STUDY AND COMPARISON OF CONTRUCTION SEQUENCE ANALYSIS WITH REGULAR ANALYSIS BY USING ETABS

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ABSTRACT:

Multistoried buildings have been analyzed 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.

Due to architectural requirements some of the columns are designed as floating columns which rests on the transfer girder which intern rests on the shear walls in the multistoreyed building. Two cases have been considered for the study and comparison. Whereas in Case 1 the building will be analysed as a whole for the subjected loading (DL, LL, WL, SL) by using ETABS software and in Case 2 the building will be analysed with reference to the construction sequence or staged construction for the subjected loading by using ETABS software.

1. CONSTRUCTION SEQUENCE

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. Staged construction is considered a type of non linear static analysis because the structure may undergo changes during the course of the analysis. However, consideration of material and geometric nonlinearity is optional.

For each nonlinear staged-construction analysis case, analysis sequence shall be defined by mentioning the variables like construction cycle, grade of concrete, strength of concrete at the stage of casting for below floors and number of cycles based on the computational effort requirements.

In ETABS all beams and columns are represented as frame elements. But design of beams and columns requires separate treatment. Identification for a concrete element is accomplished by specifying the frame section assigned to the element to be of type beam or column. If any brace element exists in the frame, the brace element also would be identified as either a beam or a column element, depending on the section assigned to the brace element.

A detailed study and comparison of the variation in deformations and forces will be presented for the transfer girders and the frame which is above the transfer girders. The whole work is carried out by using ETABS analysis and design software.

CASE 1: LUMPED MODEL CASE 2: STAGED CONSTRUCTION

Fig. Example of conventional and staged construction model

2. OBJECTIVE AND SCOPE OF THIS INVESTIGATION

OBJECTIVE:

1) Analysing the multistoreyed building as a whole for the subjected loading (DL, LL, WL, SL) using ETABS software.
2) Analysing the multistoreyed building with reference to the construction sequence or staged

construction using ETABS software.

3) Comparison of the variation in deformations and forces for the transfer girders and the frames which is above the transfer girders.

SCOPE:

Deformations and forces for the transfer girders and the frame which is above the transfer girders for **Twenty Two Storeyed building** with reference to the conventional analysis and construction sequence analysis.

3. PLANNING AND DESIGNING THE MULTISTOREYED STRUCTURAL FRAME WITH TRANSFER GIRDER AND FLOATING COLUMNS USING ETABS SOFTWARE

3.1 DESCRIPTION OF STRUCTURE:

The Project consists of residential multistoreyed building. The building is situated in Zone-III as per Indian standard code of practice IS: 1893-2002.

The structure is a reinforced concrete frame with conventional beam slab system. Lateral stability for the structure is provided by shear walls and are provided suitably at selected places. Floating columns are starting from ground floor.

It's a LB+UP+ G+22 upper floors building. Lower Basement and upper basement is used for car park and the other floor serves residential purpose.

3.2 FOUNDATION:

The foundations are mainly pile foundations with raft on plies. As per geotechnical investigation report soil type – 1 is considered for seismic analysis.

3.3 DESIGN STANDARDS:

Structural Designs are carried out as per Indian Standards. Following are the list of codes used.

IS 456: 2000 Code of practice for plain and reinforced concrete.

IS 875: 1987 (Part 1 to 5) Code of practice for design loads (other than earth quake).

IS 1893:2002 Criteria for earthquake resistant design of structures (fourth revision).

IS 4326:1993 Code of practice for earthquake resistant design and

construction of buildings (second revision).

IS 13920:1993 Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

3.4 STRUCTURAL DRAWINGS:

Fig. Structural lower Basement plan

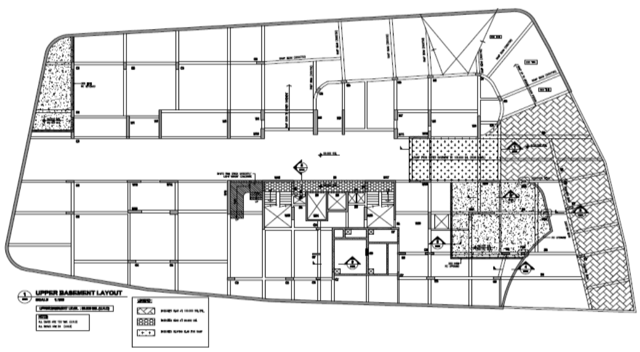


FIG:Structural upper Basement plan

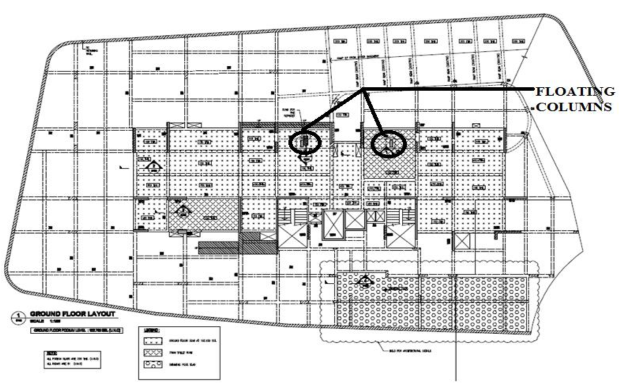


Fig. Structural ground floor plan

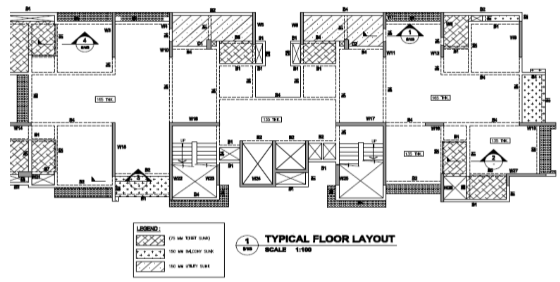


Fig. Structural typical floor plan

4.5 WALL SCHEDULE:

Table: wall shedule

Wall no:	Size	Wall no:	Size
W1	200*2750	W12	200*900
W2,W3	200*3400	W13,W20,W23,W25	200*1500
W4,W10, W18	300*1200	W14	200*1950
W7,W11	200*1200	W15	200*4050
W5,W6	200*2400	W19	200*2460
W8	200*1850	W22	200*4550
W9	200*2750	W26	200*2150

4.6 COLUMN AND BEAM SCHEDULE:

UPPER BASEMENT:

Table: column and beam schedule of upper basement

Column no:	size
C3	300*850
C4	300*900
C5	300*600
C6	200*450
C7	200*850
C8	200*900
C9	250*750
FC1,FC2,FC3	200*450

Beam no	Size
B1	200*750
B2	200*450
B3	200*600
B4	300*750
B5	300*900
B6	400*900

GROUND:

Table: column and beam schedule ground floor

Beam no:	Size
B1	300*750
B2	300*900
B3	400*900
B4	300*1350
B5	200*750
B6	200*450
B7	200*600
TB1	1000*1200

Beam no:	Size
B1	200*450
B2	200*600
B3	200*525
B4	200*750
B5	200*525/600
B6	200*675
B7	200*300
B8	200*375
DB	150*450

TYPICAL:

Table: column and beam schedule of typical floor

ETABS MODEL:

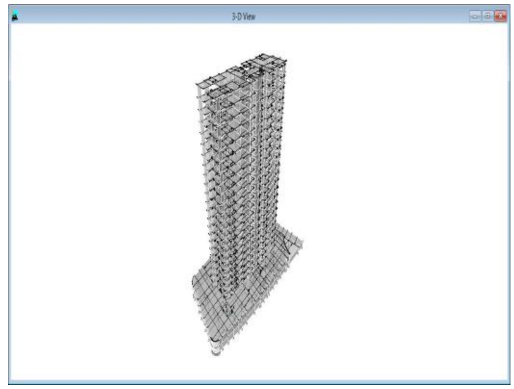


Fig. 3D view of ETABS model

4. ANALYSING THE STRUCTURE AS A WHOLE AND COMPARING THE DEFORMATIONS AND FORCES OF TRANSVERSE BEAMS, FLOATING COLUMNS AND FRAMES ABOVE TRANSVERSE BEAMS ALONG WITH CONSTRUCTION SEQUENCE ANALYSIS

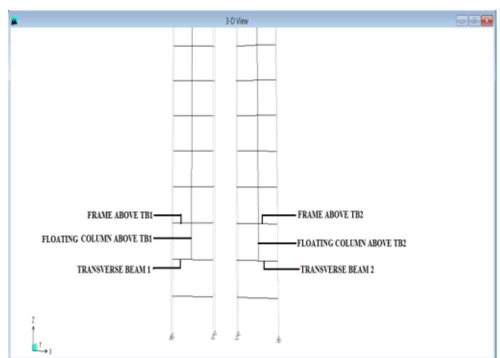


Fig. 3D view of transverse beams, floating columns and frame above transverse beams

5. COMPARISON OF DEFORMATIONS OF TB1 ALONG WITH CONSTRUCTION SEQUENCE ANALYSIS:

a) DEFORMATION OF TB1 IN CONVENTIONAL ANALYSIS:

Table: 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...

b) DEFORMATION OF TB1 IN CONSTRUCTION SEQUENCE ANALYSIS:

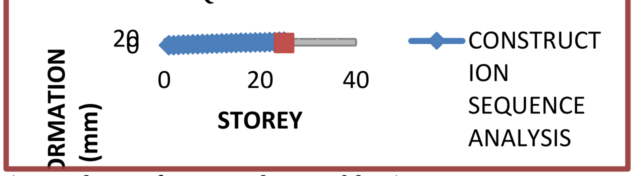
Table: Deformation of TB1 in construction sequence analysis (All deflections are in "mm")


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...

Fig: DEFORMATION OF TB1 WITH CONSTRUCTION SEQUENCE ANALYSIS



(For values refer appendix-A table 1)

6.1 COMPARISON OF DEFORMATIONS OF TB2 ALONG WITH CONSTRUCTION SEQUENCE ANALYSIS:

a) DEFORMATION OF TB2 IN CONVENTIONAL ANALYSIS:

Table: 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...

b) DEFORMATION OF TB2 IN CONSTRUCTION SEQUENCE ANALYSIS:

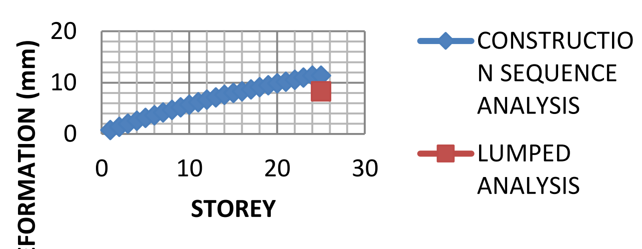
Table: Deformation of TB2 in construction sequence analysis (All deflections are in "mm")


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...

Fig: DEFORMATION OF TB2 WITH CONSTRUCTION SEQUENCE ANALYSIS



(For values refer appendix-A table 2)

RESULTS AND DISCUSSIONS

With reference to the above mentioned conventional lumped and construction stage analysis results are presented and compared in the Table

Table: percentage increase in sequence analysis

CONTENT	LUMPED ANALYSIS	SEQUENTIAL ANALYSIS	PERCENTAGE 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 floor (kN)	3300.78	4839.44	31.79%
Bending moment of TB1 (kN-m)	4798.46	7041	31.85%
Shear force of TB1 (kN)	1915.73	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 floor (kN)	3330.6	4861.36	31.49%
Bending moment of TB2 (kN-m)	4840.92	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%

METHODOLOGY

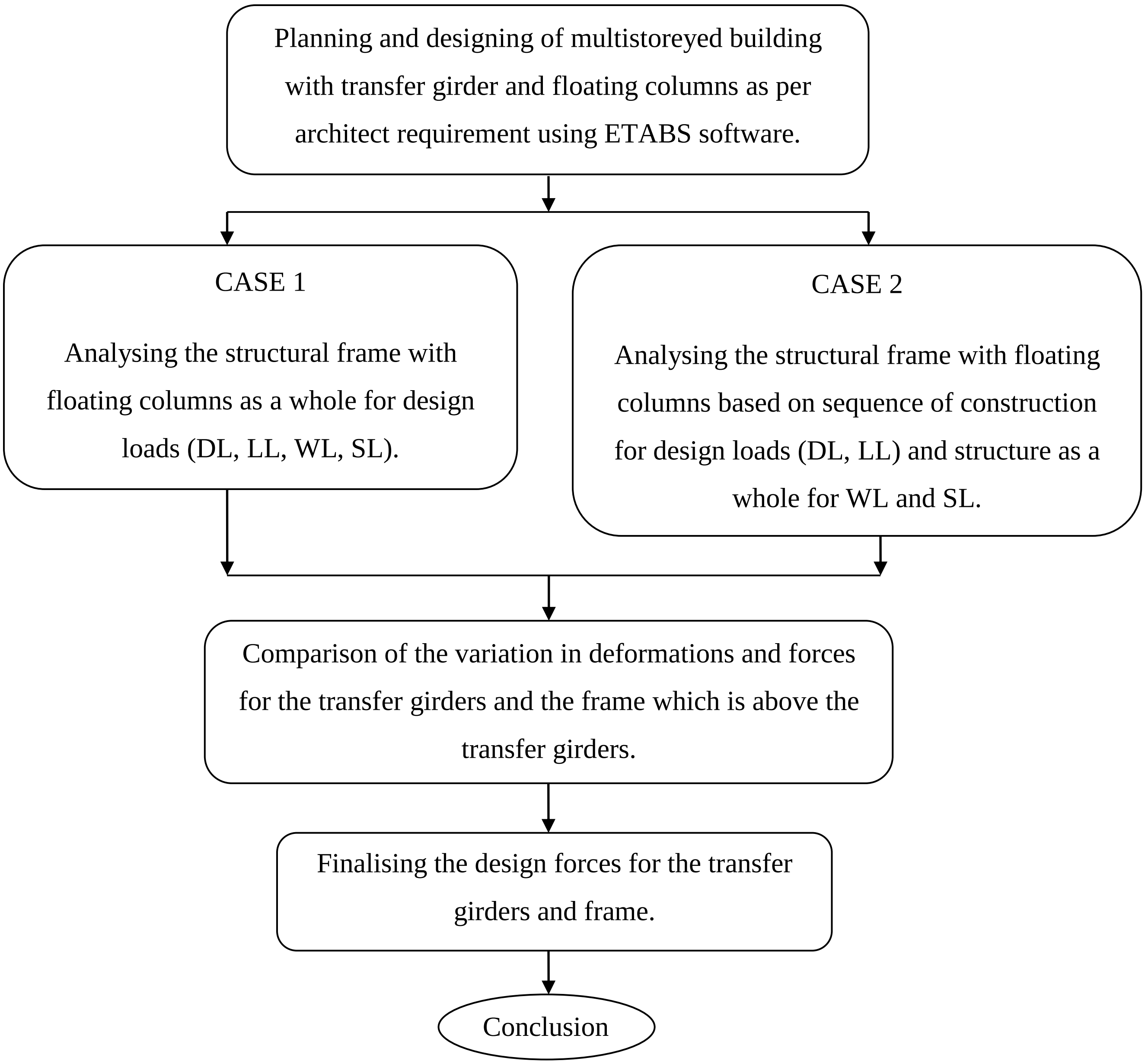


Fig. Flow chart showing methodology

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 analysis.

It is, therefore necessary that for Multistoreyed building frames with transfer girders and floating columns system, the construction sequence effect shall be taken into consideration.

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