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Guenot, M

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Marianne Guenot Jun 30, 2023, 3:48 PM BST

An annotated image of part of the Titan submersible being moved ashore after its catastrophic implosion under the North Atlantic in June. CBC News/Insider

Onlookers caught glimpses of the Titan submersible wreckage as its crews brought its remains ashore.

These provide clues to what may have happened while a formal investigation is underway.

Though it's difficult to know for sure, an expert said the carbon-fiber hull likely failed first.

Photos of the Titan submersible wreckage support the theory that the vessel's carbon-fiber hull may have led to its catastrophic implosion, an expert told Insider.

The US Coast Guard brought debris from the Titan submersible ashore this week, giving onlookers a brief, imperfect glimpse as it was taken away for analysis.

Jasper Graham-Jones, an associate professor of mechanical and marine engineering at Plymouth University, analyzed footage and photos for Insider.

Though it is impossible to reach a definitive conclusion from these pictures alone, he said the most likely scenario was that the carbon-fiber hull gave way under the enormous pressure of the ocean depths.

Another possibility is that the ship's small front viewport gave way.

Here's why, picture by picture.

1. The titanium structural rings are intact

An annotated picture of the titanium structural rings pulled from the wreckage of the Titan submersible. CBC News/Insider

The picture above, taken by Canada's CBC News, shows structural titanium rings that supported the structure of the submersible. They are intact and, therefore, do not seem to have failed.

OceanGate Expeditions' controversial Titan submersible is thought to have imploded within hours of its descent toward the wreckage of the Titanic on June 18. The five passengers on board the submersible are presumed dead.

A forensic investigation is underway to determine the exact sequence of events and will conduct an exhaustive analysis on the remains to build a conclusive picture. In the meantime, photos, the Titan's own history, and expert opinions give us something to go on.

OceanGate's design of the submersible received heavy criticism over the years, especially for its use of a carbon-fiber-composite hull.

Most submersibles are made out of titanium, and many deep-sea experts told OceanGate that they were wary about the company using carbon fiber, which is not as strong.

The Titan's design featured two titanium rings bound to the carbon-fiber hull. The rings seem to have held firm, Graham-Jones said.

An annotated picture points to the approximate location of the structural titanium rings. OceanGate Expeditions/Reuters/Insider

"It shows that titanium was the right material to use, and linking with the composite was possibly the wrong material to use," he said.

2. The front view port of the submersible seems to have failed

An annotated picture shows footage of the debris being winched off the rescue ship shows the partially covered front viewport. CBC News/Reuters/Insider

The picture, captured by CBC News, shows debris that seems to belong to the front viewport of the ship. There is nothing in the porthole anymore other than the red cable lifting it.

While Graham-Jones said that it wasn't impossible that the salvage operation removed the acrylic viewport to make room for the red cable, he said it wasn't likely.

"They could have lifted it in a bag," without tampering with it, he said.

"It looks to me like it's failed, the window's gone," he said.

Experts also questioned OceanGate's choice of front-view window before the disaster.

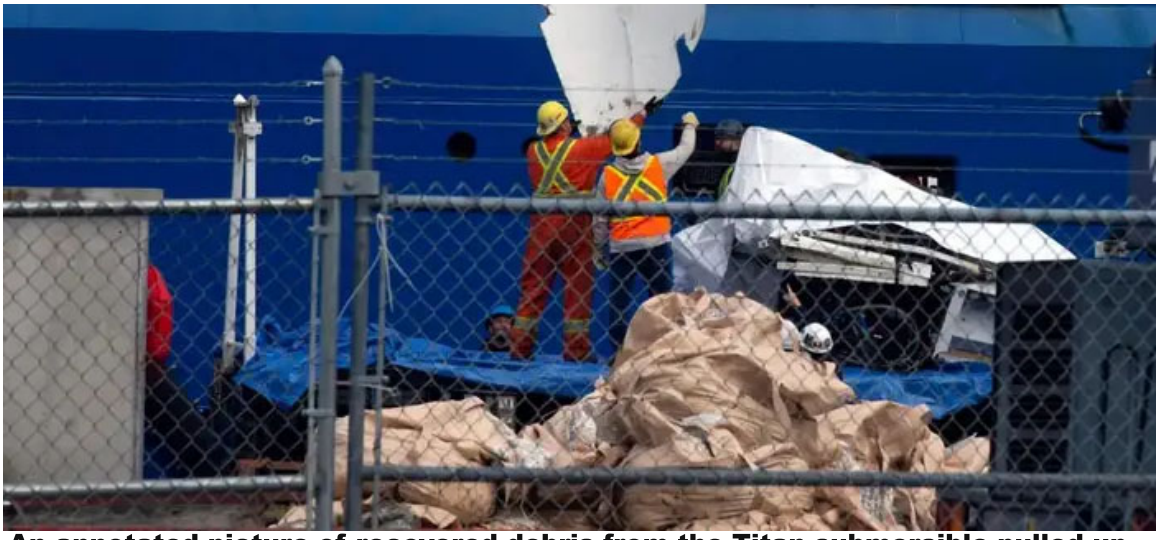
An annotated picture points to the front viewport. OceanGate Expeditions/Reuters/Insider

David Lochridge, OceanGate's former director of marine operations, alleged in August 2018 court filings that the company installed a front view port certified to a depth of only some 4,200 feet, or about 1,300 meters — far shallower than the Titanic wreckage it was built to visit.

It's not clear whether the design changed between 2018 and its final mission — but it's clear that the view port was a cause for worry from the start.

An unresolved question, Graham-Jones said, is whether the window failed first, or if another part failed and the implosion blew out the view port.

3. No large slabs of the hull seem to have been recovered



An annotated picture of recovered debris from the Titan submersible pulled up from the ocean floor. Paul Daly/The Canadian Press via AP/Insider.

Graham-Jones said the most telling part of the footage was what you couldn't see: there were no big slabs of the carbon-fiber hull.

The investigators recovered large fragments of the covering of the submersible, a material that was placed above the carbon-fiber hull, pictured above. But they don't seem to have found much of the carbon-fiber hull itself.

An annotated picture of the OceanGate submersible points to the white covering placed above the carbon-fiber hull. OceanGate/Reuters/Insider

It could be that these components happened to not be visible in the images and footage.

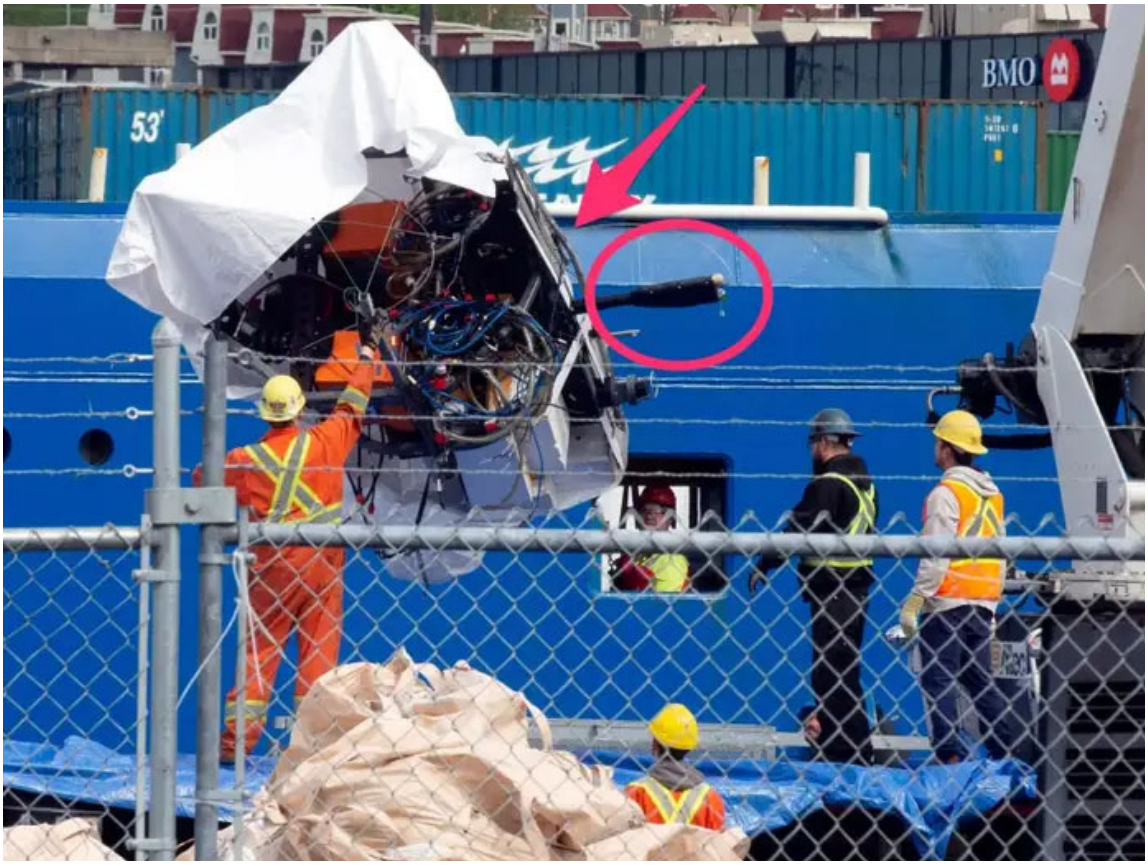
But for Graham-Jones, it is a sign the composite-carbon-fiber hull likely failed first.

Graham-Jones said both the window failing and the hull failing would have led to the implosion of the ship. But if the front view port had gone first, the pressure would have been slightly less intense on the hull, so "would probably see bigger pieces of composite there."

A possibility, he said, is that the carbon fiber failed because repeated trips had stressed the material, making small cracks that eventually gave way. This would also explain why the Titan had made trips before without incident.

If such a failure did take place, Graham-Jones said, you would expect "lots of small bits of composite carbon fiber," consistent with the absence of large chunks in the imagery.

4. Also no fragments of carbon fiber attached to other debris



An annotated picture of debris of the Titan submersible. The circle points to an antenna, which is recognizable from a picture of OceanGate's submersible. An arrow points to the metal cage around the debris that would have connected to the hull. Paul Daly/The Canadian Press via AP/Insider.

The picture above, Graham-Jones said, shows tubes and piping that would have been inside the ship. These were encased in a metal cage that would have been bound to the carbon-fiber hull.

"The joint should be strong enough that it goes into the carbon, and so you'd have carbon left on that piece," in many scenarios, Graham-Jones said.

An annotated picture shows the antenna that's recognizable on the debris. OceanGate Expeditions/Reuters/Insider

But it doesn't seem like that happened. The absence of visible carbon fiber on the joints could mean one of two things.

Maybe the joint failed. Graham-Jones said the joining is generally done with epoxy glue, which needs to be applied in a dust-free environment — improper application could lead to problems.

But Graham-Jones said it is probably more proof that the carbon-fiber hull went first, breaking into such tiny pieces that you wouldn't see the remnants on the joints.

Investigators are figuring out the real answer — but slowly

Given the information at hand, the most plausible scenario is that the hull failed first, Graham-Jones said.

Investigators will now be taking a close look at the remains of the ship to determine exactly what happened.

Graham-Jones said that investigators will be "effectively looking under a microscope, at all the parts. And that would actually give you an idea of how it's failed." On Friday, US officials said they would report back in one to two years.

Watch: