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TESTING THE LIMITS: LONG-TERM DEFLECTION OF THE C.A.P. TURNER FLAT-SLAB FLOOR

While there is significant debate regarding credit for the introduction of two-way reinforced concrete flat slabs, there is no question that Claude A.P. (C.A.P.) Turner of Minneapolis designed the most notoriously thin and least flexurally reinforced floor systems. His mushroom flat-slab concept, patented in 1908, was both applauded and criticized by the structural engineering community for its aggressive and empirically derived positive moment coefficient. Even though his slabs were load-tested for strength and immediate deflection, Turner's desire to push the system to its limits coupled with a relatively new reinforced concrete industry lead to a thin floor slab that did not account for long-term deflection.

Turner adequately reinforced the floor slab at the columns for a brittle catastrophic failure mode of punching shear, but he did not consider a serviceability failure of excessive deflection or flexibility for re-use. Unfortunately, Turner's first flat-slab building, the Johnson-Bovey Building of Minneapolis (1906), was razed; yet many others, including the Hamm Brewery of St. Paul (1907), are still in use. In Turner's own words as reported by the January 1910 issue of *Cement Age*, "the amount [of mushroom flat-slab floor] constructed and in use is rapidly approaching a thousand acres of floor." While many of the C.A.P. Turner-engineered buildings have been lost to demolition or lack of credit, his pioneering legacy of work, both written and built, has greatly informed our contemporary reinforced concrete codes and construction practices.

This presentation puts the C.A.P. Turner flat-slab system in the greater context of reinforced concrete ingenuity while considering historic and current criteria for serviceability failure due to deflection. Turner's published papers are used to compare his understanding of flat slab strength and behavior with current knowledge and code requirements. Likewise, contemporary structural reports and evaluations of several existing buildings, are used to demonstrate current performance. One hundred years later, Turner's buildings require the same innovative thought and ingenuity in analysis and re-use as they did in their original construction.