMN USING ETABS

Mr. Mohammad Furquanuddin[1], Mr. Arun Kumar HR[2], Ms. Shilpa BS[3], Dr. Nagaraja Gupta MS[4]

[1]Student, Master of Technology, Department of civil engineering, East West Institute of Technology, Bangalore
[2]Associate Professor, Department of civil engineering, East West Institute of Technology, Bangalore
[3]Associate Professor, Department of civil engineering, East West Institute of Technology, Bangalore
[4]Professor and HOD, Department of civil engineering, East West Institute of Technology, Bangalore

---***---

Abstract - The majority of the time when using FEM software to examine a multistorey building frame, a complete model is created, then the model is applied with loads at once. However, in real structures, the actual load is applied to the structure in phases as the building is constructed. Construction sequence analysis, a non-linear static analyzing technique that analyses the structure step by step by establishing an automatic construction load case in FEM software, was therefore developed to address the existing problem. The current investigation, which is being done on a G+25 residential structure, uses the CSI ETABS 2016 programme to do standard Equivalent static analysis and construction sequence analysis for the dead load situation. According to Indian Standard Code IS:1893-2002, the structure is of the RC and steel frame type and has a floating column, with two sets of models RC and steel having the same position as the outer column and the other two sets of models RC and steel having the same position as the inner column. It is located in zone 2. Results from the analysis that are generated using the CSA and ESA are abstracted, including bending moment, shear force, and column axial force.
.

***Key Words*:** Construction Sequence Analysis, Equivalent Static Analysis, Floating Column, ETABS.

1.INTRODUCTION

During eighties structure where short in height and long in length but during twenties a major demand for high rise multi-storey buildings are required to have more space due to highly dense cities and less plane area. This demand for high structure is also due to the increase in population index. Some other aspects to consider a high-rise structure is due to their aesthetic looks and functional requirements.

High-rise structures must be accurately analyzed and designed in accordance with architectural and structural standards. It is essential that they must be built and designed to function well and without failure

To overcome manual errors some computer-based software programmes came into existence to analysis the structure in a detailed and steps by step manner. In general practice the designer used the software. Since in the most cases the load is applied to a full complete model but this is not the actual case during the construction process in the field, instead the load will come on the structure as the construction progress storey by storey. However, the above point is neglected which leads to error in results. This error can be controlled by using construction sequence analysis method for both types of structure which having floating column and without floating column. In order to distribute the tension and compression forces coming from the top floor, a structure must be adequately analyzed at every step of construction.

Construction sequence analysis is a non-linear static analyzing technique that analyses the structure step by step by establishing an automatic construction load scenario in software. Construction sequence analysis is used in all types of structures that are built in phases, although it is most frequently used in constructions that have floating columns.

Since the influence of a floating column is ignored by a traditional comparable linear static analysis.
A vertical element that rests on a beam or transfer girder but does not touch the foundation is referred to as a floating column. To add more floor space, a building with floating columns is used. This additional area might be used for a parking lot, along with others. The transfer girders in seismically active zones must be carefully planned, studied, and described.

OBJECTIVES

- To identify the actual performance of structure under floating column.
- To identify the actual performance of structure under sequence construction analysis with the case dead.
- On the basis of non-linear static construction sequence analysis (for dead load case) as well as linear static equivalent analysis the models are analyse
- Checking out the results such as bending moment (BM) and shear force (SF), axial force (AF), three

bottom and three top storeys bending moment for both the above analysis method

- To know the results for different position for floating column under sequence application of load

2.MODELLING AND ANALYSIS

The study is carried out for 25 storey models having storey height 3.1m and subjected to earthquake load by equivalent static method and sequential construction analysis method. The structures are placed in zone 2 in medium soil. Basic building model details

sl.no	Type of models	Model 1	model 2	Model 3	Model 4
1	Software	ETABS 2016			
2	Size in x and y in metre	30x18	30X18	30x18	30x18
3	Spacing in x c/c	6,5,4,4.5,6			
4	Spacing in y c/c	5,4,4,5			
5	Grade of concrete	M50, M25	M50, M25	M25	M25
6	Grade of steel	Fe500		Fe345	
7	Wall thickness	200mm			

LOADS INCLUDED KN/m²				
Typical Live	3	3	3	3
Floor Finish	1.5	1.5	1.5	1.5
Roof Live	1.5	1.5	1.5	1.5

Wall load is taken four all the four model as 5.5 KN/m. The details of four models are listed below

Model 1- RCC frame having position of floating column outside

Model 2- RCC frame having position of floating column inside

Model 3- Steel frame having position of floating column outside

Model 4- Steel frame having position of floating column inside

ELEMENTS OF STRUCTURE				
Column Size	500x500 mm 600X600 mm	500x500 mm 650x650 mm	Steel tube 550x550 mm with cover 25 mm	Steel tube 550X550 mm with cover 25 mm
Beam Size	600mmx300mm		ISMB 600	ISMB 600
Secondary Beam Size	-		ISMB 450	ISMB 450
Transfer Beam Size	600mmx300 mm	600X350 mm	Built up I-section	Built up I-section

Following is the plan at second story which represents the position of floating column in all the four models.

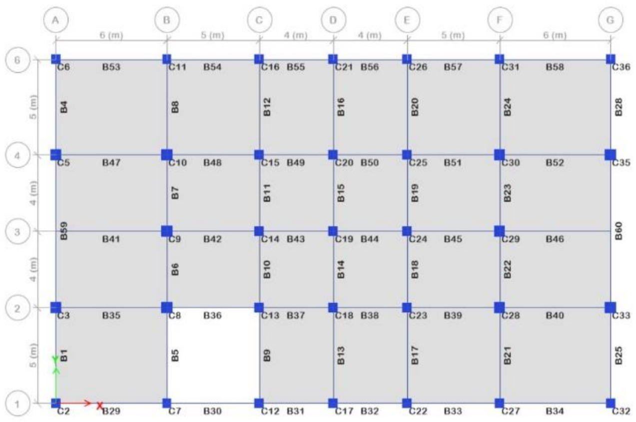

Fig -1: 2D plan view of RCC Model 1 AT Storey 2

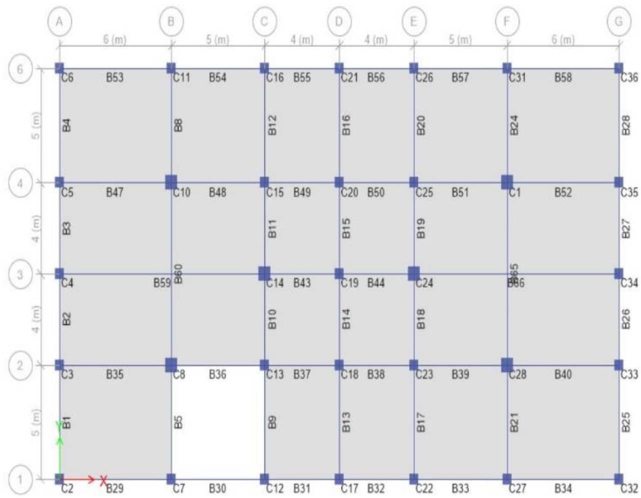

Fig -2: 2D Plan View of RCC Model 2 At Storey 2

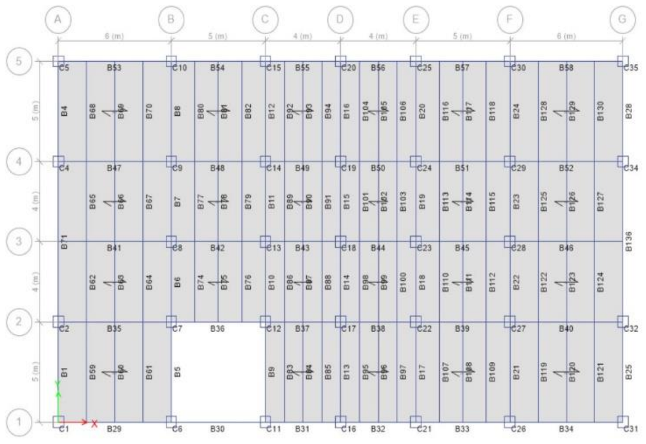

Fig -3: 2D Plan View of Steel Model 3 At Storey 2

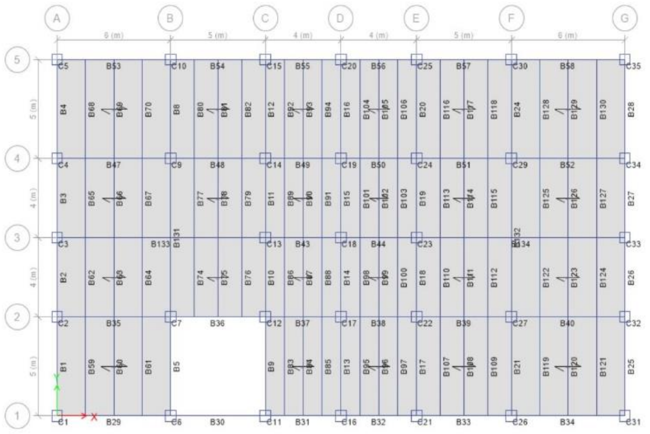

Fig -4: 2D Plan View of Steel Model 4 At Storey 2

Construction Sequence Analysis Process in ETABS

Step 1: Create the model by assigning the material properties, section properties, and other attributes.

Step 2: Assign all loads, such as floor finish, wall load, water-proofing load on terrace

Step 3: Select the define option in ETABS to define the auto building process.

Step 4. The following load cases will automatically generate the new load case as a nonlinear static stage structure.

Step 5. Run the analysis by selecting the load case as an automatic construction sequence in the analysis tab to obtain the findings

3.RESULTS

The following results compared for construction sequence dead load and for equivalent static dead load for the beam which supports floating column which is referred as transfer beam and a beam which connect to transfer beam is referred as connecting beam. To get the above set of objectives following results are compared by collating the following results. Construction sequence dead load and equivalent static dead load at story 2 for transfer beam and connecting beam. Values such as bending moment, shear force where taken, and from the obtained values percentage difference is find out. Following tables represent for bending moment and shear force percentage difference.

Table -1: bending moment %difference

AVG Pt% difference in bending moment between CSA and ESA			
Type of model	Position of floating column	Transfer beam	Connecting beam
Model 1 (RCC)	Outer	61.74%	41.15%
Model 2 (RCC)	Inner	70.75%	55.49%
Model 3 (Steel)	Outer	26.45%	32.2%
Model 4 (Steel)	Inner	54.98%	46.89%

Table -2: shear force %difference

AVG Pt% difference in shear force between CSA and ESA			
Type Of Model	Position of floating column	Transfer beam	Connecting beam
Model 1 (RCC)	Outer	50.45%	26.1%
Model 2 (RCC)	Inner	59.48%	41.52%
Model 3 (Steel)	Outer	22.08%	32.74%
Model 4 (Steel)	Inner	53.62%	38.48%

The following are the results for axial force

Axial force in column has an average variation between CSA and ESA load case. The following are percentage of variation in column axial force in reinforced concrete structure which is model 1 and in steel structure which is model 3

Table -3: Axial force %difference in model 1,3

	Column A	Column B	Column C
Model 1	0.31%	0.53%	1.97%
Model 3	0.04%	0.13%	10.41%

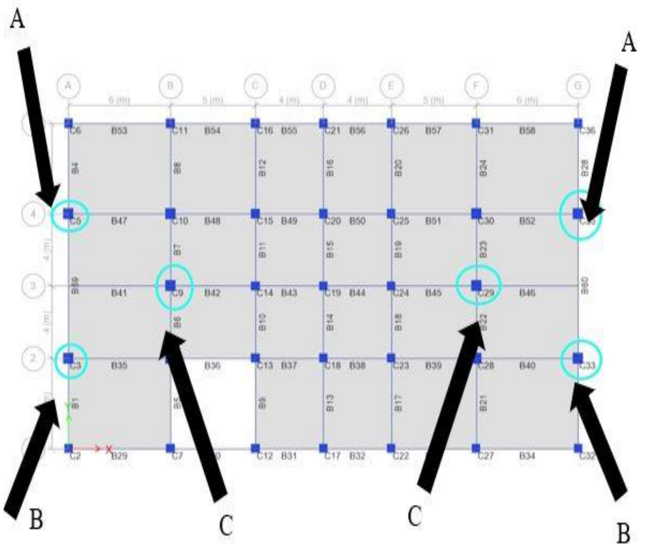

Fig -5: 2D column labelling At Storey 2 in model 1

Axial force in column has an average variation in CSA and ESA load case. The following are percentage of variation in column axial force in reinforced concrete structure which is model 2 and steel structure which is model 4. The following figure represents to denote column position

Table -4: Axial force %difference in model 2,4

	Column A	Column B	Column C	Column D
Model 2	0.40%	4.75%	5.2%	1.51%
Model 4	3.04%	3.93%	17.41%	4.42%

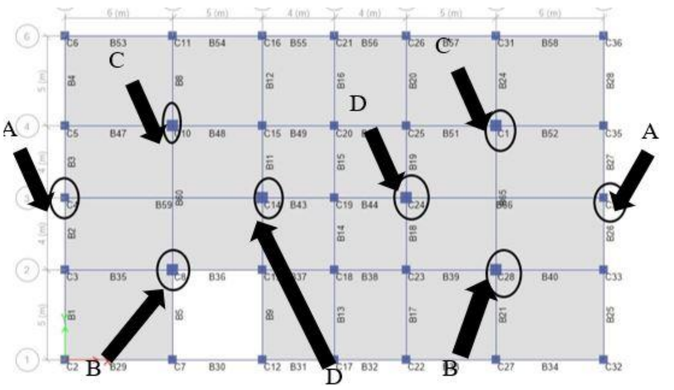

Fig -6: 2D column labelling At Storey 2 in model 2

The bending moment in transfer beam is taken also for bottom and top three storey for all the four models. The following are the tables which represents the bending moment and their %difference between construction sequence dead load and equivalent static dead load

Table -5: Pt% Difference in Bending Moment for Different Storey model 1

STOREY	Bending moment		PT% DIFFERENCE IN BM
	CSA	ESA	
2	605.67	372.11	62.76
3	398.99	295.5	35
4	309.38	257.31	20
23	24.84	57.49	131
24	21.8	57.78	165
25	13.92	44.79	221

For the above table 5 for bending moment chart is plotted and as follows

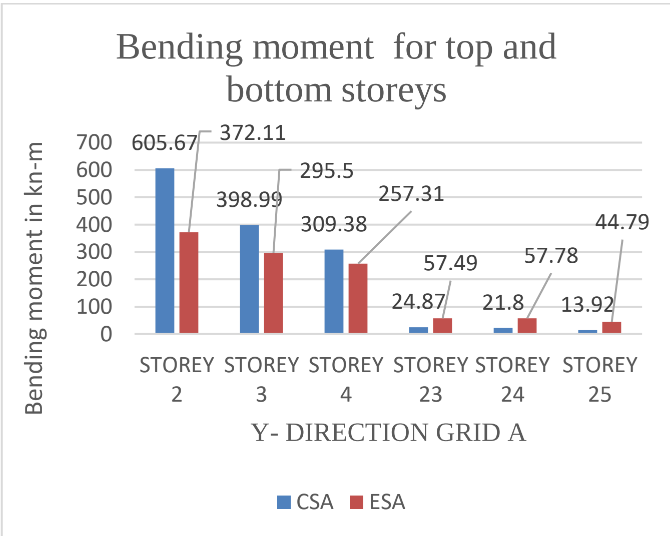

Fig -7: Bending Moment of Beams Along Storey model 1

Table -6: Pt% Difference in Bending Moment for Different Storey model 2

STOREY	Bending moment		% DIFFERENCE
	CSA	ESA	IN BM
2	806.68	469.1	71.96
3	451.29	322.78	39.81
4	353.37	281.36	25.59
23	37.79	82.54	118.41
24	31.85	83.14	161
25	21.16	51.73	144.47

For the above table 6 for bending moment chart is plotted and as follows

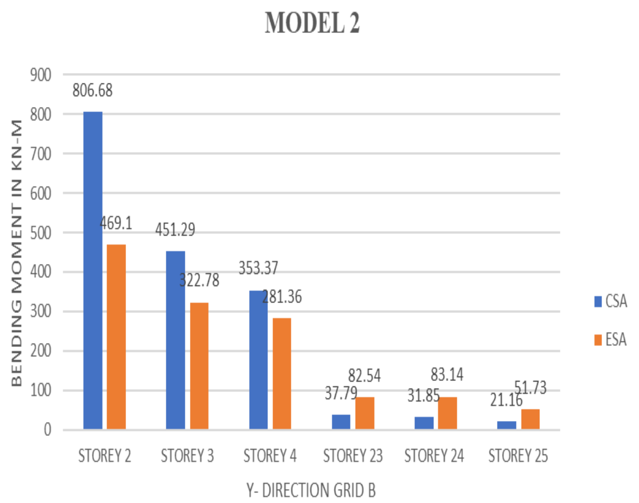

Fig -8: Bending Moment of Beams Along Storey model 2

Table -7: Pt% Difference in Bending Moment for Different Storey model 3

STOREY	Bending moment		% DIFFERENCE
	CSA	ESA	IN BM
2	1064.4	838.88	26.88
3	262.33	225.66	16.25
4	207.29	185.99	11.45
23	8.14	29.63	264
24	7.1	29.61	317
25	4.43	20.48	362.3

For the above table 7 for bending moment chart is plotted and as follows

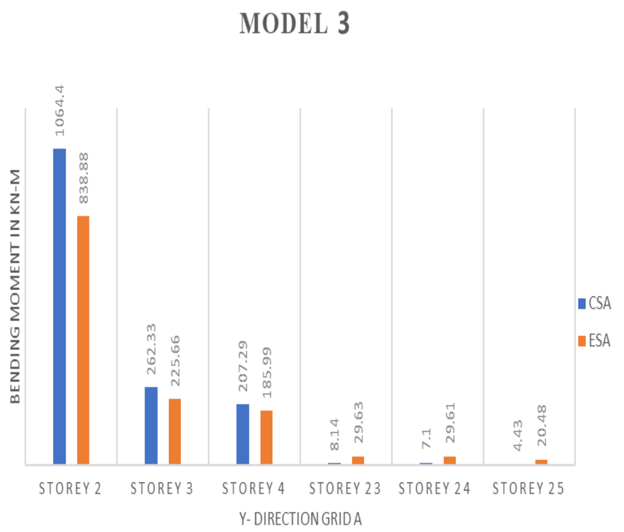

Fig -9: Bending Moment of Beams Along Storey model 3

Table -8: Pt% Difference in Bending Moment for Different Storey model 3

STOREY	BENDING MOMENT		% DIFFERENCE
	CSA	ESA	IN BM
2	1423.9	917.43	55.2
3	337.28	248.72	35.6
4	261.71	204.67	27.86
23	17.73	45.6	157.19
24	14.12	46.1	225
25	7.57	33.39	341

For the above table 8 for bending moment chart is plotted and as follows

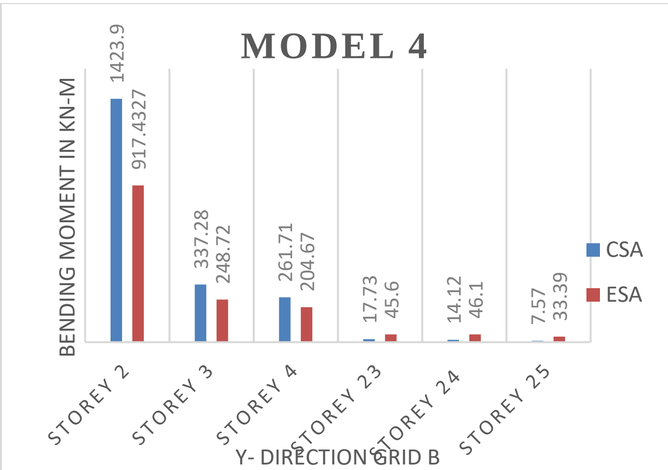

Fig -10: Bending Moment of Beams Along Storey model 4

4.CONCLUSIONS

1. From the table 1 it is concluded that the bending moment value in transfer beam as well as in connecting beam show a Pt% difference ranging between 26.45-70.75%
2. It is seen that from table 2, and 3 the bending moment and shear force shows Pt% difference more in case of reinforced concrete structure than steel structure
3. From table 2, and 3 it is concluded that in reinforced concrete and steel structure, the bending moment and shear force has more Pt% difference when the floating column is an inner column.
4. From the table 2 it is concluded that the shear force value in transfer beam as well as in connecting beam show a Pt% difference ranging between 22.08-59.48%
5. From both the tables 3 and table 4, the effect of construction sequence load case has less impact on axial forces of column as it is seen that the values of Pt% difference range between 0.04-17.41%
6. The table 5 to 8 shows the value of bending moment is more in bottom storeys and gradually decrease on top storeys, in case of construction sequence dead load case response
7. It is necessary to take construction sequence auto dead load case during analysis of a building with floating column because in all four models the difference in percentage is present.

REFERENCES

1. Prof. Mrs. K. Mythili and Mohammed Abdul Rahm “construction sequence analysis of a building with vertical discontinuity” global journal of engineering science October 2015
2. M. Lokanath Reddy & A Uday Kumar “construction sequential analysis and design of RC high rise buildings by ETABS” IJR volume 2, issue 12, December 2015
3. Geethu Girija das, Dr. Praseeda k “comparison of conventional and construction stage analysis of a RCC building” (IJSTE/ volume 3 / issue 03 / 008)
4. Santosh Panigrahi, Dr. Vikram Patil, Madan s. H, Somanagouda Takkalak “importance of construction sequence analysis in design of high-rise building” IJISET - international journal of innovative science, engineering & technology, vol. 6 issue 4, April 2019
5. Nikunj d. Banugariya and S. S. Solanke “analysis of multi-storey structures with respect to sequential analysis” © springer nature Singapore pt. ltd. 2019
6. S. D. Ajane, H. P. Rathi, S. A. Junghare “effect of construction sequence analysis with creep and shrinkage on a 4-storey building” (IJIRSET volume 9, issue 4, April 2020
7. Criteria for earthquake resistant design of structures from 1893(part 1):2002
8. Indian Standard Code of Practice for Plan and Reinforcement Concrete, IS: 456- (2000)
9. Is 875 (1987-part 1), Bureau of Indian Standards (bis), NEW Delhi, Code of Practice for Design Loads for Buildings and Structures, Dead Loads
10. Bureau of Indian Standards (bis), NEW Delhi, IS 875 (1987-part2), Code of Practice for Live Loads