Just prior to the collapse of the Ranza Plaza garment factory in Dhaka, Bangladesh, which killed more than 400 people, officials saw obvious signs of building stress. A giant crack formed on the side of the seventh floor of the structure, for instance, prompting warnings from engineers not to let workers inside. Those warnings were later overruled. As hundreds of workers remained trapped in the rubble and the building's owner, Sohel Rana, attempted to flee Bangladesh to India, officials and experts were left to figure out how a multistory concrete structure simply gave way.

One thing investigators know is that the crack was new, possibly caused by the ongoing expansion of the building. That expansion was undertaken without the proper permits and inspections, something not allowed in the United States and many other countries. Adding so much weight to the top of the concrete structure may have produced loads that were simply too much for the building to handle.

"These things aren't supposed to happen," Daniel Jansen, engineering professor at California Polytechnic State University, tells Popular Mechanics. "They were putting additional stories on the building without proper permitting. The inspections weren't there. You just can't do that."

"If it stands up, they say, 'we can keep doing it,'" he continues. "There's probably a lot of cases where it works, where people have put on a couple of extra stories and it hasn't collapsed. But there is a tipping point. People push the limits and eventually something goes awry; it is really just tragic, the ultimate results of this."

John Hooper, senior director of earthquake engineering for Magnusson Klemencic Associates in Seattle, says that concrete structures show signs of distress through cracking and spalling (crumbling), often when extremely overloaded or just prior to failure. While cracks are common and most little ones don't pose a big risk, large and growing cracks, like the one seen in the Bangladesh building, certainly do.

"We are not talking about tiny things," Jansen says, "but things that are warning signs."

Concrete proves strong in compression, but not in tension. To give it that added structural component, steel rebar reinforces the concrete. But when cracks start to grow, Jansen says, that indicates the rebar is starting to fail or stretch and may be pushed to its limit.

In some countries, the cost of steel is often high enough that contractors simply opt for added concrete—without the reinforcing rebar. That weakened combination doesn't allow concrete to transfer weight loads across sections of the building. In large warehouses, full of heavy machinery in wide open spaces, careful attention must also be paid to sufficient and ample supporting columns for weight distribution across floors.

Matthys Levy, an engineer and author of Why Buildings Fall Down, says cracks are just one possible warning sign of impending failure in a concrete structure. As loads start to increase beyond what the building was designed for, you'll see sagging in floors, sinking foundations, or even shifting of walls. The building may also start to vibrate.

"If you look at cracks in a concrete building, you can actually measure them and see if they are increasing," Levy says. "If they are increasing, something is going to happen. It is not normal."

Another problem that can lead to building failure is change in use—if the structure was designed for one purpose but converted to a different size to accommodate the new purpose. "The building has to be reanalyzed if it wasn't designed for that type of loading," Levy says.

If the building appears too weak to handle current loads or an expected addition, engineers can make it stronger by adding more concrete to reinforce columns or using cables and posttensioning designs to support floors. But getting to that level of engineering isn't common in many countries.

"Concrete structures in this country are highly controlled and we don't have any major problems," Levy says. "In many countries around the world, the construction industry is not well controlled. In the Middle East, there is no control of concrete buildings and problems occur."

And in a lightly regulated nation, you also must worry about concrete quality. "Was the concrete as strong as it was meant to be initially, or was it very cheap and someone took shortcuts?" Levy says. Hooper says that well-crafted concrete should actually strengthen over time, but that's only if it was installed and maintained properly. Cheaper mixes that are high in sand and low in cement simply won't have the strength needed to stand up to even normal loads, let alone additions without permits.

Add in the likelihood that this Bangladesh building was under construction at the time of the failure and the list of possible calamity-causing issues only rises. What we do know for sure is that hundreds of families were caught in a concrete construction catastrophe—one probably avoided with proper practices.

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