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Behind The Florida Condo Collapse: Rampant Corner-Cutting

Inadequate waterproofing, thin columns and faulty concrete emerge as leading possibilities in Champlain Towers South tragedy

By [Konrad Putzier](#), [Scott Calvert](#) and [Rachael Levy](#)

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SURFSIDE, Fla.—A startling discovery awaited an engineer who drilled into the ground-level concrete slab at Champlain Towers South last year. He could find no waterproofing in two separate sections, the engineer wrote in a letter to the condominium board.

Without that essential layer for a high rise facing the punishing Atlantic Ocean, rainwater and salty sea spray likely had seeped in for decades, slowly weakening the steel rebar and concrete holding up the condo building. Indeed, the engineer reported at the time seeing significant concrete deterioration.

Less than a year later, in the early hours of June 24, part of that slab dropped into the parking garage below. Within minutes, the east wing of the 13-story tower collapsed, killing 98 people in a disaster without modern precedent in the U.S.

Since then, a picture has emerged of a tower that was hobbled from the start. The people who oversaw its planning and construction some 40 years ago made cost-saving choices that generally met the building codes of that era but may have created long-term safety risks, a Wall Street Journal investigation found.

They skipped waterproofing in areas where saltwater could seep into concrete, the available evidence indicates. They put the building's structural slabs on thin columns

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Officials are still investigating why the tower fell. Engineers consulted by the Journal, including some involved in the official probes, say it's unlikely one design or construction issue identified so far could have brought down the building by itself, but rather that the cumulative effects of the decisions ultimately doomed the structure.



An aerial view showing the partially collapsed building on June 24.

PHOTO: MARCO BELLO/REUTERS

“These things kind of snowball,” said Roberto Leon, an engineering professor at Virginia Tech who isn’t involved in any official inquiry.

Issues like a lack of waterproofing or too little concrete cover aren’t unusual for South Florida condos built in the early 1980s, a time when building codes were laxer and engineering science less advanced, said James Prichard, a Florida-based construction lawyer who works with condo boards statewide.

“It is reasonable for people to be worried about this happening again because Champlain is not unlike many other buildings throughout the state,” he said.

Several investigations have begun at the federal and local level. A spokeswoman for the National Institute of Standards and Technology, a federal agency probing the collapse, declined to comment on potential causes. Allyn Kilsheimer, a structural engineer hired by the town of Surfside to investigate, said he is looking at dozens of possible factors.

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The people who designed and built Champlain Towers South decades ago made construction choices that created long-term safety risks.

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Investigators are still trying to determine why this section of the building collapsed.

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An engineer drilled into the structural slab under the ground-level parking area in 2020 and said he found no waterproofing. This part of the slab later collapsed.

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An engineer who tested the concrete slab under the pool deck found waterproofing **beneath the pavers**. Building permits indicate that a layer was installed in 1996 after water seeped into the garage ceiling below.

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Long, rust-colored cracks and stalactites in the **garage ceiling** were signs of water damage to the structural slab above.

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The building's drawings call for a $\frac{3}{4}$ -inch concrete cover over rebar in floor slabs. The building code at the time called for $1\frac{1}{2}$ inches of cover for rebar in slabs exposed to weather. Insufficient cover could make rebar more vulnerable to corrosion, which in turn could damage a structural slab over time.

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Part of the **pool deck** collapsed shortly before the building came down, according to eyewitnesses. Images from the site indicate that there was less rebar connecting the pool-deck slab to columns than plans called for.

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The collapsed portion of the building had only one lateral **shear wall**. Engineers say more shear walls could have potentially could have limited the extent of the collapse.

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Designed in the late 1970s, the 136-unit Champlain Towers South was completed in 1981 and marketed as luxury living. The same development team also built a nearby stand-alone sister tower, Champlain Towers North, around the same time. Town officials are still assessing the safety of that building, said Surfside Mayor Charles Burkett, though some residents continue to live there.

Many of the key principals are dead, including the architect, the lead structural engineer and the contractor. Records show the development team included Canadians Nathan Reiber and Nathan Goldlist, both deceased. Surviving members of their families either couldn't be reached or declined to comment.

In a brief interview with the Journal, Manuel Jurado, one of the project's structural engineers, now 92 years old, defended the integrity of Champlain Towers South but said he didn't recall specifics. It wasn't clear why the people behind the project made the design and construction choices they did; maximizing profits is one of several potential reasons. Nor is it clear who made many of these decisions.

The risks of some of the choices made four decades ago were well known at the time, but building codes generally gave developers wide leeway. The 1979 South Florida Building Code, for example, didn't mandate waterproofing on open-air concrete roofs next to the ocean.

As residential condo towers sprouted along Florida's coast in the 1970s and '80s, skimping on construction materials and structural elements was an easy way to save time and money, said Mr. Leon and a veteran South Florida engineer. Rebar, structural walls and waterproofing layers were hidden under tiles or paint; flaws or shortcuts were detectable but only if someone went looking.

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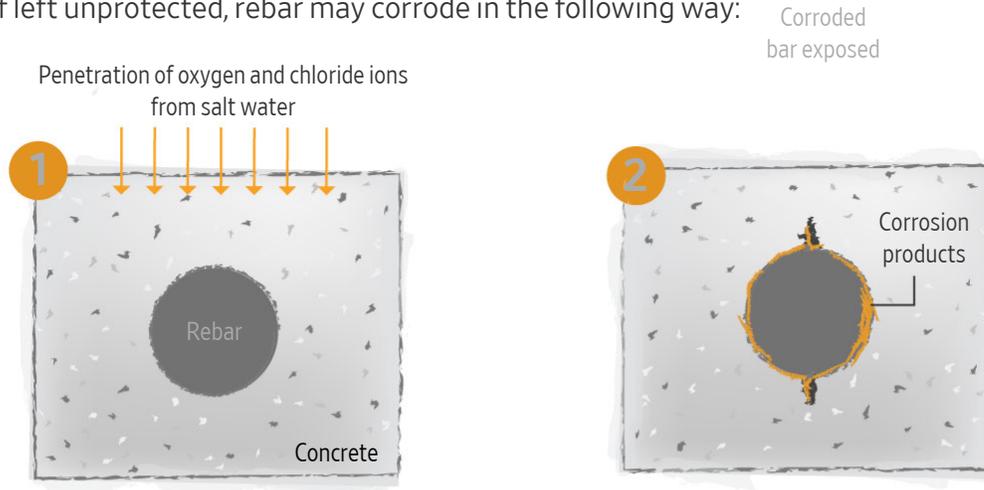
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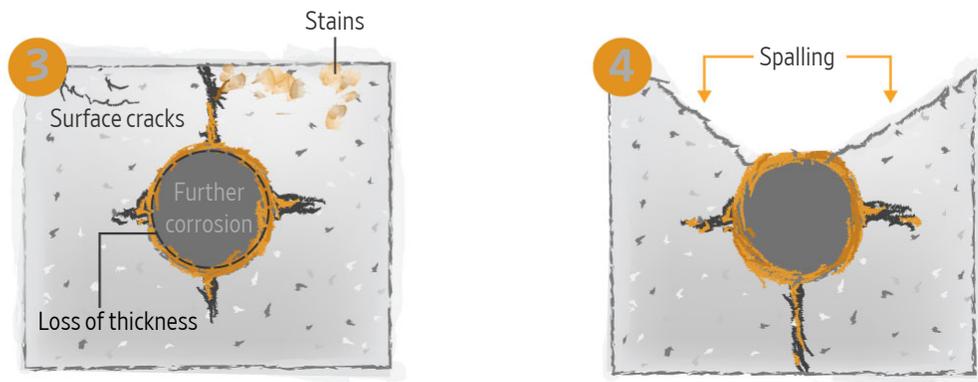
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For beachfront buildings like Champlain Towers that are made from reinforced concrete, the ocean is a constant source of danger. Like a steel skeleton, rebar rods run through concrete columns and slabs. Saltwater seeping through concrete can cause the steel to rust and expand. The concrete starts to crack and eventually may fail. Since at least the late 1970s, the American Concrete Institute has recommended placing a waterproofing membrane—often made of a type of advanced plastic—above a weather-exposed structural slab.

If left unprotected, rebar may corrode in the following way:



An accelerated corrosion of the rebar due to chloride ions will reduce the thickness of the rebar, which can weaken it and cause collapse. Another way for concrete failure is when iron oxide is formed around the rebar resulting in the expansion in volume causing the concrete to spall. This eventually leads to cracking or sections of concrete breaking away from the rebar.



Sources: The Constructor; Mehrooz Zamanzadeh PhD, Matergenics

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Champlain Towers South in 2018.

PHOTO: PICTOMETRY

“Where there is waterproofing, it has failed. Water has gotten underneath and caused additional damage to the concrete,” condo-board president Jean Wodnicki wrote in an October 2020 presentation for residents reviewed by the Journal.

In addition, part of the driveway wasn’t sloped toward drains, according to a December 2020 condo-board presentation, meaning water couldn’t run off.

Efforts to reach Ms. Wodnicki weren’t successful. A Morabito Consultants spokesman declined to answer questions. “Morabito Consultants identified extensive repairs that would be required for the recertification process, but there was nothing in the firm’s findings to indicate that the building itself was at risk of complete structural failure, that it was at imminent risk of collapse, or that it should be deemed unsafe for occupation,” the spokesman said.

Beneath the waterproofing, oceanfront buildings should have a second line of defense against saltwater: the concrete that covers the rebar and thus protects it from corrosion.

The 1979 Champlain Towers South architectural plans called for just $\frac{3}{4}$ -inches of cover in floor slabs, half the minimum 1.5 inches required by the building code at the time. Some engineers say photos from the rubble indicate the cover may have been far less than 1.5

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About a week after the collapse, a crew from Maryland-based Controlled Demolition Inc. drilled holes into support columns and sturdy walls in the still-standing part of the building to make space for explosives. Officials had hired CDI to take down the remainder of the tower due to mounting safety concerns for rescuers.

Looking on from inside the tower during preparations on July 3, CDI owner Mark Loizeaux noticed that concrete chewed up by the drills was powdery, he said in an interview, suggesting another potential flaw. This surprised him, he said, because building plans he reviewed specified those columns would get concrete with a robust 6,000 pounds per square inch of compressive strength. Very hard concrete comes out in chips during drilling, even after 40 years, he said.

“I asked my drillers, after they drilled two columns, ‘What’s the concrete like?’ They just said, ‘Soft, really soft,’” he recalled.

Mr. Loizeaux said he asked if they believed it to be 6,000 psi. “No way,” he said they replied.



A bed dangles from the partially collapsed building on June 24.

PHOTO: WILFREDO LEE/ASSOCIATED PRESS

He said his crew used pneumatic drills to make more than 120 holes on the first floor and garage level, and the concrete was “uniformly soft.” That doesn’t necessarily mean it was

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unusually smooth and homogeneous. He said he didn't see any of the gravel typically included to strengthen it, though only a lab analysis can provide definitive answers.

Engineers say the columns in the collapsed part of the building were too small. Most of them were 16 by 16 inches compared with 24 by 24 inches in the western part. That made them more likely to fail, and increased the risk that corroding rebar could cause serious damage.

Mr. Aghayere and other engineers told the Journal that photos of the rubble in some places appeared to show fewer of the horizontal steel rods meant to connect columns to the ground-level structural slab than the 1979 plans prescribed. They cautioned that it's possible the concrete contained more rebar than the photos indicate.

Inadequate waterproofing, weak concrete, small columns and too little rebar would all increase the risk of a structural slab collapsing and columns failing, possibly setting off a catastrophic domino effect, engineers say.

Even so, they say, the entire northeast wing might not have been doomed once the collapse began had it not been for another design choice.

Around 1 a.m. on June 24, Iliana Monteagudo awoke in her sixth-floor condo in Champlain and noticed a crack forming in the ceiling, according to her son, Manny Frade. Ms. Monteagudo threw on some clothes, and ran, her son said. She didn't take the nearest stairwell because she didn't know about it. As she raced down a more-distant one, she heard the building crash down around her. Within seconds, her unit and dozens like it were gone—but the staircase she was in remained standing and she made it out.

“The ‘mistake’ that she committed saved her life,” said Mr. Frade: The closer stairwell collapsed.

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Search-and-rescue personnel work at the site of the disaster.

PHOTO: MIAMI DADE FIRE DEPARTMENT/REUTERS

Engineers say the staircase she chose was likely saved by a shear wall—a thick, concrete wall running from the basement to the roof that stood between the staircase and the collapsed part of the building. Shear walls are designed to resist lateral forces like wind and are a crucial part of many reinforced-concrete buildings.

The part of the building that didn’t collapse had three such walls. The collapsed segment had only one, and none built to resist east-west forces, according to the drawings.

With more shear walls, the eastern end of the building could have held up longer after the collapse began, engineers say. “That would have saved more lives,” said Jiann-Wen Ju, an engineering professor at the University of California, Los Angeles, not involved in the investigation.

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Shear walls make it harder to design large open floors, so developers and architects often went to include as many as possible, said Mr. Lee, the Virginia Tech engineer. Building

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Engineers often add concrete boxes called drop panels to the top of columns to help prevent the slab from breaking at the point where it connects to a column. These, too, add to the construction cost.

In 2020, Morabito Consultants proposed adding drop panels atop garage columns in part of the structure where the slab “was overstressed since the day the building went up,” said a December 2020 condo-board presentation.

Buildings that don’t have drop panels sometimes have beams under slabs to help support them, but Champlain Towers South’s drawings called for beams just on parts of the west side of the property—the section that didn’t fall.

Despite the building’s many structural flaws, engineers say some issues would have been fixable, had the property’s condo board done more extensive repairs sooner.

By 1996, the slab started showing cracks, and pieces of concrete had fallen off the garage ceiling, unusual so soon after construction. Workers patched cracks and waterproofed the pool deck, but that too eventually failed.



Twisted pieces of rebar jut from the ruins of the building.

PHOTO: GIORGIO VIERA/AGENCE FRANCE-PRESSE/GETTY IMAGES

In 2018, Frank Morabito, president of Morabito Consultants, wrote that failed waterproofing “is causing major structural damage” and that the damage would “expand

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structural repairs and other fixes, as the total cost had swelled to more than \$16 million, documents show. It was to be paid by residents in a contentious special assessment.

“We have discussed, debated, and argued for years now,” Ms. Wodnicki, the condo-board president, said in an April letter to residents. Roof work began weeks before the collapse, but repairs to the steel-reinforced concrete hadn’t yet started.

The day before the building collapsed, the condo owners received a report based on the building’s 2020 finances. It said they had saved nowhere near enough for repairs.

Owners were due to pay their respective shares, ranging from about \$80,000 to \$336,000 each, the week after the building collapsed.

—Deborah Acosta, Lisa Schwartz, Arian Campo-Flores and Will Parker contributed to this article.

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