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Advanced Construction Sequential Analysis of High Rise Building without Seismic Analysis

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Abstract -*While analyzing high rise structure in Conventional method the gravity loads are applied after modeling the whole structure. In actual practice the complete frames are constructed at various stages and the stability of frames varies accordingly. The applied load assumed in Conventional method will be unsuitable as per the actual construction practice. The frame should be analyzed at every construction stage considering the effect of variation of loads at each stage. This methodology is known as construction sequential analysis. In this project the realistic structure of G+11 and G+14 considered to study the effect of construction sequence for gravity loads of combination 1.5DL+1.5LL. Tall building of three different heights has been considered for comparative study and effect on beams and joints has been studied based on different structural parameters. Based on study the necessity of the construction sequence analysis for tall building has been understood.*

***Key Words*: Conventional Analysis, Construction Sequential Analysis and High Rise Building etc.**

1. INTRODUCTION

The performance of a structure with the various loads applied in a single step differs significantly from that when the loads are applied in stages. Hence, in order to simulate the actual condition during the construction of the frame, construction sequence analysis is used. Generally civil engineers, structural engineers, researcher and decision makers have determined the behavior of structures using conventional methods. Unfortunately the designers don't give due importance to the method of sequential analysis. Time- dependent, long- term, deformations in response to construction sequence can cause redistribution of responses that would not be computed and considered by conventional methods. This analysis was complex in nature and so many parameters have to be taken into account during analysis.

In this project the structure of G+11, and G+14 has been taken and its is compared and analyzed for parameters such as bending moment, shear force and displacement by using both conventional and sequential analysis for gravity loads and for combination 1.5DL+1.5LL. As everyone doesn't use finite element software for analysis of sequential construction analysis by the use of amplification factor the approximate values of shear force, bending moment and displacement for 1.5DL+1.5LL load combination can be calculated to have actual behavior of structure.

A. Construction Sequential Analysis

Since the past, multi-storey building frames have been analyzed in a single step as a complete frame with all the loads acting on the building namely self-weight, super-imposed dead loads, live loads, and the lateral loads being applied on the frame at a given instant when the construction of the whole frame is completed. In actual, the dead load due to each structural components and finishing items are imposed in separate stages as the structures are constructed storey by storey. The performance of a structure with the various loads applied in a single step differs significantly from that when the loads are applied in stages. Hence, in order to simulate the actual condition during the construction of the frame, the frame should be analyzed at every construction stage taking into account variation of loads. The phenomenon known as Sequential Construction Analysis is used to analyze the structure at each storey.

Sequential construction analysis is a nonlinear static analysis which takes into account the concept of incremental loading. Sequential construction is also important on analysis of high rise buildings where creep and shrinkage must be considered.

2. METHODOLOGY

1. Selection of specifications of structures.
2. Modeling of the selected structure by using finite element software
3. Applying sequential construction analysis and analysis of results.
4. Compare the results of conventional and sequential analysis.

1. Selection of specifications of structures.

Live Load	3KN/m^2
Density of RCC considered:	25KN/m^3
Steel	HYSD 500
Thickness of slab	150mm
Depth of beam	450mm
Width of beam	230mm
Dimension of column	380x720mm
Height of each	3m

floor	
No of Models	3 (G+11 and G+14)

2. Modeling of the selected structure by using finite element software

Fig.1 plan for G+11, G+14 and G+17

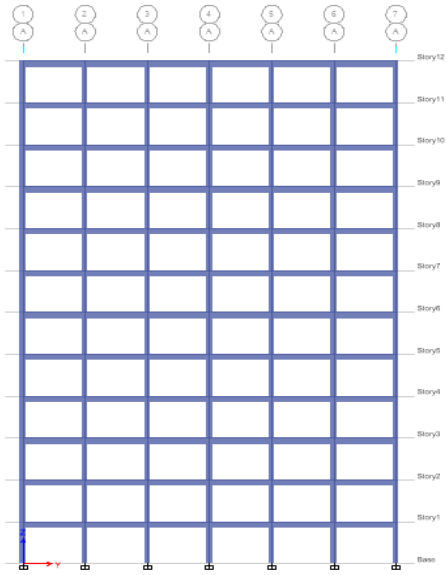

Fig 2. Elevation of G+ 11 model

3. Applying sequential construction analysis and analysis of results.

A. Define grid line

B. Define material properties.

C. Define section properties.

D. Assign section properties to grids.

E. Assign gravity loads.

F. Define auto construction sequence

G. Analyze and study the results.

4. Compare the results of conventional and sequential analysis.

A. Bending Moment

Table 1: Amplification Factor for Bending Moment of G+ 11 Storey's

STOREY	BM in kNm		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	70.49	38.07	0.54	45.99
2	76.51	38.28	0.50	49.97
3	81.20	38.25	0.47	52.89
4	85.45	38.40	0.45	55.06
5	89.18	38.53	0.43	56.80
6	92.43	38.59	0.42	58.25
7	95.19	38.57	0.41	59.48
8	97.48	38.49	0.39	60.51
9	99.31	38.34	0.39	61.39
10	100.60	38.14	0.38	62.09
11	102.82	38.01	0.37	63.03
12	93.98	37.99	0.40	59.58

Table 2: Amplification Factor for Bending Moment of G+ 14 Storey's

STOREY	BM in kNm		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	71.47	38.07	0.53	46.73
2	78.46	38.28	0.49	51.21
3	84.13	38.45	0.46	54.29
4	89.37	38.75	0.43	56.64
5	94.11	38.97	0.41	58.59
6	98.37	39.12	0.40	60.23

7	102.17	39.21	0.38	61.63
8	105.52	39.22	0.37	62.83
9	108.43	39.17	0.36	63.87
10	110.91	39.06	0.35	64.79
11	112.96	38.88	0.34	65.58
12	114.61	38.64	0.34	66.29
13	115.75	38.35	0.33	66.87
14	118.06	37.94	0.32	67.86
15	107.75	37.93	0.35	64.80

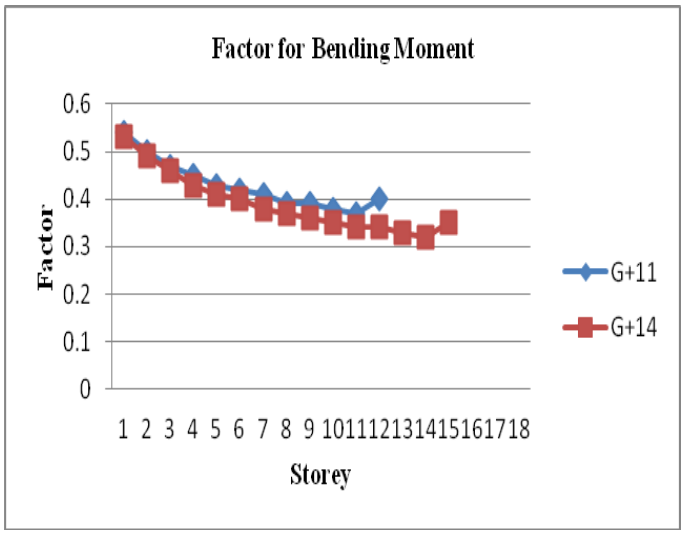

Chart 1: Amplification Factor for Bending Moment

Observations

From above graph of amplification factor for bending moment following points are observed.

1. The amplification factor for bending moment reduces as the number of storey increases.
2. The bending moment for conventional analysis shows increasing values except top storey.
3. Table's shows bending moment for sequential analysis are comparatively lesser than that of conventional analysis.
4. The factor for bending moment of G+11 is varies from 0.54 for storey 1 to 0.40 for storey 12.
5. The factor for bending moment of G+14 is varies from 0.53 for storey 1 to 0.35 for storey 15.

B. Shear force

Table 3: Amplification Factor for Shear Force of G+ 11 Storey's

STOREY	SF in kN		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	108.40	68.81	0.63	36.52
2	111.09	68.90	0.62	37.98
3	113.30	69.91	0.62	38.30
4	115.28	70.78	0.61	38.61
5	117.03	71.33	0.61	39.05
6	118.54	71.58	0.60	39.62
7	119.83	71.53	0.60	40.31
8	120.90	71.19	0.59	41.12
9	121.75	70.56	0.58	42.05
10	122.38	69.65	0.57	43.09
11	123.25	68.48	0.56	44.44
12	119.97	67.65	0.56	43.61

Table 4: Amplification Factor for Shear Force of G+ 14 Storey's

STOREY	SF in kN		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	108.85	68.81	0.63	36.78
2	112.00	69.47	0.62	37.97
3	114.67	71.03	0.62	38.05
4	117.11	72.28	0.62	38.28
5	119.32	73.21	0.61	38.64
6	121.31	73.85	0.61	39.12

7	123.08	74.20	0.60	39.71
8	124.65	74.27	0.60	40.42
9	126.01	74.06	0.59	41.23
10	127.16	73.57	0.58	42.14
11	128.12	72.83	0.57	43.16
12	128.89	71.82	0.56	44.28
13	129.45	70.56	0.55	45.49
14	130.36	69.05	0.53	47.03
15	126.39	67.41	0.53	46.67

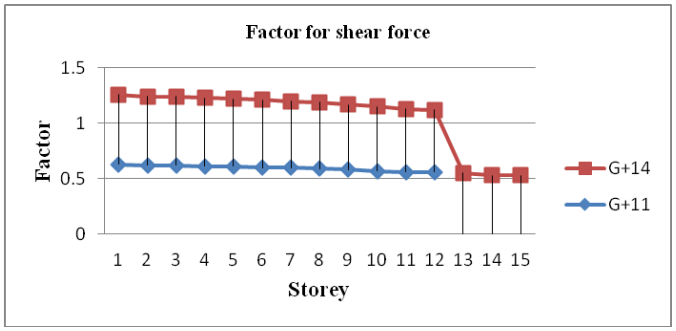

Chart 2: Amplification Factor for Shear force

Observations

From above graph of amplification factor for Shear force following points are observed.

1. The amplification factor of Shear force reduces as number of storey increases.
2. The shear force for conventional analysis shows increasing values except top storey.
3. Table shows shear force for sequential analysis is comparatively lesser than that of conventional analysis.
4. The factor for shear force of G+11 is varies from 0.63 for storey 1 to 0.56 for storey 12.
5. The factor for shear force of G+14 is varies from 0.63 for storey 1 to 0.53 for storey 15.

C. Displacement

Table 5: Amplification Factor for Displacement of G+ 11 Storey's

STOREY	Displacement in mm		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	1.57	0.97	0.62	38.22
2	3.01	1.79	0.59	40.53
3	4.32	2.45	0.57	43.29
4	5.51	2.95	0.54	46.46
5	6.55	3.28	0.50	49.92
6	7.47	3.45	0.46	53.82
7	8.26	3.46	0.42	58.11
8	8.92	3.29	0.37	63.12
9	9.44	2.97	0.31	68.54
10	9.83	2.48	0.25	74.77
11	10.1	1.82	0.18	81.98
12	10.21	0.99	0.10	90.30

Table 6: Amplification Factor for Displacement of G+ 14 Storey's

STOREY	Displacement in mm		FACTOR	% REDUCTION
	CONVENTIONAL	SEQUENTIAL		
1	1.99	1.23	0.62	38.19
2	3.85	2.31	0.60	40.00
3	5.59	3.22	0.58	42.40
4	7.19	3.97	0.55	44.78
5	8.67	4.56	0.53	47.40
6	10.01	4.99	0.50	50.15

7	11.22	5.25	0.47	53.21
8	12.29	5.34	0.43	56.55
9	13.23	5.26	0.40	60.24
10	14.04	5.02	0.36	64.25
11	14.71	4.61	0.31	68.66
12	15.24	4.03	0.26	73.56
13	15.64	3.27	0.21	79.09
14	15.91	2.35	0.15	85.23
15	16.03	1.26	0.08	92.14

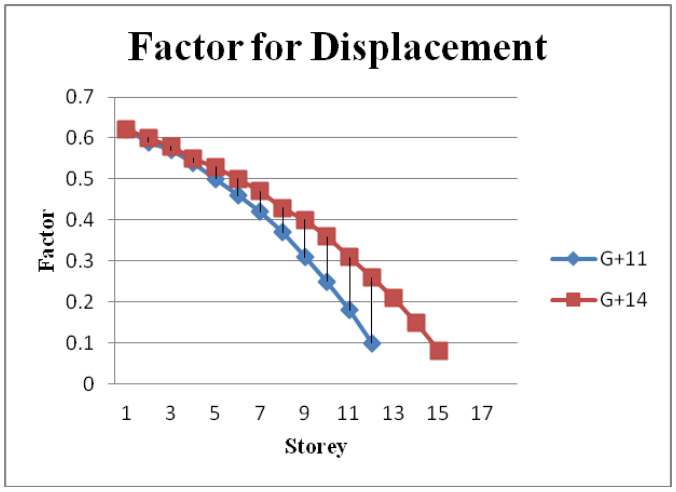

Chart 3: Amplification Factor for Displacement of storey G+11 and G+14

Observations

From above graph of amplification factor for Displacement following points are observed

1. The amplification factor for displacement reduces as the number of storey increases.
2. The displacement for conventional analysis shows increasing values.
3. The table shows deflection for sequential analysis is comparatively lesser than that of conventional analysis.
4. The factor for displacement of G+11 is varies from 0.62 for storey 1 to 0.10 for storey 12.
5. The factor for displacement of G+14 is varies from 0.62 for storey 1 to 0.08 for storey 15.

3. CONCLUSIONS

The factor for bending moment, shear force and deflection get reduces as the number of storey increases. And the sequential analysis results are more as compare to conventional one. This factor helps to estimate the actual behavior of structure by multiplying with conventional values. The following observations are listed below from above tables and graphs.

1. The factor for bending moment of G+11 is varies from 0.54 for ground floor to 0.40 for top storey, similarly for G+14 is varies from 0.53 for GF to 0.53 for top storey.
2. The factor for shear force of G+11 is varies from 0.63 for ground floor to 0.56 for top storey, similarly for G+14 is varies from 0.63 for GF to 0.53 for top storey.
3. The factor for displacement of G+11 is varies from 0.62 for ground floor to 0.10 for top storey, similarly for G+14 is varies from 0.62 for GF to 0.08 for top storey.
4. The amplification factor for bending moment, shear force and deflection get reduces as the number of storey increases for G+11 and G+14 which mean the sequential analysis shows comparatively lesser values of bending moment than conventional analysis.

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