Active Moment Connection System for Mitigating Wind-Induced Building Vibrations

Sebastian Mendes

Thornton Tomasetti, Boston, MA, USA

Anurag Bura

Thornton Tomasetti, New York, NY, USA

Contact: smendes@thorntontomasetti.com

Abstract

Modern tall buildings are increasingly being built in slender and complex forms. Limiting wind-induced vibrations of these buildings to meet serviceability criteria is increasingly challenging due to their flexibility. Tuned mass dampers (TMDs) are often incorporated into tall buildings for mitigating excessive wind-induced vibrations. However, traditional TMDs have several disadvantages including the necessity of an immense mass, occupation of a significant volume of interior space, and effectiveness over only a narrow band of vibration frequencies. This paper describes a proposed alternative system for alleviating wind-induced vibrations using a network of active moment connections. For buildings with a moment frame lateral force-resisting system, in-frame stiffness is concentrated at the fixity of the beam-to-column connections. The rotational stiffness of conventional bolted or welded moment connections is nominally static; the proposed active moment connections possess rotational stiffness that can be adjusted in response to a signal. Adjustment of the rotational stiffness of multiple beam-to-column moment connections positioned throughout a moment frame can allow for alteration of the global frame lateral stiffness, allowing greater control over a building's dynamic response to wind loading. The proposed system envisions a network of active moment connections installed strategically throughout a building's moment frame. The active moment connections are controlled by a central processing unit (CPU) that regulates the stiffness of the frame in real-time in response to input from external sensors mounted to the building, such as anemometers or wind pressure sensors. In this way, wind-induced vibrations can be mitigated by the CPU constantly regulating the global moment frame lateral stiffness. A numerical case study is presented for a portal-framed structure possessing active moment connections and loaded under service-level wind loads. The dynamic performance of the frame with and without the active moment connections is compared to demonstrate the effectiveness of the proposed system for alleviating wind-induced vibrations.

Keywords: wind vibration mitigation, active moment connection, motion control, moment frame

1 Introduction

Tall buildings must be designed to resist a multitude of environmental loads including lateral load effects from wind and seismic. Wind and seismic loads are counteracted by a building's lateral force-resisting system (LFRS). General types of lateral force-resisting systems include reinforced