CONSTRUCTION SEQUENCE ANALYSIS OF RCC FRAMED STRUCTURES USING E-tabs

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Abstract -- While analyzing Tall structure in Conventional method the gravity loads are applied after modeling the whole structure. In actual practice the complete frames are constructed at various stages and the stability of frames varies accordingly. The applied load assumed in Conventional method will be unsuitable as per the actual construction practice. The frame should be analyzed at every construction stage considering the effect of variation of loads at each stage. This methodology is known as construction sequential analysis. The present work aims for the comparative study of a G+20 structure in seismic zone II as per IS 1893:2002 (Part 1) and its behavioral responses (Moment, Force analysis, Response spectrum) with the conventional DL+LL+EQ loading. A multi-purpose G+20 complex is analyzed using AUTO-SEQ or construction sequential analysis with insertions of floating columns at different position of column and floors with same floor plans which is modeled in E-tabs and analyze their responses. It is observed that moment, shear force of transfer girder is more in constructional sequence analysis case compared to normal case.

***Key Words*:** Moment, Shear force, Tall structure and Force analysis, Response spectrum

1. INTRODUCTION

An extensive amount of time has been spent analysing the multi-story building frame under the assumption each and every load occurring on the structure, including the completed frame structure is subjected to a variety of loads, including self-weight, superimposed load, live load, and lateral loads, at a given time. in what is known as a one-step analysis. However, because the structural frame remains created storey by storey in a consecutive approach, the DL (Dead Load) owing to every essential element and finishing item is enforced in phases. When diverse loads are imposed in a single step, the performance of a building structure differs dramatically at staged application of loads. As a result, Construction Sequence Analysis (CSA) is utilized to evaluate the building according to current construction practises. CSA often called staged construction analysis is a nonlinear static method of analysis that takes incremental loads into consideration. Engineering researchers and practitioners have shown a strong interest in a variety of topics, including structural analysis of multi-storey buildings, which is one of such topics. One area that many previous researchers have neglected, however, is the consequences of building sequence analysis in a multi-storey frame, which is something that many previous researchers have overlooked. As the construction of building advances, structural components are added in stages, and the dead load imposed by these components is absorbed by the section of the structure that is completed at the time they are installed. Consequently, the properties of members that have not yet been constructed have no effect on the distribution of displacement and stresses within a single level. Achieving an appropriate dissemination of displacements besides stresses in each fragment of the structure which can be accomplished by gathering the findings of each step of the building frame structure's assessment as well as applying them together. CSA is becoming a more essential part of the analysis process, as evidenced by the inclusion of this capability in several well-established analysis software packages. However, due to a lack of understanding of its importance and scope, nonlinear static analysis is not widely used. Construction sequence analysis, like many other types of analysis, had a specific purpose throughout the design phase of the constructions. In addition to dealing with nonlinear behaviour beneath static loads there in type of consecutive increment of load as well as its implications on structure, it also concerns with building elements commencing to respond to load first before full system has been finished, as previously stated. ETABS is used for FEA, and all displacement effects are evaluated in metres, whereas moment & axial load were evaluated in KN-m and KN, respectively, for moment as well axial load analysis. **Construction Sequence Analysis (CSA)** It includes steps which are not found in the linear static analysis. Every floor, as well as its preceding floors, must be investigated, with the axial and lateral loads allocated to a certain floor from the bottom of an entire design up to that floor. Ultimately, the building's structural performance will be represented. The construction sequence analysis is the same for each storey. Today's analysis software can simply analyse the construction sequence. After grouping, the software will inquire which facility should be used, and the results will be compared. Figure 1 depicts stage formation in sequence analysis.

2. MODELLING AND ANALYSIS

At the moment, G+20 reinforced cement concrete earthquake resistant buildings are being considered for various storey heights. The modeling approach and analysis were carried out utilising the ETABS computer-aided design software.

Model Description

A rectangular building considered for analysis is symmetric in plan and elevation. The plan dimensions of the building to be modelled are 13 m × 26 m.

Title	Specifications
Plan Size	40m ×25m
Floor height	3 m
Beam sizes	200 × 600 mm
Column sizes	300 × 900 mm
Slab thickness	125 mm
Live load	2 kN/m²
Floor finish	1.5 kN/m²
Concrete Grade	M25,M40
Poisson ratio	0.17
Compressive strength	20000 kN/m²
Steel	Fe 500

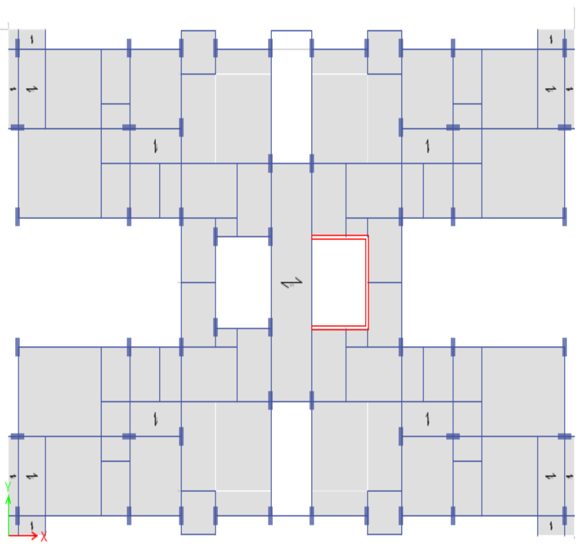

Fig 1: Plan of Building

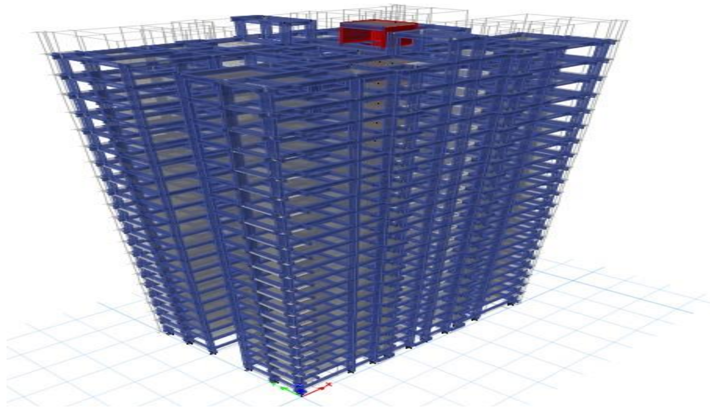

Fig 2: 3D model of Regular Building

MODELSDESCRIPTION

Five different types of structures modelled in etabs software

MODEL 1

Model 1 consist of G+20 storey RCC building with seismic zone II, at ground floor one column (column A as shown in below fig) is removed to check the behaviour of building.

MODEL 1a

Model 1 consist of G+20 storey RCC building with seismic zone II, at mid (11th)floor one column (column A as shown in below fig) is removed to check the behaviour of building.

MODEL 2

Model 2 consist of G+20 storey RCC building with seismic zone II, at ground floor one column (columnB as shown in below fig) is removed to check the behaviour of building.

MODEL 2a

Model 2 consist of G+20 storey RCC building with seismic zone II, at mid (11th)floor one column (columnB as shown in below fig) is removed to check the behaviour of building.

MODEL 3

Model 3 consist of G+20 storey RCC building with seismic zone II, at ground floor one column (columnC as shown in below fig) is removed to check the behaviour of building.

MODEL 3a

Model 3 consist of G+20 storey RCC building with seismic zone II, at mid (11th)floor one column (columnC as shown in below fig) is removed to check the behaviour of building.

MODEL 4

Model 4 consist of G+20 storey RCC building with seismic zone II, at ground floor one column (columnD

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as shown in below fig) is removed to check the behaviour of building.

MODEL 4a

Model 4 consist of G+20 storey RCC building with seismic zone II, at mid (11th)floor one column (columnD as shown in below fig) is removed to check the behaviour of building.

MODEL 5

Model 5 consist of G+20 storey RCC building with seismic zone II, at ground floor one column (columnE as shown in below fig) is removed to check the behaviour of building.

Model 5 consist of G+20 storey RCC building with seismic zone II, at mid (11th)floor one column (columnE as shown in below fig) is removed to check the behaviour of building.

Design loads

Loads	Code	Standard Value
Dead load		
Self-weight of slab (150 mm thick)	IS: 875 (Part I)-1987	3.75 kN/m²
Loading due to Floor Finishes		1.50 kN/m²
From masonry walls		10.2kN/m³.
Live load	IS: 875 (Part-II)-1987	
Live load on floor		4.00 kN/m²
Live load on roof		1.50 kN/m²
Earthquake load	IS 1893-2016	i) Zone factor - 0.1 ii) Soil type - III iii) Importance factor – 1

There were three types of loads applied to the structure: dead load, living load, and seismic load, all in combination. Following the requirements in IS: 456-2000 and SP-16, the structural adequacy of existing members was evaluated.

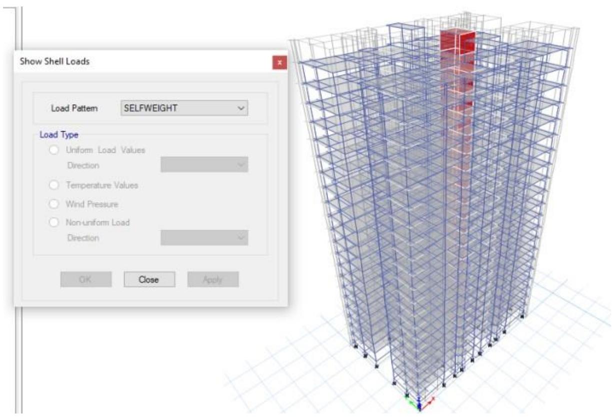

Figure 3 Self-weight for Model

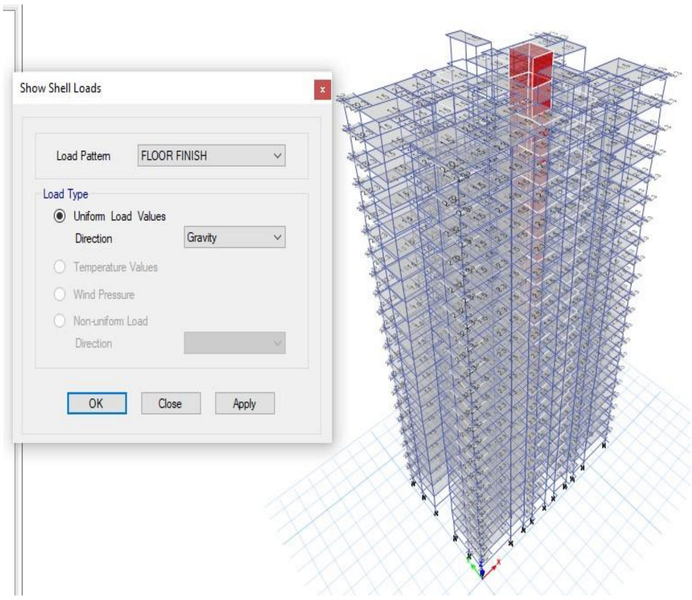

Figure 4 Floor finish load for Normal Model

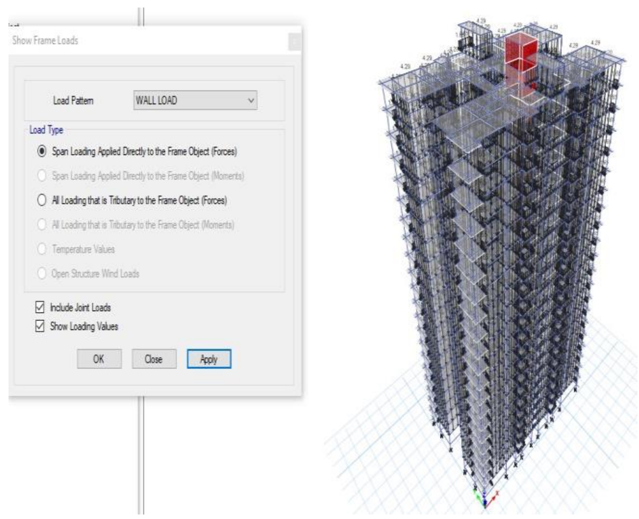

Figure 5 Wall load for Normal Model

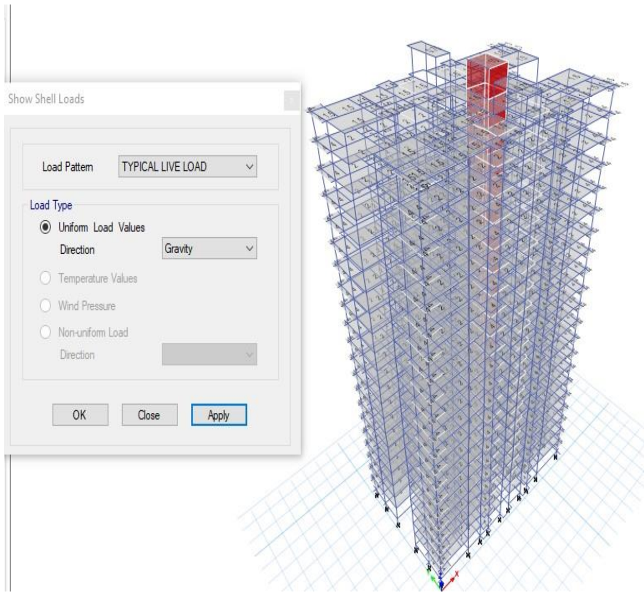

Figure 6 Typical live load for Model

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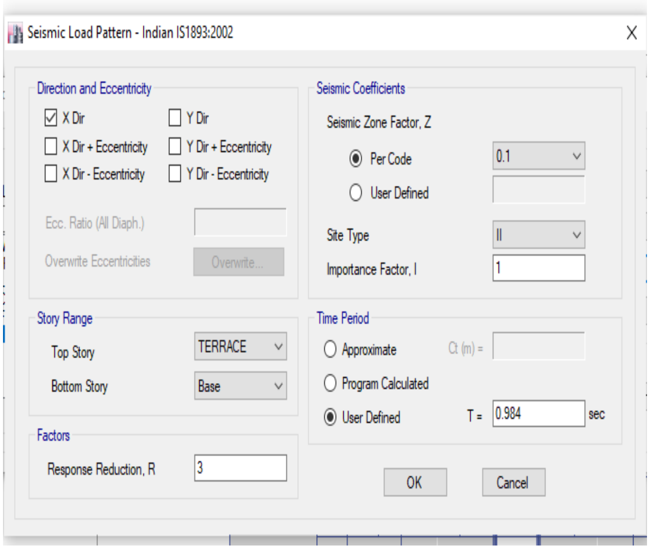

Figure 7 Seismic load definitions in X- Direction

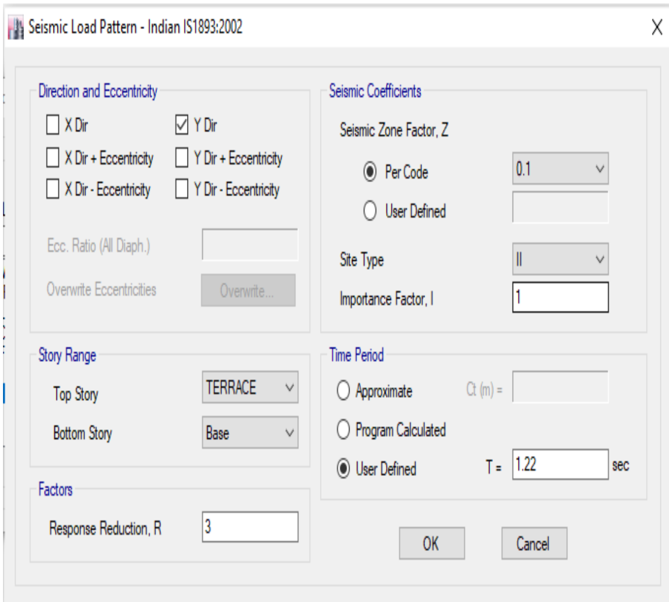

Figure 8 Seismic load definition in Y- Direction

IJSREM sample template format ,Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

3. RESULTS

A**) MOMENTS:** Moments for transfer girders for different position of column like A, B, C, D, E at ground and mid floor level.

AT COLUMN A: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid-level is 58.09%, 122.93% compared to DL+LL.

AT COLUMN B: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 60.26%, 157.69% compared to DL+LL.

AT COLUMN C : From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 55.44%, 77.62% compared to DL+LL.

AT COLUMN D: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 23.57%, 102.17% compared to DL+LL.

AT COLUMN E: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 30.01%, 114.92% compared to DL+LL.

b) **SHEAR FORCE:** Shear force for transfer girders for different position of column like A, B, C, D, E at ground and mid floor level.

AT COLUMN A: From the results of transfer girder shear force it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 53.31%, 86.08% compared to DL+LL.

AT COLUMN B: From the results of transfer girder shear force it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 53.59%, 55.07% compared to DL+LL.

AT COLUMN C: From the results of transfer girder shear force it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 23.64%, 66.18% compared to DL+LL.

AT COLUMN D: From the results of transfer girder shear force it is noted that the maximum moment occur at auto seq model transfer girder. The increase in

AT COLUMN E: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 29.35%, 72.51% compared to DL+LL.

c) **COLUMN MOMENT:** Adjacent to the floating columns moment for right and left column like A, B, C, D, E at ground and mid floor level

GROUND FLOOR

AT COLUMN A: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in

moment for AUTO SEQ right and left columns at ground level is 54.63%, 57.61% compared to DL+LL.
AT COLUMN B: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at ground level is 61.35%, 61.69% compared to DL+LL.
AT COLUMN C: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at ground level is 51.85%, 77.43% compared to DL+LL.
AT COLUMN D: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at ground level is 25.28%, 28.4% compared to DL+LL.
AT COLUMN E: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 34.66%, 32.08% compared to DL+LL.

MID FLOOR

AT COLUMN A: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at mid level is 182.17%, 162.4% compared to DL+LL.
AT COLUMN B: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at mid level is 203.74%, 230.9% compared to DL+LL.
AT COLUMN C: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at mid level is 99.00%, 259.65% compared to DL+LL.
AT COLUMN D: From the results of column moments it is noted that the maximum moment occur at auto seq model both right and left column. The increase in moment for AUTO SEQ right and left columns at ground level is 109.75%, 157.25% compared to DL+LL.
AT COLUMN E: From the results of transfer girder moment it is noted that the maximum moment occur at auto seq model transfer girder. The increase in moment for AUTO SEQ girder at ground and mid level is 39.3%, 63.92% compared to DL+LL.

4. CONCLUSIONS

1. Moment of transfer girder is more in constructional sequence analysis case by around 125% when compared to normal case.
2. Shearforce of transfer girder is greater by around 60% in constructional sequence analysis case when compared to normal case.
3. Columns adjacent to floating column has more moment in constructional sequence analysis case compared to normal case.

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