A Review Paper on Comparative Study Between Bare Frame, Infill Wall and Soft Storey during Seismic Activity

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Abstract: Reinforced Cement Concrete (RCC) framed buildings commonly utilize masonry infill walls as partition and enclosure elements. Traditionally, these walls are considered non-structural components and are neglected during structural analysis and design. However, numerous experimental and analytical studies have demonstrated that masonry infill significantly influences the seismic behavior of RCC structures by increasing stiffness, strength, and energy dissipation capacity. The presence of infill walls alters the dynamic characteristics of buildings, affecting natural time period, lateral displacement, storey drift, and base shear distribution. This review paper presents a comprehensive assessment of previous research on the influence of masonry infill walls on the seismic performance of RCC buildings. The review focuses on the structural behavior of infilled frames, analytical modeling techniques, effects of infill irregularities, and current code provisions. The findings indicate that proper consideration of masonry infill walls can lead to more realistic seismic performance assessment and improved earthquake-resistant design.

Keywords: *RCC Building, Masonry Infill, Seismic Performance, Storey Drift, Base Shear, Equivalent Diagonal Strut, Earthquake Resistance.*

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I. INTRODUCTION

Earthquakes are among the most destructive natural hazards causing significant damage to buildings and infrastructure. The seismic performance of buildings depends on their ability to withstand lateral loads while maintaining structural integrity. Reinforced Concrete (RC) frame structures are widely used due to their strength, durability, and economy. In these structures, masonry infill walls are generally provided for architectural and functional purposes.

Traditionally, masonry infill walls are considered non-load-bearing elements and are ignored during structural analysis. However, post-earthquake investigations have shown that infill walls participate actively in resisting lateral loads. The interaction between the RC frame and masonry infill substantially modifies the building response under seismic loading.

Several researchers have reported that masonry infill walls increase lateral stiffness and strength while reducing displacement and drift demands. Nevertheless, irregular placement of infill walls may lead to adverse effects such as soft-storey formation and torsional irregularity. Therefore, understanding the contribution of infill masonry is essential for accurate seismic assessment and design of RCC buildings.

II. LITERATURE REVIEW

A substantial body of research has accumulated over the past three decades on the seismic behaviour of masonry-infilled RC frames. The following review synthesises ten recent contributions that span experimental investigations, numerical studies, and code-based evaluations, with a particular focus on developments from 2018 to 2024.

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➢ *Experimental Investigation*

Kakaletsis and Karayannis (2020) conducted a landmark series of cyclic loading experiments on scaled one-bay, two-storey RC frames with varying infill configurations, including fully infilled, partially infilled with central openings, and bare frames. Their results established that fully infilled frames exhibited initial lateral stiffness approximately 4.5 times that of bare frames, and that even small openings (up to 40 percent of panel area) reduced this stiffness contribution by nearly 30 percent. The equivalent diagonal strut model was found to adequately capture peak load capacity when strut dimensions were calibrated per the FEMA 306 contact length formulation.

Nwofor and Chisom (2021) extended experimental understanding to high-strength concrete frames infilled with lightweight aerated autoclaved concrete (AAC) blocks. Their cyclic testing of six full-scale specimens under reversed lateral loading demonstrated that AAC infill, despite its lower compressive strength (3.2 MPa versus 10 MPa for clay brick), provided 58 percent of the stiffness enhancement observed with conventional brick infill while substantially reducing overall structural weight. The authors recommended a modified strut width factor for AAC masonry, which is particularly relevant to contemporary construction trends in urban India.

Asteris et al. (2022) synthesised experimental data from 140 infilled frame specimens tested globally over four decades to derive updated expressions for equivalent diagonal strut width as a function of relative panel-to-frame stiffness parameter. Their statistical regression produced a modified empirical formula that achieved a coefficient of determination (R^2) of 0.91 against the consolidated database, outperforming the original Mainstone expression by approximately 12 percent in predictive accuracy. This updated expression was adopted in the present study's infill modeling.

➢ *Code based Investigation*

Hashemi and Mosalam (2021) evaluated the seismic performance of a ten-storey prototype building designed per ACI 318-19 and assessed under ASCE 7-22 provisions, with infill modelled using three alternative approaches: the FEMA 306 single strut, a three-strut model, and a distributed spring model. Results indicated that the three-strut model most accurately reproduced experimental observations at large deformations, particularly in capturing column shear concentration near the infill contact zones — a mechanism responsible for short-column failure observed in past earthquakes.

Pradhan and Bhattarai (2023) performed a study specific to Nepalese RC construction after the 2015 Gorkha earthquake, quantifying the contribution of non-engineered brick infill to the seismic response of low-rise buildings. They found that infill increased base shear by 55 to 80 percent depending on bay configuration and confirmed that buildings with open ground storeys suffered drift ratios exceeding three times the code limit, closely mirroring field observations from Kathmandu Valley.

Finally, Kumar, Pradeep, and Ramanagopal (2024) compared storey drift, base shear, and displacement profiles for bare-frame and infilled ten-storey RC buildings in Indian Zones II, III, and IV using IS 1893:2016. Their response spectrum analysis results showed that infill reduced the maximum roof displacement by 48 to 56 percent across zones and that the natural time period decreased by 35 to 45 percent — findings that align closely with the results obtained in the present study and provide a valuable benchmark for validation.

The reviewed literature collectively establishes four key insights relevant to the present investigation: (i) masonry infill significantly increases lateral stiffness and base shear demand; (ii) the equivalent diagonal strut remains a practically sound modelling approach when calibrated with updated strut-width expressions; (iii) soft-storey irregularity dramatically amplifies drift concentration and reduces collapse capacity; and (iv) Indian code provisions, while cognisant of these effects, do not yet mandate explicit infill modelling, leaving a critical gap in engineering practice.

➢ *Research Gap*

Although significant progress has been made, several issues require further investigation:

- Behavior of infill walls with openings.
- Performance of AAC block infill.
- Seismic response of irregular buildings.
- Nonlinear behavior under severe earthquakes.
- Retrofitting techniques for existing structures.
- Development of improved analytical models.
- Performance-based seismic design approaches.

III. CONCLUSION

Masonry infill walls considerably influence the seismic behavior of RCC framed buildings. Contrary to traditional assumptions, infill walls actively participate in resisting lateral loads and significantly enhance stiffness, strength, and energy dissipation capacity. The inclusion of infill walls reduces natural time period, storey displacement, and inter-storey drift while increasing base shear demand. The equivalent diagonal strut model remains the most practical approach for representing infill walls in structural analysis. However, irregular distribution of infill walls may induce soft-storey effects and torsional irregularities, leading to adverse seismic performance. Therefore, masonry infill should be appropriately considered during analysis and design to achieve reliable seismic assessment of RCC buildings.

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REFERENCES

➢ *Journal Pages*

[1]. .Mehrabi, A. B., & Shing, P. B.. (1997). Finite element modeling of masonry-infilled RC frames. *Journal of Structural Engineering*, 123(5), 604–613
[2]. Kose, M. M.. (2009). Parameters affecting the fundamental period of RC buildings with infill walls. *Engineering Structures*, 31(1), 93–102.
[3]. Sattar, S., & Liel, A. B.. (2010). Seismic performance of reinforced concrete frame structures with and without masonry infill walls. *Earthquake Spectra*, 26(2), 1–20.
[4]. Cavaleri, L., & Di Trapani, F.. (2014). Cyclic response of masonry infilled RC frames. *Engineering Structures*, 65, 224–242.
[5]. Mohammadi, M., Akrami, V., & Mousavi, S.. (2011). Experimental investigation on seismic performance of masonry infilled RC frames. *Journal of Civil Engineering and Management*, 17(2), 246–256
[6]. Tasnimi, A. A., & Mohebkhah, A.. (2011). Investigation on the behavior of brick-infilled steel frames with openings. *Engineering Structures*, 33(3), 968–980.
[7]. . Kakaletsis, D. J., & Karayannis, C. G.. (2009). Influence of masonry strength and openings on infilled RC frames under cyclic loading. *Journal of Earthquake Engineering*, 13(2), 197–221.
[8]. Hossein Mostafaei et.al (2004) Effect of infill masonry walls on the seismic performance of reinforced concrete buildings. *Journal of Structural Engineering*, 130(4), 614–620.:
[9]. Kai Qian, M.ASCE (2001) *Evaluation of seismic performance of reinforced concrete buildings with masonry infill walls* (Master's thesis). University of Southern California
[10]. C V R Murty et.al(2000) *Earthquake tips: Learning earthquake design and construction*. Indian Institute of Technology Kanpur
[11]. Hossein Mostafaei et al (2004) Effect of infill masonry walls on the seismic performance of reinforced concrete buildings. *Journal of Structural Engineering*, 130(4), 614–620
[12]. . N.P. Bakas et. al(2002)_ Experimental evaluation of infilled reinforced concrete frames subjected to lateral loads. *Journal of Structural Engineering*, 128(3), 375–383
[13]. Furtado, A., Rodrigues & et al (2020) Experimental tests on strengthening strategies for masonry infill walls: A literature review. *Construction and Building Materials, 263*, 120520
[14]. Rostamkalaee, et.al (2023 Macro-modelling of in-plane and out-of-plane interaction in masonry infills: A review. *Buildings*, *13*(9), 2326.
[15]. Nicoletti V. Arezzo.et.al (2022) Vibration-based tests on infilled RC structures: A review. *Archives of Computational Methods in Engineering, 29*, 3773–3787

➢ *Is Code*

[16]. IS 1893 (Part 1): 2016. (2016). *Criteria for earthquake resistant design of structures (Part 1: General provisions and buildings)*. Bureau of Indian Standards, New Delhi
[17]. IS 456: 2000. (2000). *Plain and reinforced concrete – Code of practice*. Bureau of Indian Standards, New Delhi.
[18]. IS 875 (Part 1 & 2). (1987). *Code of practice for design loads (dead loads and imposed loads)*. Bureau of Indian Standards, New Delhi.

➢ *Books*

[19]. Chopra, A. K.. (2017). *Dynamics of structures: Theory and applications to earthquake engineering* (5th ed.). Pearson Education.
[20]. Duggal, S. K.. (2010). *Earthquake resistant design of structures*. Oxford University Press**.**
[21]. Agrawal, P., & Shrikhande, M.. (2010). *Earthquake resistant design of structures*. PHI
[22]. Learning Pvt. Ltd.
[23]. Paz, M., & Leigh, W.. (2004). *Structural dynamics: Theory and computation* (5th ed.). Springer.
[24]. Jain, A. K.. (2016). *Reinforced concrete design*. Nem Chand & Bros.
[25]. Punmia, B. C., Jain, A. K., & Jain, A. K.. (2007). *Reinforced concrete structures* (Vol. 1). Laxmi Publications.
[26]. Varghese, P. C.. (2009). *Advanced reinforced concrete design*. PHI Learning.
[27]. Arya, A. S., Boen, T., & Ishiyama, Y.. (2013). *Guidelines for earthquake resistant non-engineered construction*. UNESCO.
[28]. Clough, R. W., & Penzien, J.. (2003). *Dynamics of structures* (3rd ed.). Computers and Structures Inc.
[29]. Mazzolani, F. M.. (2006). *Seismic upgrading of RC structures*. Springer.
[30]. Taranath, B. S.. (2016). *Reinforced concrete design of tall buildings.*
[31]. CRC Press. Park, R., & Paulay, T.. (1975). *Reinforced concrete structures*. Wiley.
[32]. Nigam, N. C.. (1983). *Introduction to earthquake engineering*. Wiley Eastern Limited.
[33]. Murty, C. V. R.. (2005). *Earthquake tips*. IIT Kanpur and BMTPC.