THE ROYAL ALBERT BRIDGE, SALTASH,

AND

ISAMBARD KINGDOM BRUNEL.

ABSTRACT OF A LECTURE BY MR. S. GORDON MONK, M.SC.(ENG.), B.SC., A.M.I.E.E.

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I. K. BRUNEL was born at Portsmouth on the 9th April, 1806. His father was Marc Isambard Brunel, a native of Hacqueville, Normandy, who came to England in 1799, and married Sophia Kingdom at Portsmouth.

Marc Brunel (later Sir Marc) was engaged from 1823 onwards in building the Thames Tunnel, in which work I. K. Brunel played an important part and acted as resident engineer. On two occasions when these works were flooded, Brunel sustained injuries, after the second of which he came to Plymouth to recuperate, and made his first acquaintance with Saltash and investigated the prospects of a bridge there.

In 1831, I. K. Brunel was successful in a competition for plans for the building of a suspension bridge across the Avon at Bristol. He was appointed engineer for this work, but after several years the task had to be abandoned, as proving too costly.

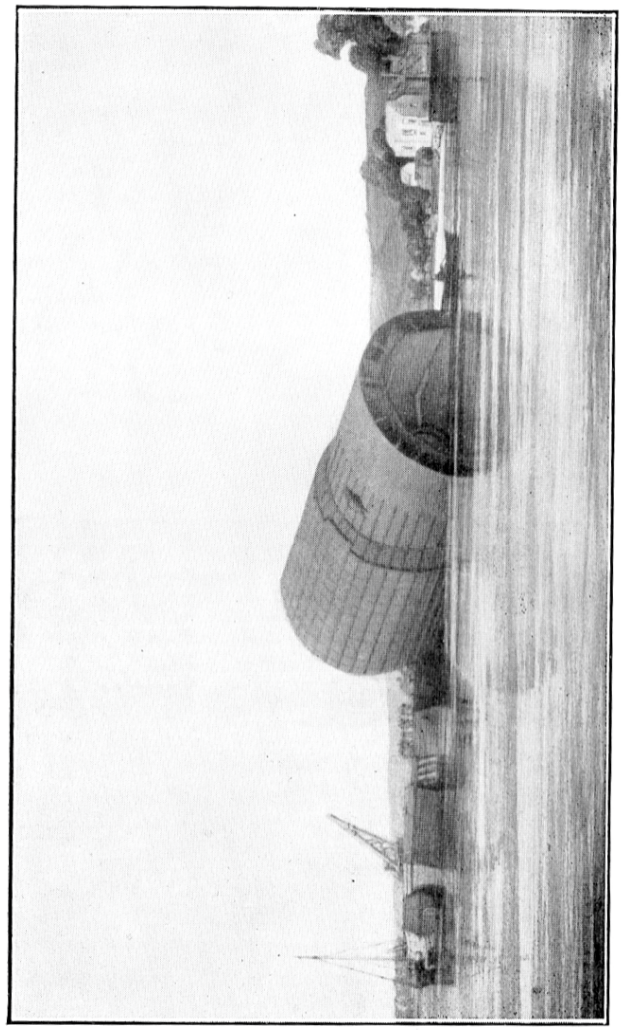
In 1832, the Great Western Railway was formed by the merchants of Bristol, and Brunel was appointed the engineer of the Company. In 1837, the *Great Western* Steamship was launched and completed on the Thames; on its first trip to Bristol, fire broke out on board, and Brunel very nearly lost his life by falling from a burnt ladder into the heart of it. This *Great Western* was the first steamship to make regular sailings to New York, and Brunel later built the *Great Britain*, the *Great Northern*, and, finally, the *Great Eastern*, these being very large iron ships for that period.

In 1843, Brunel, while engaged in some amateur conjuring, unfortunately swallowed a half-sovereign, which lodged in his throat and remained there for many weeks. He actually built a special stretcher which enabled him to be turned upside down in the hope of dislodging this coin.

In 1844, the South Devon Railway was formed, and Brunel realised that the steep gradients necessitated by the contour of the land would render necessary the application of some external aid to the trains, and he rather reluctantly agreed to the installation of the "Atmospheric System" over a portion of the line. This system proved unworkable, and was abandoned in 1848.

Bringing the South Devon Railway into Plymouth aroused considerable controversy. Brunel recommended Eldad "at the end of five fields" as the terminus, in order that an extension should be made into Cornwall "if this should be thought expedient." Mr. George Soltau warmly opposed the choice of "No Place" for the purpose, because persons would find their way to Devonport instead of to Plymouth, and he advocated Friary as a more appropriate station site. Brunel laughed at the idea of conflicting interests. "Although", he said, "you speak of your Three Towns, we only know one long straggling, scattered community". He held that no Company would dream of approaching such a population at one extremity; but he so far yielded to pressure as to abandon his own idea and substitute land "at the back of the Octagon". This surrender aroused the fears of Devonport, whose citizens had subscribed to the undertaking on the understanding that a station would be placed near the North-East Barrier Gate. Passionately protesting that "there is neither public landing-place nor population at Millbay", they insisted on petitioning Parliament in favour of Devonport. Their Town Clerk, Mr. Thomas Woollcombe, as Chairman of the Company, "solemnly warned" them that they would not improve their position by this course; and, harsh though the hint sounded, it was justified in the event. (Above from Whitfield, *Plymouth and Devonport in War and Peace*, p. 382.)

In 1844, the Cornish Railway was proposed, and Brunel suggested crossing the Tamar by a Train Ferry at Torpoint. In the following year the Company was formed to construct the Cornish Railway, but Parliament would not agree to a ferry crossing at Torpoint, but sanctioned a bridge at Saltash. In 1847, Brunel made several borings into the bed of the river at Saltash to ascertain the state of the mud and rock bed there; he made a trial cylinder, and with its aid built a small piece of masonry into the bed of the river, within



THE GREAT CAISSON, ROYAL ALBERT BRIDGE, SALTASH.

The Royal Albert Bridge, Saltash, to face page 91.

which was placed a copper tablet in an oaken box, with the inscription : " Cornwall Railway, Saltash Bridge. Trial Foundation of Central Pier. January, 1849. I. K. Brunel, Engineer. William Glennie, Resident ditto ".

In 1852, Brunel had to effect considerable alterations in his plan for the river crossing at Saltash. In order to save £100,000, he reduced the bridge from carrying two tracks to one track only ; this was of the broad gauge (7'), and ample room allowed for it, so that with very slight modification his revised bridge could have carried the two tracks of the new standard gauge.

In 1853, the Admiralty having approved of the plan for the bridge, a great cylinder was built, as shown in the accompanying illustration, in order to build the pier in the centre of the river. This " caisson " was 90 ft. long, 37 ft. in diameter at the top, 35 ft. at the bottom, and weighed 300 tons. This was floated out to the centre of the river, and sunk into place after considerable difficulty owing to the irregular shape of the rock bed. The lower part of this cylinder was really a large diving bell and enabled the mud to be removed down to solid rock, when a granite pier could be constructed. The interior sub-divisions of the cylinder were cut away as the masonry rose, and when ultimately the pier was 12 ft. clear of high water, the upper part of the cylinder was unbolted and removed, but the lower part is apparently still around the base of the pier.

Brunel had played a considerable part in the erection of the Great Exhibition building in Hyde Park in 1851, and when in 1855 this was removed to Sydenham to form the Crystal Palace, Brunel constructed the two great water towers. These were 284 ft. high, and carried on the top tanks 47 ft. in diameter, 38 ft. deep, and holding 1,200 tons of water. The tanks had to be more than 200 ft. high, and the towers and tanks weighed 3,000 tons each, and had to be built on the sloping side of a clay hill. The towers were 12-sided, having two hollow cast iron columns at each angle. These towers survived the fire which destroyed the Crystal Palace on 30th November, 1936, but were felled in 1941 in order to recover the metal.

In 1857, while work on the central pier for the bridge at Saltash still proceeded, the construction of one of the spans was undertaken on the Devon shore, near the Ferry Passage.

The spans consist of elliptical tubes forming the compression member, 16¾ ft. wide and 12¼ ft. deep. The curved length is 460 ft. and the straight length 445 ft. There are 11 trusses connecting the tube with the chains and track girders, and the track is further hung from the chains at each intermediate point between the trusses. The chains were the ones made for the Clifton Bridge and not used there owing to the failure of that undertaking, so they are ten years older than the rest of the bridge. The links of these chains are 20 ft. long, 7 ins. deep and 1 in. thick, there being 14 links abreast and two tiers of links on each side. It is interesting here to note that after Brunel's death, the Hungerford Suspension Bridge across the Thames was dismantled on building the Charing Cross Railway Bridge, and the chains thereby recovered were used in the completion of the Clifton Suspension Bridge at Bristol. This Hungerford Bridge had been designed by Brunel, and its construction was completed in 1845.

When the span was completed on its shore site, it was tested with an added load of 1,190 tons, the span itself weighing 1,060 tons. The official test load was 400 tons, which gave a deflection of only 1 in. This is about the load of the heaviest trains now taken across the bridge, namely the "broccoli trains", but these extend over both spans. The Cornish Riviera train fully loaded is about 360 tons.

At each end of the span, docks were excavated and two pontoons were floated in. Massive timber stages were built on these pontoons to carry the ends of the span. With the help of the Admiralty, the span was floated out at high tide and towed into position between the supporting piers, on which the ends rested when the tide went down, and the pontoons floated clear. One of these pontoons is still in use in the Millbay Docks, where the Great Western tenders berth.

There then came the difficult task of lifting the span into place. Under each end of the span were placed three hydraulic jacks, the one in the centre alone, or the two outer ones together, being sufficient to lift the end of the span. The rams of the presses had a screw thread cut on them, and a nut was screwed down as the lift proceeded to prevent any falling should the presses fail.

The lifting was done 3 ft. at a time. At the shore end of the span the limestone masonry was built up, and ample time left for it to set before taking weight. Since only half the

river was obstructed, there was no need to hurry the lifting process.

The piers at the shore ends of the spans are 29 ft. wide, 17 ft. thick, 190 ft. from the foundation to the summit. The standards on the top of the piers are over 200 tons each, in five 6 ft. joints, each over 40 tons. In the centre, on the granite pier, two octagonal columns were built up of cast iron blocks, each 6 ft. high, 2 ins. thick, braced inside with ribs and angle irons, and 10 ft. across, and standing 10 ft. apart. These cast iron blocks were about the largest single castings so far made. The two columns, ultimately standing 100 ft. high, and each weighing 150 tons, were transversely braced by a wrought iron framework.

The first lift was made on 25th November, 1857, and the span was finally up in position by 19th May, 1858.

Meanwhile, the second tube was in hand and it was lifted by its pontoons on the 30th June, 1858. The floating into position was similar to that of the first span, but the operations were directed by Mr. Brereton (Brunel's Assistant Engineer), since Brunel was abroad at Lausanne, and in ill health.

The masonry piers at each of the land side approaches are double, 11 ft. square, and spanned by boiler plate girders.

The bridge was opened by the Prince Consort on Monday, 3rd May, 1859, amid scenes of great rejoicing. (See Whitfeld, p. 387.) The train was received at Saltash Station by the Mayor, Mr. J. H. Cook, who presented an address, to which the Prince listened and replied without leaving his carriage. The train then proceeded to Coombe viaduct, so that they could view the whole structure, and then returned to Saltash Station, when the Prince alighted and received many prominent people. Those present included the Marquis of Abercorn, the Earl of Mt. Edgcumbe, Viscount Valletort, the Earl of Morley, the Mayors of Saltash, Plymouth and Devonport, each in his robes of office, and each attended by the antique maces and their scarcely less antique mace-bearers. The Prince then walked back across the bridge, amidst great acclamations on all hands.

There is a persistent rumour in the Saltash district that Brunel was so displeased with his bridge that he committed suicide by throwing himself from it before it was opened. This story may have arisen at the time owing to his absence

from the opening ceremony, but he was then at Lausanne. He returned a few weeks later, and was wheeled across the bridge in an invalid chair to view this, his greatest, undertaking.

During the construction of the bridge, Brunel had also been engaged in building the *Great Eastern* on the Thames. This had to be launched sideways, and proved particularly difficult, for it took over six months to get the boat afloat, but it was ultimately completed and did most valuable work on the New York service.

On 5th September, 1859, Brunel wanted to sail in the *Great Eastern* to Weymouth, but was taken ill and went to his home at Duke Street, London, when it was evident that he was suffering from paralysis. He passed away ten days later.