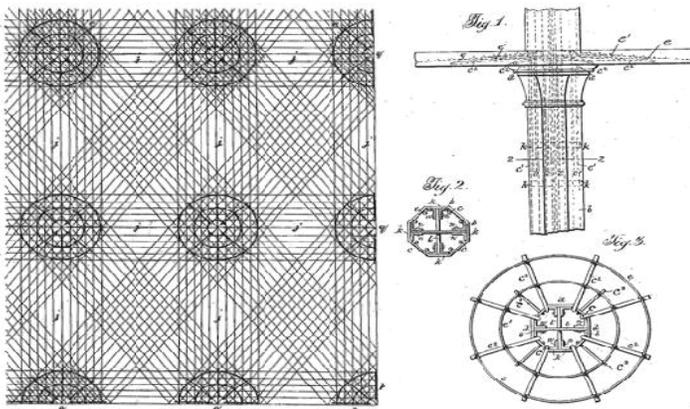
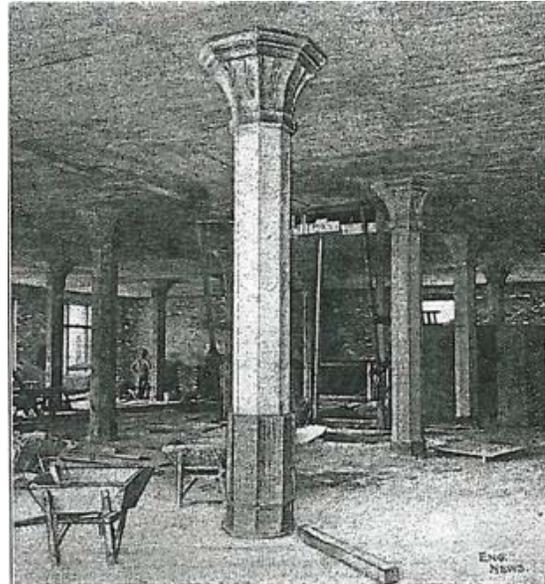


## SQUARE BUILDINGS AND ROUND BARS: C.A.P. TURNER AND THE MINNEAPOLIS WAREHOUSE DISTRICT

The explosive commercial growth of the Minneapolis Warehouse District, especially between 1904 and 1920, coupled with the local engineering and architectural knowledge, fostered a shift in construction type from masonry and wood-framed buildings to structures of reinforced concrete. In fact, the construction history of the district closely reflects the commercial evolution of the roughly 30-block area. The earliest recorded structures of the district (1855-1885) were typically mills of wood and heavy timber frames which served the lumber industry. As the grain industry took hold in the 1880's, typical structures transitioned to three-story load-bearing exterior brick masonry buildings with internal timber framing. The strong growth of the railroads in the area jump-started the local building industry; the Warehouse District quickly became the farm implement capital of the nation and aptly named "Implement Row". In close correlation, building structures transitioned from masonry and wood to reinforced concrete. Reinforced concrete was ideally suited to demands for bigger and taller fireproofed buildings capable of supporting the higher floor loads of the warehouse and wholesaling industries. Claude Allen Porter (C.A.P.) Turner found opportunity in the shifting economy and technology with his mushroom flat slab floor system.



Turner's US Patent 985,119, filed October 19, 1910 and issued February 21, 1911.



Johnson Bovey Building, Minneapolis, 1906, demolished.

Turner, noted as a man of broad interests and great energy, began his engineering, architecture, and building business in Minneapolis, Minnesota, in 1901. Often cited as an inventor, he demonstrated innovation early with numerous patents being granted for concrete-steel bridge systems, methods of support for steel reinforcing in concrete, and the famous (or infamous) "mushroom" flat slab system. Turner's mushroom slab system is a girderless and notoriously thin flat slab floor system. Turner arranged the floor reinforcement in four directions in bands running perpendicular to and diagonally between the column heads. He additionally provided concentric rings around and hooks into the column heads. He conceptualized the system as a series of cantilevers over the column heads. With this arrangement, he concluded that the center of the slab panels resisted very little force and was thus able to significantly reduce the thickness of the slab. His slab designs met with skepticism from his professional colleagues and contemporary academic structural engineers.

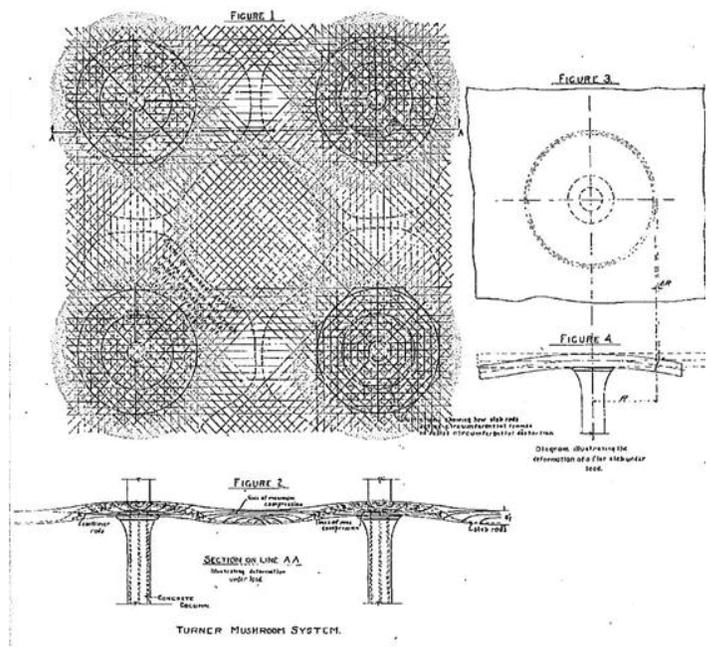
The advantages of the mushroom system were well recognized: greater floor-to-ceiling height, easier formwork, economical use of reinforcement, and high floor capacity values. Its greatest disadvantage, however, was the vague analytical explanation. It has been conjectured that Turner deliberately withheld his analytical methods in an attempt to protect his proprietary knowledge. Today, Turner is still well-known in the structural engineering community of Minneapolis in part for his contributions to the development of reinforced concrete (see the well-written and concise article “Contributions of C.A.P. Turner to Development of Reinforced Concrete Flat Slabs 1905-1909” by D.A. Gasparini), but more for the poor long-term performance of the floor slabs. Owners of Turner’s buildings have documented floor deflections (sag) of up to 4 inches over a 16-foot floor bay.

recognized by the merger of the local and national Minneapolis Warehouse districts in January 2010. Turner is listed as one of the key designers (engineer, builder, and architect) to make the district significant. Likewise, the earliest remaining example of Turner’s mushroom system, known today as the Western Container building, in Minneapolis was individually designated by the Minneapolis Heritage Preservation Commission specifically for its representation of Turner’s work.



Green and DeLaitre Grocery Company Warehouse, Minneapolis, 1908, now known as the Western Container Building

Fortunately, much of the Minneapolis Warehouse District maintains its historic integrity. Beginning in the 1920’s, the wholesaling industry in Minneapolis began to decline as a result of changes in the transportation industry and general economic conditions. The Great Depression followed by local economic stagnation left many of the buildings generally unchanged. Now, new economic opportunities are bringing renewed attention and development to the area. Likewise, Turner’s contribution to the importance of the district was recently



Turner’s depiction of slab stress from his book *Concrete-Steel Construction*, 1919, with H.T.Eddy



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