Post-tensioning Retrofit of Fallingwater

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ABSTRACT

The innovative materials and methods of the 20th century offer new possibilities for the conservation of modern heritage. This is well illustrated in the case of the post-tensioning retrofit of Fallingwater. As one of Frank Lloyd Wright's greatest masterpieces and an icon of modern heritage, Fallingwater has faced challenges of structural deflection since its construction. A multi-faceted investigation conducted in 1995 confirmed the continued downward movement due to the lack of reinforcement steel. Accordingly, in 2001, a restoration team led by Robert Silman Associates chose to install post-tensioned steel cables alongside the main beams to reinforce the cantilevered terraces. Subsequent monitoring has shown that this repair work has effectively prevented further sagging of the structure. Fallingwater is thus one of the earliest examples of using prestressed concrete members to repair and strengthen an historic building. This research reviewed the deflection problems and investigation methods, analyzed the restoration scheme and process, and discussed the reasons for choosing the post-tensioning method over other structural strengthening options. The case of Fallingwater shows that post-tensioning can be a promising retrofit technique in both functional and aesthetic terms. It effectively ensures the house's structural stability and, at the same time, takes advantage of the interstitial space between the floor finish and the soffit slab. The newly added strands were attached to the structure's exterior yet concealed from the outside. In this way, the restoration team preserved the historic appearance of Wright's design while minimizing intrusion into the original structure. The advantages of post-tensioning in minimal intervention and reversibility fit well with the needs of historic preservation, showing the great potential of an existing method widely used in architecture and civil engineering but rarely applied in the field of conservation. The promise of the post-tensioning method as a conservation technique deserves more practice, while its challenges for investigation and intervention also require more in-depth research.

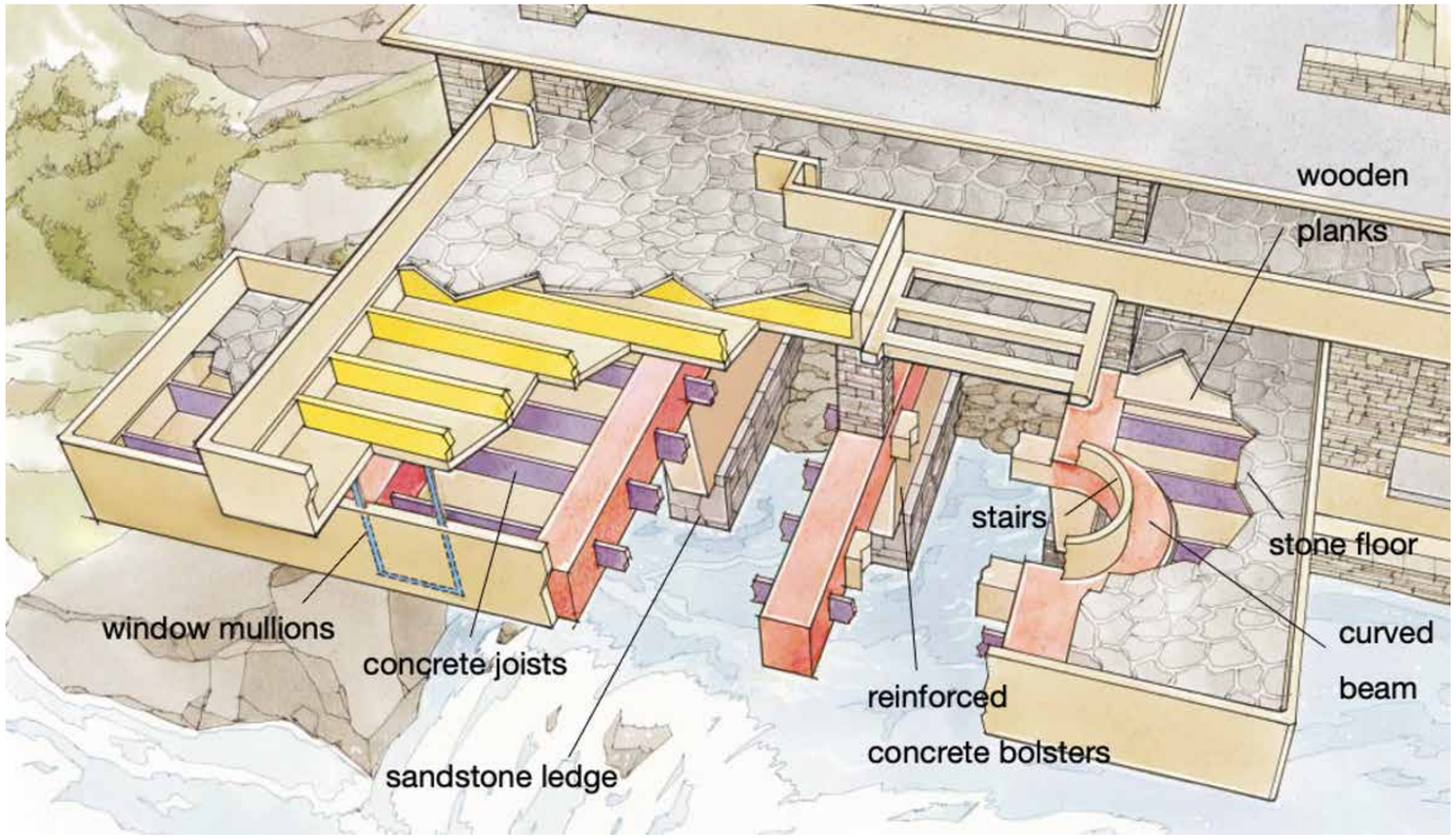

Figure 1. Cutaway of Fallingwater and its main structural components. (Source: Silman, Robert. "The Plan to Save Falling Water." Scientific American 283, no. 3 (2000): 88–95, component names added by Ni).

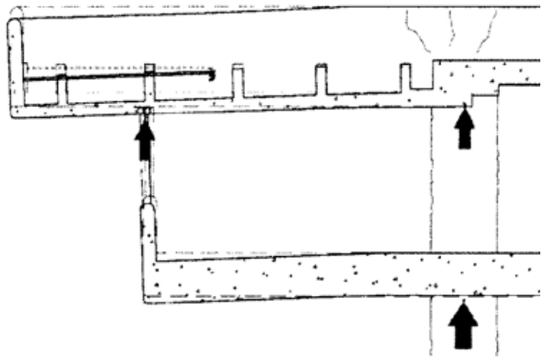

Figure 2. Diagram of loading and existing cracks along the parapets of upper cantileveredterrace . (Source: Ceraldi, Theodore M. "Stabilizing the Falling of Falling water: A Structural Rehabilitation Proposal for The Master Terrace". 1999 ACSA-CIB TECHNOLOGY CONFERENCE).

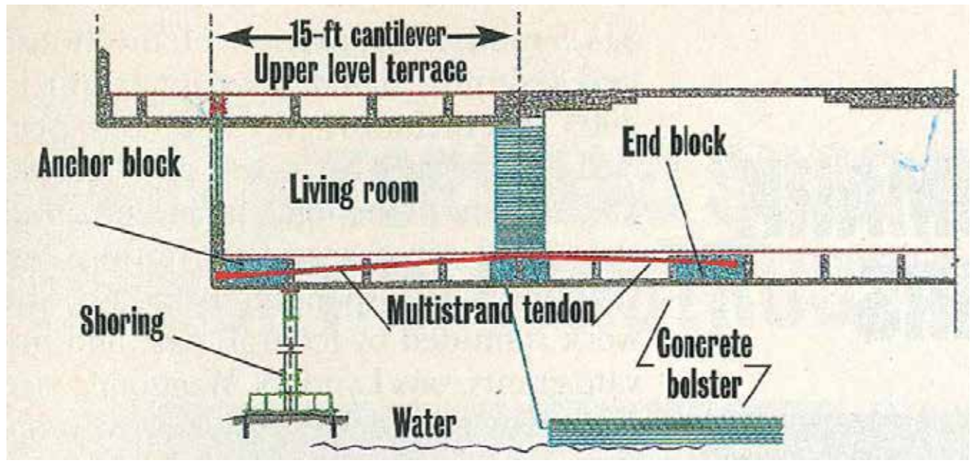

Figure 3. Section view of post-tensioning retrofit scheme. (Source: Gonchar, Joann in Mill Run, Pa. "Wrighting' a Fragile Landmark Sagging for Nearly 65 Years." ENR. 248, no. 11, 2002).