International Journal of Research in Advent Technology (IJRAT)
(E-ISSN: 2321-9637)
Special Issue National Conference "CONVERGENCE 2018", 09th April 2018

Staged Construction Analysis for Multistoried Building by using ETABS

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Abstract- Multistoried building has been analyzed for years on the assumption that all loads are applied on concrete frame. By considering the relative frequency of the load it's very clear that part of the load is applied in stages as the construction of frame proceeds and after the accomplishment of the frame the remaining part of the load imposed on it. Present study deals with the study of staged construction analysis on different storey's considering the combination of dead load and live load and providing the comparative study between conventional analysis and staged construction analysis.

Keywords- Staged Construction Analysis, Auto-Sequential Loading, Construction Load, and "ETAB".

1. INTRODUCTION

Throughout the period, multi-storied building frame has to be analyzed as a complete frame in a single stage, with all loads are applied on concrete frame. Dead load is the main considerable fact due to each building component. Imposed load will be differing after construction of storey by storey depending on finishing items and furniture requirement etc. Sequential application of loads deals with the stability of the structure in construction staged analysis. Hence in this study only dead loads case and dead load along with live load cases are considered for analyzing the structure.

Staged construction analysis is also called as construction sequential analysis (CSA). Staged construction is a sequence of construction stages in which structural system and load patterns are added or removed to evaluate the base reactions, natural frequencies, eigenvalue, displacements etc. During design and construction of high-rise building sequential analysis consider the chronological construction phases which consist of the residual stress of each storey of the structure. This analysis is done by separately and step by step to view the final displacement.

In year 2012, O.A. Rosenboom, T.F. Paret and G.R. Searer have studied about chronological construction sequence, creep, shrinkage, and pushover analysis of an iconic 1960s reinforced concrete building. In 2013 CSA were used to design and solve the problems during construction of IB Tower, a 58-storey reinforced concrete building. In 2014, Yousuf Dinar, Munshi Md. Rasel, Muhammad Junaid Absar Chowdhury, and Md. Abu Ashraf put up the chronological effect of sequence of construction due to the self-weight of members and its effect on the Overall design forces using finite element modeling. At the time of designing the world's tallest tower i.e. Burj Khalifa CSA was done along with other analysis.

2. RESEARCH METHODOLOGY

In this paper a study of effects of staged construction analysis on the multistoried building is carried out using building shown in figure 1 and 2. A 10th storey building has been analyzed for self-weight using staged construction analysis method using CSI ETABS-2016. The building consists of 5 bays along width and 10 bays along length. All models are analyzed to find out the base reaction and displacement using IS 456-2000 and IS 800-2007. The building was assumed in Buldana city of Maharashtra in the territory of India. The details of building model are as follows.

Table 1. Details of Building Model.

Sr.No.	Title	Description
1	Height of Building	30.2
2	Size of Beam	300 X 450
3	Size of Column	600 X 900
4	Soil Type	Medium Stiff
5	Importance Factor	1
6	Building Frame System	Special RC Moment-Resisting System
7	Zone Factor	0.16
8	Height of Storey	3.2 for Ground Storey and 3 for remaining storey
9	Grade of Steel	Fe 415 and Fe500
10	Grade of Concrete	M30

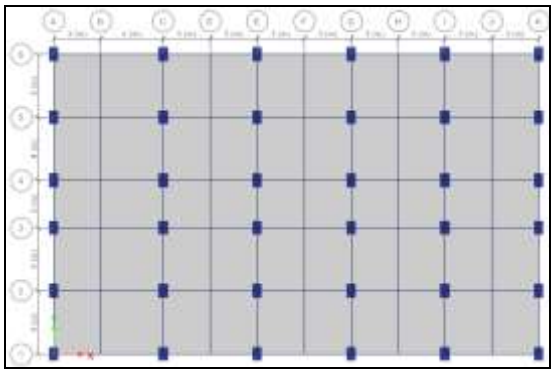

Figure No. 1. Plan for 10 Storey building model.

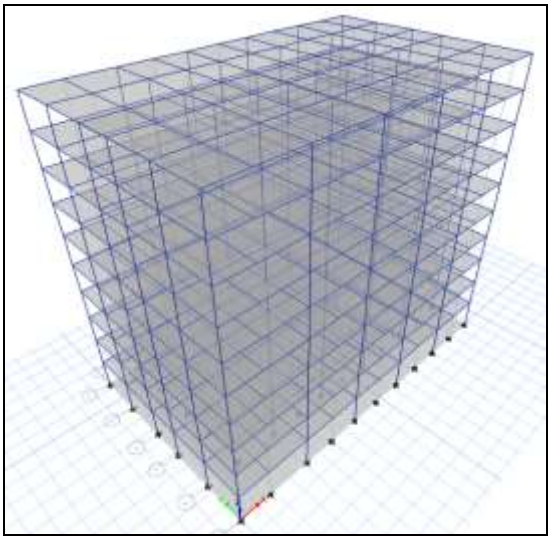

Figure No. 2. 3D view of 10 storey building model.

2.1. *Staged Construction Analysis*

The construction Staged analysis can be divided into two parts; the first part covers the order in which loads are applied and the effects of the loads on the unfinished structure. During construction the loads in the structure might cause different stresses than they would if they were placed on a finished building. Then an analysis should be performed after each storey has been constructed, advanced FEM software can perform such analyses. The second part involves the effects of the time dependent effects creep and shrinkage.

Let us consider a 10 storey building being constructed one floor at a time. When construction of 1st floor is completed and concrete is poured in 2nd floor, its assumed that 1st floor has attain its maximum strength and therefore, the total load applied at 1st floor is self-weight of beam and column i.e. SW1, self-weight of beam and column i.e.SW2 applied to 1st floor level and the weight of shuttering from 1st to 2nd floor i.e.SH.

Thus, the total load at 1st floor level is,

W1= SW1+SW2+SH.

Similarly, when shuttering will be removed from 2nd floor, it's assumed that 2nd floor has attained maximum strength. Removal of shuttering cause a load of (SW2+SH) in the 1st floor and the total load at 2nd floor is W2=SW2+SW3+Sh.

3. Analytical Results

The parameters such as moment, displacement, base shear, etc. have been study under dead load and live load, with and without construction sequential analysis.

Table 2. Base Reactions

Load Case	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	-2.147E-06	-1.04E-05	102314.3236	972418.4181	-1591422	-0.0001	0	0	0
Live	0	-3.323E-06	24441	232527	-375895	-3.61E-05	0	0	0
Auto Seq Max	0	0	58318.556	554280.3079	0	0	0	0	0
Auto Seq Min	0	0	0	0	-907445	-5.67E-06	0	0	0
DCon 1	-3.221E-06	-1.561E-05	153471.4853	1458628	-2387133	-0.0002	0	0	0
DCon 2	-3.869E-06	-2.059E-05	190132.9853	1807418	-2950977	-0.0002	0	0	0

Table 3. Model Periods and Frequencies

Mode	Period sec	Frequency cyc/sec	Circular Frequency rad/sec	Eigenvalue rad²/sec²
1	2.072	0.483	3.0319	9.1924
2	1.566	0.638	4.011	16.0882
3	1.471	0.68	4.2711	18.2424
4	0.633	1.581	9.9309	98.6222
5	0.469	2.133	13.4004	179.5699
6	0.444	2.251	14.1451	200.083
7	0.329	3.043	19.121	365.6135

8	0.237	4.222	26.5261	703.6319
9	0.227	4.409	27.7004	767.3124
10	0.2	5.001	31.4249	987.525
11	0.142	7.062	44.3726	1968.9232
12	0.136	7.332	46.0701	2122.4502

3.1 Displacement Result-

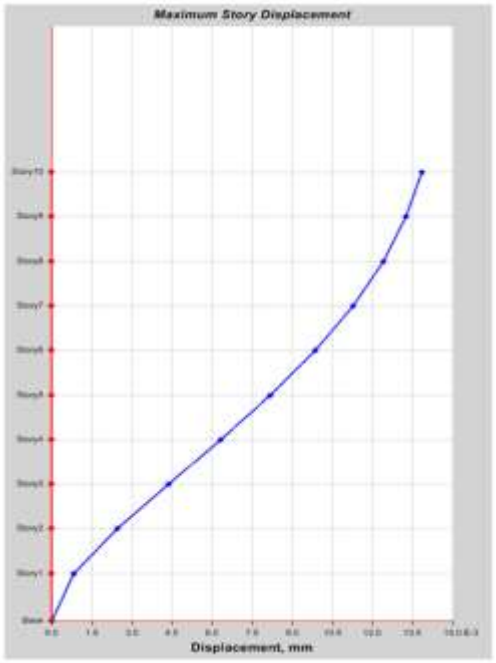

Figure No. 3 Maximum displacement from conventional analysis.

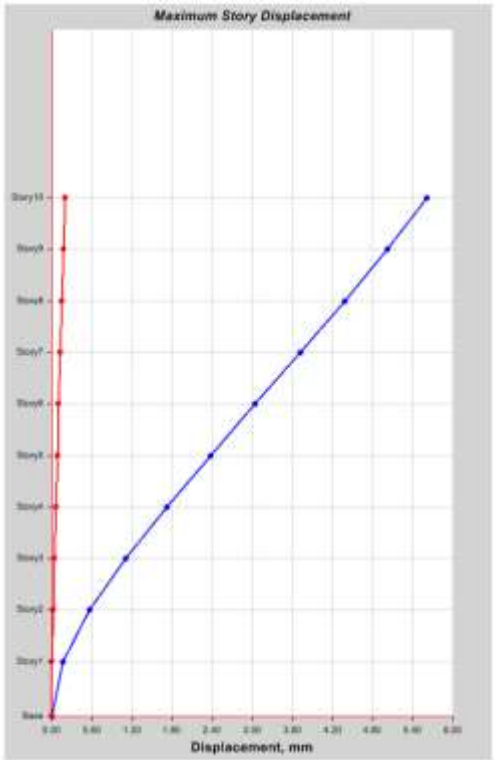

Figure No. 4 Maximum displacement from stage construction analysis case.

3.2 Storey drift Result-

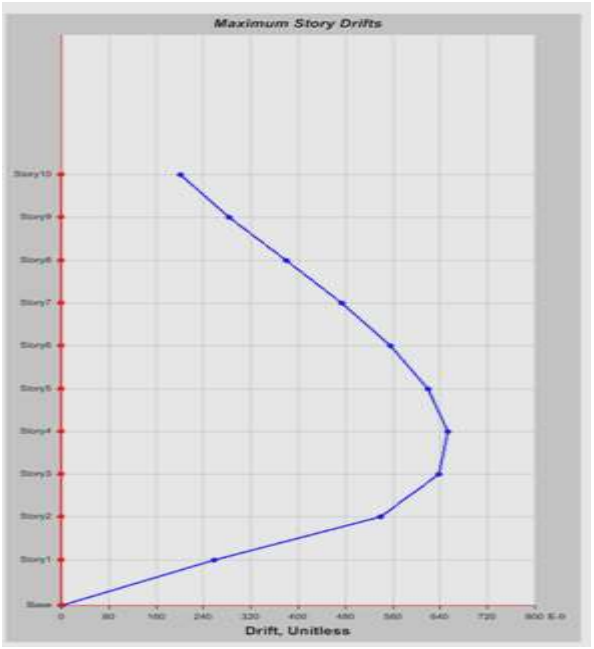

Figure No. 5 Maximum storey drift from conventional analysis.

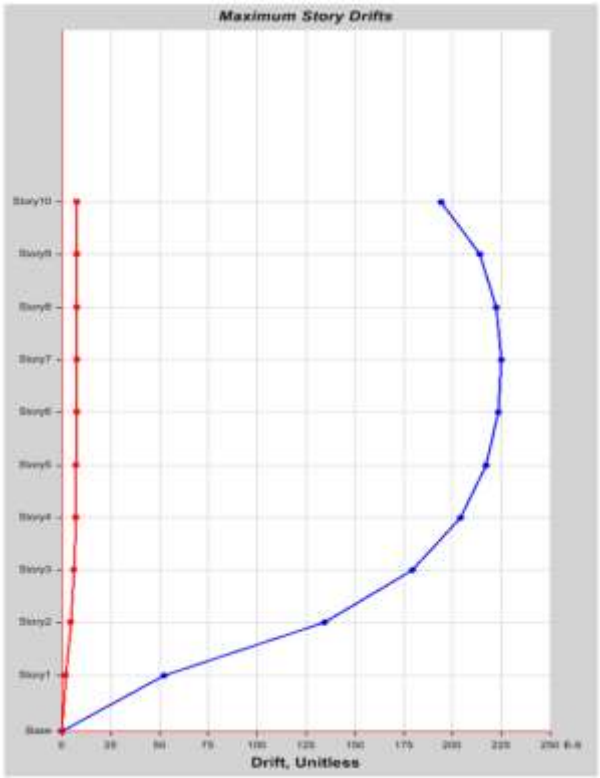

Figure No. 6 Maximum storey drift from stage construction analysis case.

Table 5. Model load participation ratio

Case	Item Type	Item	Static %	Dynamic %

Modal	Acceleration	UX	99.99	95.75
Modal	Acceleration	UY	99.99	95.68
Modal	Acceleration	UZ	0	0

4. Importance of Staged Construction Analysis

A non-linear analysis approach in which the loads are applied sequentially and the structure is analyzed at various stages corresponding to the construction sequence. The importance of staged construction analysis is as follows,

1. This assumption is not valid in real construction sequence because building is constructed by floor by floor and dead load acts sequentially.
2. General assumption is performed under the assumption that all loads are applied simultaneously on the complete structure.

5. Conclusion

For whole structure overall Construction staged analysis is necessary to improve the analysis accuracy in terms of moment, displacement, shear force and also provide more reliable results and recommended for usual practice.

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