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Study and Comparison of Sequence Analysis with Conventional Lumped Analysis Using ETABS

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Abstract:

Due to architectural requirements some of the columns are designed as floating columns with transfer girder support in multistoried buildings and are being analysed in a single step on the assumption that the frame is subjected to design loads. In fact during construction, loads are applied in various stages as the frames are constructed storey by storey. In this paper two cases has been considered. Whereas in Case 1 the multistoried building (22 storied) with floating columns and transfer girder will be analysed as a whole for the subjected loading and in Case 2 the multistoried building (22 storied) with floating columns and transfer girder will be analysed with reference to the construction sequence or staged construction. A detailed study and comparison of the variation in deformations and forces will be presented for the transfer girders, for the floating column on girders and for the frames which is above transfer girders. The building is analysed and designed using ETABS software.

Introduction:

Multistoreyed buildings have been analysed for years on the assumption that whole of the load is applied on the complete frame. Looking in to the mode of incidence of the load, it is evident that part of the load is applied in stages as the construction of the frame proceeds, whereas the remaining part of it is imposed on completion of the frame.

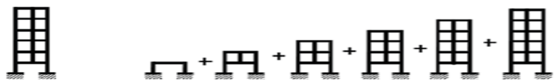
The main factors affecting the limit state of serviceability of building are:

1.Creep and shrinkage.

2.Span and cross section of the structural members.

3.Cycle time for floor to floor construction and strength of concrete.

In present paper the main factor which we are considering is Cycle time for floor to floor construction and strength of concrete.Staged construction allows defining a sequence of stages wherein one can add or remove portions of the structure, selectively apply load to portions of the structure, and to consider time-dependent material behavior such as aging, creep, and shrinkage. Staged construction is variously known as incremental construction, sequential construction, or segmental construction.



CASE 1: LUMPED MODEL
CASE 2: STAGED CONSTRUCTION
Fig1: Example of conventional and staged construction model.

Design:

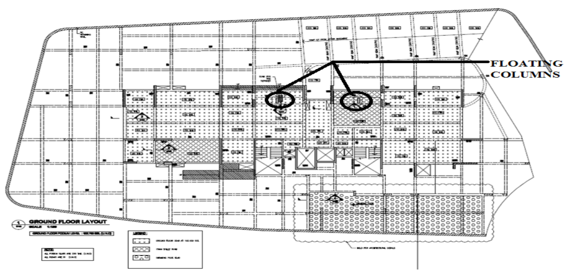


Fig2: structural plan of ground floor showing the transfer girder and floating columns.

Table:1 column and beam schedule ground floor:

Beam no:	Size
TB1	1000*1200

Column no:	Size
FC1,FC2	300*700

Etabs model:

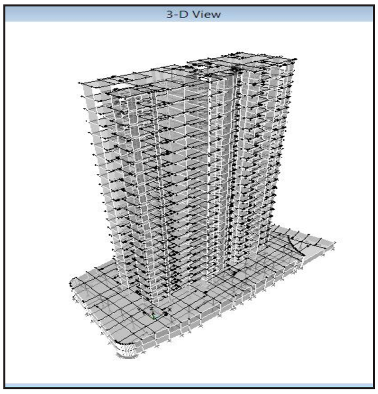


Fig.3 3D view of ETABS model

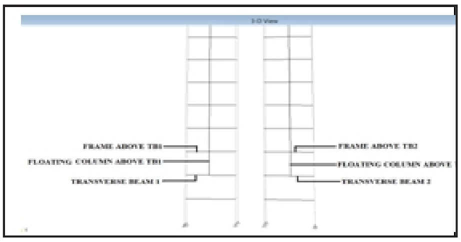


Fig.4 Transverse beams, floating columns and frame above transverse beams

Load combinations:

a) Static load cases
b) Unfactored load combinations
c) Factored load combinations

Analysing and comparing deformations and design forces

1)Comparison of deformations of TB1 along with construction sequence analysis:

Table:2 Deformation of TB1 in conventional analysis (All deflections are in "mm")

Point Displacements

Point Object 804 Story Level GROUND

	X	Y	Z
Trans	0.077989	-0.498950	-8.104977
Rotn	0.000282	0.000201	-0.000021

Lateral Drifts...

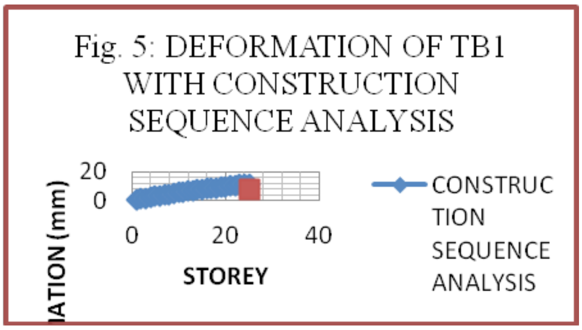
Table:2 Deformation of TB1 in conventional analysis (All deflections are in "mm")

Point Displacements

Point Object 804 Story Level GROUND

	X	Y	Z
Trans	0.079453	-0.818605	-11.362602
Rotn	0.000713	0.000263	-0.000039

Lateral Drifts...



2)Comparison of deformations of TB2 along with construction sequence analysis:

Table: 4 Deformation of TB2 in conventional analysis (All deflections are in "mm")

Point Displacements

Point Object 806 Story Level GROUND

	X	Y	Z
Trans	0.099078	-0.478652	-8.277245
Rotn	0.000203	-0.000181	0.000023

Lateral Drifts...

Table: 5 Deformation of TB2 in construction sequence analysis (all deflections are in "mm")

Point Displacements

Point Object 806 Story Level GROUND

	X	Y	Z
Trans	0.106443	-0.833145	-11.373426
Rotn	0.000463	-0.000281	0.000032

Lateral Drifts...

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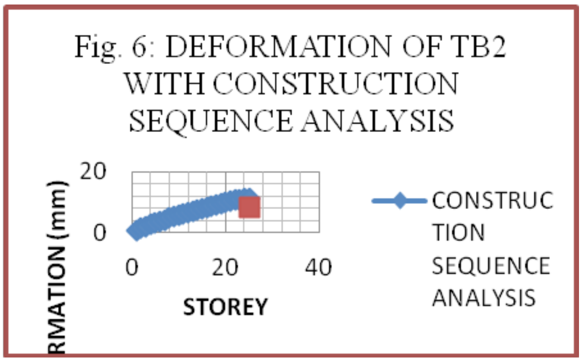


3)Comparison of bending moment of TB1 and TB2 along with construction sequence analysis:

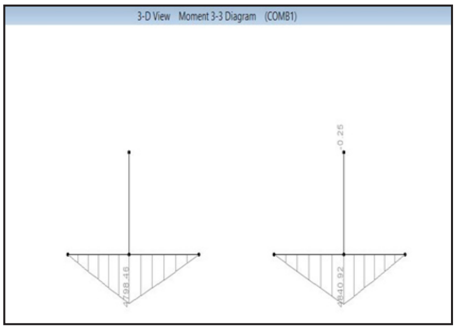


Fig.7 Bending moment of TB1 and TB2 in conventional analysis

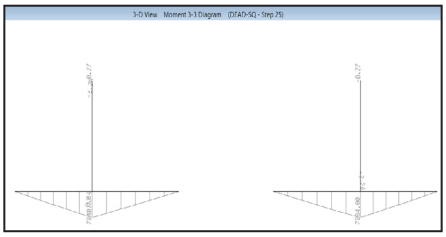
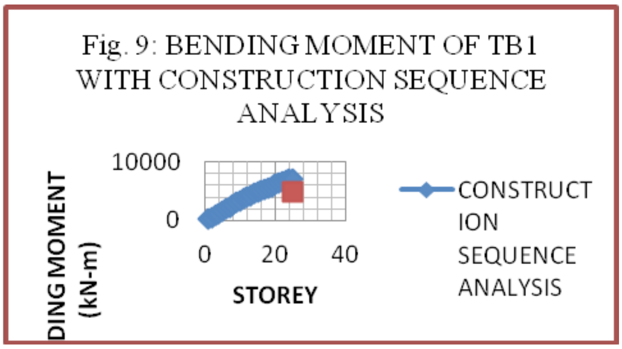
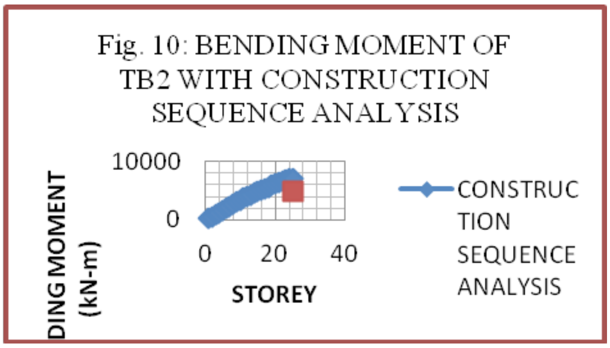


Fig. 8 Bending moment of TB1 and TB2 in construction sequence analysis





4) Comparison of shear force of TB1 and TB2 along with construction sequence analysis:

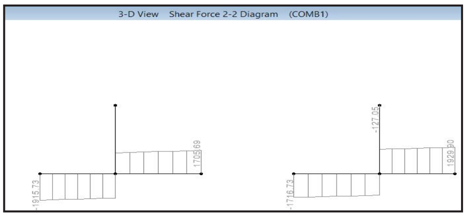


Fig. 11 Shear force of TB1 and TB2 in conventional analysis.

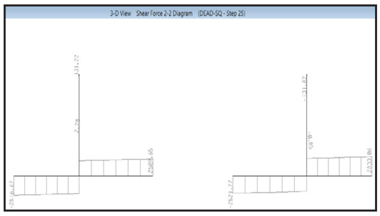
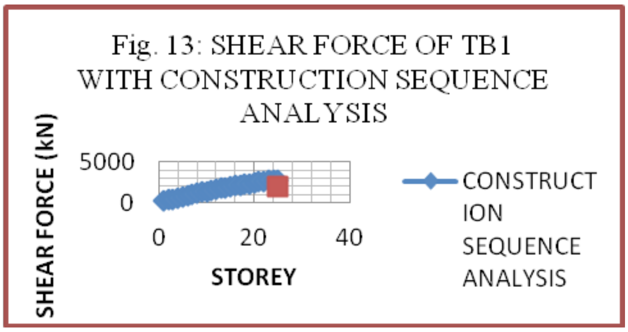
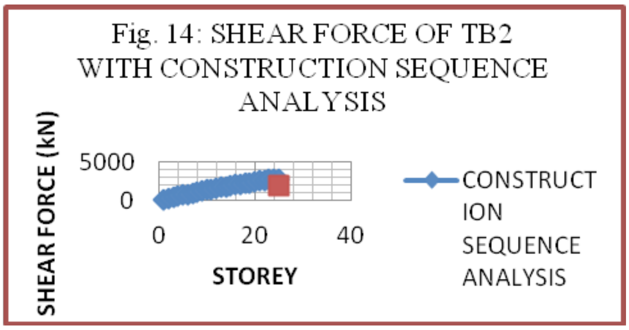


Fig.12 Shear force of TB1 and TB2 in construction sequence analysis.





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Results:

Content	Lumped analysis	Sequential analysis	% increase in sequential analysis
Deformation of TB1 (mm)	8.105	11.363	28.67%
Deformation of frame above TB1 (mm)	9.695	13.062	25.78%
Column force of the column above TB1 in ground (kN)	3300.7	4839.44	31.79%
Bending moment of TB1 (kN-m)	4798.4	7041	31.85%
Shear force of TB1 (kN)	1915.7	2817	31.99%
Bending moment of frame above TB1 (kN-m)	76.14	108.69	29.95%
Shear force of frame above TB1 (kN)	59.1	76.78	23.03%
Deformation of TB2 (mm)	8.277	11.374	27.23%
Deformation of frame above TB2 (mm)	9.822	13.027	24.60%
Column force of the column above TB2 in ground (kN)	3330.6	4861.36	31.49%
Bending moment of TB2 (kN-m)	4840.9	7084	31.66%
Shear force of TB2 (kN)	1930	2833	31.87%
Bending moment of frame above TB2 (kN-m)	75.35	103.81	27.42%
Shear force of frame above TB2 (kN)	58.77	74.67	21.29%

Conclusion:

It is evidenced that simulation of sequence of construction in the analysis leads to considerable variations in deformations and design forces obtained by conventional one step analysis. It is, therefore necessary that for Multi storied building frames with transfer girders and floating columns system, the construction sequence effect shall be taken into consideration.

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