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COMPARITIVE STUDY OF CSA AND LSA OF RCC BUILDING WITH EXTERNAL AND INTERNAL FLOATING COLUMN RESTING ON RCC TRANSFER GIRDER

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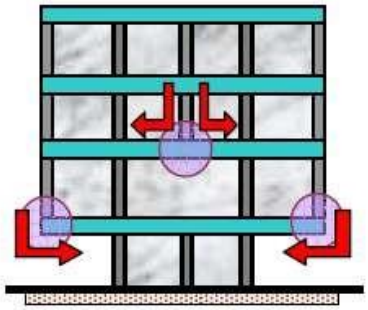
***Abstract*: Floating columns are very common these days and are adopted to increase the built up area on the floor. Floating column can be considered as structural vertical irregularities in buildings and it is highly undesirable in building built in seismically active areas. This paper presents the comparative study of behaviour of irregular building with floating column and is compared with construction sequential analysis. The crack width calculation is also done on transfer girder in order to check for structural failure. The study is subjected to gravity loads includes the analysis of irregular building with internal and external floating column .The analysis is done by using ETABS software by equivalent static method. The outcome of this analysis will help to understand how the behaviour of structure's response with Construction Sequence Analysis and conventional analysis with vertical discontinuity and mass irregularity in the structure.**

***Keywords:* Floating columns, Construction, structural failure.**

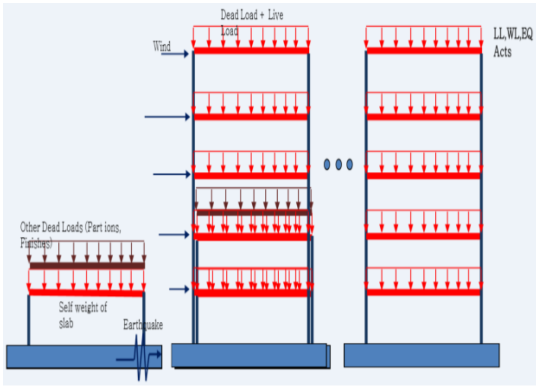
1. INTRODUCTION

Since a long time the multi-storied building frame have been analysed on the assumption that whole of the load is applied to the completed frame structure with all the loads acting on the building that are **gravity loads(dead load (weight of building and contents i.e. self-weight), live loads (floors , roof , snow live loads)), lateral loads(wind load , earthquake loads , loads due to earth pressure , water pressure, blast and impact)** which are applied on the completed frame at a given instant as a single step analysis. But in actual practice the dead load due to each structural component and finishing items are imposed in separate stages as the building frame is constructed story by story in a sequential order. The performance of a building structure with the various load applied in a single step differ significantly from that when the loads are applied in stages. Hence, in order to analyse the structure according to the actual construction practices this is known as construction sequence analysis (CSA). Construction sequence analysis is also known as staged construction analysis which is a nonlinear static form of analysis which takes into account the concept of incremental loading.

Sequential analysis is becoming an essential part in design package. However this nonlinear static analysis is not so popular because of lack of knowledge about its necessity and scope. Like so many other analysis, construction sequential analysis had specific purposes in design phase of the structures.



Hanging or Floating Columns



Crack width calculation of transfer girder in internal and external floating column

As per IS: 456 - 2000, Annex F, procedure to determine the flexural crack width is given. The design crack width (Wcr) can be calculated as:

$$Wcr = \frac{3a_{cr}e_m}{1 + 2\frac{a_{cr} - c_{min}}{D - x}}$$

Where

a_{cr} = Shortest distance from the selected level to the surface of the nearest longitudinal bar

C_{min} = Minimum clear cover to the longitudinal bar

D = Overall depth of the member

x = depth of the neural axis of the member

Ɛm or e_m = average strain at the level at which cracking is being considered

Ɛ1 or e1 = Strain at the level being considered

OBJECTIVE

Following are the **objectives** of the study:

1) The main objective of this work is to reduce the effects of structural failure during the construction phase ultimately reducing the risk of injury and delays in construction projects.

2) To understand the multi-storeyed structure behavior analytically during construction at different stages using construction sequence analysis.

3) **Comparative** study of Construction Sequence analysis with the conventional method.

4) To evaluate in what way the construction sequence analysis influences the variation of responses of structure with **floating column,** such as bending moments, displacements and shear forces against linear static analysis

5) To calculate the crack width of transfer girder in case of internal and external floating column and to compare the values with CSA and LSA.

2. METHODOLOGY

In order to understand the sequential analysis work the high rise buildings with floating column subjected to loads are considered.

Modelling description

1. A model 1 of RCC frame with 10 stories with EXTERNAL floating column with RCC transfer girder
2. A model 2 of RCC frame with 10 stories with INTERNAL floating column with RCC transfer girder

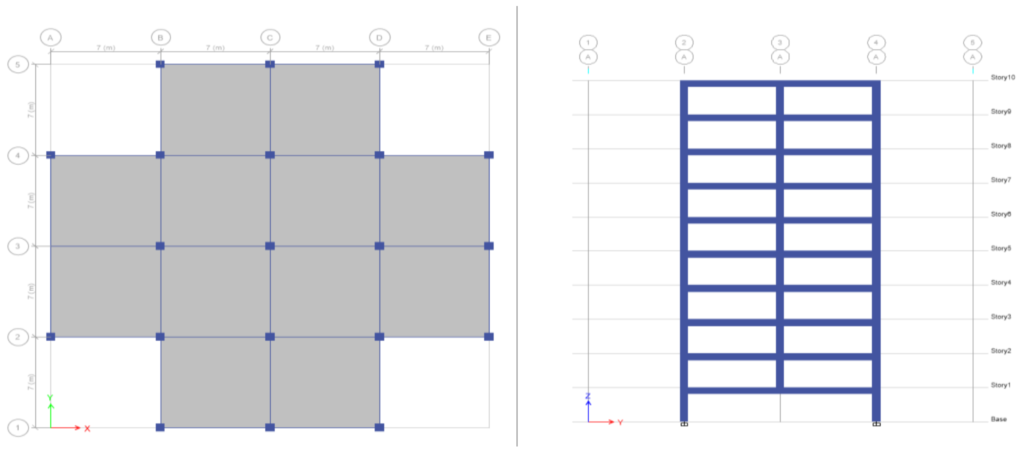
The details of the model are as follows:

Dimension of building	28m x 28m
Number of storeys	G+10
Height of each storey	3.0m
Height of parapet wall	1.2m
Dimension of beam	400 x 600 mm
Dimension of column	500 x 500 mm
Thickness of slab	150mm
Thickness of outer wall	230mm
Thickness of inner wall	115mm
Imposed load LIVE LOAD	1.5 kN/m^2
Floor finish	1.5 kN/m^2
Roof load	1.5 kN/m^2
Wall load on outer beams	13.8 kN/m
Wall load on inner beams	6.9 kN/m
Wall load on parapet	5.52 KN/m
Grade of concrete	M25
Grade of steel	Fe 415

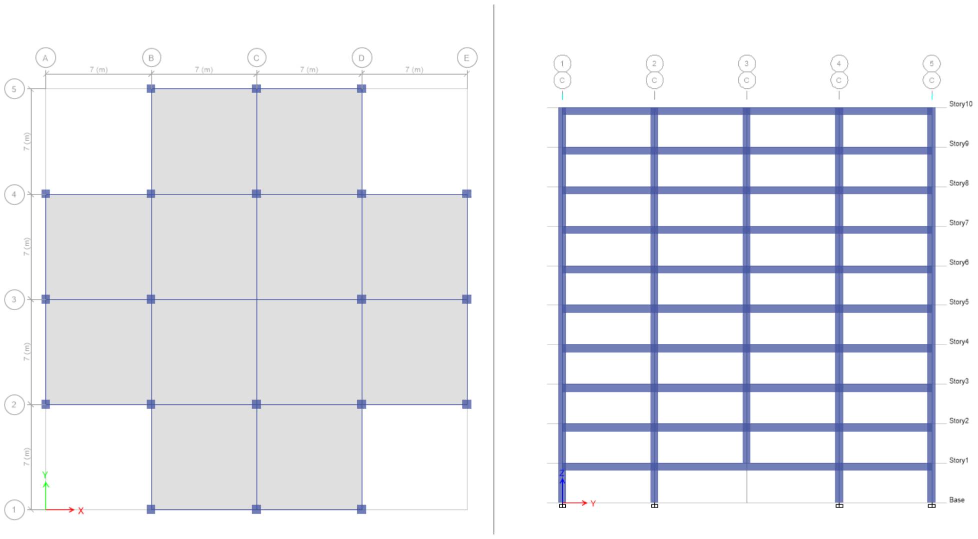
Loads assigned on models are as per IS codes.

Dead load	As per IS: 875 (Part I): 1987
Live load	As per IS: 875 (Part II): 1987

Plan of the building and Elevation model of the building



MODEL 1



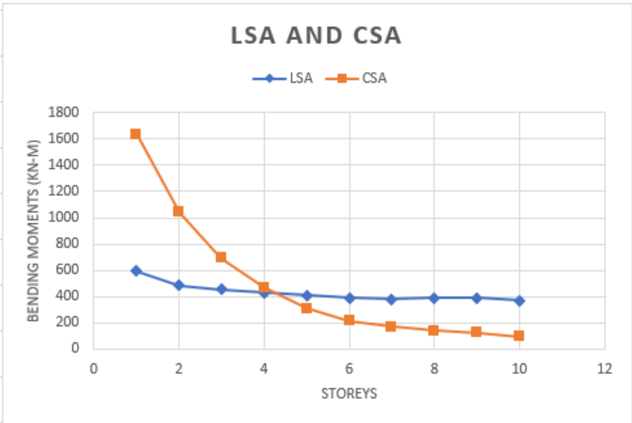
MODEL 2

3. COMPARITIVE RESULTS

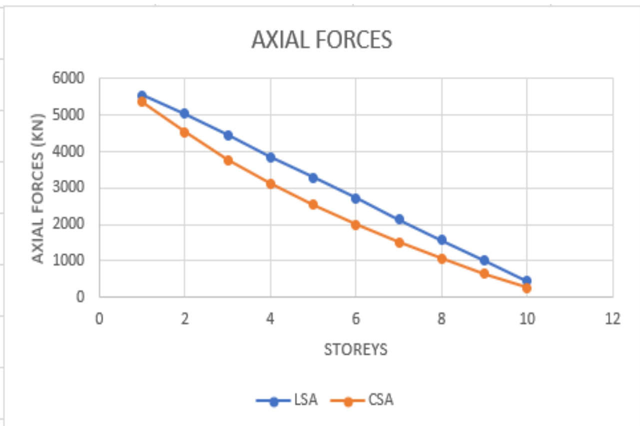
Thus, it can be seen that the moments in the transfer beam are considerably high when there is internal floating column, in conventional analysis and the difference in percentage variation in conventional and construction stage analysis are as given below:

MODEL 1

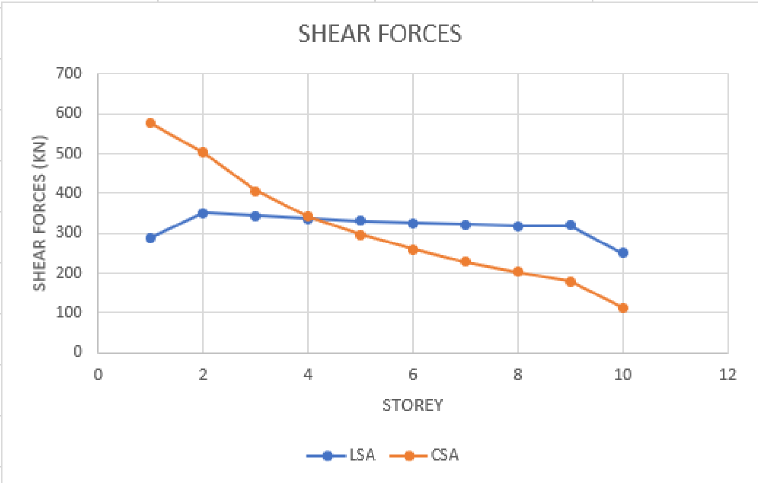
G+10 BENDING MOMENT **EXTERNAL FLOATING COLUMN:** The variation of bending moment in the transfer girder, of external floating column was observed and is plotted.



G+10 AXIAL FORCES: The variation of axial forces in the floating column in case of linear static analysis (LSA) and construction sequence analysis (CSA), of external floating column was observed and is plotted.



G+10 SHEAR FORCES : The variation of shear force in the transfer girder, of external floating column was observed and is plotted.



COMPARISON OF **MAXIMUM BENDING MOMENTS** (KN-m) VALUES

OBTAINED IN TRANSFER GIRDER

Type of transfer girder	Linear static analysis	Construction sequence analysis
Model 1	592.61	1633.42

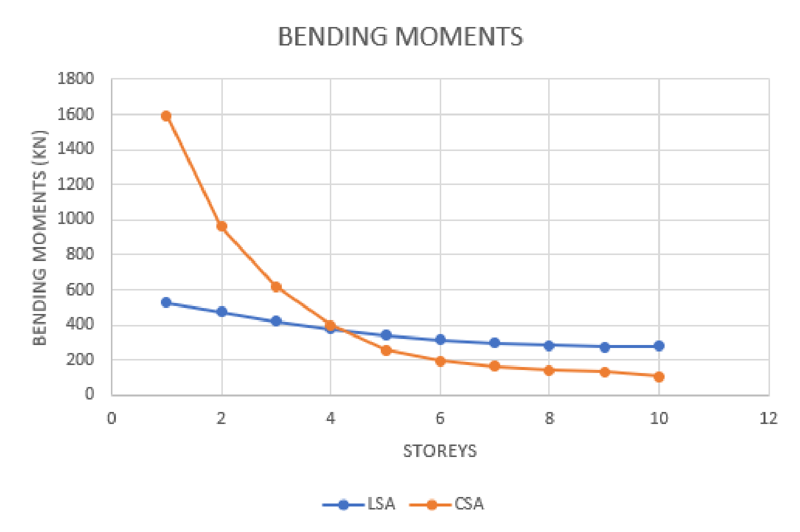
COMPARISON OF **DEFLECTION** VALUES (mm)

OBTAINED IN TRANSFER GIRDER

Type of transfer girder	Linear static analysis	Construction sequence analysis
Model 1	34.929	87.089

MODEL 2

G+10 BENDING MOMENT **INTERNAL FLOATING COLUMN :** The variation of bending moment in the transfer girder, of external floating column was observed and is plotted.



G+10 AXIAL FORCES: The variation of axial forces in the floating column in case of linear static analysis (LSA) and construction sequence analysis (CSA), of interanl floating column was observed and is plotted.

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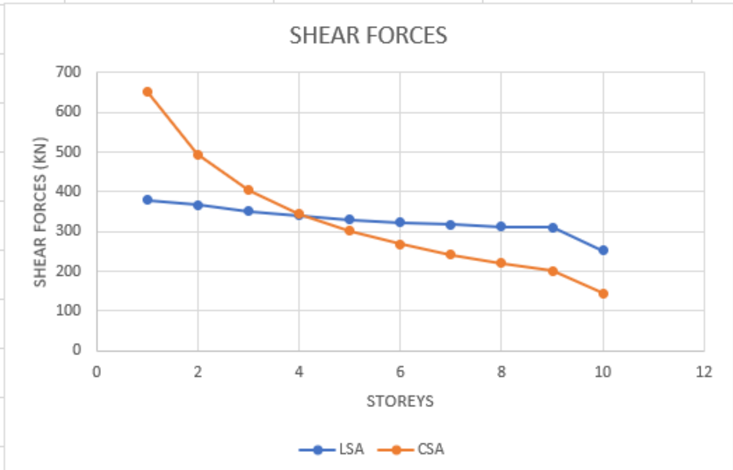
G+10 SHEAR FORCES: The variation of shear force in the transfer girder, of external floating column was observed and is plotted



COMPARISON OF **MAXIMUM BENDING MOMENTS (G+10)** (KN-m) VALUES

OBTAINED IN TRANSFER GIRDER OF MODEL 1 AND MODEL 2

Type of transfer girder	Linear static analysis	Construction sequence analysis
Model 1	529	1592

COMPARISON OF **DEFLECTION VALUES (G+10)** (mm)

OBTAINED IN TRANSFER GIRDEROF MODEL 1 AND MODEL 2

Type of transfer girder	Linear static analysis	Construction sequence analysis
Model 1	35.691	86.147

AXIAL FORCES (G+10) (KN)

	Internal Column	External Column
LSA	5561.61	9593.21
CSA	5373.024	10047.13

CRACK WIDTH (mm)	LSA	CSA
EXTERNAL	0.03	0.098
INTERNAL	0.028	0.096

4. CONCLUSIONS

From the above studies it can be concluded that

1. The effects of construction sequence analysis is compelling over conventional analysis.

2. Interior column experience more axial forces as compared to exterior column

3. If frame has more floors the bending moment induced at bottom floors will become more significant and it may go beyond tolerable limit.

4. Moments and shear forces in transfer beam are higher in construction sequential analysis which should be taken in account during manual or computer aided design in the design phase for avoiding cracking of beam and column due to sequence effects.

5. The maximum value of deflection of transfer girder when analysed by CSA gives a higher value and thus should be taken into account in order to avoid failure

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. The crack width in transfer girder is beyond permissible limit in construction stage analysis which may lead to steel corrosion and loss of performance of structure.

EXTERNAL COLUMN	LSA	CSA	% VARIATION
BENDING MOMENT	592.61	1633.42	175%
SHEAR FORCE	192	384	100 %
AXIAL FORCE(KN)	9593	10047	4.73 %
DEFLECTION(mm)	34.929	87.08	149 %

INTERNAL COLUMN	LSA	CSA	% VARIATION
BENDING MOMENT	529	1592	200 %
SHEAR FORCE	253	435	71 %
AXIAL FORCE	5561	5373	3.3%
DEFLECTION(mm)	35.691	86.14	141 %

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