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STABLE GENIUS

Putting a Damper on Movement at One Dalton

40,000-Gallon Tank Limits Skyscraper's Sway

A slosh tank damper limits the movement at the top of the One Dalton Four Seasons Hotel and Private Residences, where a penthouse unit sold in January for $34 million. Image courtesy of CambridgeSeven and Pei Cobb Freed.

One Dalton Four Seasons Hotel and Private Residences, Boston's newest residential building, is a 61-story tower featuring some of the region's most spectacular homes. Views from each residence looking out on the surrounding city, harbor and beyond are unparalleled.
The building is tall and thin, with very small floor plates and a limited number of residential units per floor. This small size, combined with an overall height of over 740 feet, would normally suggest the building might be susceptible to wind-driven movement, but thanks to careful engineering and technology it is not.

Like a tree, which sways when wind pushes on its trunk and canopy, a tall building reacts similarly; it moves. All buildings move somewhat, albeit minimally, and shorter buildings move less than taller ones. Building motion is well understood by structural engineers. In fact, they can accurately calculate how much a building is expected to move long before it's built.

You might wonder: How can a building move at all? With building materials like concrete and steel, how can those seemingly strong and unbendable products cause a structure to move in the wind? In the most simplistic of terms, all building materials are ductile: They can bend without losing strength. Then there are the many joints and connection points that comprise a building, with bolted steel connections being the simplest to understand. The ductility of the material and the connections allow for movement. Under the force of the wind those connections "give" under pressure, ever so slightly. In concrete buildings, millions of microscopic cracks in the material allow the building to move minutely when reacting to the wind.

Architects and engineers know how to work with that movement to make sure that the building maintains structural integrity and that the inhabitants are not alarmed by any motion. This is particularly important in buildings where people live. In office buildings where occupants are focused, working or walking about, movement is not readily apparent or felt because of those distractions. However, in a residential building where occupants might be sitting or lying in bed, movement is more easily felt and detected.

The Solution: An Aquatic Shock Absorber

Like the tree swaying in the wind, a building moves in the direction of the wind and then, like a spring, it rebounds to its original position and then moves again. This motion can be felt especially at the topmost floors of a building where movement is greatest. As improbable as it may seem, placing a weight at the top of the building where it is free to move in a manner that is opposed to the wind direction and velocity, you can slow down the movement of the building. The motion can be slowed down enough so that no shift is perceptible. Even though the building will still be moving, it is the slowing or dampening of the movement that makes occupants feel as if there is no movement at all.

The One Dalton tower has two “slosh tank dampers” in its upper reaches. Each tank is filled with 40,000 gallons of treated water fitted with internal steel “baffles.” When the wind exerts force on the structure, the water flows, or sloshes, through and around the baffles. These baffles drastically slow the flow of the water from one side of the tank to the other. As the tower is buffeted by the wind, the movement of the water lags behind the movement of the tower, effectively dissipating the energy and acting like a shock absorber at the top of the building.

The One Dalton tower has even less motion than predicted, partly because it used a very high strength concrete mix. This combined with the slosh damper tanks results in a very comfortable building even under the harshest of wind conditions. Engineering and fluid dynamics have come together on this project to make this high-rise a wonderful and virtually wind-free living experience.

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