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In Weak Rivets, a Possible Key to Titanic's Doom

By WILLIAM J. BROAD

Researchers have discovered that the builder of the Titanic struggled for years to obtain enough good rivets and riveters and ultimately settled on faulty materials that doomed the ship, which sank 96 years ago Tuesday.

The builder's own archives, two scientists say, harbor evidence of a deadly mix of low quality rivets and lofty ambition as the builder labored to construct the three biggest ships in the world at once — the Titanic and two sisters, the Olympic and the Britannic.

For a decade, the scientists have argued that the storied liner went down fast after hitting an iceberg because the ship's builder used substandard rivets that popped their heads and let tons of icy seawater rush in. More than 1,500 people died.

When the safety of the rivets was first questioned 10 years ago, the builder ignored the accusation and said it did not have an archivist who could address the issue.

Now, historians say new evidence uncovered in the archive of the builder, Harland and Wolff, in Belfast, Northern Ireland, settles the argument and finally solves the riddle of one of the most famous sinkings of all time. The company says the findings are deeply flawed.

Each of the great ships under construction required three million rivets that acted like glue to hold everything together. In a new book, the scientists say the shortages peaked during the Titanic's construction.

"The board was in crisis mode," one of the authors, Jennifer Hooper McCarty, who studied the archives, said in an interview. "It was constant stress. Every meeting it was, 'There's problems with the rivets and we need to hire more people.' "

Apart from the archives, the team gleaned clues from 48 rivets recovered from the hulk of the Titanic, modern tests and computer simulations. They also compared metal from the Titanic with other metals from the same era, and looked at documentation about what engineers and shipbuilders of that era considered state of the art.

The scientists say the troubles began when its ambitious building plans forced Harland and Wolff to reach beyond its usual suppliers of rivet iron and include smaller forges, as disclosed in company and British government papers. Small forges tended to have less skill and experience.

Adding to the problem, in buying iron for the Titanic's rivets, the company ordered No. 3 bar, known as "best" — not No. 4, known as "best-best," the scientists found. Shipbuilders of the day typically used No. 4 iron for anchors, chains and rivets, they discovered.

So the liner, whose name was meant to be synonymous with opulence, in at least one instance relied on cheaper materials.

Many of the rivets studied by the scientists — recovered from the Titanic's resting place two miles down in the North Atlantic by divers over two decades — were found to be riddled with high concentrations of slag. A glassy residue of smelting, slag can make rivets brittle and prone to fracture.

"Some material the company bought was not rivet quality," said the other author of the book, Timothy Foecke of the National Institute of Standards and Technology, a federal agency in Gaithersburg, Md.

The company also faced shortages of skilled riveters, the archives showed. Dr. McCarty said that for a half year, from late 1911 to April 1912, when the Titanic set sail, the company's board discussed the problem at every meeting. For instance, on Oct. 28, 1911, Lord William Pirrie, the company's chairman, expressed concern over the lack of riveters and called for new hiring efforts.

In their research, the scientists, who are metallurgists, found that good riveting took great skill. The iron had to be heated to a precise cherry red color and beaten by the right combination of hammer blows. Mediocre work could hide problems.

"Hand riveting was tricky," said Dr. McCarty, whose doctoral thesis at Johns Hopkins University analyzed the Titanic's rivets.

Steel beckoned as a solution. Shipbuilders of the day were moving from iron to steel rivets, which were stronger. And machines could install them, improving workmanship.

The rival Cunard line, the scientists found, had switched to steel rivets years before, using them, for instance, throughout the Lusitania.

The scientists discovered that Harland and Wolff also used steel rivets — but only on the Titanic's central hull, where stresses were expected to be greatest. Iron rivets were chosen for the stern and bow.

And the bow, as fate would have it, is where the iceberg struck. Studies of the wreck show that six seams opened up in the ship's bow plates. And the damage, Dr. Foecke noted, "ends close to where the rivets transition from iron to steel."

The scientists argue that better rivets would have probably kept the Titanic afloat long enough for rescuers to arrive before the icy plunge, saving hundreds of lives.

The researchers make their case, and detail their archive findings, in “What Really Sank the Titanic” (Citadel Press).

Reactions run from anger to admiration. James Alexander Carlisle, whose grandfather was a Titanic riveter, has bluntly denounced the rivet theory on his Web site. “No way!” Mr. Carlisle writes.

For its part, Harland and Wolff, after its long silence, now rejects the charge. “There was nothing wrong with the materials,” Joris Minne, a company spokesman, said last week. Mr. Minne noted that one of the sister ships, the Olympic, sailed without incident for 24 years, until retirement. (The Britannic sank in 1916 after hitting a mine.)

David Livingstone, a former Harland and Wolff official, called the book’s main points misleading. Mr. Livingstone said big shipyards often had to scramble. On a recent job, he noted, Harland and Wolff had to look to Romania to find welders.

Mr. Livingstone also called the slag evidence painfully circumstantial, saying no real proof linked the hull opening to bad rivets. “It’s only waffle,” he said of the team’s arguments.

But a naval historian praised the book as solving a mystery that has baffled investigators for nearly a century.

“It’s fascinating,” said Tim Trower, who reviews books for the Titanic Historical Society, a private group in Indian Orchard, Mass. “This puts in the final nail in the arguments and explains why the incident was so dramatically bad.”

The Titanic had every conceivable luxury: cafes, squash courts, a swimming pool, Turkish baths, a barbershop and three libraries. Its owners also bragged about its safety. In a brochure, the White Star Line described the ship as “designed to be unsinkable.”

On her inaugural voyage, on the night of April 14, 1912, the ship hit the iceberg around 11:40 p.m. and sank in a little more than two and a half hours. Most everyone assumed the iceberg had torn a huge gash in the starboard hull.

The discovery in 1985 of the Titanic wreck began many new inquiries. In 1996, an expedition found, beneath obscuring mud, not a large gash but six narrow slits where bow plates appeared to have parted. Naval experts suspected that rivets had popped along the seams, letting seawater rush in under high pressure.

A specialist in metal fracture, Dr. Foecke got involved in 1997, analyzing two salvaged rivets. He was astonished to find about three times more slag than occurs in modern wrought iron.

In early 1998, he and a team of marine forensic experts announced their rivet findings, calling them tentative.

Dr. Foecke, in addition to working at the National Institute of Standards and Technology, also taught and lectured part time at Johns Hopkins. There he met Dr. McCarty, who got hooked on the riddle, as did her thesis adviser.

The team acquired rivets from salvors who pulled up hundreds of artifacts from the sunken liner. The scientists also collected old iron of the era — including some from the Brooklyn Bridge — to make comparisons. The new work seemed only to bolster the bad-rivet theory.

In 2003, after graduating from Johns Hopkins, Dr. McCarty traveled to England and located the Harland and Wolff archives at the Public Record Office of Northern Ireland, in Belfast.

She also explored the archives of the British Board of Trade, which regulated shipping and set material standards, and of Lloyd's of London, which set shipbuilding standards. And she worked at Oxford University and obtained access to its libraries.

What emerged was a picture of a company stretched to the limit as it struggled to build the world's three biggest ships simultaneously. Dr. McCarty also found evidence of complacency. For instance, the Board of Trade gave up testing iron for shipbuilding in 1901 because it saw iron metallurgy as a mature field, unlike the burgeoning world of steel.

Dr. McCarty said she enjoyed telling middle and high school students about the decade of rivet forensics, as well as the revelations from the British archives.

"They get really excited," she said. "That's why I love the story. People see it and get mesmerized."

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