Performance-based Design of Civic Buildings

Mark Sarkisian, Peter Lee, Eric Long, Rupa Garai, Lindsay Hu, Andrew Krebs, Alvin Tsui

Skidmore, Owings & Merrill LLP, San Francisco, CA, USA

Contact: rupa.garai@som.com

Abstract

Courthouses and government buildings have an important role in providing order and service to the public. They are required to be functional following extreme events, including natural disasters such as extreme wind events and earthquakes, or blast and ballistic threats.

This paper emphasizes the design efforts and challenges encountered during the design phase and construction of the San Diego Central Courthouse, New San Bernardino Justice Center, and the New Los Angeles Federal Courthouse. Each of these structures utilizes innovative technologies like viscous damping devices to supplement ductile Special Moment Frame, Triple Concave-Friction Pendulum bearings and Buckling Restrained Braces to achieve enhanced seismic and blast resistant structures. The goal of designing resilient structures beyond code prescriptive methods were met, while efficiently utilizing community's civic resources. This paper also summarizes the seismic risk and life-cycle assessments that were completed to assist decision making in the selection of alternative structural systems leading to cost-effective enhanced seismic and security performance objectives.

Keywords: Viscous Damping Device, Base Isolation, Triple-Concave Pendulum bearings, Buckling Restrained Braces.

1 Introduction

The 24-story San Diego Central Courthouse (SDCC) and 12-story New San Bernardino Justice Center (SBJC), both located in regions of high seismicity in California (USA), achieve enhanced seismic performance objectives through the use of viscous damping device (VDD) combined with special steel moment-resisting frames. The SBJC, in addition, employs an energy dissipating seismic base isolation system consisting of 69 Triple Concave-Friction Pendulum (TC-FP) bearings located above a reinforced concrete mat foundation. In the design of SBJC, the combination of the isolation bearings and VDDs not only reduced the expected structural damage but also significantly decreased the floor accelerations to reduce the expected damage to non-structural components and loss of occupancy. In the design of SDCC, effective damping of the nonlinear viscous damping devices under resonant induced wind loading was also evaluated using modal energy methods. Properties of both the dampers and isolation bearings for respective projects were verified by prototype testing during construction phases.

The New Los Angeles Federal Courthouse utilizes 16 Buckling Restrained Braces as part of a steel roof hat truss at the upper penthouse level to "couple" the reinforced concrete shear walls together, reducing concrete and steel quantities, as well as to limit inter-story drift, which in turn lowers the ductility demands in the lateral system. The courthouse is also located on a tight urban site in downtown Los Angeles, California, which resulted in a unique design approach to mitigate blast threats. The most vulnerable elements of the building, the perimeter columns, are designed to be supported from the steel roof hat truss and do not extend down to the street level, protecting them further from threats.

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