## FENTON HOLLOWAY S.S. GREAT BRITAIN RESTORATION STRUCTURAL AWARDS 2006 SUBMISSION

0 minut

THE N PERSON NEW

SS GREAT BRITAIN

H



s.s.great britain restoration



*Client:* ss Great Britain Trust

*Architect:* Alec French Partnership

*Project Manager and QS.* Capita Symonds

*Structural engineer (Ship and buildings):* Fenton Holloway

*Mechanical/electrical engineer:* WSP

*Conservation contractor:* Eura Conservation After languishing in the Falklands for 90 years, Brunel's famous ship, the ss Great Britain, was returned to Bristol in 1974 where she was berthed in the dry dock in which she was built in 1845. The iron hull was, of course, severely corroded, and the deterioration continued until 2005 when the interior and hull below the waterline were enclosed in a low humidity environment such that further corrosion would be arrested indefinitely.

Following his work on Clevedon Pier and other historic structures Richard Fenton's firm Fenton Hollowav were commissioned to assess the strength of the damaged hull in relation to the loading to which the ship would be subjected as an occupied museum artefact. The brief was, while avoiding damaging the patina of the corroded metal during both survey and repair, to provide a loading capacity adequate to support the expected visitor numbers. Any structural interventions were to be minimal while being clearly identifiable and not replicas of the original.

2



Although visitors to the ss Great Britain today will hardly be aware of it, Fenton Holloway were responsible for an inventive design solution to strengthen and secure the hull utilising existing holes in the structure wherever possible, and where this was not possible installing clamps and props that left no irrevocable effect on the hull.



Structural engineering work involved:

- Definition of ship into a three dimensional structural model and producing an analytical model from a detailed dimensional survey.
- Detailed examination of each structural element of representative areas of the hull and decks.
- Calculation of the section properties of the remaining sound metal in each structural element examined.
- Banding of section properties and relating these bands to observable and readily measurable symptoms of damage.
- Condition survey of the whole of the ship using the parameters established.
- · Detailed investigation of realistic worst case loading patterns
- Structural analysis of ship as original and in present corroded state for various conditions of support.
- Design of minimal intervention strengthening. This involve an iterative process of dropping out 'failed' members from the model before adding new elements of similar size to the originals.
- Close working with iron conservator to develop practical and economic repair methodology consistent with minimum intervention and safety.
- Computer modelling of the

stern

The ss Great Britain was constructed using 1040 tonnes of wrought iron. We estimate that

she has lost more than 200 tonnes due to corrosion over her 160 years. Our interventions involved 15 tonnes of steel. We believe that this work is a significant example of the work of the structural engineer in conservation where very considerable skill, effort and technology is applied to minimise physical change to the historic structure.

av 3



In-house computer modelling combined the photogrammetrically developed hull shell with internally surveyed ribs, posts and beams to produce a working model ready to receive condition survey data.



Corrosion products inside the hull were viewed as historic artefacts complicating the process of collecting accurate data.



The ship's hull was reduced to a composite grillage system made up of hull plates double thick at overlap locations and ribs.





Holloway



Above: Weather deck overstressing caused by removal of longitudinal members in 1970's - new beams reinstated to original locations.

Below: Forward hold corrosion.





Replica rudder provides key support for overstressed cantilever stern via new internal strut and steel crown arrangement at weather deck level.



## 3.1 supporting material - history

## The ssGB in Sparrow Cove.



The ss Great Britain has an illustrious past. Brunel's second ship, she brought together the cutting-edge technologies of the mid 19th century. At the time of her launch by Prince Albert in 1843, she was the world's first iron-hulled, screw-propelled, steam-powered ship. As the world's first great ocean liner, the ss Great Britain transformed the way Victorians approached mass travel and communications, including the timetabling of long distance voyages. She survived a beaching at Dundrum Bay, Ireland, in 1846, and went on to take 15,000 emigrants to Australia. Passengers included the first All England Cricket Team tour to Australia, in 1861, and author Anthony Trollope. The ship was commissioned as a troop carrier for the Crimean War and Indian Mutiny. In 1882, with the engine removed, she became a cargo carrier, before ending her

working life as a floating warehouse in Port Stanley, The Falkland Islands. She was finally abandoned in 1937 when she was towed across the bay and scuttled on the beach in Sparrow Cove before her eventual epic rescue and return to Bristol in 1970.

Once secured in her original dry dock in Bristol she was looked after by the ss Great Britain Project with help from a large number of volunteers and contractors. There is no doubt that without the efforts of the early trustees and their helpers the ship would not have lasted as she did. However, in spite of their best efforts it became clear in the mid 1990s that the ironwork was rusting fast and a different approach was needed. The trust employed a specialist marine curator/director and conservators, whose first task was to survey the ship and propose treatment options.

During early 1998, as the survey work progressed, it became apparent that a window of only a few years existed, before the battle against corrosion of the great ship's hull would be largely lost. The iron which had been a source of much wonder in her early years, and which had given her the strength to weather many an Atlantic storm, was finally proving her downfall. The ship's iron hull had been subjected to continuous aggressive chloride attack from seawater. Once thick, strong plates came to resemble lace and were in danger of being unable to support the ship's weight.

This damage accelerated following the return of the ss Great Britain to her Dry Dock in 1970, where the relative humidity often reached 80% and the average is higher than in Sparrow Cove. In addition to corrosion, the ship's timber and lead work had also suffered degradation. Without intervention, this national treasure would have crumbled away. A glass waterline plate was installed to seal the gap between the wall of the dock and the ship, allowing the entire hull below the waterline and plate and the interior



s.s.great britain restoration



of the ship to be dehumidified, while the external topsides are treated more 'conventionally'. Fenton Holloway was a member of the team responsible for the conservation process.

Today Brunel's ss Great Britain rests securely in the very same Bristol Dry Dock he built for her. Since the ship's 're-launch' visitor numbers have more than doubled. *Text by Robert Turner* 





Cover, page 10: Lance McNulty.

Pages 1, 2, 3, 6, 8, 9 bottom right, 11: Mandy Reynolds.

Pages 5, 7: Fenton Holloway.

Page 9 top left: ss Great Britain Trust.



