



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 5 ISSUE : 6 Print / Issue Publication Date: 21-Dec-2020



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2020.v05i06.025

Indexed In



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editor@ijeast.com



SEISMIC BEHAVIOUR OF VARYING FLOORS OF RC CONVENTIONAL AND MONOLITHIC BUILDING

Chinmayi M
P.G. student
Department of civil Engineering
Malnad college of Engineering, Hassan,
Karnataka, India.

Dr.H S Narashimhan
Associate professor
Department of Civil Engineering
Malnad College of Engineering, Hassan
Karnataka, India

G Ambrish
Executive Director
Nixit Consultants Pvt.Ltd.
Bengaluru, Karnataka, India

Abstract: RC structures are traditionally modelled by assuming that all the loads are applied in one step. This assumption does not reflect the structure's actual behaviour. Here we study the variations in load and seismic response of structure at each stage of construction. A 24 storeys Conventional and RC Monolithic buildings are modelled for every stage and Response spectrum analysis is performed in zone III, with hard soil condition using ETABS version 17 software. The response of the structure is studied in terms of Maximum storey displacement, Maximum storey drift, and Base shear.

It is observed that there is continuous variation in the Maximum storey displacement, Maximum storey drift, and Base shear during each stage of construction and RC monolithic building performs well compared to conventional building when subjected to seismic loads.

Keywords: Conventional building, ETABS, RC Monolithic building, Response spectrum analysis, Stage wise construction

I. INTRODUCTION

The growing population and urbanization demands tall structures and these tall structures are sensitive to seismic forces. So the buildings are designed to resist earthquake loads. Though the effect cannot be nullified we can reduce the effects on the structure. The recent progress in construction industry has brought RC monolithic building. In this construction method all the structural components are cast in place in one operation by the use of specially designed modular formwork made of aluminium.

Buildings are analysed assuming all the loads are applied in one step but in actual practice structural components like

walls, floors finish are provided at different stages of construction to a storey.

II. OBJECTIVE OF THE WORK

The primary objective of the work is to analyse the seismic response at every stage of construction for RC Conventional and Monolithic buildings and to evaluate which structure performs better for seismic loads in seismic zone III with hard soil condition according to Indian standard code IS 1893-2002(part 1)

III. LITERATURE REVIEW

Pradeep B, Ambrish G. et.al., (2016) Studied the seismic behaviour of conventional and RC wall building. The author considered the same plan for G+7 storey conventional and RC wall building and performed response spectrum analysis using ETABS version 15.2.0 software for both building models in all the 4 zones according to Indian standards code IS:893-2002(part 1). It is concluded that the RC Wall building performs better than conventional building.

Ambrish G. et.al., (2017) Studied seismic response of reinforced concrete monolithic building provided with base isolation. They performed response spectrum analysis to investigate the response of G+7 storey RC monolithic building provided with base isolation and fixed base in terms of base shear, displacements, storey acceleration and the results are compared. It is observed that zone V has more response compared to zone II responses for base shear, displacement and storey acceleration. Base isolation is very effective at lessening the seismic response of the structure.

Nagashree V. et.al., (2017) studied the seismic performance on RC Wall structure. The author performed dynamic



analysis using response spectrum method with 5% damping, medium soil type and by varying seismic zones .they studied the influence of stiffness irregularities in the form of soft storey, door openings provided at different positions. The performance is evaluated in terms of response spectrum base shear, storey displacement, and modal time period. It is observed that there is very deflection and RC Wall structure enhances the seismic capacity of the structure.

Ahmed Alghuff, Bassam Tayeh, (2019) Performed comparative study of static and response spectrum methods for seismic analysis of regular RC buildings. The author created two structural model using ETABS version 16.1.2 software for regular RC buildings with typical plans. The first model has a total height of 75m and the second model has a total height of 24m. The buildings were analysed using the static and dynamic methods under ASCE7-10 and IBC 2015 provisions and concluded that the displacements obtained using response spectrum method are less compared to equivalent static method.

IV. METHODOLOGY

In the present investigation, it is assumed that the 24 storeys building with irregular plan is constructed by raising 3 floors at each construction stage and other structural components are added to the underlying floors as the construction process proceeds.

Each stage is modelled for RC conventional and monolithic building and the response spectrum analysis is performed in Zone III with hard soil condition according to IS 1893-2002(part1) and studied in terms of displacement, drift, and base shear.

RC Conventional building	
Number of floors	24
Height of each floor	3m
Size of beam	200x500mm
Wall thickness	200mm
Slab thickness	150mm
The lift core number	3
The lift core size	2.3x3m
Thickness of lift core	270mm
RC Monolithic building	
Number of floors	24
Height of each floor	3m
Wall thickness	200mm
Slab thickness	150mm
The lift core number	3

The lift core size	2.3x3m
Thickness of lift core	270mm
Material properties	
Grade of concrete	M30
Grade of reinforcing steel	Fe500
Density of concrete block	17.65 kN/m ³
Loading	
Floor finish	1.5 kN/m ²
Loads on all rooms	2 kN/m ²
Loads on staircase	3 kN/m ²
Load on corridor, balcony	3 kN/m ²

Table 1: Loads applied on each floor during the process of construction (DL-Dead load, WL-wall load, FF-floor finish, LL- live load)

Stages	Storey	Conventional	Monolithic
1 (3 storeys)	1	DL	DL
	2		
	3		
2 (6 storeys)	1	DL+WL	DL
	2		
	3		
	4	DL	DL
	5		
	6		
3 (9 storeys)	1	DL+WL	DL
	2		
	3		
	4	DL+WL	DL
	5		
	6		
	7	DL	DL
	8		
	9		
4 (12 storeys)	1	DL+WL+FF	DL+FF
	2		
	3		
	4	DL+WL	DL
	5		
	6		
	7	DL+WL	DL
	8		
	9		
	10	DL	DL
	11		
	12		
5	1	DL+WL+FF	DL+FF



(15 storeys)	2		
	3		
	4	D+WL+FF	DL+FF
	5		
	6		
	7	DL+WL	DL
8			
9			
6 (18 storeys)	10	DL+WL	DL
	11		
	12		
	13	DL+WL	DL
	14		
	15		
7 (21 storeys)	16	DL	DL
	17		
	18		
	1	DL+WL+FF	DL+FF
	2		
	3		
8	4	DL+WL+FF	DL+FF
	5		
	6		
	7	DL+WL+FF	DL+FF
	8		
	9		
	10	DL+WL+FF	DL+FF
	11		
	12		
	13	DL+WL	DL
14			
15			
8	16	DL+WL	DL
	17		
	18		
	19	DL	DL
8	20		
	21		

(24 storeys)	2			
	3			
	4	DL+WL+FF	DL+FF	
	5			
	6			
	7	DL+WL+FF	DL+FF	
	8			
	9			
	10	DL+WL+FF	DL+FF	
	11			
	12			
	13	DL+WL+FF	DL+FF	
14				
15				
9 (24 storeys, Ready to occupy)	16	DL+WL	DL	
	17			
	18			
	19	DL+WL	DL	
	20			
	21			
	22	DL+WL	DL	
	23			
	24			
	10 (24storeys, Occupied)	1	DL+WL+FF	DL+FF
		2		
		3		
4		DL+WL+FF	DL+FF	
5				
6				
7		DL+WL+FF	DL+FF	
8				
9				
10		DL+WL+FF	DL+FF	
11				
12				
10 (24storeys, Occupied)	13	DL+WL+FF	DL+FF	
	14			
	15			
	16	DL+WL+FF	DL+FF	
10 (24storeys, Occupied)	17			
	18			
	19	DL+WL+FF	DL+FF	
	20			
	21			
	22	DL+WL+FF	DL+FF	
	23			
24				
10 (24storeys, Occupied)	1	DL+WL+FF+ LL	DL+FF+LL	
	2			
	3			
	4	DL+WL+FF+ LL	DL+FF+LL	
10 (24storeys, Occupied)	5			
	6			
	7	DL+WL+FF+ LL	DL+FF+LL	

8	LL	
9		
10	DL+WL+FF+	DL+FF+LL
11	LL	
12		
13	DL+WL+FF+	DL+FF+LL
14	LL	
15		
16	DL+WL+FF+	DL+FF+LL
17	LL	
18		
19	DL+WL+FF+	DL+FF+LL
20	LL	
21		
22	DL+WL+FF+	DL+FF+LL
23	LL	
24		

V. ETABS MODELLING

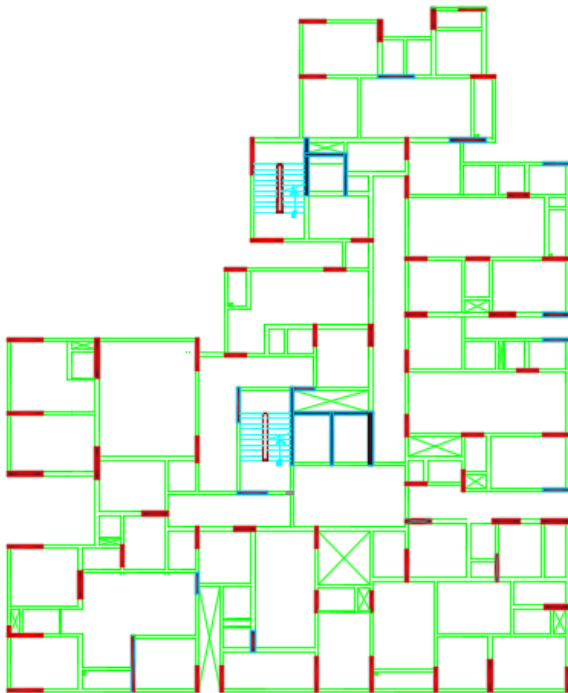


Fig 1: Plan of building

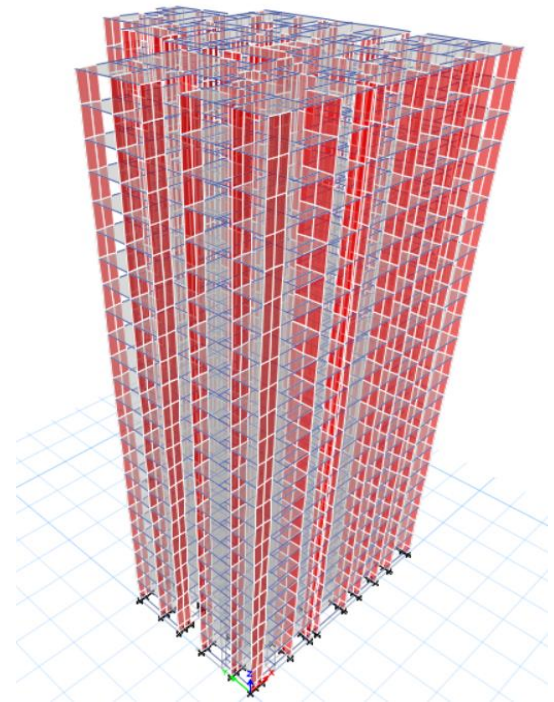


Fig 2: 3D model of RC Conventional building

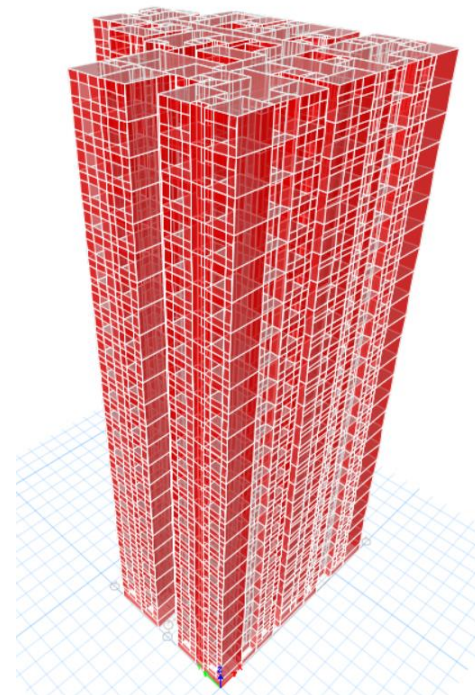


Fig 3: 3D modelling of RC Monolithic building



VI. RESULTS

The RC conventional and monolithic building is analysed using response spectrum method at every construction stage according to IS 1893-2002(part 1) and the responses are studied in terms of storey displacement, storey drift, Base shear.

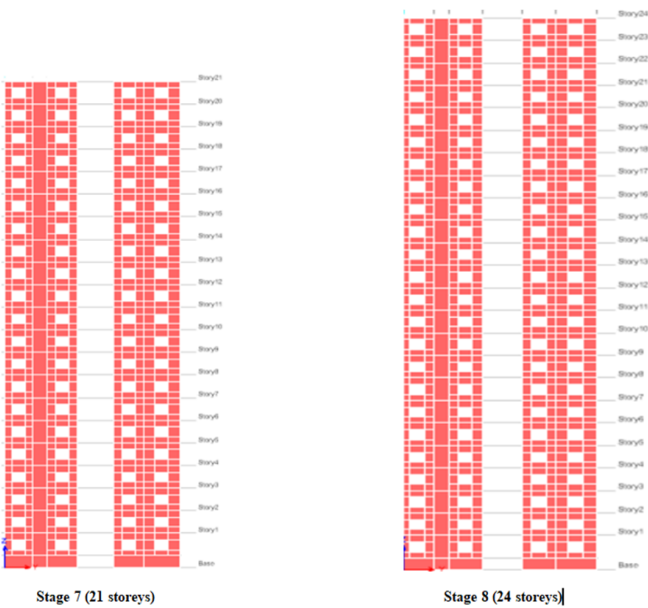
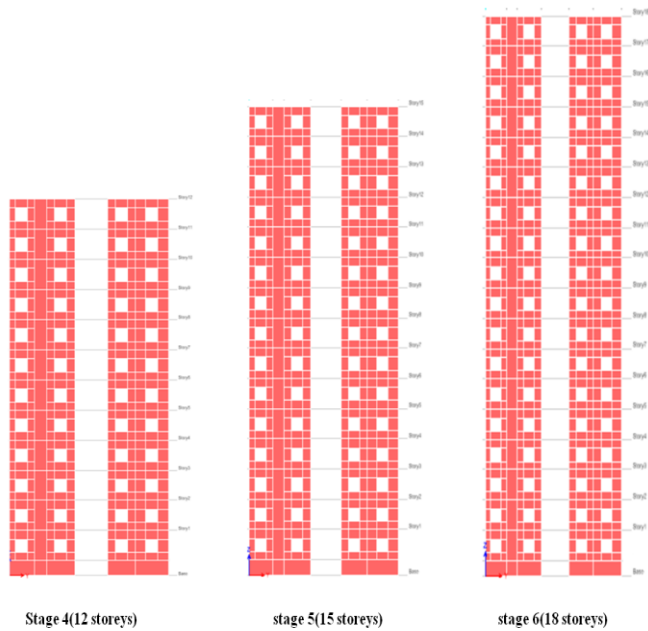


Fig 2: Stages of construction

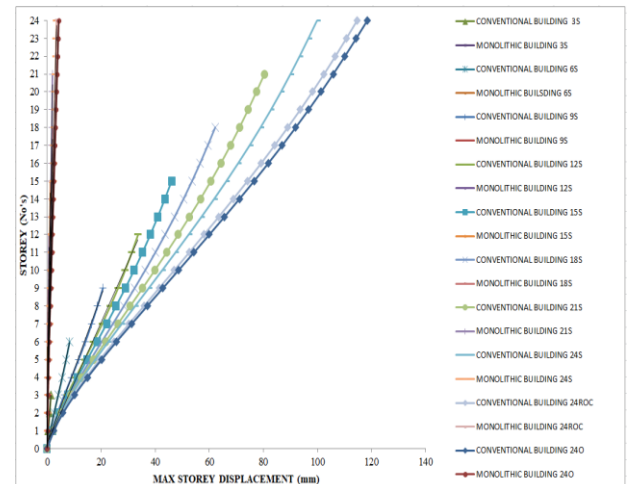


Chart 1: Variation in storey displacement at every stage of construction - RS X

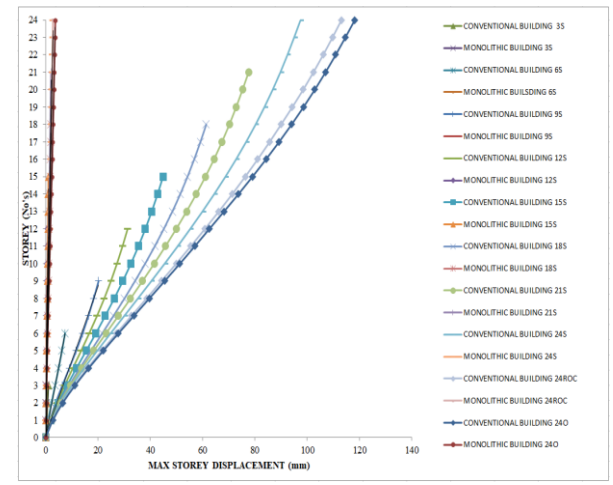


Chart 2: Variation in storey displacement at every stage of construction - RS Y

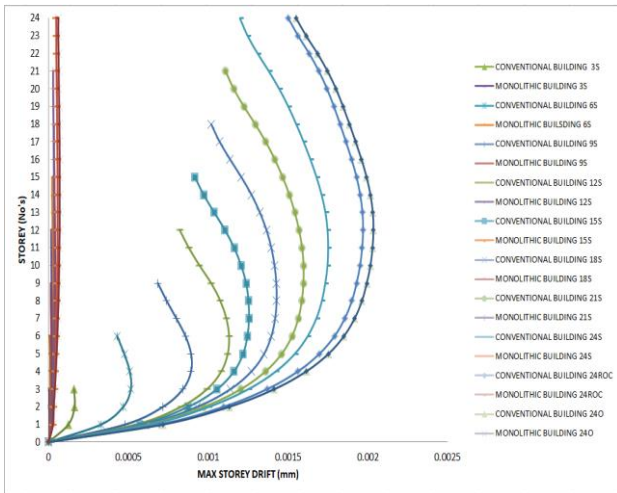


Chart 3: Variation in storey drift at every stage of construction - RS X

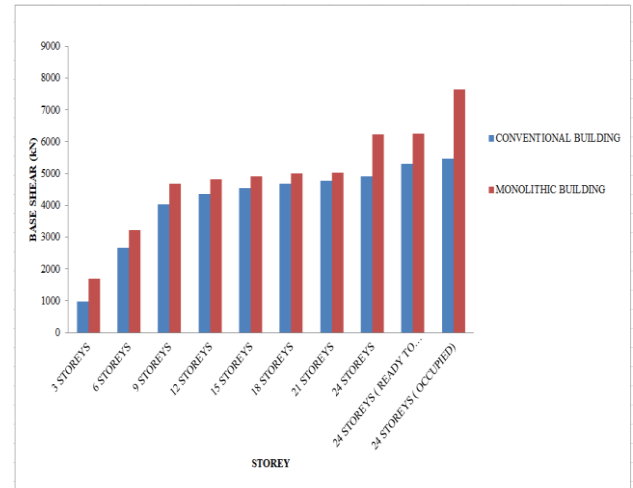


Chart 6: Variation in Base shear at every stage of construction - RS Y

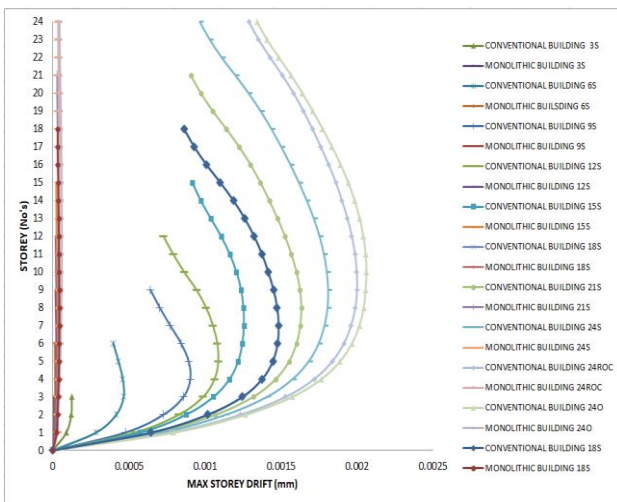


Chart 4: Variation in storey drift at every stage of construction - RS Y

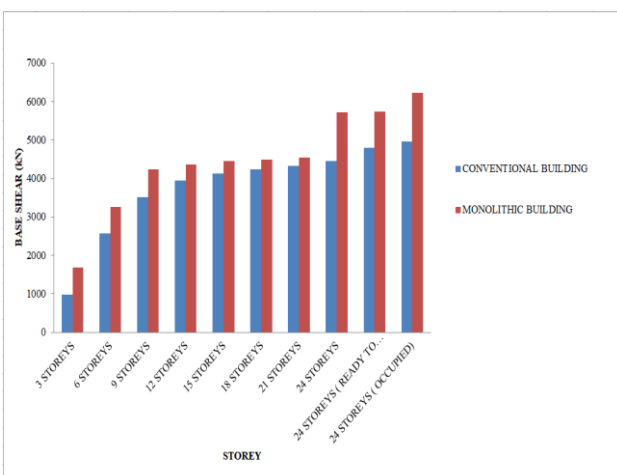


Chart 5: Variation in Base shear at every stage of construction - RS X

VII. CONCLUSIONS

An effort is made to examine the structural response of 24 storeys RC Conventional and Monolithic building at each stage of construction for seismic loads. From the analysis results it can be inferred that,

1. In RC Conventional buildings, maximum storey displacement and maximum storey drift is 97% greater than Monolithic buildings. As a result, RC Monolithic building is more robust to seismic loads
2. Base shear is greater in RC monolithic building than conventional building.
3. Storey displacement is induced by the lateral force on each floor level of the structure. Lateral displacement on the top floor would be more significant. The disparity in maximum storey displacement and Maximum storey drift during the construction of 24th floor and the fully occupied 24 storey building (all the loads are assumed to be acting in one step) is 15% for conventional RC building and 18% for monolithic building.
4. The difference in base shear during the construction of 24th floor and the entirely occupied 24-storey building(all loads are presumed to work in one stage) is 10% more for conventional building in both the directions and 8% more in x direction, 18.5% more in y direction for RC monolithic building.
5. It is found from the above graph and discussion that there is significant variation in storey responses on the construction of each floor and other structural components.



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