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Nonlinear Response of Tall Reinforced Concrete Shear Wall Buildings under Wind Loads

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Abstract : Reinforced concrete shear walls are commonly used as the lateral load-resisting system of mid- to high-rise office or residential buildings around the world. Design of such systems is often governed by wind rather than seismic effects, in particular in low-to-moderate seismic regions. The current design philosophy as per the majority of building codes under wind loads require elastic response of lateral load-resisting systems including reinforced concrete shear walls when subjected to the rare design wind load, resulting in significantly large wall sections needed to meet strength requirements and drift limits. The latter can highly influence the design in upper stories due to stringent drift limits specified by building codes, leading to substantial added costs to the construction of the wall. However, such walls may offer limited to moderate over-strength and ductility due to their large reserve capacity provided that they are designed and detailed to appropriately develop such over-strength and ductility under extreme wind loads. This would significantly contribute to reducing construction time and costs, while maintaining structural integrity under gravity and frequently-occurring and less frequent wind events. This paper aims to investigate the over-strength and ductility capacity of several imaginary office buildings located in Edmonton, Canada with a glance at earthquake design philosophy. Selected models are 10- to 25-story buildings with three types of reinforced concrete shear wall configurations including rectangular, barbell, and flanged. The buildings are designed according to National Building Code of Canada. Then fiber-based numerical models of the walls are developed in Perform 3D and by conducting nonlinear static (pushover) analysis, lateral nonlinear behavior of the walls are evaluated. Ductility and over-strength of the structures are obtained based on the results of the pushover analyses. The results confirmed moderate nonlinear capacity of reinforced concrete shear walls under extreme wind loads. This is while lateral displacements of the walls pass the serviceability limit states defined in Pre standard for Performance-Based Wind Design (ASCE). The results indicate that we can benefit the limited nonlinear response observed in the reinforced concrete shear walls to economize the design of such systems under wind loads.

Keywords : concrete shear wall, high-rise buildings, nonlinear static analysis, response modification factor, wind load
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