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Innovative Seismic Design using Performance-based Procedures

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1 Abstract

In modern projects, performance based seismic design (PBD) procedures are often used to design buildings in areas of high seismic activity that meet defined performance objectives instead of prescriptive building code requirements or have certain features and configurations that are not normally permitted by the building codes. Evaluating buildings with PBD is computationally intensive and time-consuming, resulting in little opportunity for iteration during the design development phase. This paper illustrates how rigorous use of PBD can result in less expensive and more sustainable buildings that meet the intent of building codes with a higher degree of precision than typical code-compliant designs.

Several examples show the relative cost of a building designed using PBD procedures compared with that of a conventional code-based design. The first example compares a PBD concrete core-only system with a code-based dual system comprising concrete core walls and moment frames. The second example presents direct benefit resulting from PBD, reducing vertical and confining steel reinforcing in concrete wall buildings. The third example shows PBD reducing column and foundation demands in structural steel braced frame buildings. Project stakeholders can use the presented data to evaluate the economic viability of PBD for their structures.

Keywords: performance-based design; seismic design; nonlinear analysis; cost reduction; efficient design.

2 Introduction

In today's world of information technology, building development has become more competitive than ever before. New projects must be cost-effective and are often located on difficult sites, require innovative structural systems, or present complex geometric configurations. These characteristics often require the use of structural systems that do not conform to certain provisions of the building code. In the United States, many local jurisdictions have established provisions to permit such buildings where they require review of the structural system by an independent panel of experts with prior experience relevant to the challenges faced by the project (peer review). These nonconforming designs typically use complex nonlinear analyses to demonstrate acceptable seismic performance. In most cases, these complex analyses are implemented as a verification for preliminary designs derived using conventional methods. This

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