

A Comprehensive Review on the Study of Monolithic Building with Conventional Building

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ABSTRACT

This review paper presents a comprehensive and systematic analysis of the design and performance of monolithic structures, with a specific focus on G+7 building of Nagpur, in comparison with traditional framed systems. Monolithic construction involves casting of walls, slabs, and other structural components in a single continuous concrete pour using aluminium formwork, thereby eliminating beam-column joints and enhancing structural continuity. In contrast, conventional RCC framed structures rely on discrete beam-column systems, where load transfer occurs through flexural action, often leading to stress concentration and reduced stiffness under lateral loading. This paper critically reviews 25 research studies to evaluate various aspects such as construction methodology, structural behaviour, load combinations, seismic and wind performance, and overall efficiency of both systems. The study incorporates detailed design considerations based on Indian Standard codes including IS 875 for load calculations and IS 1893 (Part 1):2016 for seismic analysis. A step-by-step analytical methodology using structural analysis software is discussed for modelling and evaluating both monolithic shear wall systems and conventional framed structures. Key parameters such as storey displacement, inter-storey drift, stiffness, torsional resistance, and load distribution are examined under different loading conditions. The findings from the literature indicate that monolithic structures exhibit superior performance in terms of global stiffness, reduced lateral displacement, better load transfer efficiency, improved crack resistance, and enhanced seismic stability. Additionally, the use of aluminium formwork significantly reduced construction time and ensures uniform quality and surface finish. The paper highlights current research trend focusing on seismic behaviour, modular construction techniques, and optimization of construction processes. It also identifies future research opportunities such as the analysis of taller structures (G+15 and above) development of hybrid structural systems combining shear walls and frames, and advanced analytical modelling for performance enhancement.

Keywords: *Monolithic Structure; Conventional RCC frame; Shear wall; G+7 Building; Seismic Analysis; Load combination; Aluminium formwork; Structural stiffness; Inter-storey drifts; Structural analysis.*

1 INTRODUCTION

Structural system significantly influenced the safety and serviceability of multi-storey buildings. Monolithic structures are constructed by casting walls and slabs in single continuous concrete pour using aluminium formwork systems. This eliminates beam-column joints and enhance structural integrity [1].

Conventional RCC framed structure consist of beam and columns cast separately, where loads are transferred through flexural action [2]. Comparative studies indicates that shear wall-based systems exhibit greater stiffness and reduced lateral displacement when compared to framed systems [3][4].

The objective of this review is to analyse previous research findings related to:

- Construction methodology of monolithic system
- Structural behaviour under different load combination
- Seismic performance comparison
- G+7 building analysis

1.1 Monolithic structure system

Research indicates that monolithic construction improves global stiffness due to structural continuity [5]. Experimental studies confirm that elimination of construction joints enhances load transfer efficiency [6]. Seismic performance evaluation using Incremental Dynamic Analysis (IDA) show reduced inter- storey drift in shear wall systems [7]. Analytical modelling of G+7 building demonstrates improved torsional resistance in monolithic system compared to moment resisting frames [8][9]. Studies also reveal improved crack resistance and durability due to uniform concrete casting [10].

1.2 Construction process of monolithic system

The monolithic construction process involves:

1. Reinforcement fixing for walls and slab simultaneously
2. Installation of aluminium formwork panels
3. Single-stage concrete pouring
4. Early de-shuttering and repetition

Construction cycle reduction of up to 20% has been reported in several studies [11][12]. Cost analysis indicates that although initial investments in formwork is high, overall projects duration decreases significantly [13].

1.3 Conventional frame structure

Conventional framed system rely on beam-column interaction to resist loads. Structural analysis of G+7 framed building shows higher lateral displacement under seismic loading [14].

Comparative research indicates that framed structure offer greater architectural flexibility but lower stiffness compared to shear wall systems [15][16].

Wind load performance and storey drift behaviour of framed buildings have been widely studied [17].

2. Load combinations and design consideration

Design of both systems follow **Limit State Method**.

1. 1.5 (DL+LL)
2. 1.2 (DL+LL+EQ)
3. 1.5 (DL+EQ)
4. 0.9 DL+1.5 EQ
5. 1.5 (DL+WL)

Where DL = dead load, LL = live load, EQ = earthquake load, WL = wind load. The vale of seismic zone for Nagpur as per IS 1893 part-1 2016 page no. 37 is:

Town	Zone	Z
Nagpur	II	0.10

Studies confirm that monolithic shear wall system show better response under seismic combinations [18][19]. Response spectrum analysis results indicates reduced base shear fluctuation and improve damping characteristic [20].

3. DESIGN METHODOLOGY

3.1 Data for analysis

Table 3.1: Summary of geometric data of the building

Parameter	Conventional Frame	Monolithic
Building type	Residential G+7	Residential G+7
Plan dimensions	20.0 m × 15.0 m	20.0 m × 15.0 m
Number of storeys	8 (G + 7)	8 (G + 7)
Storey height	3.0m (uniform)	3.0m (uniform)
Total height above foundation	24.0 m	24.0 m

Slab thickness	0.15m	0.15m
Column / Wall	0.45 x 0.45m RC columns	0.2m thick RC shear walls
Beam	0.45 x 0.30m RC beams	0.30 x 0.15m concealed beams
External walls	0.23m brick masonry infill	0.2m RC structural wall
Internal walls	115 mm brick masonry	200 mm RC structural wall
Support condition	Fixed base	Fixed base

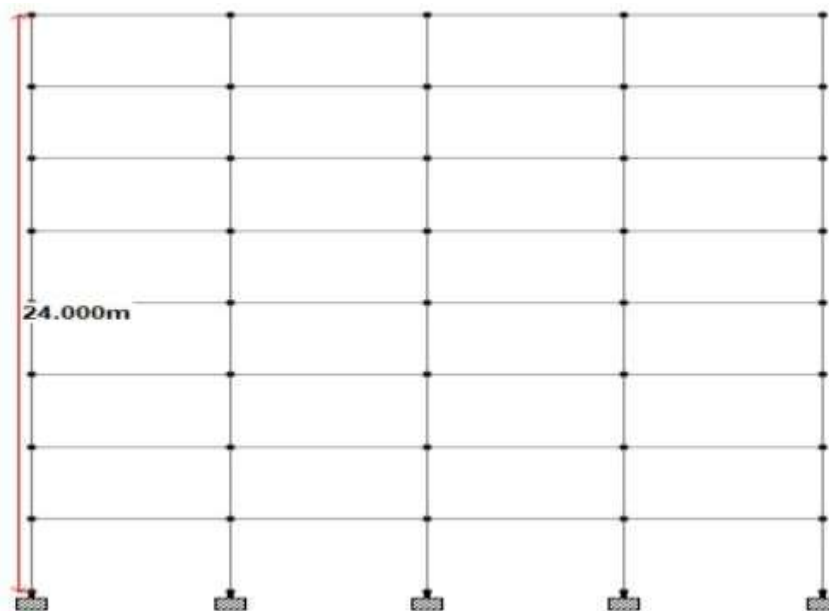


Figure 3.1: Elevation of the G+7 building showing storey heights

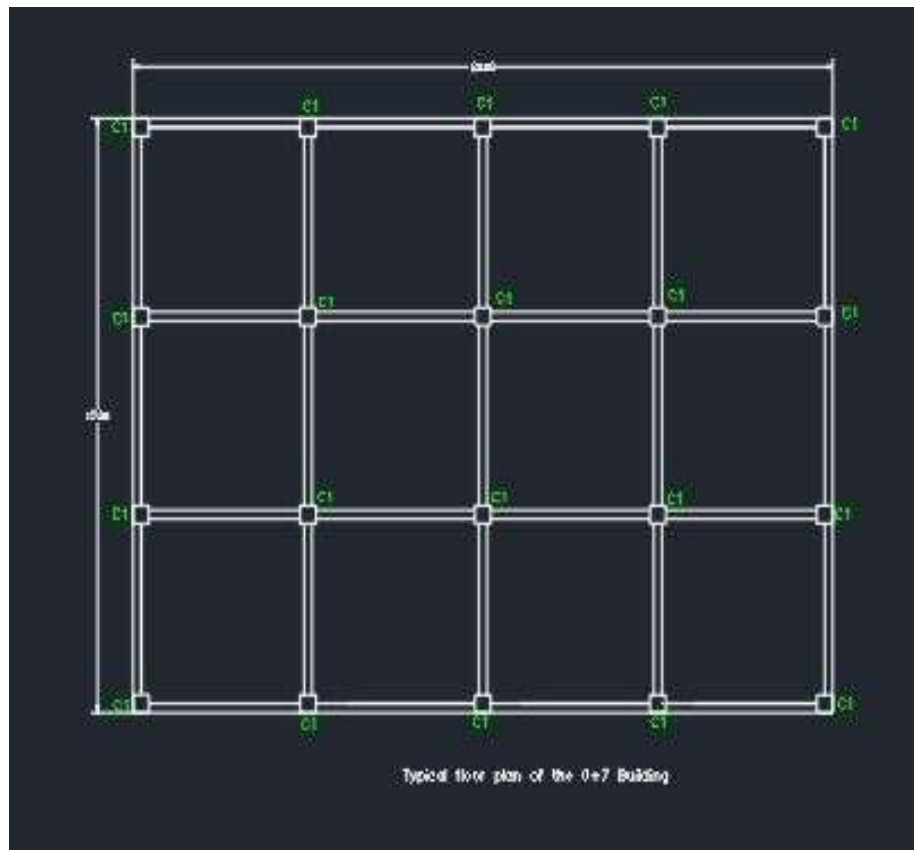


Figure 3.2: Beam and column layout of the conventional framed configuration

3.2 IS Code

- IS 875: This code deals with different types of loads acting on structure.
 - IS 875-1 (1987): Part 1 is for calculation of dead load on structure
 - IS 875-2 (1987): Part 2 is for live load calculation on structure
 - IS 875-3 (1987): Part 3 is for wind load calculation on structure
- IS 1893 (2016): This code deals with seismic design in India

3.3 Design and analysis by using software

The structural analysis and design of both monolithic shear wall systems and conventional RCC framed structures were carried out using **STAAD Pro**, a widely used structural analysis software. The software was utilized to develop three-dimensional models of G+7 buildings and to evaluate their structural behaviour under various loading conditions. The modelling process involved defining the geometry of the structure, including beams, columns, slabs, and shear walls, along with the assignment of material properties and sectional dimensions. Appropriate boundary conditions were provided by assigning fixed supports at the base. The loads considered in the analysis included dead load, live load, wind load, and seismic load as per relevant Indian Standard codes. Wind load calculations were performed in accordance with IS 875 (Part 3), while seismic loads were applied based on IS 1893 (Part 1):2016 using the equivalent static method. Load combinations were generated as per limit state design requirements to evaluate the

critical structural response. The software was further used to analyse important parameters such as storey displacement, inter-storey drift, base shear, and bending moments. Comparative analysis was carried out between monolithic and conventional structures to assess their performance under similar loading conditions.

4. COMPARATIVE PERFORMANCE OF G+7 STRUCTURE

Based on analytical and experimental studies:

- Monolithic system shows lower storey displacement [21].
- Framed system demonstrates higher bending moments in beams and columns [22].
- Inter-storey drifts significantly reduced in shear wall systems [23].
- Time efficiency and repetitive floor advantages make monolithic construction suitable for irregular plans and commercial buildings [24].

5. CURRENT RESEARCH TREND AND FUTURE SCOPE

5.1 Current research trends

1. Recent studies focus on the seismic performance of monolithic shear wall structures, which show higher stiffness and reduced lateral displacement compared to conventional RCC framed structure [3],[7],[15].
2. Researchers are analyse the use of aluminium formwork systems in monolithic construction to achieve fater construction cycles and improved structural quality [11], [12].
3. Several studies emphasize the structural behaviour of G+7 building using monolithic systems and compare them with conventional framed structure in terms of storey displacement and drifts [8], [21].
4. Current research also focuses on modular monolithic systems, where wall and slab components are assembled to improve construction efficiency and reduced project duration [6], [14].

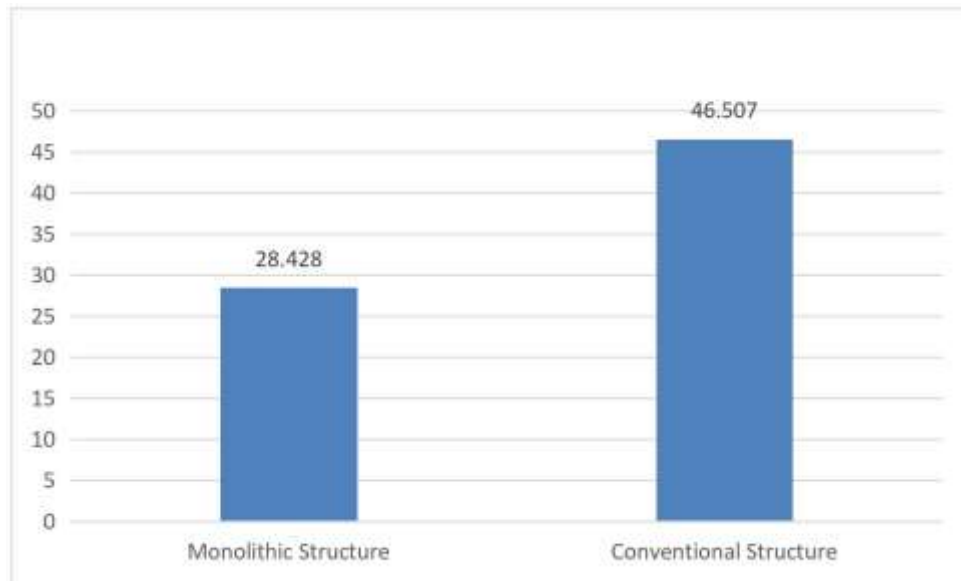
5.2 Future scope

1. Future research can focus on analysis of taller building (G+15 or above) using monolithic structural systems to evaluate their performance using seismic and wind loads [20], [25].
2. Further studies are required to developed hybrid structural systems combining monolithic shear wall with conventional framed structures to achieve both structural stiffness and architectural flexibility [15], [24].

7. RESULT

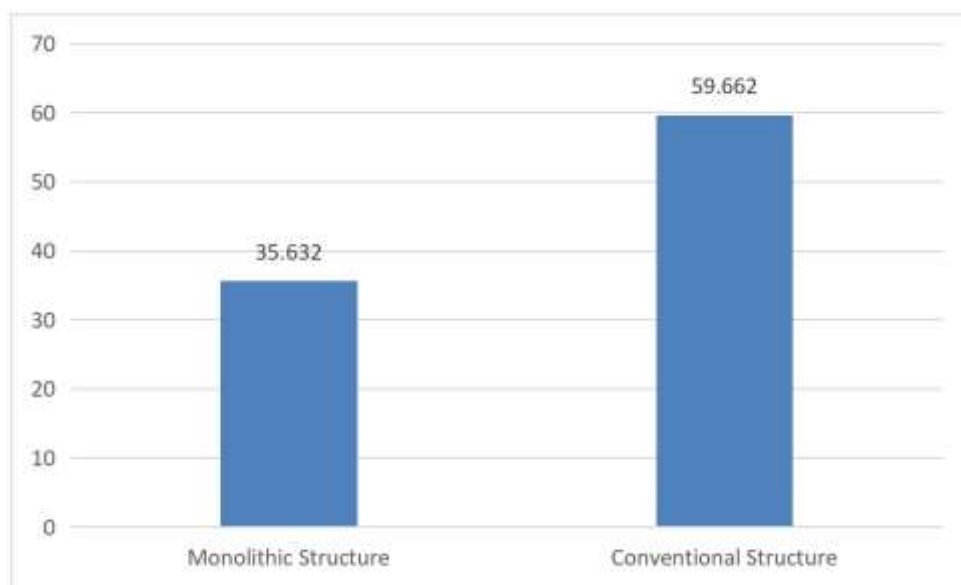
The following graphs are shown to compare the result of monolithic G+7 building and conventional framed G+7 structures for load combination (DL+LL+WL)x1.2 generated at corner column, inner column, centre column.

7.1 Bending Moment



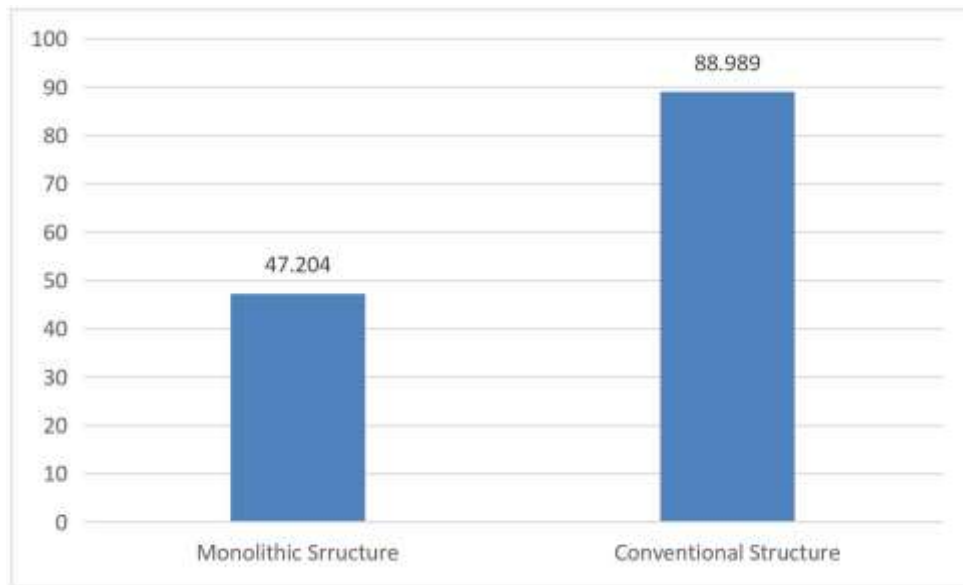
Graph 1: load case 12 for corner column

In this graph 1 the load case 12 auto load generated at corner column is shown for both structures.



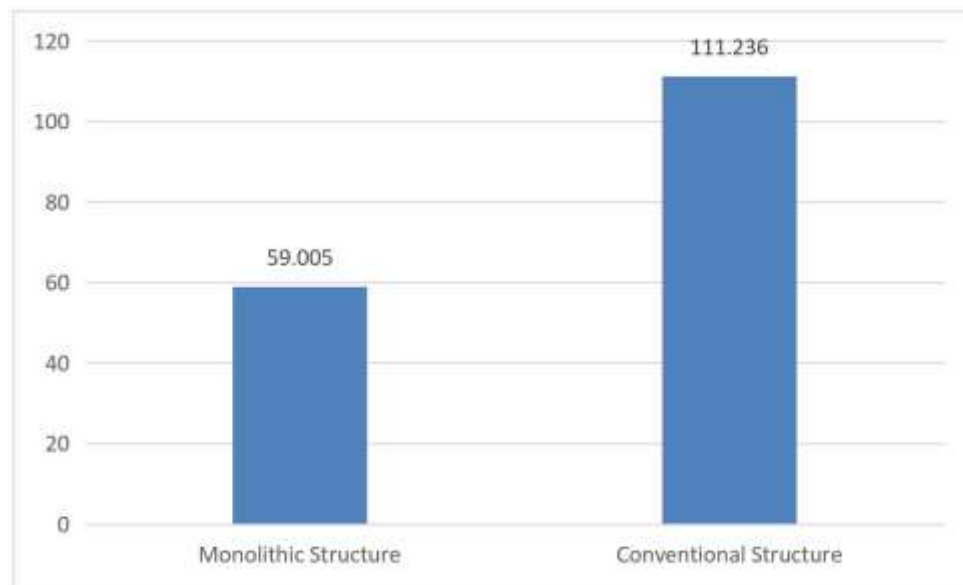
Graph 2: load case 28 for corner column

In this graph 2 the load case 28 auto load generated at corner column is shown for both structures.



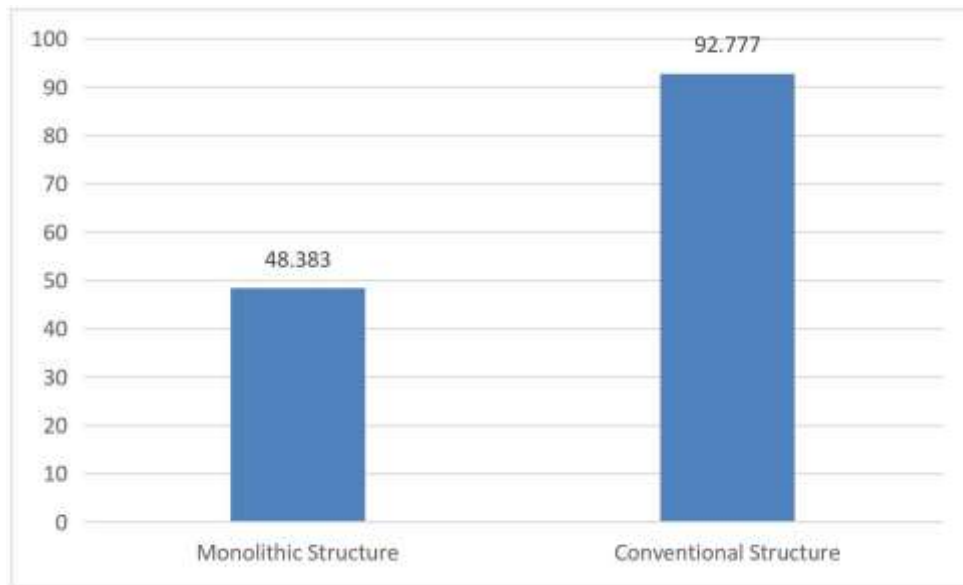
Graph 3: load case 12 for centre column

In this graph 3 the load case 12 auto load generated at centre column is shown for both structures.



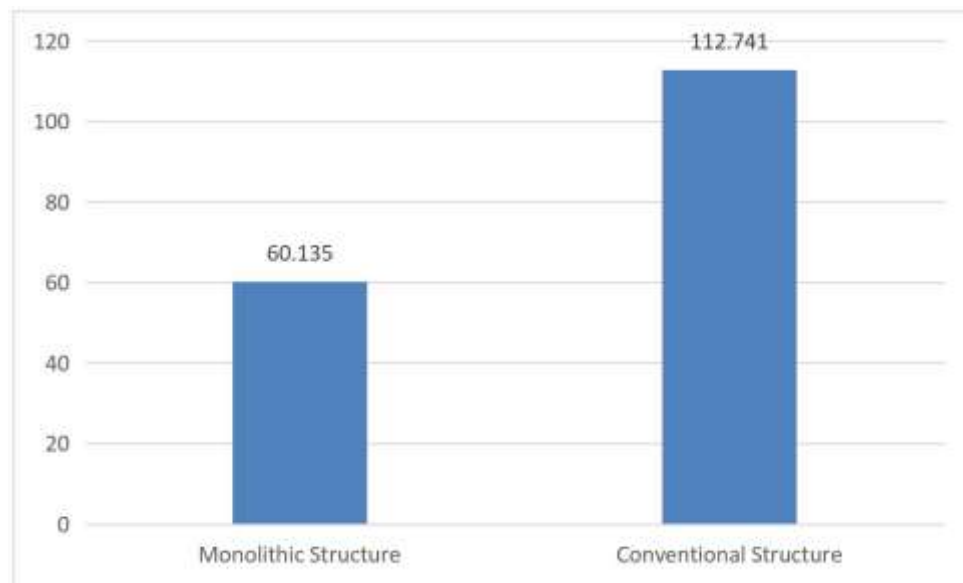
Graph 4: load case 28 for centre column

In this graph 4 the load case 28 auto load generated at centre column is shown for both structures.



Graph 5 load case 12 for inner column

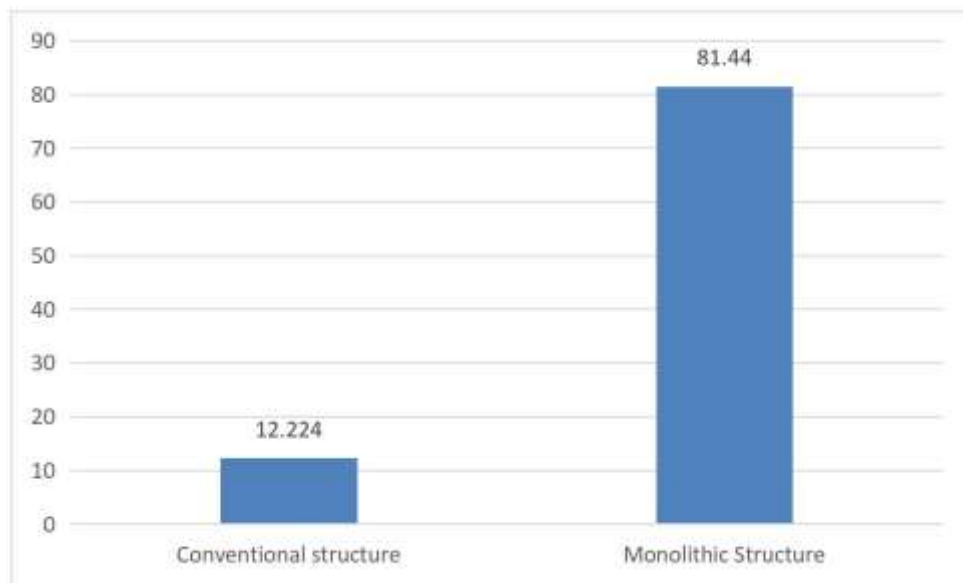
In this graph 5 the load case 12 auto load generated at inner column is shown for both structures.



Graph 6: load case 28 for inner column

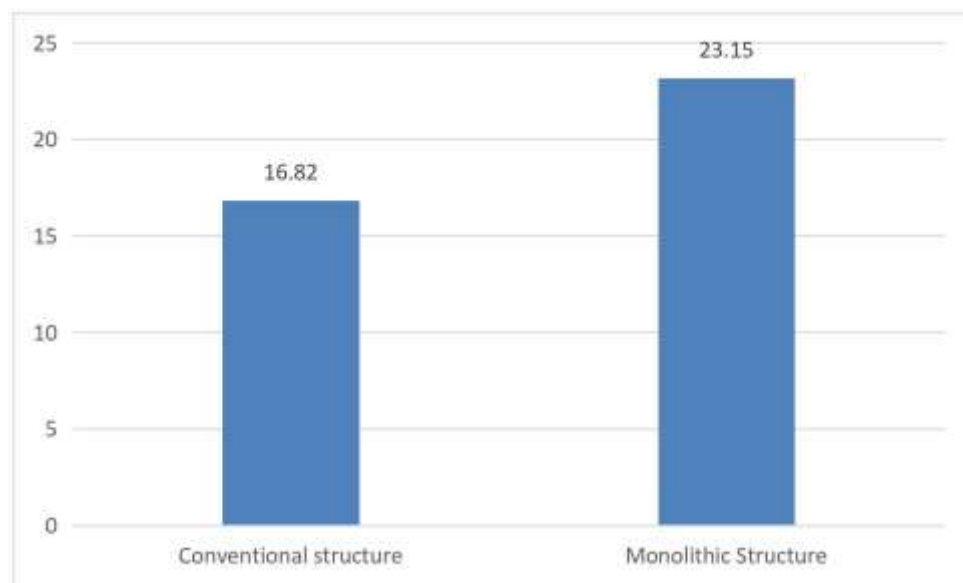
In this graph 5 the load case 28 auto load generated at inner column is shown for both structures. The bending moment values in the monolithic structures are lower than those in conventional structure across inner, centre and corner columns as shown in graph 1 to 6. The reduction is approximately 30-50% across different storeys. This reduction occurs because monolithic structures have continuous load paths and shear walls, which distribute loads more uniformly and reduce stress concentration at beam-column joints.

7.2 Sher Force



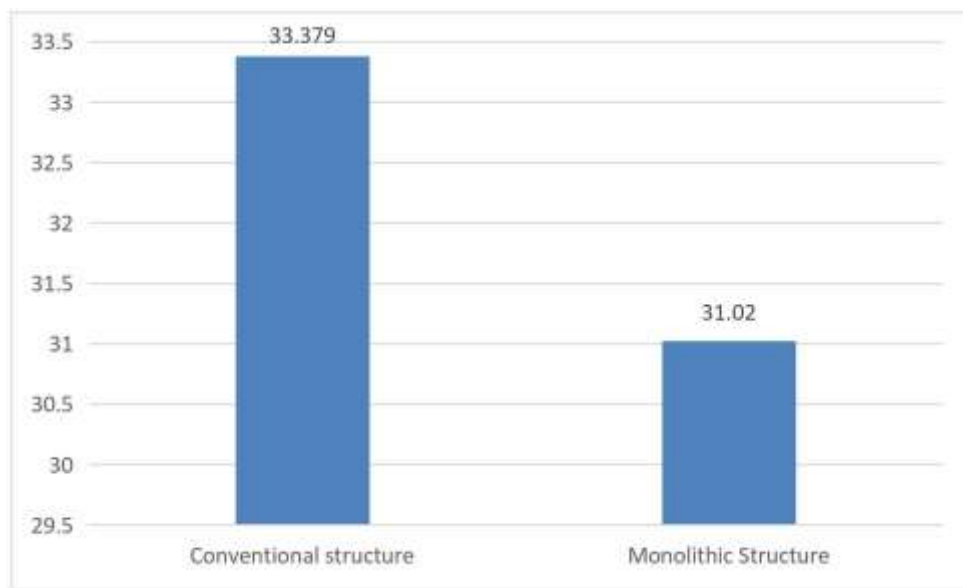
Graph 7: load case 12 for corner column

In this graph 6 the load case 12 auto load generated at corner column is shown for both structures.



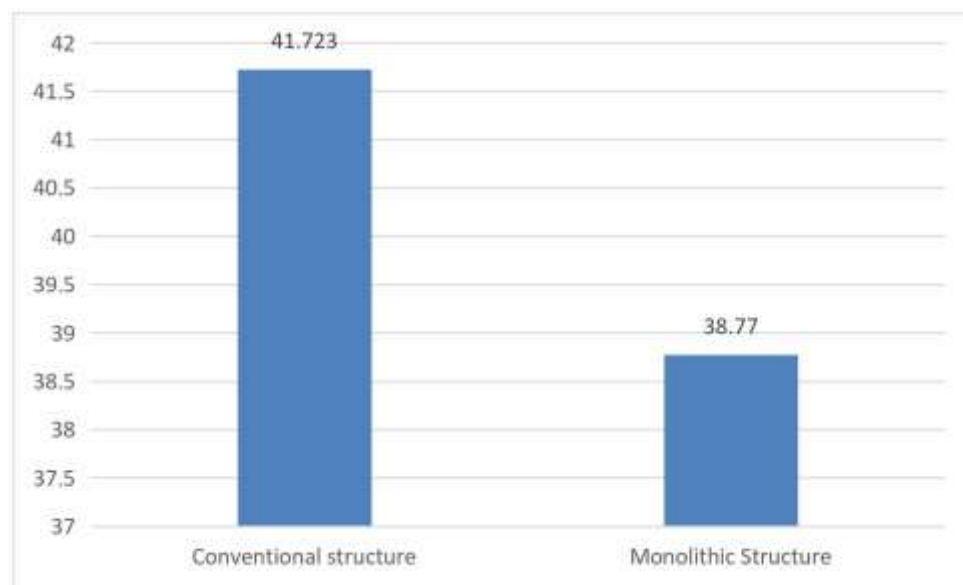
Graph 8: load case 28 for corner column

In this graph 7 the load case 28 auto load generated at corner column is shown for both structures.



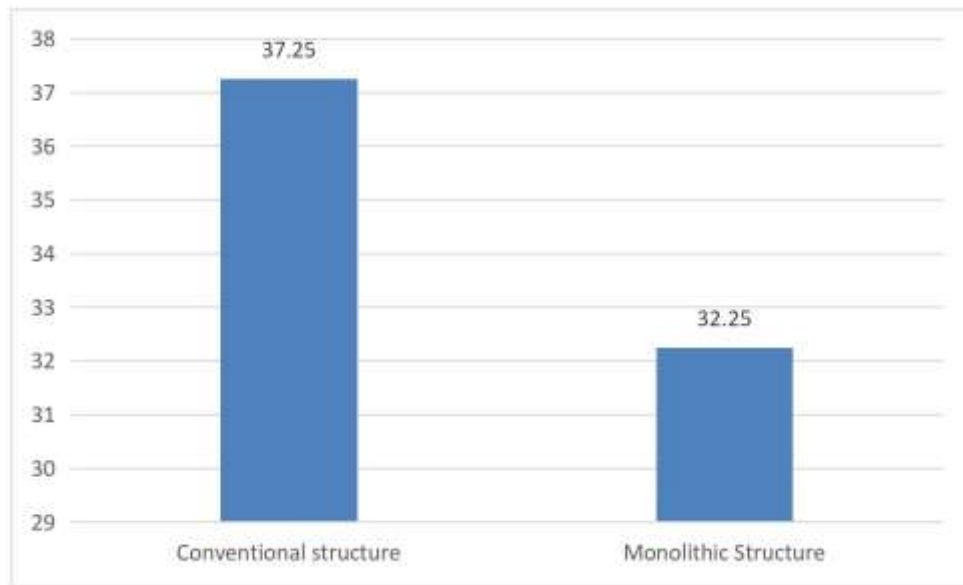
Graph 9: load case 12 for centre column

In this graph 8 the load case 12 auto load generated at centre column is shown for both structures.



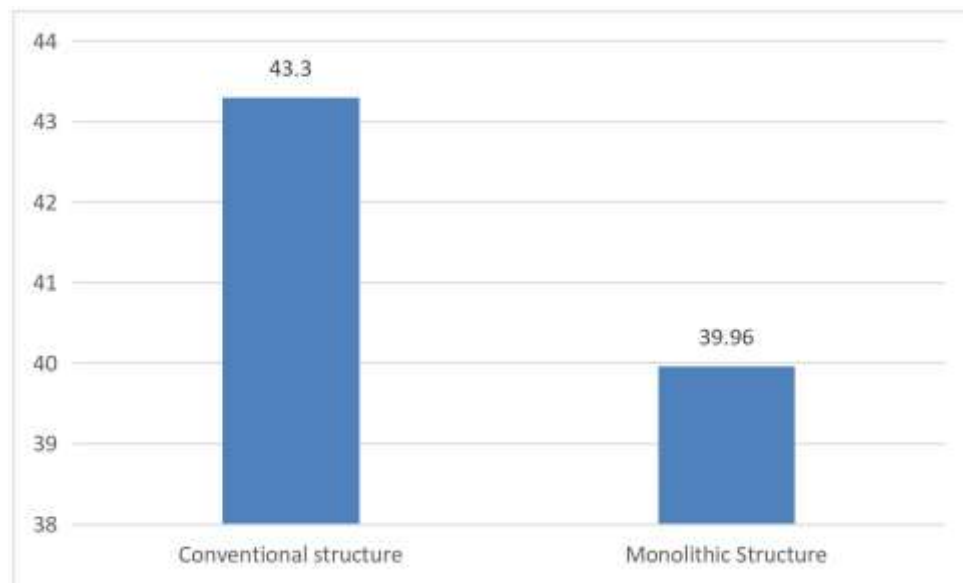
Graph 10: load case 28 for centre column

In this graph 9 the load case 28 auto load generated at centre column is shown for both structures.



Graph 11: load case 12 for inner column

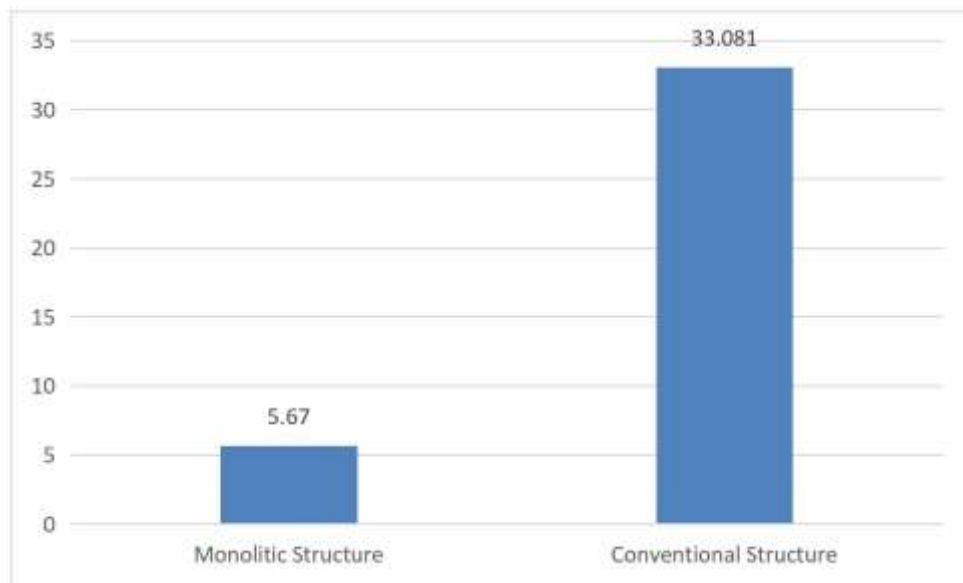
In this graph 10 the load case 12 auto load generated at inner column is shown for both structures.



Graph 12: load case 28 for inner column

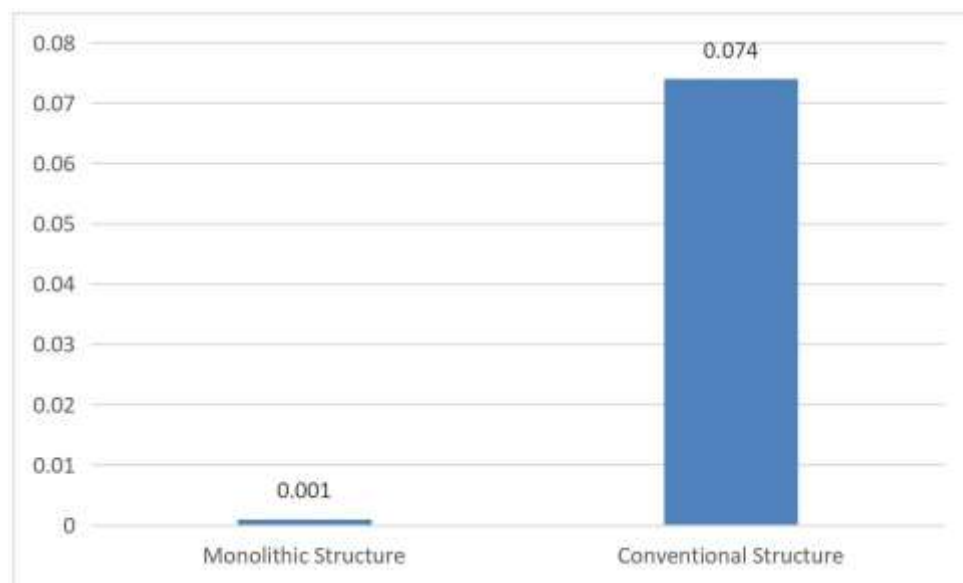
In this graph 11 the load case 28 auto load generated at inner column is shown for both structures. The shear force values in the monolithic structure are lower compared to conventional structure for all column types as shown in graph 7 to 12. A reduction of around 20-40% is noted. This is due to improve load transfer mechanisms and the absence of weak joints, which enhances overall structural stability.

7.3 Displacement



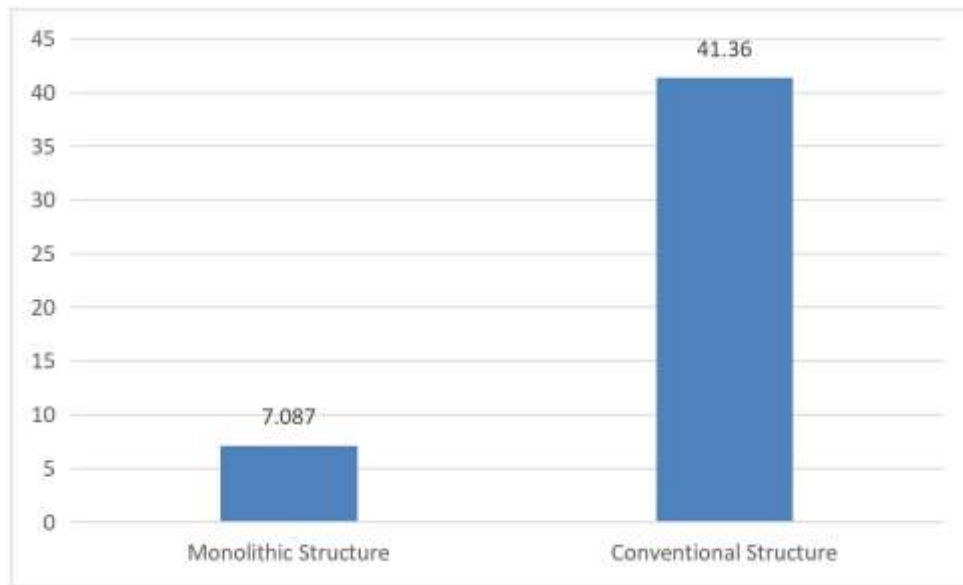
Graph 13: load case 12 for X direction

In this graph 12 the load case 12 auto load generated at X direction is shown for both structures.



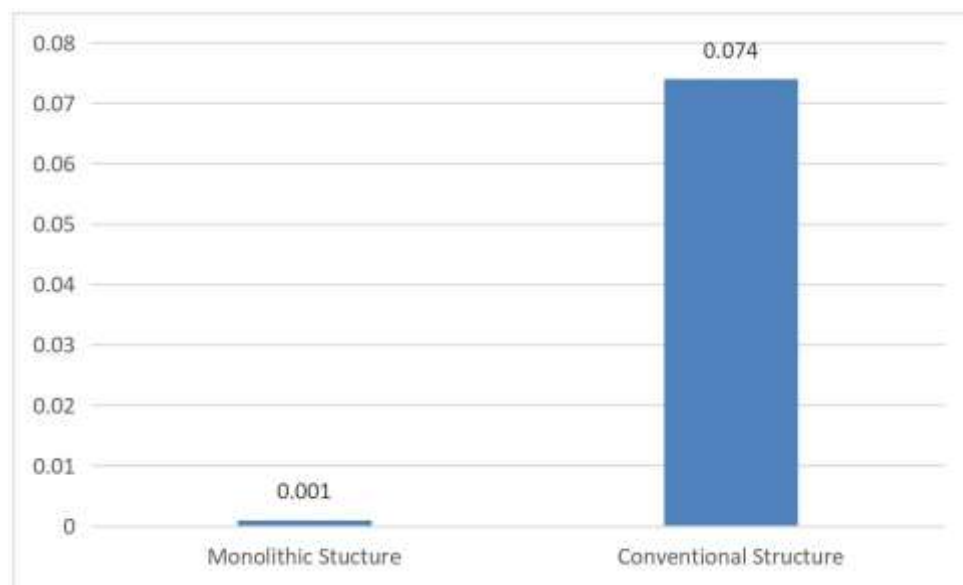
Graph 14: load case 12 for Z direction

In this graph 13 the load case 12 auto load generated at Z direction is shown for both structures.

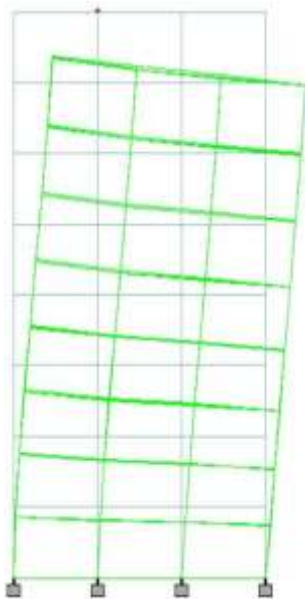


Graph 15: load case 28 for X direction

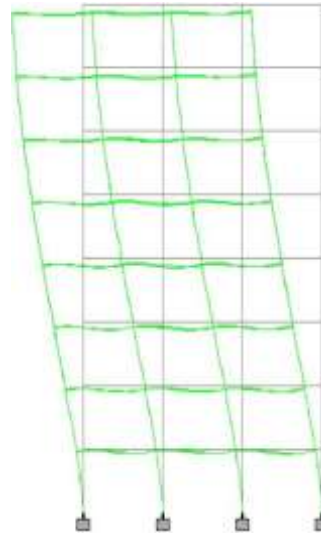
In this graph 15 the load case 28 auto load generated at X direction is shown for both structures.



Graph 16: load case 28 for Z direction



*Monolithic Building
drift comparison and code limit envelope*



Conventional Building Figure 7.1: Inter-storey

In this graph 16 the load case 28 auto load generated at Z direction is shown for both structures. The displacement analysis is carried out at the top corner of structure in X and Z direction to evaluate the lateral response under loading conditions. From the monolithic structure is lower compared to the conventional structure. The reduction in displacement is significant, indicating improved stiffness of the monolithic system. This behaviour is due to presence of continuous structural elements, which provide better resistance against lateral forces. Lower displacement results in reduced storey drift, thereby enhancing the overall stability and seismic performance of the structure.

6. CONCLUSION

The reviewed literature established that monolithic structural systems provide improved seismic resistance, higher stiffness, faster construction cycles compared to conventional RCC framed structures. However, design flexibility and architectural adaptability remain strengths of framed systems. For G+7 buildings in seismic zones, monolithic systems present structural advantages, but final selection should consider economic and functional requirements.

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