International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 08 | Aug 2022 www.irjet.net p-ISSN: 2395-0072

THE EFFECT OF PARTIAL CONSTRUCTION IN 3D-MULTISTORIED FRAME

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Abstract –

Multistoried buildings have been analyzed for year on the assumption that whole of the load is applied on the completed frame. Looking into the mode of incidence of the load or various stage of partial construction, it is evident that part of the load is applied in stages as the construction of the frame proceeds, where as the remaining part of it is imposed on completion of the frame. Unfortunately, the aspect of partial construction of the frame due to any reasons has been over looked till now by engineers, although its effect on the final stresses of the frame is quite considerable.

Computer aided analysis of building system is considered in present work by considering the self-weight, Dead loads, Live Loads & Earth-quake loads with different load cases and later the effect of partial construction is studied. The building system consists of slabs supported on beams which are framed into columns and foundations. The software STADPRO V8i is used for analysis.

Initially Three dimensional six storied is considered under various combination of loading as per IS 456:2000 and later different modes of partial construction are chosen by eliminating either some storeys or bays. At each instant the variation in bending moments and axial loads over column has been studied.

The comparative study between main frame and different modes of partial construction is being done. It is evident from this study that during analysis of multistoried frame, the mode of partial construction should be pre-defined, if constructed in phases.

Key Words: partial construction, building system, multistoried frame, different modes, load cases.

1. INTRODUCTION

Safety, Serviceability and Economy are the basic qualities which all structures should possess during their designed life span.

Analysis and design of structures constitute the two major activities in Structural Engineering practices. Generally, structural analysis and design are two mutually coupled processes. The results of the analysis decide the choice of variables in the design.

Generally, multistoried building frames have been analyze in a single step as complete frame by considering the self weight , dead loads , live loads & earth-quake loads with different load cases acting on the building. The performance of structure with various load applied in single step differs significantly from that when the structure is constructed in different cases [i.e. stages of partial construction].

The structural analysis of multistoried building is on of the areas that have attracted the engineering researchers & designer attention. There is area of partial construction, however, which has been ignored by many designers till now.

In this study we are considering 3D multistoried frame under various combition of loading & later different mode of partial construction are considered by eliminating either some storeys & bays.

2. Work Methodology

2.1 General

In the present work, software package STAAD.ProV8i is used to analysis the THREE DIMENSIONAL SIX STOREYED building frame under combination of Dead, Live load and Seismic Load. Later, we consider different modes of partial construction. The considered modes of partial construction are mentioned in Article 3.3. The effect of each mode of partial construction is to be noted in columns in comparison with main six storied structure.

This is a real problem, generally occurs in practical life that builders take design and drawing of complete structure but construct only some part due to various constraints (i.e. financial, time requirement etc.).

2.2 Details of Building

The details of the main building are given below:

Table 2.1 –Parameters of Main Building

S.No.	Particulars	Description
1	No's of Storey's	6
2	No's of Bays in X-direction	3
3	No's of Bays in Z-direction	2
4	No's of joints	84
5	No's of member	174
6	Type of Building	Mercantile
7	City	Lucknow
8	Earthquake Zone	IV
9	Soil Type	Medium Soil
10	Importance factor	1.5
11	Building Frame System	Ordinary RC moment resisting frame
12	Zone Factor	0.16
13	Storey Height	3.00 m
14	Grade of concrete	M25
15	Grade of steel	Fe 500

2.3 MODES OF PARTIAL CONSTRUCTIONS:

The following modes of partial construction were considered for comparative study:

- Case –I: One bay of span = 5.00 m is removed from sixth storey.
- Case-II: One bay of span = 5.00 m is removed from fifth and sixth story.
- Case-III: The building is constructed up to fourth floor.
- Case-IV: The building is constructed up to second floor.
- Case-V: The building is constructed up to first floor.

The main frame and all five cases of partial construction were analyzed and designed by using software STAAD.ProV8i. These six models were used for the comparison of response of various forces in terms of axial force, bending moments and shear forces in different loading combinations.

2.4 Loads

In the current work combination of Self-weight, Dead Loads, Live loads and Earthquake loads is taken in account. The loads are confiriming to IS 875 (part1 & part2) and IS 1893 (part1):2002.

3. Modelling of Structure

3.1 General

Data preparation for structural analysis problem basically involved, (1) describing the structural geometry, (2) defining the static and / or dynamic load conditions for which the structure needs to be analyzed.

3.2 Problem Statement

The details of main problem taken in this work are as below:

- Type of building = Mercantile
- Nos. of bays in X – direction = 3
- Nos. of bays in Z – direction = 2
- Nos. of storey = 6
- Nos. of Joints = 84
- Nos. of members = 174
- Thickness of slab = 125mm(M25)

Details of beams:

Table 3.1 - Dimensions of Beams Section

SPAN	FIRST & LAST PORTAL		INTERMEDIATE PORTAL		MIX
(M)	B (mm)	D (mm)	B (mm)	D (mm)	
4.0	230	350	230	450	M25
5.0	230	550	230	650	M25

Details of columns:

Table 3.2 - Dimensions of Columns Section

LOCATION OF COLUMNS	FIRST & LAST PORTAL (mm)	INTERMEDIATE PORTAL (mm)	MIX
EXTERIOR	300 X 400	300 X 500	M25
INTERIOR	300 X 450	300 X 650	M25

Details of loading on beams:

Table 3.3:- Loading on beams

SPAN (M)	LOCATION OF BEAMS	AT FLOORS (KN/m)	AT TERRACE (KN/m)
4.0	END BEAM	17	14
	INTERMEDIATE	25	21
5.0	END BEAM	20	16
	INTERMEDIATE	30	26

3.3 Main Model

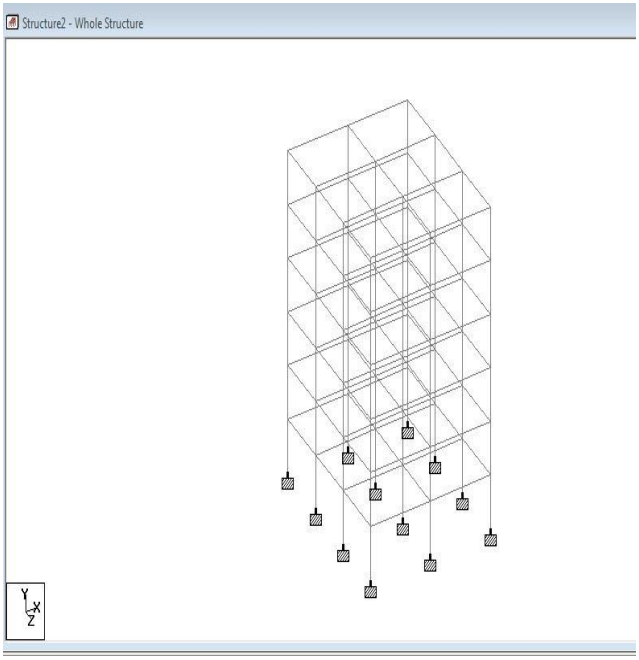


Figure 3.1 : THREE DIMENSIONAL SIX STOREYED FRAME

3.4 Different Models

The different modes of partial construction are as follows:

- Case-I: One bay of span = 5.00 m is removed from sixth storey [Refer figure 3.2]
- Case-II: One bay of span = 5.00 m is removed from fifth & sixth storey [Refer figure 3.3]
- Case-III: The building is constructed up to fourth floor [Refer figure 3.4]
- Case-IV: The building is constructed up to second floor [Refer figure 3.5]

  Case-V: The building is constructed up to first floor [Refer figure 3.6]

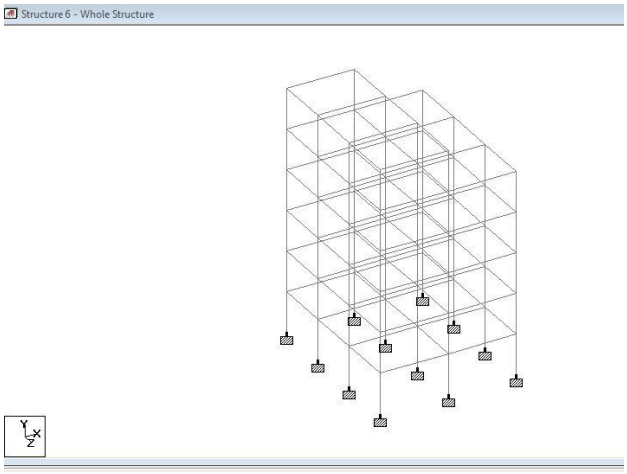


Figure 3.2 : CASE-I OF PARTIAL CONSTRUCTION FRAME [One bay of span 5m is removed from 6th storey]

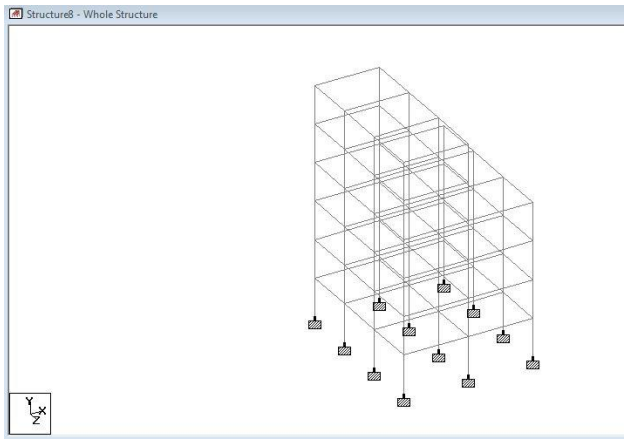


Figure 3.3 : CASE-II OF PARTIAL CONSTRUCTION FRAME [One bay of span 5m is removed from 5th and 6th storey]

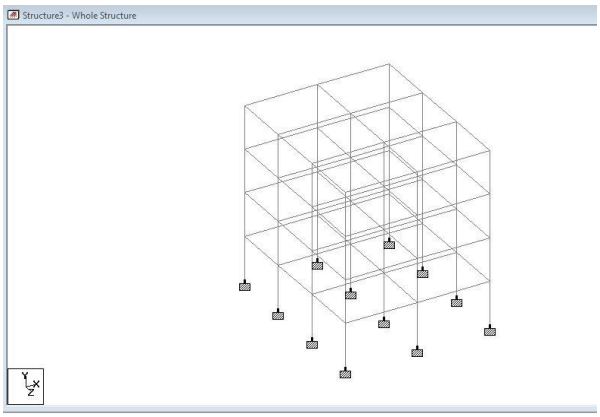


Figure 3.4 : CASE-III OF PARTIAL CONSTRUCTION FRAME [Building constructed up to fourth floor]

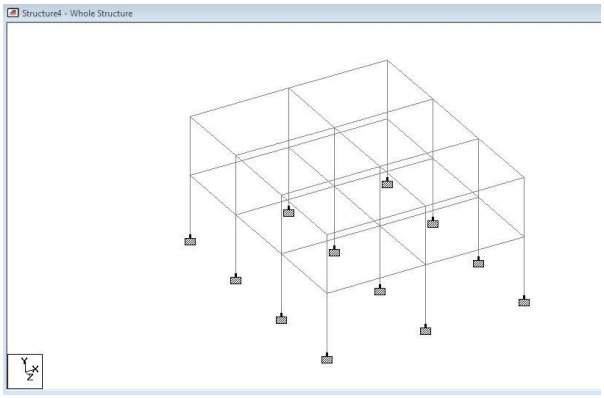


Figure 3.5 : CASE-IV OF PARTIAL CONSTRUCTION FRAME [Building constructed up to second floor]

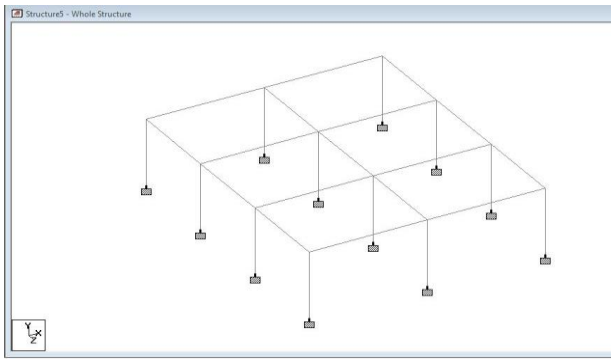


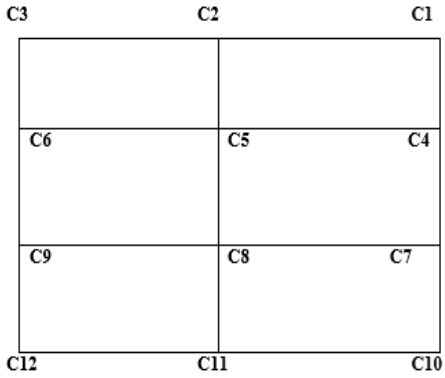
Figure 3.6 : CASE-V OF PARTIAL CONSTRUCTION FRAME [Building constructed up to first floor]

4. Analysis

All structures may be analyzed by the linear elastic theory to calculate internal actions produced by design loads. In the present work we have used the software STAAD.ProV8i for the analysis.

5. Comparative Study

The different modes of partial construction were analyzed. These modes were chosen by eliminating either some storey or bays. At each instant the variation in bending moments and axial loads for various members has been studied. The variation in moments in axial load in columns with respect to main complete frame is to be performed.



Figures 5.1 Plan of columns locations

6. Discussion

6.1 Column no.1

The graph for axial load (Pu) and bending moment (Mz)are as follows:

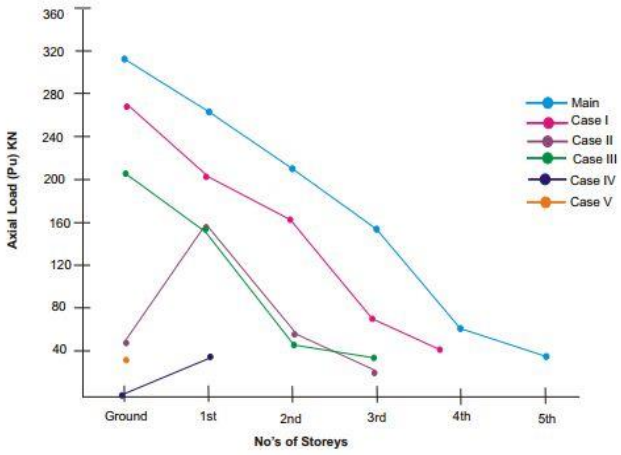


Figure 6.1(a): Comparison of Axial load (Pu) values of Column No. 1 obtained from Main complete frame and different cases of Partial Construction

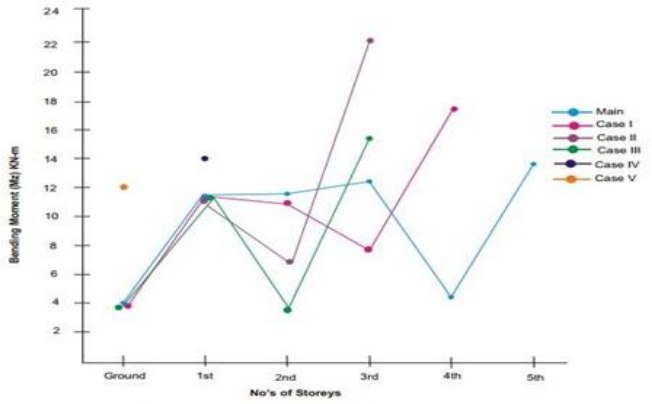


Figure 6.1(b): Comparison of Bending Moment (Mz) values of Column No. 1 obtained from Main complete frame and different cases of Partial Construction

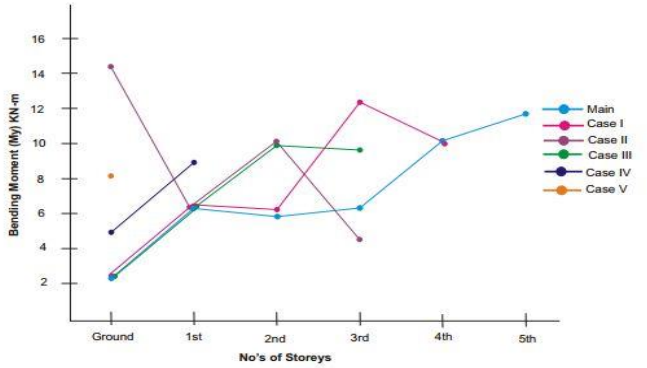


Figure 6.1(c): Comparison of Bending Moment (My) values of Column No. 1 obtained from Main complete frame and different cases of Partial Construction

After the detail study from the results and graph that the design of column section obtained from main complete frame analysis & design. It needs scrutiny of the proposed section at following floor level, if constructed in any one of the modes of partial construction:

i. If the building is constructed in case-I (i.e. one bay of span 5.00 m is removed at 6th storey) of partial construction in place of main complete frame then column No: 1 is critical at 4th floor.

ii. If the building is constructed in case-II (i.e. one bay of span 5.00 m is removed at 5th & 6th storey) of partial construction in place of main complete frame then column No: 1 is critical at 3rd floor.

iii. If the building is constructed in case-III & IV than design of main complete frame has no scope of check this Column.

iv. If the building is constructed in case-V (i.e. building is constructed up to 1st floor) of partial construction in place of main complete frame then column No: 1 is critical at Ground floor.

6.2. Column No.2

The graph for axial load (Pu) and bending moment (Mz)are as follows:

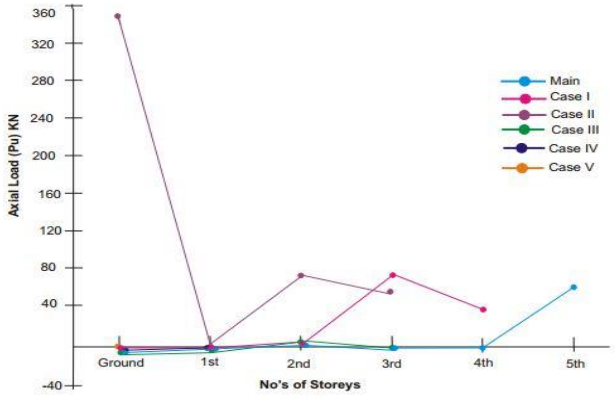


Figure 6.2(a): Comparison of Axial load (Pu) values of Column No. 2 obtained from Main complete frame and different cases of Partial Construction

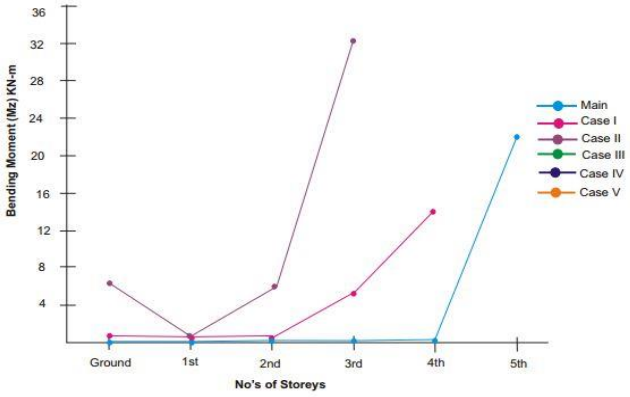


Figure 6.2(b): Comparison of Bending Moment (Mz) values of Column No. 2 obtained from Main complete frame and different cases of Partial Construction

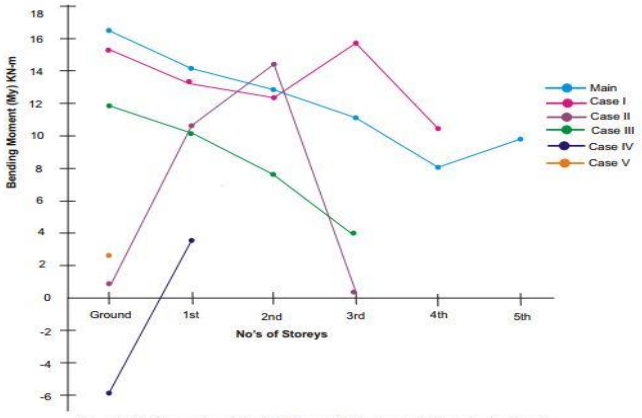


Figure 6.2(c): Comparison of Bending Moment (My) values of Column No. 2 obtained from Main complete frame and different cases of Partial Construction

After the detail study from the results and graph that the design of column section obtained from main complete frame analysis & design. It needs scrutiny of the proposed section at following floor level, if constructed in any one of the modes of partial construction:

i. If the building is constructed in case-I (i.e. one bay of span 5.00 m is removed at 6th storey) of partial construction in place of main complete frame then column No: 2 is critical at 4th floor.

ii. If the building is constructed in case-I (i.e. one bay of span 5.00 m is removed at 6th storey) of partial construction in place of main complete frame then column No: 2 is critical at 3rd floor.

iii. If the building is constructed in case-II ((i.e. one bay of span 5.00 m is removed at 5th & 6th storey) of partial construction in place of main complete frame then column No: 2 is critical at 3rd floor.

6.3. Column No.3

The graph for axial load (Pu) and bending moment (Mz)are as follows:

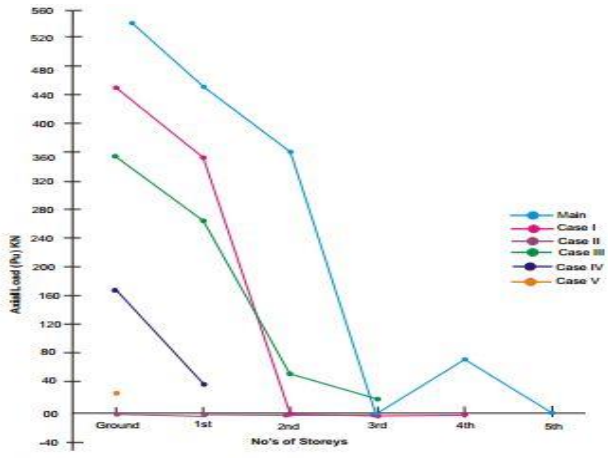


Figure 6.3(a): Comparison of Axial load (Pu) values of Column No. 3 obtained from Main complete frame and different cases of Partial Construction

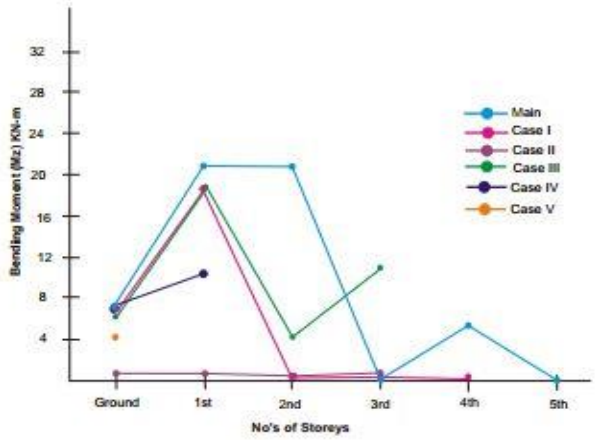


Figure 6.3(b): Comparison of Bending Moment (Mz) values of Column No. 3 obtained from Main complete frame and different cases of Partial Construction

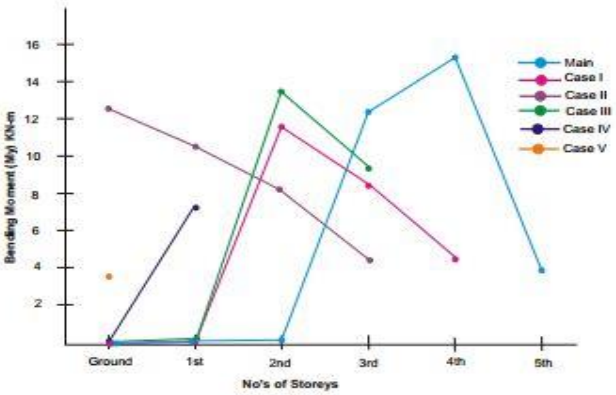


Figure 6.3(c): Comparison of Bending Moment (My) values of Column No. 3 obtained from Main complete frame and different cases of Partial Construction

After the detail study from the results and graph that,if the building is constructed in any mode of partial construction in place of main complete frame than column No: 3 has no scope to check in any mode of partial construction, hence provided section of main complete frame is adequate.

Comparative study for other columns will be done separately.

7. Conclusions

a) The following are evident from above study:

i. If the building is constructed in Case -I (ie. one bay of span 5.00 m is removed at 6th storey) of partial construction than the column no. 1, 2, 5, 6, 7 & 8 were redesigned.

ii. If the building is constructed in Case-Il (i.e. One bay of span 5.00 m is removed at 5th & 6th storey) of Partial construction than the column no. 1,2, 5, 6, & 7 were redesigned.

iii. If the building is constructed in Case -V (i.e. building constructed up to first floor) of Partial construction than the column no. I was redesigned.

b) As from above study it is seen that in some cases of partial construction column moments and axial load both increase.

c) Nature of column moments may change in different mode of partial construction, such as some of the columns designed for axial loads may be subjected to uniaxial and biaxial bending under partial construction.

If magnitude of column moments and axial loads increases or nature of column moments in different plane changes, then it should be considered in design for safety and serviceability of structure.

d) More rational and economical design can be done by considering the effects of partial constructions.

e) As is evident from above discussion, it is concluded that in analysis of multistoried structure, the mode of partial construction should be pre-defined, if constructed in phases and its behaviour should be taken into account.

8. Future Perspective

There is an immense scope in this field of CAD for future work. Limited modes of partial construction are used in present study. Wind loads have not been considered at present. However, this can be added to the work with little effort, but has been left out due to lack of time.

The work can be extended to carry out the wind analysis. An interface between analyses can be developed.

9. Reference

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