Comparison of Linear Static Analysis and Construction Sequence Analysis on Multistorey Building with RC Floating Column Resting on RC and Composite Transfer Girders

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Abstract

In recent times, many buildings are planned and constructed with architectural complexities. The complexities include various types of irregularities like floating columns at various level and locations. These floating columns are highly disadvantageous in building built in seismically active areas. The earthquake forces that are developed at different floor levels in building need to be carried down along the height to ground by shortest path, but due to floating column there is discontinuity in the load transfer path which results in poor performance of building.

Building structures are analyzed in a single step using linear static analysis (LSA) on the assumption that the structures are subjected to full load at 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 storey by storey for nonlinear behavior of material hence construction sequence analysis (CSA) is carried out.The analysis of the model is carried out with the help of ETABS software.

It involves two types of analysis such as LSA and CSA, which is carried out on RC building structure of G+ 5 storeys with floating column in exterior position where the RC transfer girder is replaced by composite transfer girder and the parameter such as beam moments and deflection are compared.

Keywords - *Floating column, composite structure, linear static analysis, construction sequence analysis, ETABS.*

I. Introduction

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which at its lower level rests on a beam which is a horizontal member. Buildings with columns that hang or float on beams at an intermediate storey and do not go all the way to the foundation, have discontinuities in the load transfer path. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as a point load.

There are many projects in which floating columns are already adopted, especially above the ground floor, so that more open space is available on the ground floor. These open spaces may be required for assembly hall or parking purpose. The column is a concentrated load on the beam which supports it. The structures already made with these kinds of discontinuous members are endangered in seismic regions.

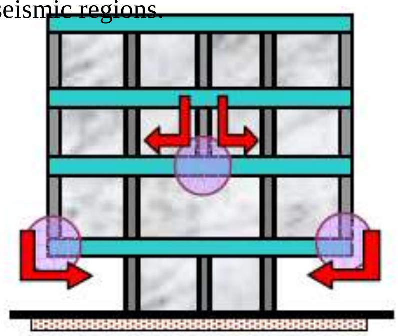

Fig 1: Hanging or floating column

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 construction stages of each story of the building structure due to the material non-linearity behaviour. 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.

II. Objective

- To carryout linear static and construction sequence analysis for G+5 storey RCC building with floating column in exterior position which is resting on RCC transfer girder is replaced by steel concrete composite transfer girder.
- To compare the parameters such as moment and deflection in both RCC and steel concrete composite transfer girder.

III. Analytical study

The present study is done by using ETABS v9.7.4(Extended Three-dimensional Analysis of Building Systems) it is fully integrated program that allows model creation, modification, execution of analysis, design optimization, and results review from within a single interface ETABS v9.7.4 is a standalone finite element based structural program for the analysis and design of civil structures. It offers an intuitive, yet powerful user interface with many tools to aid in quick and accurate construction of models, along with sophisticated technique needed to do more complex projects.

The structure considered here is a regular building with plan dimension of 30m X 30m, G+5 storey building is considered where the floating column is located in exterior position, the RCC transfer girder is been replaced by composite transfer girder. Table shows the Structural data for RC structureand Figure shows the positions of floating column considered in building and the composite transfer girder.

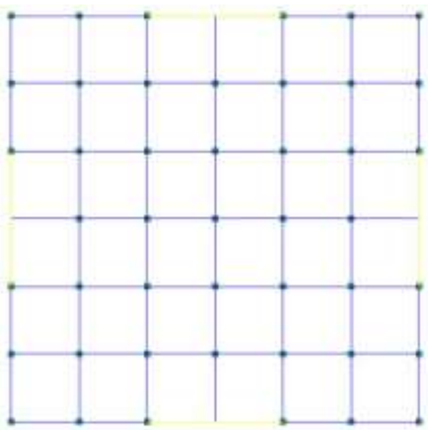

Fig.2 Columns removed in outer face of exterior frame (plan view)

TABLE I:STRUCTURAL DATA FOR RCC STRUCTURE

Dimension of building	30m X 30m
Number of storeys	G+5
Height of each floor	3m
Beam dimension	300 X 450 mm
Column dimension	600 X 600 mm
Thickness of slab	150 mm
Thickness of exterior wall	230mm
Thickness of interior wall	150mm
Seismic zone	II
Zone factor	0.10
Importance factor	1
Type of soil	Medium soil
Response reduction factor	5
Live load	$3kN/m^2$
Floor finish	$1.5\ kN/m^2$
Floor load on roof	$1.5\ kN/m^2$
Wall load on exterior beam	12kN/m
Wall load on interior beam	6kN/m
Grade of concrete	M25
Grade of steel	Fe415

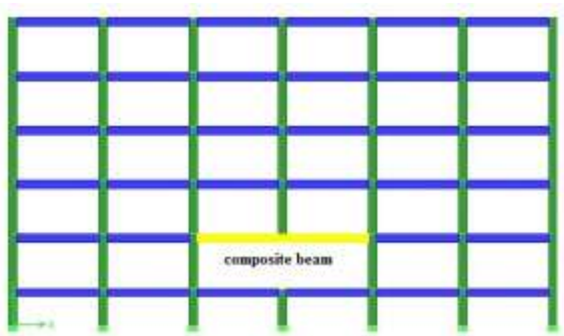

Fig. 3Elevation of G+ 5 storey building were RCC transfer girder is replaced by composite transfer girder

In the figure 3 and figure 4, G+5 storey RCC structure the column in removed in ground floor in outer face of exterior frame and the RCC transfer girder (300X450mm) is replaced by composite transfer girder(300 X 450 mm of ISMB 350) and the analysis is carried out. The yellow color in the figure 3 and fig 4 is the composite transfer girder in the RCC structure.

IV.Results and discussion

The following table and graph gives the value of bending moment and deflection by two different analysis such as linear static analysis and construction sequence analysis for two models

Model 1: G+ 5 storeys RCC building with floating column in exterior position and a RC transfer girder.

Model 2: G+5 storeys RCC building with floating column in exterior position and a composite transfer girder.

TABLE II: BENDING MOMENT VALUES OBTAINEDBY LINEAR STATIC ANALYSISIN MODEL 1 AND MODEL 2

Storey No.	Model 1	Model 2
1	2.87	2.63
2	84.71	113.02
3	75.47	72.69
4	71.81	68.8
5	70.39	67.5
6	65.03	62.33

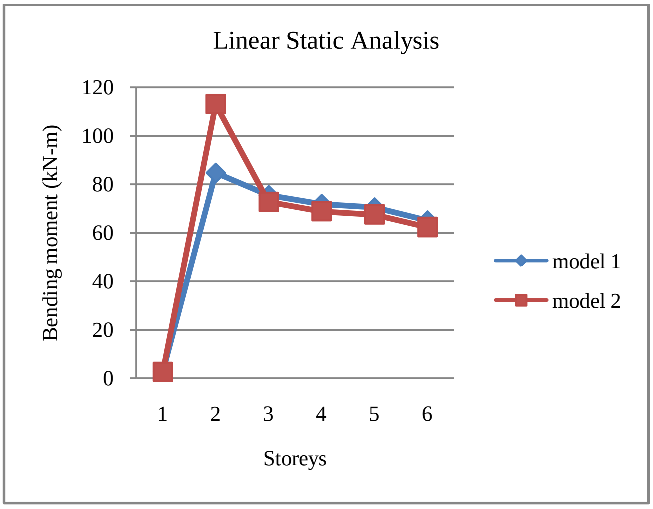

Fig.4Bending moment values of model 1 and model 2 by linear static analysis.

TABLE III: BENDING MOMENT VALUES OBTAINEDBY CONSTRUCTION SEQUENCE ANALYSISIN MODEL1AND MODEL 2.

Storey No.	Model 1	Model 2
1	2.05	1.96
2	151.38	178.69
3	73.93	68.81
4	41.65	39.1
5	21.02	19.82
6	7.04	7.11

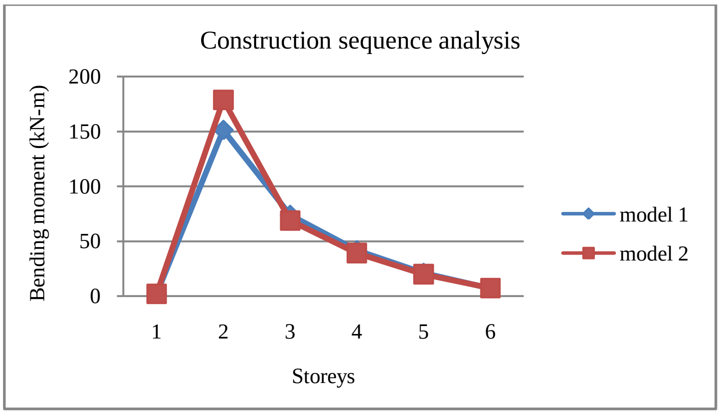

Fig.5Bending moment values of model 1 and model 2 by construction sequence analysis.

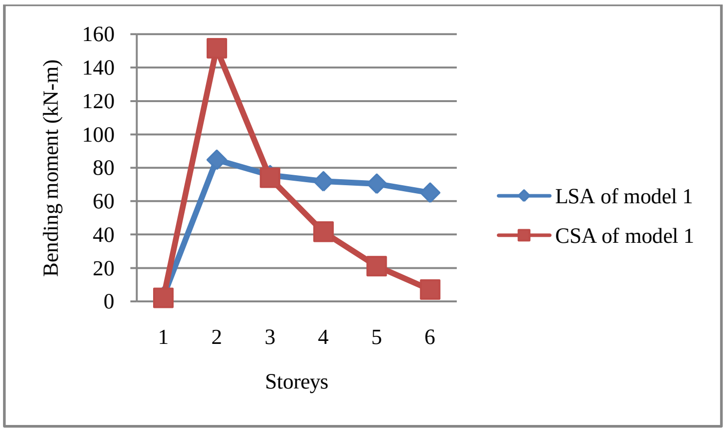

Fig.6Comparison of bending moment values obtained by linear static analysis and Construction sequence analysis for model 1.

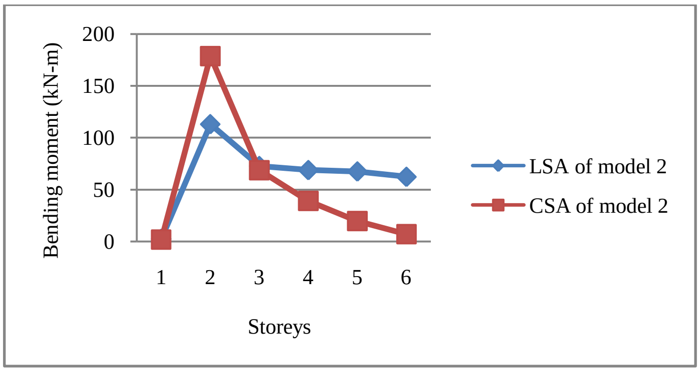

Fig.7Comparison of bending moment values obtained by linear static analysis and Construction sequence analysis for model 2.

TABLE IV: COMPARISONOF BENDING MOMENT VALUES OBTAINED IN TRANSFER GIRDEROF MODEL1 AND MODEL 2.

Type of Transfer Girder	Linear Static Analysis	Construction Sequence Analysis
Model 1(RC transfer girder)	84.71	151.38
Model 2 (Composite transfer girder)	113.02	178.69

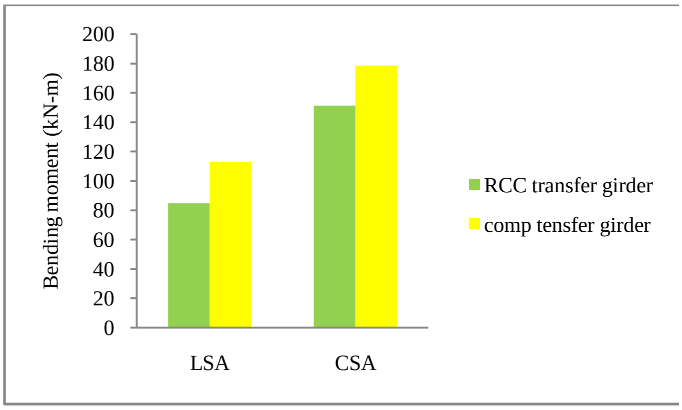

Fig.8Comparison of bending moment values obtained in transfer girder of model 1 and model 2.

TABLE V: COMPARISON OF DEFLECTION VALUES OBTAINED IN TRANSFER GIRDEROF MODEL 1 AND MODEL 2

Type of transfer girder	Linear static analysis	Construction sequence analysis
Model 1(RC transfer girder)	8.296	13.81
Model 2 (Composite transfer girder)	8.017	11.98

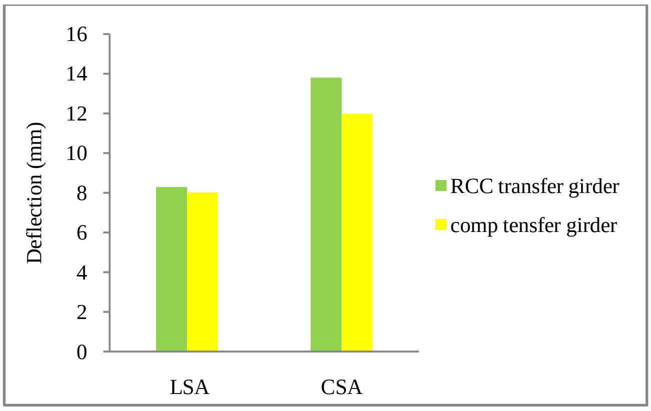

Fig. 9Comparison of deflection values obtained in transfer girder of model 1 and model 2.

The bending moment value obtained in model 2 the transfer girder shows more bending moment capacity value than model 1 in both linear static and construction sequence analysis.

- Compare to linear static analysis, construction sequence analysis has given more accurate value as it is a stage wise analysis.
- The deflection is less in model 2 compare to model 1 due to the stiffness in composite section compare to RCC in both the analysis.

V.Conclusions

- The outcome obtained from analysis shows the moment is taken by steel concrete composite transfer girder is more when compare to RCC transfer girder which proves that steel concrete composite structure resist maximum moment.
- Hence it is necessary that for multistory building frame with transfer girders and floating columns system, the construction sequence effect shall be taken into consideration.
- Axial load from floating column may causes of destruction of supporting beam, hence compare to RCC transfer girder composite transfer girder can take more bending moment and with less deflection.

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