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A Systematic Review of Seismic Performance of Monolithic Mivan Construction and Conventional RCC Structures in High Seismic Zone 5

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Abstract: ***India falls within one of the most seismically active regions of the world, with Seismic Zone V representing areas of very high earthquake risk. In such regions, the selection of an appropriate structural system plays a crucial role in ensuring seismic safety, structural reliability, and serviceability. In recent years, Mivan construction technology, which employs monolithic wall–slab construction using aluminium formwork, has gained significant importance in multistorey residential construction.***

This paper presents a systematic review of existing research studies comparing the seismic performance of Mivan construction and Conventional Reinforced Cement Concrete (RCC) framed structures in Seismic Zone V conditions. The review focuses on key seismic response parameters reported in the literature, including storey displacement, inter-storey drift, base shear, natural time period, and frequency, which are critical indicators of seismic behaviour and structural safety.

The reviewed studies consistently indicate that Mivan structures exhibit lower displacement and drift, reduced base shear demand, and shorter fundamental natural time periods when compared to conventional RCC structures. These trends are primarily attributed to the monolithic wall–slab action and enhanced stiffness characteristics of Mivan systems. The findings highlight the improved seismic resilience and serviceability performance of Mivan construction.

Overall, this review establishes that Mivan construction offers superior seismic performance and is a viable and effective solution for multistorey residential buildings located in high seismic risk zones such as Seismic Zone V.

Keywords: Mivan Construction; Conventional RCC; Seismic Zone V; Seismic Performance; Inter-storey Drift; Base Shear; Time Period; Structural Stiffness; Earthquake-Resistant Design.

I. INTRODUCTION

Earthquake-resistant design is a critical requirement for structures located in Seismic Zone V, which includes regions prone to severe ground motion and high seismic intensity. In such zones, structural performance is governed not only by strength but also by stiffness, deformation control, and continuity of load transfer mechanisms. The choice of structural system therefore plays a decisive role in ensuring safety, serviceability, and post-earthquake functionality of buildings. Conventional RCC framed structures, consisting of beams, columns, and slabs, have been extensively used due to design flexibility and construction familiarity. However, under seismic loading, these structures rely heavily on beam–column joint behaviour and frame action, which may result in increased lateral displacement and inter-storey drift if adequate stiffness is not provided. Mivan technology has emerged as an alternative construction system, particularly suitable for mass housing and multistorey residential buildings. This system utilizes aluminium formwork to construct monolithic reinforced concrete walls and slabs in a single pour. The resulting wall–slab action creates a continuous and uniform structural system capable of resisting both gravity and lateral seismic forces effectively. Several analytical studies have been carried out to compare the seismic response of Mivan and conventional RCC structures under Zone V seismic conditions. These studies commonly assess parameters such as storey displacement, inter-storey drift, base shear, and fundamental natural time period using response spectrum and dynamic analysis methods in accordance with IS 1893 (Part 1):2016. However, the available literature is scattered across various journals and lacks a consolidated review focusing specifically on Zone V performance. Therefore, this review paper aims to systematically examine and synthesize existing research findings related to the comparative seismic behaviour of Mivan technology and conventional RCC structures in Seismic Zone V, with emphasis on identifying consistent performance trends and establishing the suitability of Mivan construction in high seismic risk regions.

II. OBJECTIVES

The primary objectives of this review paper are as follows:

1) To systematically review existing research studies comparing Mivan construction technology and Conventional RCC structural systems with respect to seismic performance
2) To evaluate and compare the seismic behaviour of both structural systems for buildings located in Seismic Zone V, as defined by IS 1893 (Part 1):2016.
3) To assess key seismic response parameters reported in the literature, such as storey displacement, inter-storey drift, base shear, natural time period, and frequency.
4) To identify the advantages of monolithic Mivan construction over conventional RCC framing in terms of stiffness, deformation control, and seismic resilience.
5) To highlight research gaps and establish the need for adopting efficient construction systems for multistorey residential buildings in high seismic regions.

III. SCOPE OF STUDY

The scope of this review paper is limited to a comparative assessment of Mivan construction technology and Conventional RCC structural systems with specific reference to buildings located in Seismic Zone V, as defined by IS 1893 (Part 1):2016. The review focuses on evaluating the seismic resilience of both systems based on findings reported in existing analytical and numerical studies.

This study examines key seismic response parameters, including storey displacement, inter-storey drift, base shear, natural time period, and frequency, which are widely used to assess structural safety, stiffness, and dynamic behaviour during earthquake events. Only research works that adopt Indian Standard codes, numerical modelling tools such as ETABS, or comparable analytical frameworks are considered to maintain consistency and relevance.

The scope of the review is confined to linear seismic analysis–based studies reported in the literature. Experimental investigations, nonlinear analysis, construction cost assessment, and life-cycle performance evaluation are not covered in detail and are considered beyond the present scope. The review is primarily intended to support structural engineers, researchers, and decision-makers in understanding the relative seismic performance of Mivan and RCC systems and in selecting appropriate construction technologies for multistorey residential buildings in high seismic risk regions.

IV. REVIEW OF PREVIOUS STUDIES

Several researchers have investigated the seismic performance of Mivan construction technology and Conventional Reinforced Cement Concrete (RCC) framed structures using analytical and numerical approaches. Most of the reviewed studies have focused on evaluating seismic response parameters such as storey displacement, inter-storey drift, base shear, natural time period, and frequency, in accordance with the provisions of IS 1893 (Part 1):2016.

Studies comparing storey displacement behaviour have consistently reported that Mivan structures exhibit lower lateral displacement when compared to conventional RCC framed buildings. This reduction in displacement has been primarily attributed to the monolithic wall–slab action of Mivan construction, which provides higher global stiffness and improved structural continuity. Researchers have observed that the reduction in displacement is more pronounced at upper storey levels, where seismic effects tend to be critical.

Inter-storey drift behaviour has also been extensively examined in the literature. The reviewed studies indicate that both Mivan and RCC structures generally satisfy the permissible drift limits specified by Indian Standard codes. However, Mivan structures have been reported to exhibit significantly lower inter-storey drift values compared to RCC framed systems. The reduced drift response in Mivan construction reflects improved deformation control and a lower likelihood of damage to non-structural components such as infill walls, partitions, and façade elements during earthquake events.

Base shear comparison between Mivan and RCC structural systems has been addressed in several research works. The literature consistently reports lower base shear demand for Mivan structures under identical seismic loading conditions. Researchers have attributed this behaviour to the efficient seismic force transfer mechanism and favourable stiffness characteristics of monolithic wall systems. In contrast, conventional RCC framed structures tend to attract comparatively higher base shear due to increased flexibility and mass participation.

Dynamic characteristics, including natural time period and frequency, have been widely analysed in previous studies. It has been reported that Mivan structures generally possess shorter fundamental natural time periods and higher natural frequencies than conventional RCC structures.

This behaviour confirms the higher lateral stiffness of Mivan systems and their reduced flexibility under seismic excitation. The trends observed in time period and frequency are found to be consistent with the displacement and inter-storey drift responses reported in the literature.

Several researchers have also highlighted that the uniform stiffness distribution along the height of Mivan buildings helps in preventing localized deformation and soft-storey formation, which are common concerns in conventional RCC framed structures. The continuous load path provided by the monolithic configuration contributes to improved overall seismic behaviour and structural integrity.

Despite the extensive research conducted on seismic analysis of RCC framed buildings, the literature indicates a relatively limited number of studies focusing specifically on a consolidated comparison of Mivan and RCC systems in Seismic Zone V. Most existing studies are limited to linear elastic analysis, with fewer investigations addressing nonlinear behaviour and performance-based seismic assessment. This highlights the need for further research to strengthen the understanding of Mivan construction performance under severe seismic conditions.

Overall, the reviewed studies consistently demonstrate that Mivan construction exhibits superior seismic performance compared to conventional RCC framing in terms of stiffness, deformation control, base shear demand, and dynamic response. These findings strongly support the suitability of Mivan construction technology for multistorey residential buildings located in high seismic risk zones such as Seismic Zone V.

V. RESEARCH GAP IDENTIFIED

A detailed review of existing literature indicates that several studies have been carried out to evaluate the seismic performance of Mivan and Conventional RCC structures. Most researchers have focused on parameters such as storey displacement, inter-storey drift, base shear, and natural time period using linear static and response spectrum analysis methods.

However, the following research gaps have been identified from the reviewed studies:

1) Limited studies provide a direct comparative review between Mivan and Conventional RCC systems specifically for Seismic Zone V, which represents the highest seismic risk category in India.

2) Many available studies focus on individual performance evaluation, while a consolidated and systematic comparison of seismic response parameters for both systems remains insufficient.

3) The majority of research emphasizes numerical modelling and analysis results, with less focus on synthesizing findings across multiple studies to evaluate overall seismic resilience.

4) Parameters such as dynamic characteristics (time period and frequency) and their correlation with stiffness and deformation control are not consistently discussed in existing literature.

5) There is a lack of comprehensive review studies that collectively assess displacement, drift, base shear, and dynamic response to establish the suitability of Mivan construction in high seismic zones.

Therefore, a clear research gap exists for a systematic review-based comparative assessment of Mivan and Conventional RCC structural systems in Zone V, which this study aims to address.

VI. CONCLUSIONS

This review paper presented a comparative assessment of Mivan construction technology and Conventional RCC structural systems with specific reference to buildings located in Seismic Zone V. Based on a systematic review of existing literature, the seismic performance of both systems was evaluated using key response parameters such as storey displacement, inter-storey drift, base shear, natural time period, and frequency. The reviewed studies consistently indicate that Mivan construction exhibits superior seismic performance compared to conventional RCC framing. The monolithic wall–slab configuration of Mivan systems results in higher global stiffness, reduced storey displacement, and significantly lower inter-storey drift, particularly at upper storey levels where seismic effects are more pronounced. Furthermore, several researchers have reported lower base shear demand and shorter fundamental natural time periods for Mivan structures, reflecting improved force transfer mechanisms and enhanced resistance to dynamic excitation. The uniform stiffness distribution along the building height helps in controlling seismic response and minimizing damage to both structural and non-structural components. While both structural systems satisfy the Codal requirements prescribed by IS 1893 (Part 1):2016, the reviewed literature clearly establishes that Mivan construction provides a higher margin of safety, improved serviceability, and enhanced seismic resilience. Therefore, based on the findings of existing research studies, Mivan construction is found to be more suitable for multistorey residential buildings in high seismic risk regions, particularly for mass housing and repetitive construction projects in Seismic Zone V.

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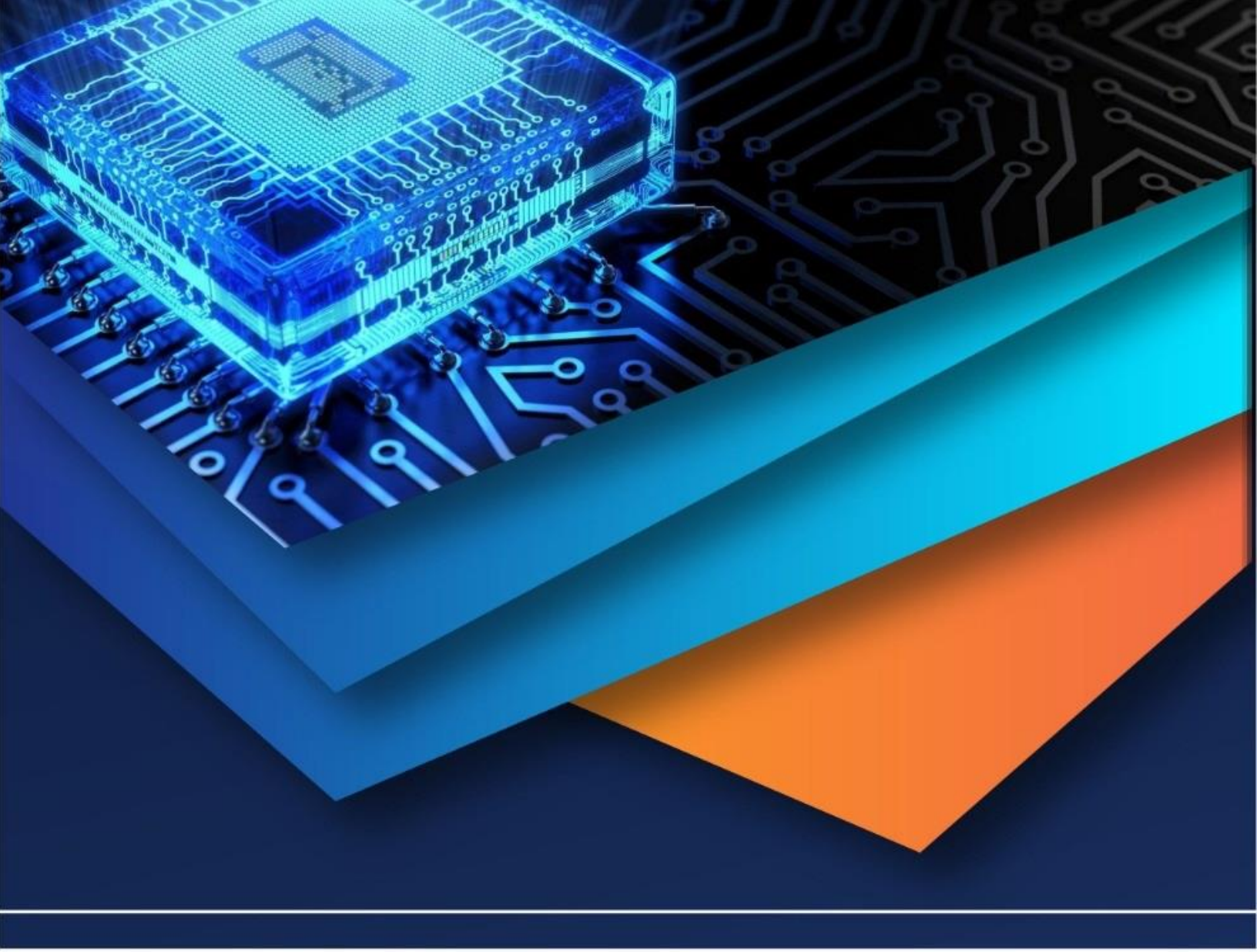

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