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Effect of Staged Construction on Behaviour of Building

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Abstract – *Generally in now a days multi-storeyed building construction is increase day by day. And while designing a building in any structural software does not take effect of the staged construction. But the effect of staged construction plays vital role in designing the multi-storeyed building. Increase in building height increases the difference between result of sequential analysis and conventional analysis.*

In this paper the detailed study of G+10 storied building is compared with the results obtained by conventional analysis. The comparison is done with various properties like bending moment, shear force, axial deformation and axial force.

Key Words: Non linear staged construction, shear force, bending moment, axial force and axial deformation.

1. INTRODUCTION

Engineers generally determine the behaviour of structures by adopting a linear elastic numerical analysis including summations of vertical column loads. For high- rise buildings with multiple construction phases, the structural responses may significantly diverge from such a typical linear analysis results. Furthermore, time-dependent long-term deformation resulting from construction sequence can cause a redistribution of the structural responses that cannot be estimated using conventional methods. The existence of a transfer floor within the building height adds to the complexity of the structural system which also cannot be analysed using typical linear analysis method. Fortunately, recent advanced of the finite element method facilitate the nonlinear analysis and provided tools for proper design of complex structures, especially high-rise buildings.

Thus, construction sequential analysis which is now essential for high-rise building with transfer slabs can be easily included in the analysis. However, this nonlinear analysis is not so popular because of lack of knowledge about its necessity and scope. In this research, a nonlinear numerical analysis for high rise buildings with transfer floor is presented, considering the effect of construction stages. The analysis results are compared to the result of a conventional analysis for these types of buildings. The main objective of this work is to assess the effect of construction stages analysis and time dependent material properties of various structural elements for a high rise building with a transfer floor on the performance and design of these buildings.

High rise buildings are being made everywhere in present world. The dimensions such as height of high-rise buildings are getting larger and larger day by day. It has been noticed that structural design of high-rise buildings is very much dependent on dynamic analysis for winds and earthquakes. Since, in present scenario use of computer has progressed remarkably, almost all structural designers use software for the analysis and structural design of high rise buildings. Hence, after that the determination of structural plan and outline of high rise buildings, the structural design of individual structural members has been done by using various structural software. This analysis procedure by structural software makes it more important that the structure model becomes more realistic and field oriented in nature. Assumptions have been made over the past few decades that the multi-storied frames have been analysed, taken into consideration that all the loads coming over the structure to be constructed namely dead weight of structure that is self- weight, the load due to objects present in structure that is live completion of structure. However, in actual scenario the construction of the frame takes place storey by storey that is stage by stage that is in a sequential order and loads are applied accordingly on a frame in sequential manner. The variation present or observed in the performance of the framed structure is due to fact that the difference between theoretical and actual construction practice manner.

1.1 Research Methodology

Generally in conventional analysis whole structure is considered as a single structure or a single building and total load is taken in a single step. But in a practice condition is different. Because the construction is done in step by step manner. But in reality the behavior of structure is different as the deflection of the components is different due to the self-weight which acts sequentially. The structural self-weight, external loads, boundary conditions and materials are depended on stages during the construction process and their variations are overlooked in conventional design which is nothing but a limitation of conventional design procedure. Non-linear static load case has to be generated to analyze the structure step by step which represents the sequential load case. Grouping of each story is considered during analysis so that software can identify its total steps required for completing the procedure. Recording and investigating the variation of responses, of a particular point from starting step of sequential analysis to the last one, exhibit how construction sequence has a well impact over the design of the structures. Afterward the comparison between the findings of construction sequential analysis and linear static analysis will explain the importance of considering sequential effects during design and eventually meet the objectives of this study.

1.2 Sequential Analysis

Construction sequence analysis also known as stages construction analysis is a nonlinear static analysis which considers the step-by-step loading of a structure. Loads of the structure is applied as the frame proceeds. This method is more accurate and practical as it considers the loads at their actual time of application. The order in which the structural members are casted, whether casted monolithically are also important. Hence construction sequence analysis should be carried out for precise analysis of structure. In this paper efforts have been made to analyze multistorey buildings of various heights with and without consideration of construction sequence.

Following fig. shows exact meaning of sequential analysis.

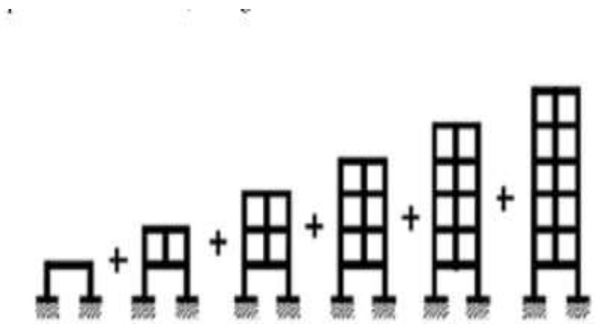

Fig.no.1.2.1

2. Comparison of results between sequential analysis and conventional analysis.

2.1 G+10 Axial force:

Stage	Conventional analysis	Sequential analysis	% difference
0	0	0	0
1	-1111.31	-1162.92	4.64
2	-1087.46	-1139.12	4.75
3	-983.07	-1033.17	5.09
4	-879.76	-928.32	5.52
5	-777.84	-824.89	6.05
6	-677.44	-722.58	6.66
7	-578.52	-620.9	7.32
8	-480.95	-519.2	7.96
9	-384.51	-417.22	8.51
10	-288.95	-314.33	8.78
11	-194.01	-210.4	16.39
12	-99.28	-105.45	6.21

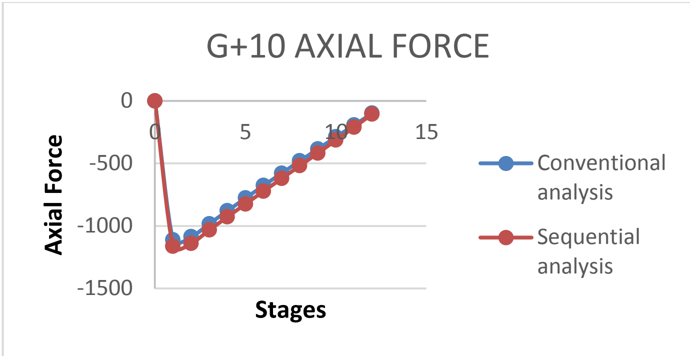

Fig .no.2.1

Axial force is linearly increases for successive stages.

2.2 G+10 Axial Deformation:

Stage	Conventional analysis	Sequential analysis	% difference
0	0	0	0
1	0.482	-0.163	133.82
2	0.518	0.571	10.23
3	0.396	0.333	15.91
4	0.349	0.232	33.52
5	0.302	0.129	57.28
6	0.258	0.033	87.21
7	0.215	-0.060	127.91
8	0.175	-0.148	184.57
9	0.139	-0.234	268.34
10	0.076	-0.318	518.42
11	0.423	-0.388	189.48
12	-3.337	-0.619	81.45

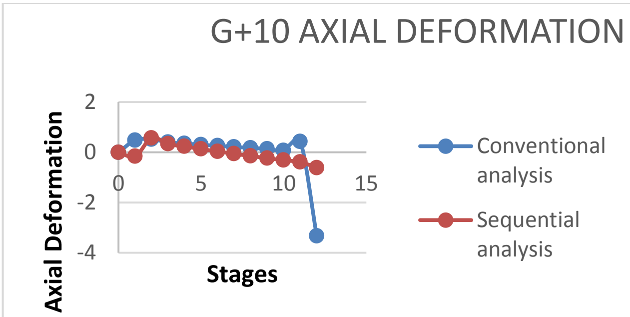

Fig.no.2.2

Axial deformation shows wavy nature up to middle stage and after that linearly decreases.

2.3 G+10 Bending Moment:

Stage	Conventional analysis	Sequential analysis	% difference
0	0	0	0
1	2.18	2.26	3.67
2	2.26	2.6	15.04
3	2.58	2.99	15.89
4	2.84	3.88	36.62
5	3.13	3.54	13.09
6	3.48	3.62	4.023
7	3.76	3.56	5.32
8	3.98	3.36	18.45
9	4.16	3.1	25.48
10	4.3	2.87	33.26
11	4.48	2.56	42.86
12	3.52	2.42	31.25

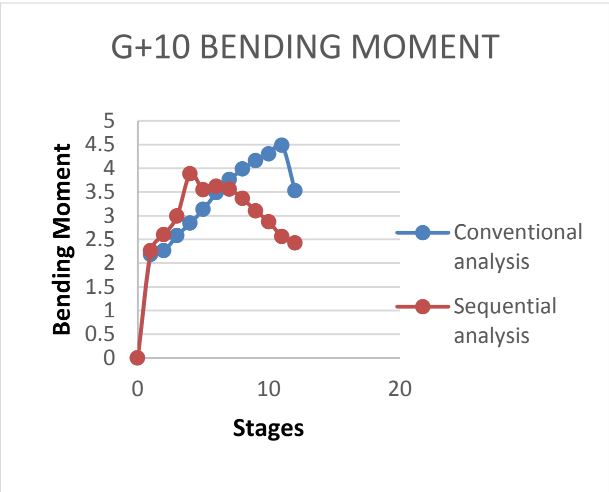

Fig.no.2.3

Bending moment is linearly increases up to middle stage and after that linearly decreases.

2.4 G+10 Shear force:

Stage	Conventional analysis	Sequential analysis	% difference
0	0	0	0
1	1.58	2.01	27.22
2	1.53	1.77	15.69
3	3.14	3.74	19.11
4	4.32	4.79	10.88
5	5.30	5.44	2.64
6	6.11	5.73	6.22
7	6.77	5.73	14.86
8	7.31	5.47	25.17
9	7.74	4.95	36.04
10	8.09	4.19	48.21
11	8.32	3.18	61.78
12	9.16	1.90	79.25

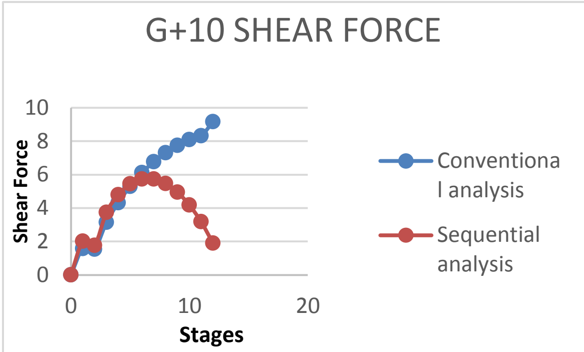

Fig .no. 2.4

Shear force is linearly increases up to middle stage and after that linearly decreases.

3. CONCLUSIONS

It is evidenced that simulation of sequence of construction in the analysis leads to considerable variations in deformations and design forces obtained by conventional one step analysis. While analysis various parameters changes according to following manner:

1] Axial force get constantly increases for each stage as compared to conventional analysis.
2] Axial deformation get decreases and increases up to middle stage and after that it decreases rapidly.
3] Bending moment get constantly increases up to middle stage and after this stage it get constantly decreases.
4] Shear force get constantly increases up to middle stage and after this stage it get constantly decreases.

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