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Evaluating Seismic Design Provisions for Ductile Shear Walls in Canadian Codes

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Introduction

The seismic design of ductile shear walls is a critical aspect of structural engineering in earthquake-prone regions, where ensuring both safety and performance during seismic events is paramount. Canadian building codes have evolved significantly in their approach to seismic resistance, particularly in the treatment of ductile reinforced concrete shear walls. Early iterations of the code aimed to introduce ductility as a design criterion, promoting energy dissipation and controlled inelastic behavior during seismic loading. However, as seismic understanding has progressed, so has the need to reevaluate and refine these provisions to reflect actual structural performance under earthquake conditions. The landmark critique by Paulay and Uzumeri (1975) played a pivotal role in challenging the adequacy of the Canadian seismic design philosophy, specifically questioning assumptions related to stiffness, strength distribution, plastic hinge behavior and confinement detailing. This critical analysis, along with subsequent contributions such as those from Paulay and Priestley (1993), laid the groundwork for improving the stability and safety of ductile wall systems in seismic design [1].

Description

One of the key challenges addressed in Canadian seismic provisions is the need to ensure ductility without compromising overall wall stability. The 1975 review by Paulay and Uzumeri emphasized inconsistencies in the application of ductility principles, particularly in how plastic hinge zones were defined and detailed. They argued that the code did not sufficiently enforce the confinement of boundary elements or prescribe rational limits for curvature and deformation demands. These shortcomings could lead to premature crushing or buckling of compression zones during seismic events, ultimately affecting the wall's energy dissipation capacity. Furthermore, they highlighted how the code often assumed uniform lateral load distribution and idealized strain profiles that did not align with experimental and field data. Their recommendations pushed for more rigorous detailing, realistic modeling of nonlinear behavior and improved understanding of shear-wall interactions with the rest of the structural system.

The stability of ductile structural walls, further analyzed by Paulay and Priestley (1993), expanded on these concerns by focusing on lateral-torsional instability and out-of-plane deformation modes that were not adequately captured by conventional design methods. Their work underscored the need for capacity design principles ensuring that inelastic deformations are confined to intended plastic hinge regions while all other elements remain elastic and stable. They advocated for higher safety margins against buckling, improved axial load limits and better integration of experimental evidence into design models. Importantly, their research demonstrated how code provisions should incorporate both strength and deformation-based performance indicators, recognizing that ensuring ductility goes beyond just providing sufficient reinforcement it also requires structural configurations that can maintain stability under large displacements. This comprehensive understanding led to major changes in how Canadian codes approached the design and verification of ductile shear walls in seismic zones [2].

Conclusion

The critical evaluations and research-led insights by Paulay, Uzumeri and Priestley significantly influenced the evolution of seismic design codes in Canada, especially concerning ductile shear wall systems. Their work revealed fundamental gaps in early code provisions and offered evidence-based recommendations to address issues of stability, confinement and realistic deformation modeling. As a result, Canadian codes have progressively shifted toward performance-based and capacity design approaches that prioritize not only strength but also controlled ductility and structural integrity during seismic events. Continued reassessment of these provisions ensures that buildings are better equipped to withstand future earthquakes, preserving both lives and infrastructure.

Acknowledgement

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Conflict of Interest

None.

References

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