

## **Damage to Engineered Buildings and Bridges in the Wake of Hurricane Katrina**

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Hurricane Katrina made landfall on August 29, 2005 and caused significant damage to the built environment including buildings, roads and bridges, utility distribution systems for electric power and water, waste water collection facilities, and vital communication networks. Following the hurricane, investigators from the Multidisciplinary Center for Earthquake Engineering Research (MCEER), conducted post-disaster field reconnaissance to examine the impact of Hurricane Katrina. The mission objectives were to collect perishable data and examine damage from a multi-hazard perspective. More specifically, lessons learned from Hurricane Katrina are being evaluated to mitigate damage not only from future hurricanes, but also from other extreme events such as earthquakes or terrorist attacks. For example, a multi-hazard objective of this mission was to identify similarities between damage typically observed after earthquakes and damage caused by Hurricane Katrina with the goal of identifying seismic design principles that could mitigate structural damage caused by wind and storm surge forces.

MCEER investigators observed that the majority of multistory commercial buildings constructed of steel or reinforced concrete framing performed well structurally during Hurricane Katrina. However, extensive losses were incurred from nonstructural damage to cladding, windows, and roof-mounted equipment. In many of these cases, wind, water and wind-born debris infiltrated the interior of the building causing additional water damage to property. The observed damage indicates the important role of architectural finishes in protecting the building interior and minimizing losses. In storm surge regions such as the Mississippi coast, structural damage was observed in buildings and bridges exposed to extreme loads, mainly storm surge exceeding 20 ft and impact from large storm surge debris such as barges. In evaluating the performance of parking structures in the Biloxi and Gulfport, Mississippi coast, it was found that while none of the cast-in-place structures suffered any structural damage (with the exception of one that partially collapse from impact by a casino barge carried by storm surge), all of the precast concrete structures examined suffered partial collapse of the second-floor deck. Bridges along the coast, also made from precast construction with minimal lateral restraints suffered similar damage. These bridges in the Gulf Coast were designed according to AASHTO standards to handle static forces and minor dynamic loading from wind, braking and vibration. However, Hurricane Katrina introduced unexpected loads as it brought in strong winds and storm surge. In areas with highest storm surge, bridge spans were completely removed from their supports, with the exception of some elevated spans. While further from the eye of the storm, bridge spans were shifted a few feet but remained on their supports. In addition to the direct storm surge forces, bridges were hit by large surge-borne debris such as vessels and large containers.