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ANALYSIS OF MULTI STORIED RCC BUILDING FOR CONSTRUCTION SEQUENCE LOADING

Sagupta R. Amin[1], S.K. Mahajan[2]
[1] *M-Tech Student (Structural Engg.), Department of Civil Engineering , K.I.T.S., Ramtek .*
saguftaamin@gmail.com
[2] *Assistant Professor, Department of Civil Engineering, K.I.T.S., Ramtek sunrays-75@rediffmail.com*

Abstract- Since the past , multi-storied 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, live and the lateral loads being applied on the frame at a given instant when the construction of 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.

Present study deals with the study of effect of construction sequence on different storey's considering earthquake forces and wind forces. And a comparative study between linear static analysis and construction sequence analysis is being done.

Keywords: construction sequence analysis, sequential loading, construction loads, multi storied frames . lateral forces .

I. INTRODUCTION

Over the years, multi-storied 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, live and the lateral loads being applied on the frame at a given instant .In reality, 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 Construction Sequence Analysis is used to analyze the structure at each storey.

The structural analysis of multistoried buildings is one of the areas that have attracted a no. of engineering researchers and designers attention. There is one area, however, which has been ignored by many previous investigators, i.e., the effects of construction sequence in a multistory frame analysis.

Construction sequence analysis (CSA) also known as staged construction analysis is a nonlinear static form of analysis which takes into account the concept of incremental loading. Load on the building frame is applied in stages as the construction of the frame proceeds. Staged construction analysis is a more practical and accurate method of analysis as it takes into account the various stages in which load is applied on the frame, by analysis for strength, stability and deflection at the end of each step. Also the order in which the various components of the building are constructed is important.

In year 1978, S.C. Chakrabarti, G.C. Nayak And S.K.Agrawala have researched on construction sequential for multi-storeyed building frame for self weight only. In 2012, a historic reinforced concrete shear wall building with unique lightweight aggregates, the chronological pushover confirmed field observations that cracking due to shrinkage and tensile creep from dead load and construction sequencing was more predominant in the building than any damage related to the 2006 earthquakes. In 2014, the effects of sequence of construction were studied on 25 storeyed building with 5 storey interval. While designing the world's largest structure (*Burj Khalifa*) construction sequence analysis is performed along with other analysis.

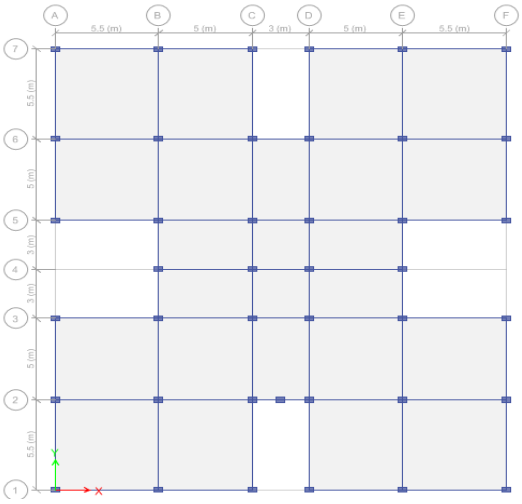
II. RESEARCH METHODOLOGY

In this paper a study of effect of construction sequence analysis on the multistoried building is carried out using building shown in figure 1 & 2. The details of building models are given in table 1.

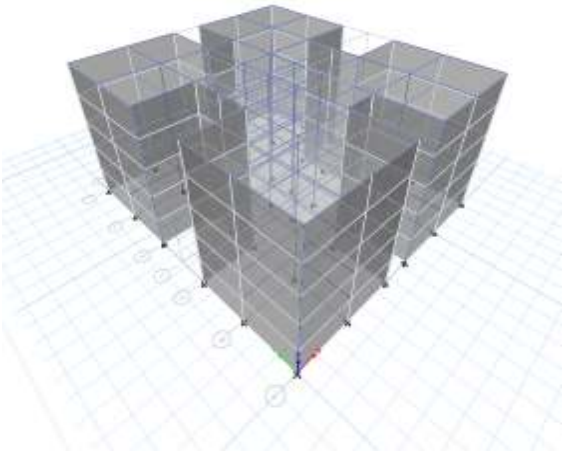
A 5, 7, 9 Storey Building has been analyzed for self weight using Linear Static Method and Construction Sequence Method using ETABS. The building consists of 5 bays along length and width. The end bays are 5.5 m, intermediate bays are 5m and centre bay is 3 m along both the direction .The size of beam is 500mm x 300mm and size of column is 450mm x 300mm .The building has been analyzed for M30 grade concrete and Fe 415 steel. All models are analyzed for an earthquake forces in both the direction providing coefficients in accordance with IS 1893(Part 1)-2002 and wind coefficients with accordance to IS 875(Part 3)-1987. The building was assumed in Nagpur city of Maharashtra in the territory of India.

"Table 1. Details of Building Model"

S.N.	Title	Description
1.	No. Of Storey's	5, 7, 9
2.	Size Of Beam	500 mm x300 mm
3.	Size Of Column	450 mm x300 mm
4.	Earthquake Zone	II
5.	Soil type	Medium soil
6.	Importance factor	1
7.	Building frame system	Special RC moment-resisting frame
8.	Zone factor	0.16
9.	Wind speed	44 m/sec
10.	Storey height	3 m
11.	Grade of Steel	Fe 415
12.	Grade of Concrete	M30



"Figure 1. Plan for 5, 7, 9 Storey Building"



"Figure 2. 3D view of 5 storey building model"

II. 1 .Construction Sequence Analysis

Let us consider a 5 storey Building being constructed one floor at a time. When construction of 1st floor is completed and concrete is poured at 2nd floor, it is assumed that 1st floor has attain its strength and thus the total load applied at first floor is self weight of beams and columns of first floor (SW1) and the self weight of beams and columns of second floor (SW2) carried to first floor level and the weight of shuttering from first to second floor (SH).Thus, the total load at first floor is W1= SW1+SW2+SH.

Similarly, when the shuttering has been removed from 2nd floor, it is assumed that 2nd floor has attained its strength. Removal of shuttering cause a load of (SW2+SH) in the first floor and the total load at 2nd floor is W2=SW2+SW3+SH.

This process continues till the last floor when shuttering from below the roof has been removed.

In construction sequence analysis, loading is considered sequentially at each storey being constructed whereas in linear static analysis, loading is considered when whole structure is being constructed.

In case of multi-storey buildings, importance of Construction Stage Analysis can be understood from following facts:

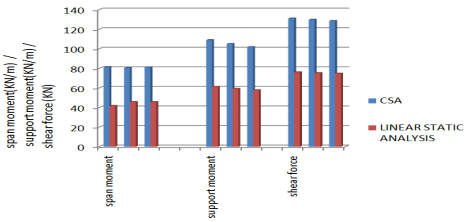
1. The assumption that all loads are applied simultaneously is not valid in a real construction sequence because a building is constructed floor by floor and dead load acts sequentially.
2. For a building where wind could be a part of critical load combination for the complete frame, earthquake could turn out to be part of critical load combination for staged construction case.

CSA should be performed for all structures where there is a change in support conditions, loading and varying material properties.

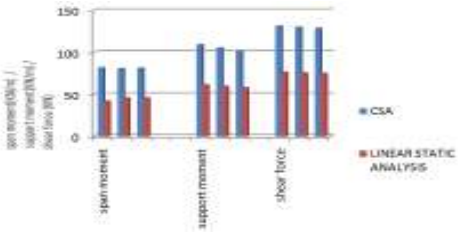
III. COMPARATIVE STUDY

The parameters such as moment, axial load, displacement, shear etc. have been studied under earthquake forces and wind forces, with and without CSA.

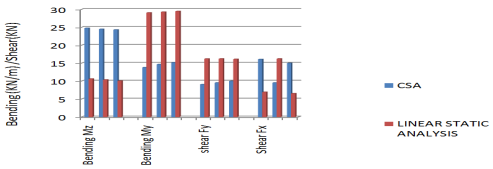
A) EARTHQUAKE FORCES



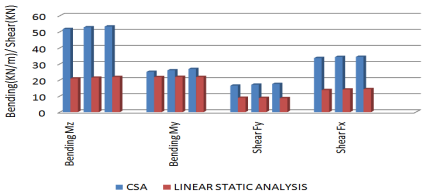
"Figure 3: Responses in Interior Beams at 5th, 7th , 9th storey RC Buildings".



"Figure 4: Responses in Edge Beams at 5th, 7th , 9th storey RC Buildings".

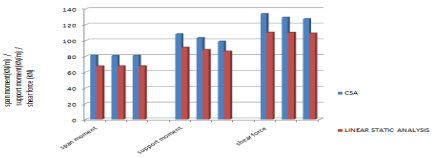


"Figure 5: Responses in Interior Column at 5th, 7th , 9th storey RC Buildings".

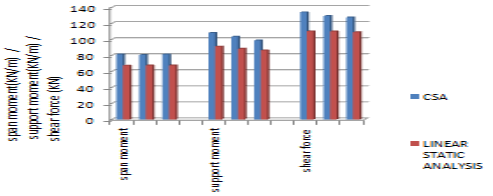


"Figure 6: Responses in Exterior Column at 5th, 7th , 9th storey RC Buildings".

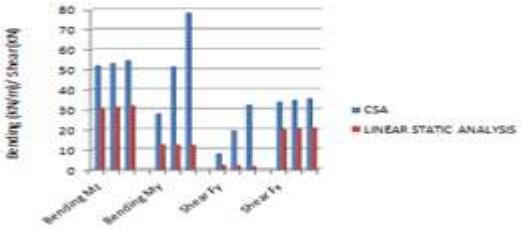
B) WIND FORCES



"Figure 7: Responses in interior Beam at 5th, 7th , 9th storey RC Buildings".



"Figure 8: Responses in Edge Beam at 5th, 7th , 9th storey RC Buildings".



"Figure 9: Responses in Interior Column at 5th, 7th , 9th storey RC Building

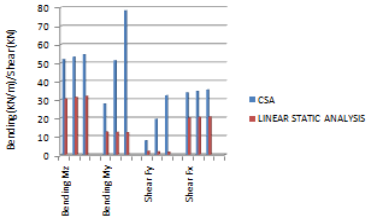


Figure 10: Responses in Edge Column at 5th, 7th , 9th storey RC Buildings

Figure 3,4,5,6 represents the responses in interior and edge beam and column for earthquake loading in both the directions. Whereas, fig 7, 8,9,10 represents the responses in interior and edge beam and column for wind in both the directions. From the study it is found that while analyzing, Construction Sequence Analysis is proved to be critical for columns and beams.

Hence it must be concluded that Construction Sequence Analysis will provide more reliable results and recommended in usual practice.

IV. IMPORTANCE OF CSA

As the construction of building proceeds, the structure members are added in stages & thus their dead load is carried by part of the structure completed at the stage of their installation .Therefore, the correct distribution of displacements and stresses can be obtained by accumulating the results of analysis at each stage. Linear static counts the total effect of final stage of construction without considering step by step nonlinear effects for sequential construction , the output are not reliable for high rise structures. Therefore, it becomes necessary to perform construction sequence analysis for high rise structures. Otherwise the results lead to inappropriate deign which may leads to destruction.

CONCLUSION

The Construction sequence analysis in structures of both Steel and RCC is necessary to improve the analysis accuracy in terms of displacement, axial, moment and shear force in supporting beam and column near of it and also for the whole structure overall.

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