

When Structure Dies

Some things you never forget. As a structural engineer, the first building collapse I visited was intimidating. It was just a convenience store, forty feet by fifty feet at the most. Sometime in the night, the wood truss roof completely collapsed, and my client sent me there to figure out why.

It wasn't a slow, sag or crumple. It was a catastrophic, sudden, messy failure that ends as a pile of twisted building materials. I remember sitting on the roof, or what was left of it, looking at the rubble trying to make sense of the mess.

If you pay attention, eventually the building speaks to you. It shows you the place of its final moments. The point where stress exceeded capacity, structural components crumbled, separated, ripped or disconnected and surrendered to gravity. At that moment, there is no negotiation. As the fallen member dies, it suddenly releases its load to its neighbors. More often than not, that neighboring structural member, now overloaded shares the fate of its dying companion, and then, in turn, it yields its load to the next member in line. In quick succession, the structural members rush to the site of the fatal wound. Eventually, the forces of gravity, momentum and inertia are satisfied, and the fallen members lie in a pile that bears only faint resemblance to its previous order. If you look you can read the message of the fallen members. "Here," they say, "is the one that brought us down. We fell toward him. Look how he differs from us. Most of us broke from a similar impact and load. We were wounded all the same. But, the one that brought us down, he is different."

And, so it is. The structure points to the fallen member unless affected by some single great force: a high wind that blows everything in one direction; a tornado that scrambles the structure; a great excessive load of soil or snow or water. Each fallen structure large and small since that unfortunate convenience store confirmed my initial lesson. Stand back and look at the whole site. The members lean toward the fatal wound. Find the epicenter of the debris, the point to which all members lean. The member there displays unique damage. At the convenience store, the Achilles heel was a single steel plate that connected pieces of the wood roof truss together. Slivers punched out of the plate formed multiple spike-like projections. Properly installed, the plate should lie symmetrically on the joint. But, someone set the plate wrong and one side of the joint received more than its fair share of spikes. The other side, deprived of connectors made do with its insufficient ration. It took years for those overstressed nails to release. But, when they did the entire building shared the fate of that single member.

Sometimes the nearby structure follows a failing member only so far. Then, released, they go their own way and rush from the site of the fatal blow. So it was at the opera house that fell one day after standing for over 100 years. Neglect and water rotted the roof until the structure there could no longer bear even its own weight. As it fell, it pulled the wall that held it all those years until the tug-of-war between the wall and the falling roof ended where nails joined them all those decades. The components then went their separate ways: the roof to the stage below, the wall escaped out to the world beyond reeking havoc as it tumbled to the building next door. Buildings that live in tension do the same. They fall out and away as they are released from the forces that held them.

With each new structural failure I visit, I learn new lessons, but the first lesson made the greatest impact on me: look for the pattern; look for the difference, know how the structure lives and it tells you how it dies.