# *OLYMPIC* & *TITANIC*: REFINING A DESIGN

By Mark Chirnside

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Author's Note: Back in 2005, I published information about some previously unknown refinements to *Titanic* based on experience Harland & Wolff gained from observing *Olympic* during a particularly severe North Atlantic storm in January 1912. The article was published on the *Titanic* Research & Modelling Association (TRMA) website. It discussed some modifications to some of her rivetted joints fore and aft: *Olympic*'s great length meant that the stresses at these points – from about a quarter of her length ahead of the stern and a quarter of her length abaft the bow – required some additional reinforcement, beyond what previous experience had suggested was necessary, to prevent rivets in these areas becoming gradually slack in severe weather conditions.

It goes to show how much we are still learning about the '*Olympic*' class ships all these years later, but the demise of the TRMA website offered an opportunity to publish this new article. It contains the original article's information about the changes to *Titanic*, supplemented by additional material, including new diagrams of both *Titanic* and *Britannic*, and contextual information about other large liners of the period.*

By the time *Titanic* was completed she incorporated hundreds, if not thousands, of changes compared to her older sister: ranging from the more obvious changes, such as her first class accommodation on B-deck, to an improved propeller configuration which Harland & Wolff estimated would increase her speed by between

* When *The 'Olympic' Class Ships: Olympic, Titanic & Britannic* was published (History Press; revised and expanded edition, 2011) I included this information on page 226. For an analysis of these changes and their potential impact on *Titanic*, see Parks Stephenson's article 'What Caused *Titanic* to Sink?' in the *Titanic* Historical Society's *Titanic Commutator* 2014: Volume 39 Number 206. Pages 92-100. See, also: Rudi Newman's 'A "Riveting" Article – an Historical Rejoinder to Metallurgical Studies of the *Titanic* Disaster' in the British *Titanic* Society's *Atlantic Daily Bulletin* 2012: Pages 18-30.

one-eighth and one-quarter of a knot. These refinements represented practical experience supplementing theoretical knowledge as the shipbuilder learned from *Olympic*'s operation.

*Olympic* passed the Daunt's Rock Light Vessel at 2.11 p.m. on 11 January 1912, starting her first westbound crossing of 1912. Her log abstract recorded 'rough sea' on the first day out, followed by 'snow' on the second day, then 'fresh NW west winds to S'ly to whole WNW Gale' and 'Whole NNW Gale, Heavy Squalls, High Sea'. *Olympic*'s progress slowed as the sea conditions deteriorated: the first day's run of 485 miles fell to a run of 389 miles on the third day and then only 301 miles on the fourth day out. (On a normal westbound day, she might have been expected to cover well over 500 miles.) The weather improved towards the end of the voyage but, by the time she arrived at the Ambrose Channel Light Vessel, her average speed was a mere 18.62 knots. This was a strong indication of how bad the weather had been. Based on average speed performance data covering almost 90 per cent of the voyages she made, it was the third-slowest westbound crossing of her entire career.

The *New York Times* reported she had 'experienced very rough weather on the voyage, and in spite of her enormous size she shipped one huge sea over her bows on Sunday afternoon that tore off the cover of No.1 hatch on the foc'sle deck and lifted it bodily over the guard rails at the break of the deck and deposited it safely on the well deck below'. It said J. Bruce Ismay 'had one of his ports smashed by the big sea':

> He has come over to discuss business in New York and also to see how the *Olympic* behaved in bad weather. He found that, in spite of her size, the ship rolled and pitched a good deal, but that her promenade decks were dry and that the majority of passengers were able to go into the saloon for their meals.

Harland & Wolff also gained valuable information. It was, sometimes, only through observing their designs in service that shipbuilders were able to confirm something was working well or identify improvements. (Early in January 1911, for instance, Cunard were discussing plans for their new *Aquitania* with their shipbuilder and Lloyd's registry. They drew on experience with *Lusitania* and *Mauretania*, which had been in service since September and November 1907, respectively. The plans showed '**treble** [original **emphasis**] riveted landings in bottom plating. *Lusitania* and *Mauretania* have **double** [original **emphasis**] riveted

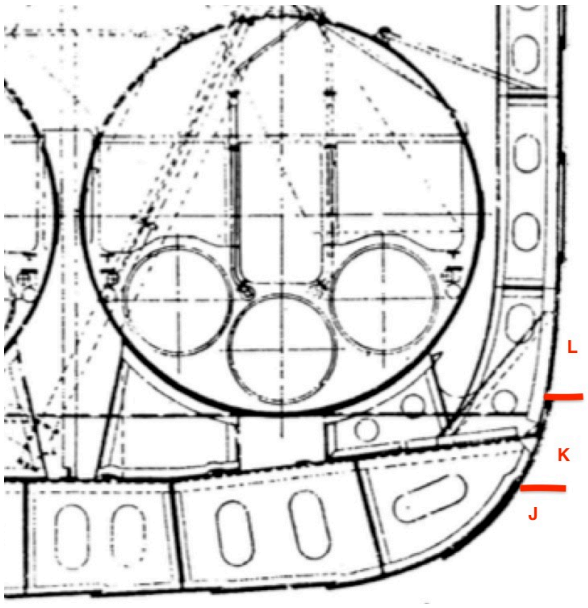
landings. *Olympic* [and] *Titanic*…have treble riveted landings. As the *Lusitania* and *Mauretania* have shown no signs of weakness in the riveting of bottom shell plating it was agreed to accept double riveting for shell landings on bottom, with the exception of the strake in way of the outer line of docking blocks on each side…') Harland & Wolff were a proactive shipbuilder, quick to apply their practical experience to supplement previous theoretical knowledge.

As a result of observing *Olympic* in the storm, which turned out to be one of the worst of her career, Harland & Wolff decided to make a number of refinements, including changes to Number 1 Hatch. On 13 February 1912, Francis Carruthers, Ship Surveyor to the Board of Trade at Belfast, also reported that the shipbuilder was making changes to *Titanic* as a result of her older sister's experience. They were fitting a one-inch-thick steel 'strap' on the port and starboard sides of the ship 'in way of no. 6 boiler room and extending three frame spaces forward of the watertight bulkhead at the forward end of the boiler room.' The strap extended from frame 63 to frame 81 at the landing of strakes J and K, at the 'upper turn of the bilge.' At this area, the hull frames were spaced thirty-six inches apart (the furthest distance between frames throughout the entire ship).

Further aft 'in way of the turbine room and extending two frame spaces into the reciprocating [engine] room', another one-inch-thick 'strap' was fitted from frame 50 to frame 73 at the landing of strakes K and L.* In addition, 'one extra row of holes has been drilled in the plate above the landing, making it a quadruple riveted landing.'

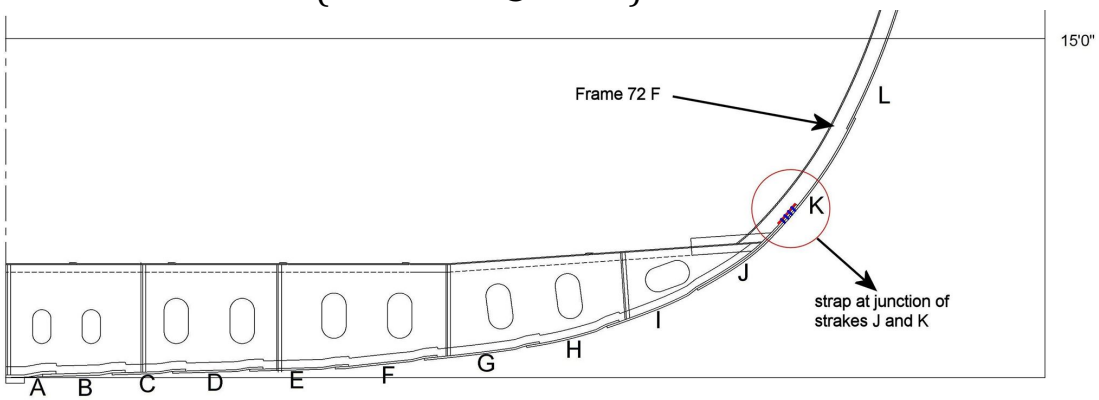
Carruthers noted: 'I am informed that this strengthening is in consequence of observations made on board the *Olympic* during a recent heavy passage across the Atlantic'.

* On both the port and starboard sides of the hull at this landing the condenser injection openings, which were large and rectangular, probably contributed to additional 'working' in this area on the *Olympic*. In spite of the double plating already provided, Scott Andrews points out: 'I'm sure the presence of the large rectangular openings in what is basically the bottom two corners of the box girder formed by the hull caused these seams to "work" a bit more than those of the neighbouring strakes'.




Left: An extract from a midsection plan of *Olympic* and *Titanic*, showing a cutaway view of the ship at boiler room 2. The letters in red mark the locations of the strakes of hull plating, J, K and L. The thick red lines mark the approximate location of the rivetted landings between (top) strakes L and K and (bottom) strakes K and J. (*The Shipbuilder*, 1911/Ioannis Georgiou collection)

Below: The ship's hull shape changed considerably over its length, narrowing towards the extremities of the bow and stern as the width of the ship progressively decreased. This plan shows the area located at frame 72 forward. (Bob Read © 2019)




Following a request for further information from London on 22 February 1912, Carruthers confirmed that the joints in question were double hand rivetted joints. (This was a contrast to other similar joints, which were double or treble hydraulically rivetted.) Near the end of the month, the Board of Trade decided to take the opportunity to examine *Olympic* when she was drydocked for the replacement of a port propeller blade. Accordingly, Carruthers made a detailed inspection and reported on 6 March 1912. The Board were concerned that there might be other signs of stress, beyond the specific riveted joints which they knew were being modified. Carruthers' report allayed those fears:

> Below the waterline starboard side forward in way of no. 6 boiler room in the shell landing of J & K strakes from frame 63 to 74, about 160 rivets were slack and were drilled out and & renewed.

> About four feet below this landing in the tank bar, from frame 71 to 75 about 50 slack rivets were drilled out & replaced.
> Port side fwd. [forward] in the tank bar from about frame 71 to 78, about 90 rivets were showing a little slack & were caulked.
> On both sides aft in way of turbine [engine] room, in the shell landing of K & L strakes from about frames 52 to 69, 100 rivets found slack were drilled out & replaced. **I carefully inspected the vessel inside in the neighbourhood of these slack rivets but found no further signs of stress**. [my **emphasis**]

The Board of Trade's estimate of stress 'on rivets due to shearing' showed that increasing the number of rows of rivets in a joint could make a substantial difference. A double rivetted landing had a stress of 9.8 tons; a treble rivetted landing a stress of 6.5 tons; and a quadruple rivetted landing a stress of 4.9 tons.

*Olympic* herself saw similar, or identical, changes to *Titanic*. On 22 May 1912, the Board of Trade noted: 'Some of the landings near the bilge were only double riveted & gave trouble. Inside straps have now been fitted'.

Nor did Harland & Wolff forget *Britannic*. She had been laid down on 30 November 1911 and her double bottom was not yet completed, so they had ample opportunity to make sure her design was refined to take into account their experience operating *Olympic*. On 5 February 1912, Edward Wilding had already noted that 'This landing [between strakes K and L], & any other coming above the tank side level, to be treble rivetted between frames 39 & 85 forward & aft (about)'.

The available evidence is that Harland & Wolff's changes did their job in correcting what could have become a recurring maintenance nuisance during the ship's annual overhauls.* There is no record of any

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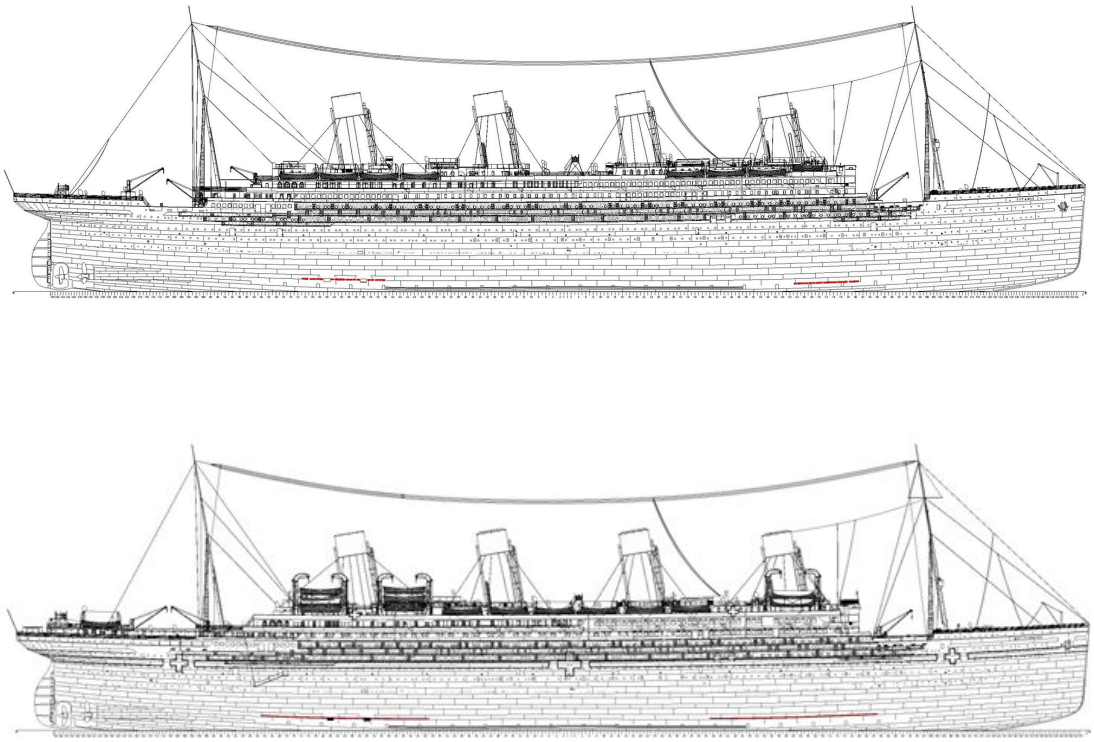
* It is ironic that these changes were misrepresented later on by conspiracy theorists. When I published my article originally, my argument was that these minor changes demonstrated the fundamental strength of *Olympic*. She came through one of the worst North Atlantic storms in her career and did not show any significant weakness.

Carruthers' careful inspection of the hull revealed 'no further signs of stress' beyond the small number of slack rivets identified. The entire purpose of his inspection was to look for such signs of stress, but he did not find any. However, writer Brad Matsen claimed it was evidence 'that *Olympic*'s hull was cracking', which is completely the opposite of what the documentation shows. (See Matsen, Brad. *Titanic's Last Secrets*. Twelve; 2008. Page 295. A detailed analysis of these and similar false claims can be found

further issues on *Olympic*. Several years later, Edward Wilding noted that: 'We have had less repairs to the *Olympic* than to any large ship we have ever built, due to external causes, of course'.*

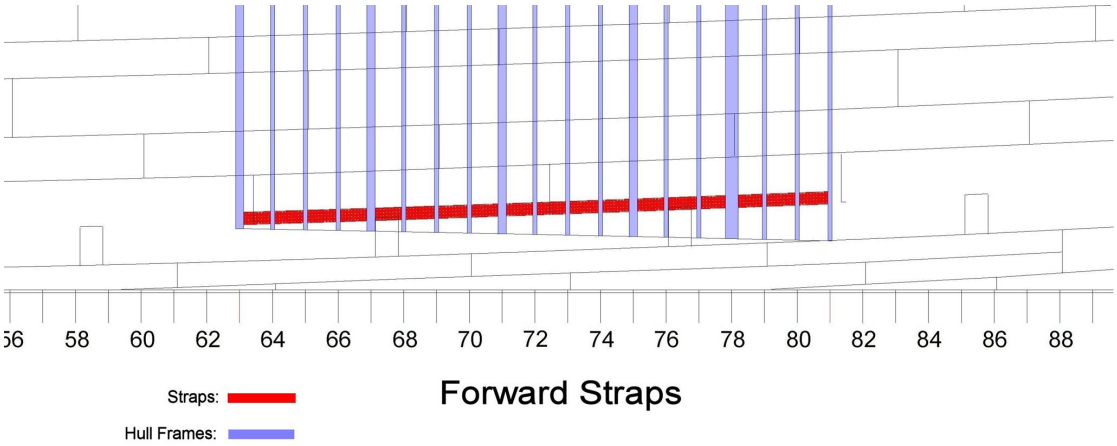
## COMPARISON OF *TITANIC* & *BRITANNIC*



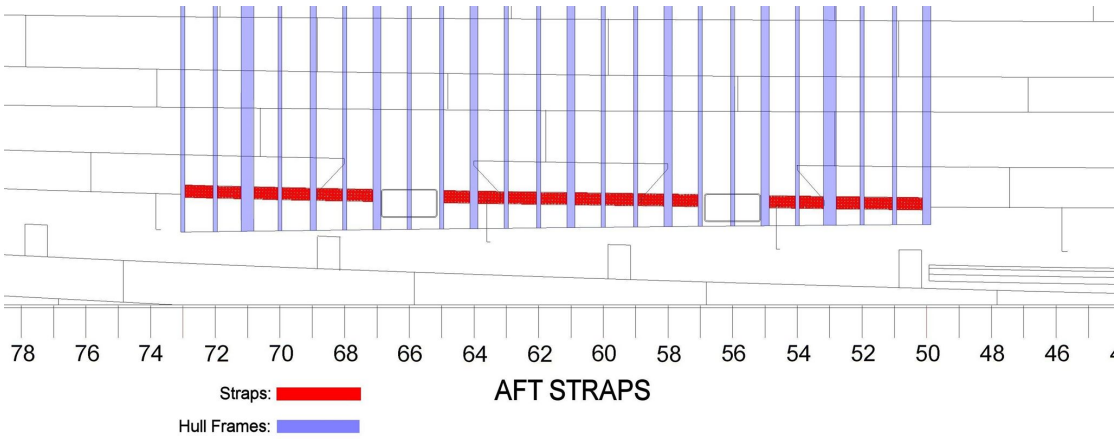
Above, top: Longitudinal view of *Titanic* with the locations of the 'straps' fore and aft marked in red. (Bob Read © 2019)
Above, bottom: Longitudinal view of *Britannic*, in her completed configuration, with the locations of the treble rivetted joints specified by Edward Wilding marked in red. (Bob Read © 2019)

in my article, '*Titanic*: Allegations & Evidence', published in the *Titanic* International Society's journal *Voyage* 94 December 2015: Pages 55-60 and online: http://www.markchirnside.co.uk/TitanicAllegations&Evidence.htm.)

* In total, 310 rivets were replaced and another ninety were caulked on *Olympic* in March 1912. Similar, more serious repairs needed to be undertaken to a number of her contemporary peers. Shortly after *Majestic* entered service in 1922 she needed thousands of rivets in the bottom of the hull caulking, and similar issues were reported in the case of *Empress of Britain* and *Aquitania*.




Above and below: These diagrams show close up views of the location of the 'straps' added fore and aft on *Titanic*. The thicker vertical hull frames are 'web' frames, which added enormously to the strength of the hull structure. Unlike some other ships of the period, whose hull frames were numbered consecutively, on *Olympic* and her sisters the numbering system started from the middle of the ship. Therefore numbers were duplicated and we see frame number 60 (forward) and frame number 60 (aft). (Bob Read © 2019)




Liners such as Cunard's *Aquitania* and HAPAG's *Bismarck*, which followed *Olympic*, had additional rivetting in landings at about a quarter of the length of the hull from both the bow and stern, because shipbuilders believed that this was where high shearing stresses might be expected.

*Bismarck*, which was launched in 1914 and completed after World War I, became White Star's *Majestic* (1922). She was the largest liner in the world when she entered service and the longest, as well, with an overall length of 956 feet. During a drydock inspection near the end of March 1925, three years after she had entered service, a surveyor noted:

'Several hundreds of "weeping" rivets in the flat of the bottom and at quarter length from forward have been caulked'. This was, of course, underneath the ship rather than at the side of the hull, however the Board's Principle Ship Surveyor asked 'I should like to know whether the landing edges of the shell plating at ¼ length from forward and aft in way of the neutral axis [36 feet above the ship's keel, or around the usual waterline] are double or treble riveted'.

On 20 April 1925, the Senior Ship Surveyor replied: 'The landing edges of the shell plating are riveted thus: XW and WV, treble for full length; VU and UT treble for 6/10 lengths amidships; TS, SR and RQ treble at zones between 100 feet and 320 feet from each end of vessel. Rest of landings double'. The letters for the relevant strakes of hull plating and corresponding landings are not comparable to the lettering scheme used on *Olympic* or her sisters, however it is interesting to note that the shipbuilder had specified an increase from double to treble rivetting for these landings. These landings represented about a quarter of the ship's length (between perpendiculars) fore and aft.*

Cunard's *Aquitania* had similar design features, whereby the number of rivets in these areas was increased. The *Shipbuilder* noted:

> The seams of the side plating in general are treble-rivetted for three-fourths of the vessel's length amidships and double rivetted beyond this length; but for those portions of the side plating at about the one-fourth length of the ship from each end, where the maximum shearing stresses may be expected, the seams have been quadruple rivetted.

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The progressive changes we see from ship to ship aid our understanding of shipbuilding before World War I, as builders such as Harland & Wolff supplemented theoretical knowledge with practical experience down to even the smallest details. Even today, there is still much to learn.

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* On *Majestic*, strakes X and W were the side plating of D and E-deck; W and V, E-deck; V and U, F-deck; U and T, F and G-deck; T and S, G and H-deck; S and R, H-deck; R and Q, H and J-deck. These strakes were not near the turn of the bilge, but close to the normal waterline.

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