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# CONSTRUCTION SEQUENCE ANALYSIS OF A BUILDING WITH VERTICAL DISCONTINUITY

**Prof. MRS. K.MYTHILI[*1] and MOHAMMED ABDUL RAHMAN[2]**
**Department of Civil Engineering, Aurora's Scientific Technological and Research Academy, Hyderabad, India**

## ABSTRACT

Building structures are analyzed in a single step using linear static analysis on the assumption that the structures are subjected to full load once the whole structure is constructed completely. In reality the dead load due to the each structural components and finishing items are imposed in separate stages as the structures are constructed story by story for nonlinear behavior of materials. In sequential analysis there is involvement of several important steps which usually are not included during the general linear static analysis. To obtain the effects of construction sequential analysis of each storey is done with the preceding storeys in such a way that the assignment of vertical loads is done from the base of the entire structure till that particular floor. Ultimately the results will signify the response of the building structure up to that floor. As the similar procedure is followed by every storey of the building the thorough sequential effects can be pictured. In this thesis the structures of both RCC

And steel with floating column and RCC model with shear wall with dead load case have been taken for sequential analysis. The analysis outcome will help to understand how the behavior of structure going to response with Construction Sequence Analysis and linear static analysis with vertical discontinuity in the structure. As it is observed from the results that the deflection of the beam under floating column in construction sequence analysis is 97% more than the deflection developed in linear static analysis for final stage i.e. when loaded for all twelve storeys. It is found from the results that shear force in beam under floating column in construction sequence analysis is 77% More than the shear force developed in linear static analysis for final stage i.e. when Loaded for all twelve storeys and it is also observed that the bending moments in the beam in construction sequence analysis is 117% more than the bending moments developed in linear static analysis for final stage i.e. when loaded for all twelve storeys.

***Keywords-*** *Lateral loads, High-rise buildings, Indian code, ETABS, Shear wall, Construction Sequence Analysis, LSA-Linear Static Analysis, CSA-Construction Sequence Analysis.*

## 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.

Structural analysis of multistoried buildings is one of the areas that have attracted a no. 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 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 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.

Building structures are analyzed in a single step using linear static analysis (LSA) on the assumption that the structures are subjected to full load once the whole frame is constructed completely, But In reality the dead load due to the each structural components and finishing items are imposed in different stages as the structures are constructed story by story for nonlinear behavior of materials. Advancement of finite element modeling accelerates the accuracy of finite element simulation by taking the consideration of construction sequential effects.

During analysis of a building structure, normally after complete modeling full loads are applied on entire building frame and linear static analysis is done. But in actual practice the dead load due to each structural element is applied in various

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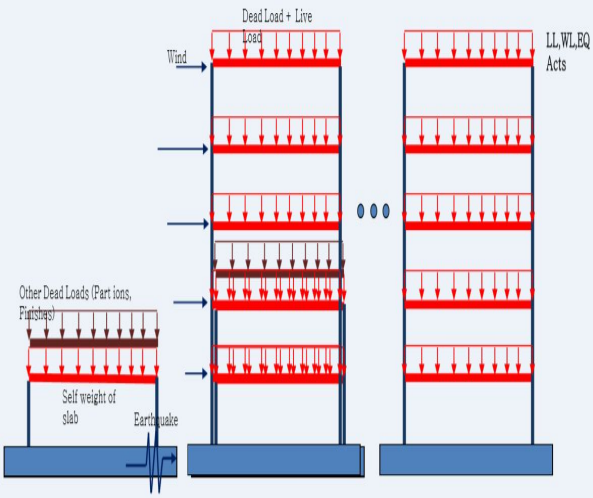
construction stages of each story of the building structure due to the material non-linearity behavior. The loads considered in linear static analysis change in transitory situation and hence the outcomes will not be suitable and satisfactory. Therefore the building structure should be analyzed at every stage of construction taking into account the load variations. Finite element modeling enhances the precision of finite element prototype which takes into account the effects of construction sequence. 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.




## II. OBJECTIVE

The aim and objective of this study comprises of the following

- To evaluate in what way the construction sequence analysis influence the variation of responses of structure with floating column such as bending moments, displacements and shear forces against linear static analysis for main construction materials of the structures i.e., reinforced concrete and steel.
- To evaluate in what way the construction sequence analysis influence the variation of responses of structure with shear wall such as bending moments, displacements and shear forces against linear static analysis for main construction material of the structures i.e., reinforced concrete.

## III. METHODOLOGY

In order to carry out the sequential analysis work the various high rise buildings with shear walls subjected to various loads are considered.

**Modeling Description**

This work includes four models of 12 story

- A model of simple RCC frame of 12 story.
- A model of RCC frame of 12 storey with floating columns.
- A model of STEEL frame of 12 storey with floating columns.
- A model of RCC frame of 12 storey with shear wall.

i. All the plans have same area i.e. 20m x 20m
ii. Number of bays in X-direction is four.
iii. Number of bays in Y-direction is four.
iv. Height of each storey is 3m.

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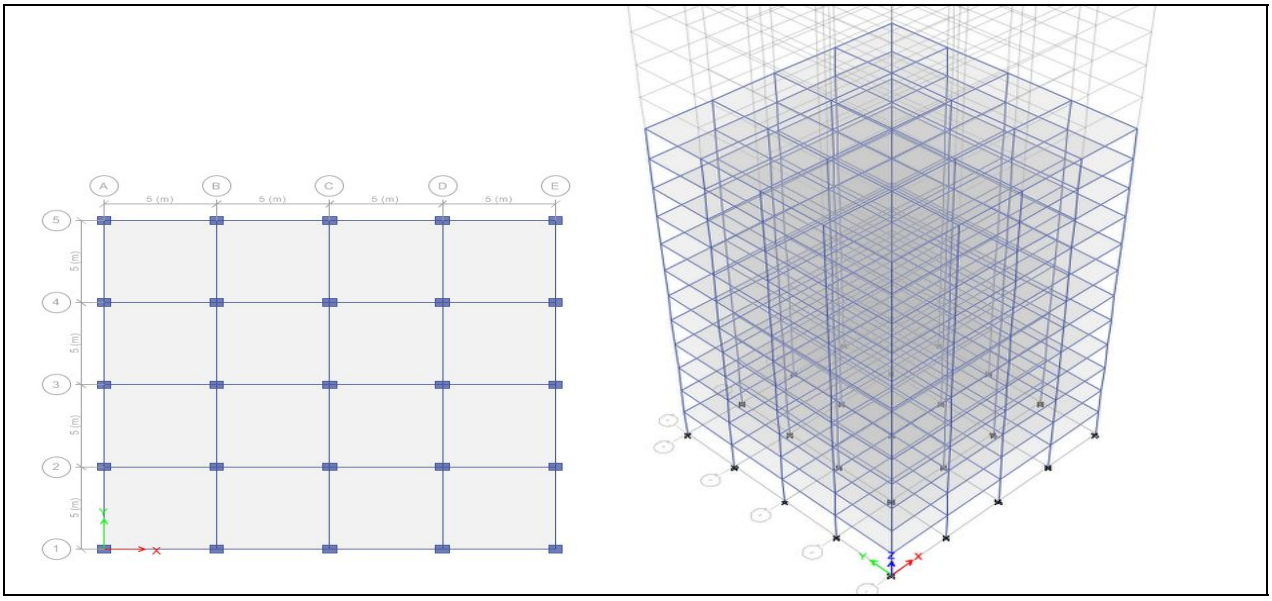
***PLAN OF THE BUILDING*** ***3-D MODEL OF THE BUILDING***




***NOTE:-***

All the models are same for steel and RCC except number of stories. Here 3-D model of G+12 building is shown.

## IV. COMPARITIVE RESULTS

### 1. RCC G+12 without floating column

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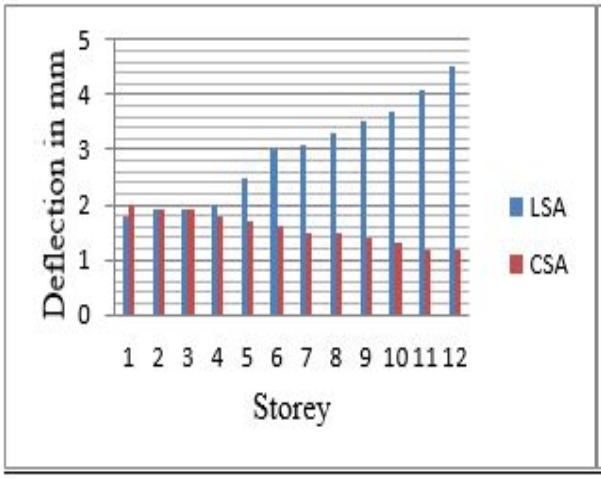
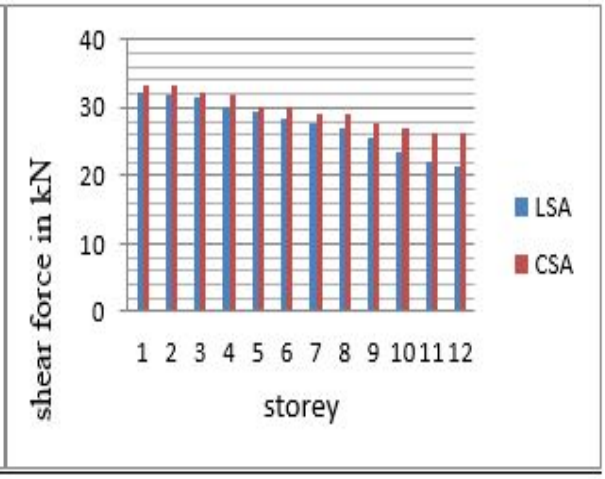
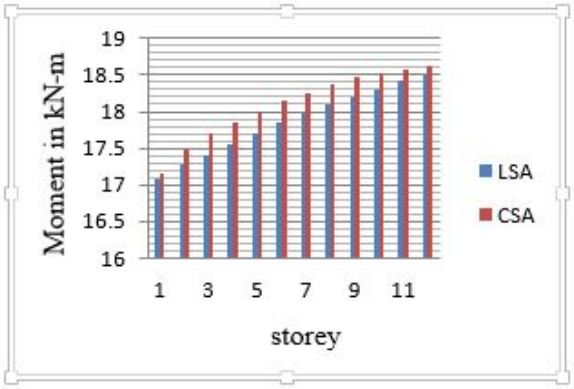


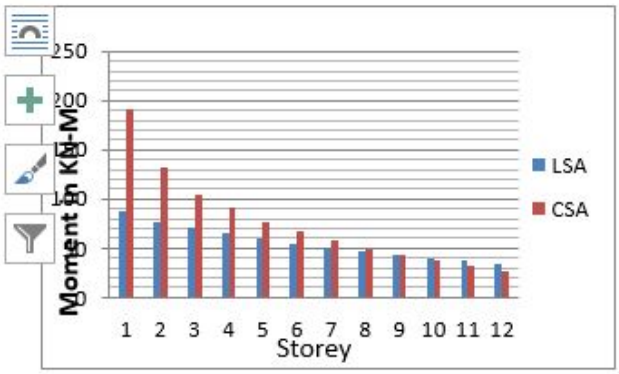

Storey vs. Deflection for LSA and CSA




Storey vs. Shear force for LSA and CSA



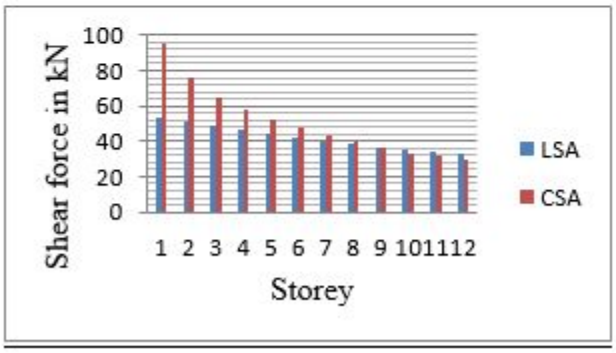

Storey vs. Moment for LSA and CSA




Storey vs. Moment for LSA and CSA

**2. RCC 12 Storey With floating column**


Storey vs. Deflection for LSA and CSA




Storey vs. Shear force for LSA and CSA

As it is observed from the results that the deflection of the beam under floating column in construction sequence analysis is 97% more than the deflection developed in linear static analysis for final stage i.e. when loaded for all twelve storeys. It is found from the results that shear force in beam under floating column in construction sequence analysis is 77%. More than the shear force developed in linear static analysis for final stage i.e. when loaded for all

twelve storeys and it is also observed that the bending moments in the beam in construction sequence analysis is 117% more than the bending moments developed in linear static analysis for final stage i.e. when loaded for all twelve storeys.

Moment developed in sequential analysis is more in column compared to linear static analysis .This is possibly due to truss analogy behavior of complete frame in linear static analysis and in sequential analysis the loads and hence moment is transferred to lower storey.

In sequential analysis shear wall may. Resist the axial load by developing moment behaving as a deep beam. This axial load is not transferred to the lower storey.

Due to application of gradual load in sequential analysis, loads are transferred to lower storey's thereby increasing the moments in the beam.

Increasing in moment reduces the vertical support reactions thereby reducing shear force in the beam.

Shear force in columns in sequential analysis is high compared to linear static analysis. This is possibly because of stage wise construction. The gravity load applied is causing lateral sway of existing structures which is developing more horizontal shear compared to linear static analysis

## V. CONCLUSIONS

1. 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 the structure overall.

2. The Displacement in the construction sequence analysis is more in supporting beam of storey 1 and it is going to be less in supporting beam of top storey compare to linear static analysis, were the displacement is more in top and less in bottom.
3. The shear forces are more in construction sequence analysis and less in linear static analysis. Hence, the convention sequence analysis should be taken for design.
4. Regarding displacement results, structure considered sequential effects shows the worst part than that of structure which have not considered these effects i.e. Linear Static Analysis which makes it significant to consider the effects of sequence and time-dependent.
5. The bending moment are more in construction sequence analysis and less in linear static analysis i.e., approximately double.
6. The axial force in exterior columns in construction sequence analysis is less compare to linear static analysis and the axial force in interior columns are more in construction sequence analysis compare to linear static analysis.
7. Hence preference is drawn first for the steel structure than the RCC structures for construction sequence analysis for the loading effects of long term.

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