First Unitarian Church - Roof retrofit

RAVI ENGINEERING & LAND SURVEYING, P.C.

Situation and Task

Louis Kahn challenged the engineering community to design a column free space of 6,500 square feet in concrete for the main sanctuary of the First Unitarian Church in Rochester, New York. The response resulted in a roof system that is an engineering marvel even today. The roof conceived by the famous architect is a combination of a post tensioned roof system and cantilevered flat plates. At the time of its construction in the early 1960's, post tensioning systems were fairly new and computer systems required to design such structures were non-existent.

The cantilevered flay plates at the four corners had cracked and sagged over the years, some as much as 6 1/2'" and thus required restoration. The cracking and sagging of the slabs also resulted in breakage of window panels and water entering the window system. Over the years, the Owner repaired the window system and revised the window head detail only to find that the slab movement would crack the windows again. A permanent solution was needed.

Analysis and Result

Ravi Engineering & Land Surveying (RE&LS) used the modern methods of Finite Element Analysis to analyze the flat plates and determine the cause for the cracking and sagging of the slabs. The analysis revealed that the albs required bottom reinforcement even though the flat plates were cantilevered from two edges.

Restoring a roof structure of exposed concrete, block walls and light tunnels without compromising Louis Kahn's original design was no easy task. Addition of any structural members across the roof or columns in the sanctuary was completely out of the question. After careful consideration of several alternatives, RE&LS conceived and implemented an approach that would keep the profile of the retrofit to within a few inches of the bottom part of the slab.

The cracked slabs required support at the two cantilevered edges and needed bottom reinforcement to stabilize them. The design required a two step process. RE&LS designed a Vierendeel truss system to support the slab edges and used Carbon Fiber and E-Glass reinforcement, a composite strengthening system, to add the badly needed tensile strength to the bottom of the slab. Each Vierendeel truss was carefully designed with its vertical members matching the location of the new window mullions and preserving the original architectural rhythm.

As part of the design, the cracked windows were replaced and a new roof was added to prevent moisture penetration and improve the energy quality of the monitors that would otherwise deteriorate the fiber reinforcing system and interior finishes. The end result is a stunning restoration of the original Architectural masterpiece.