William Arrol and Peter Lind: Demolition, construction and workmanship on London’s Waterloo Bridges (1934–46)

Christine Wall
University of Westminster, London, UK

ABSTRACT: In 1924 when serious settlement to the piers of John Rennie’s Waterloo Bridge rendered it unsafe for traffic William Arrol and Company erected a temporary steel bridge. The company was later tasked with demolition of the old bridge in 1934, the process revealing high levels of workmanship in its construction. The New Waterloo Bridge, 1937–45, engineered by Rendel, Palmer and Tritton, designed in collaboration with Giles Gilbert Scott and in association with London County Council engineers was built by contractor Peter Lind. The result was a modern, functional, concrete bridge but which required precise and skilled work to the steel reinforcement. This paper, using documentary and photographic evidence from a number of archives, together with personal testimonies, considers the changing labour force, from demolition of the old bridge and as the new bridge progressed. Questions of skill and labour, conditions of work, and workmanship are examined in the context of both war and peacetime.

Keywords: 1930–50, UK, Bridge, Labour, Workmanship

1 INTRODUCTION

By 1924, when William Arrol and Co. constructed a temporary crossing, John Rennie’s Waterloo Bridge was ‘marred by a broken back … and had passed from utility to obstruction’ (Buckton and Fereday 1936). Arrol was tasked with demolition of the old bridge in 1934, the process revealing perfectly cut and tapered arch-stones and faultless construction of the piers. The new bridge, engineered by Rendel, Palmer and Tritton, designed in collaboration with Giles Gilbert Scott and in association with London County Council engineers was built by contractor Peter Lind. The result was a modern, functional addition to London’s river crossings. However it was a complicated structure and required a large amount of temporary works including gantries, steel bridges, timber piles and platforms. The design also required innovative welding techniques leading to labour disputes with the steel-fixers. The construction process was delayed by four strikes in 1938 and 1939. Labour shortages because of war resulted in a diminished workforce while working conditions were very harsh with severe winters in 1938 and ’39 and bomb raids throughout 1940 and ’41.

This paper, using documentary and photographic evidence from both public and family archives, considers the changing labour force, including demolition of the old bridge and construction of the new bridge, employed by the two contracting firms. It examines the different approaches to labour, and labour disputes, demonstrated by the contractors. William Arrol and Co., a Scottish civil engineering firm established in the nineteenth century and specialising in bridge building, and Peter Lind and Co. a smaller civil engineering firm based in London and set up by the Danish engineer in 1917.

1.1 Old Waterloo Bridge

The first Waterloo Bridge, completed in 1817, designed by John Rennie the elder and assisted by his son, was built initially as a purely commercial enterprise funded by tolls but was taken into public ownership in 1877 and became the responsibility of the London County Council (LCC) in 1888. The site, spanning the river from the Somerset House on the north bank to the rapidly developing south bank near Waterloo Station, enabled Rennie to design the first level, multi-arched road bridge over the Thames (Saint 2007). Rennie’s monumental, masonry structure soon became a significant landmark in London’s social, political and urban history. It became known in Victorian popular culture as ‘The Bridge of Sighs’ after Thomas Hood’s poem locating the bridge as the site of female suicides, the victims invariably deviant or ‘fallen’ women (Nicoletti 2004). It also inspired more positive passions from Londoners, tourists, and artists, including Constable, and Monet who...
famously painted it 40 times, but most of all in civil engineers. In a discussion at the Institute of Civil Engineers following a paper given by the engineers responsible for its demolition, its destruction was described as, ‘the most wanton and shameful piece of vandalism ever perpetrated in London’ (Buckton and Fereday 1936). The campaign to save Rennie’s Bridge is notable for being the first time a powerful consortium assembled to fight against its demolition. The RIBA, Society for the Protection of Ancient Buildings (SPAB), Royal Academy and Town Planning Institute combined to put forward alternative schemes and for the first time the preservation opposition was orchestrated, professional and determined, setting a precedent for future battles (Delafons 1997).

The arches of Waterloo Bridge first showed signs of movement and cracking in 1923 and for the next ten years, while it became increasingly unstable, the debate on whether to repair, reconstruct or demolish was played out in the press and in parliament. Earlier investigations in the 1870s had revealed that scouring of the bridge piers, caused by dredging of the riverbed during works to the Embankment, had exposed the foundations which had to be filled with rubble. Arrol and Company’s involvement with Rennie’s bridge began in 1924 when they were engaged to prop up the failing arches and then, in the same year, build a temporary steel bridge alongside the existing to share the increased load of traffic and to ensure a river crossing in case the bridge had to be closed for safety reasons. Later, in 1934, they won a competitive tender and were awarded the contract for demolition of the bridge on a ‘value-cost’ basis (Buckton and Fereday 1936).

The company founder, William Arrol, died in 1913 and his life story is typically portrayed as a self-made, heroic Victorian engineer rising from humble origins, although one account does reveal that his this is not entirely true as his family were already established in business and manufacturing (McKean 2006). He became famous for building the Tay, Forth and Tower bridges, and setting up the Laid low engineering works, among many achievements in his phenomenally productive life. He gained a knighthood for the Forth Bridge, and later entered parliament as the Liberal Unionist MP for South Ayrshire. He has become almost a regal figure in Scottish history, his portrait adorning the first ever polymer £5 notes printed by the Clydesdale Bank in 2015. It is difficult to find any detailed account of his relationship with his workforce beyond the narrative of the paternalistic, and caring, employer who regarded his men as a valuable asset. He has been described as constantly inventing machinery for aiding and increasing efficiency on his engineering projects and also in order to make working practices safer for his employees. Although in his biography an account is given of Arrol inventing a riveting machine while building the Broomielaw Bridge over the Clyde which suggests otherwise: “While engaged on this work it chanced that 500 tons of iron material were lying ready for riveting. Suddenly it occurred to the riveters, or their professional instigators, that here was a fine opportunity to exact a rate of wages which Arrol thought too high” (Purvis 1913, 35).

So Arrol ‘called on his peculiar resources’ and ‘solved the economic problem without the aid of the workmen’ by inventing a hydraulic riveting machine which, he concluded, completed the work at half the cost of manual labour and at 30% better quality. In this he was certainly typical of that strand of thinking in engineering history, exemplified by his contemporary and fellow countryman James Nasmyth, that continually sought to replace human work with ‘self-acting’ machines (Nasmyth 2010). This legacy of the paternalistic, but controlling, hierarchical firm outlived William Arrol into the twentieth century, together with a reputation alongside other Clydeside firms, for being tough on labour and their organisations (Johnston and

Figure 1. William Arrol 1890 (public domain portrait).
McIvor 2000). At the same time the firm gained well-deserved plaudits for workmanship of a very high standard, an attribute essential for the difficult task of demolishing Waterloo Bridge.

1.2 Demolition: June 1934-October 1936

After the erection of the temporary bridge the large pro-Rennie conservation lobby campaigned to protect, what was perceived by many as a national monument. There followed ten years of wrangling and indecision between parliamentary committees, lobby groups, expert engineers, and the LCC on whether to fund widening and reconditioning of Waterloo Bridge and build a new crossing at Charing Cross, or demolish and build a new Waterloo bridge designed to take increased road and river traffic. The Labour politician Herbert Morrison was a key figure throughout, both as Minister for Transport between 1929–31 and as Leader of the LCC (Donoughue and Jones 1973). Finally, with Morrison back as Leader, the LCC voted to go ahead with a new bridge even without funding from central government and demolition commenced in 1934 with a symbolic blow from a mallet and chisel wielded by Herbert Morrison himself.

The demolition process needed careful design and planning to prevent bridge collapse and restriction of river navigation during the works and so the consulting engineers, Rendell, Palmer and Tritton working closely with LCC engineers under Sir Pierson Frank, decided to use suspended centring of the arches, rather than propping with temporary steel structures. The extraordinary process of demolition is described and illustrated in great technical detail in a paper given by two of the engineers involved at the Institute of Civil Engineers (Buckton and Fereday 1936). The process was in a sense reverse engineering in that it revealed previously hidden elements of design and construction of the old bridge. It involved first lightening the load by removal of the superstructure above the arch keystones and erecting girders, bearing on the piers and spanning the arches, from which steel rods were drilled through the masonry to the steel centring beneath the arches. Associated works included building retaining walls to the abutments, supporting the piers and extensive propping of the arches. Masonry was lifted by two travelling gantry-crane and placed on barges for removal. During the arguments on whether to preserve or destroy Rennie’s bridge, which had been built by the contractor Joliffe and Banks, there had been debate on whether its failure was due to poor workmanship but this was proved not to be the case.

“… it was only with the demolition of the bridge that it became known how perfectly every arch-stone had been cut to taper and how faultless had been the interior construction of the piers” (1936, 478).

The demolition of the bridge was carried out with equivalent care with much of the worked stone, Cornish granite, taken to storage in Middlesex from where it was later re-used for facing to river walls of the Thames and also in the construction of the new bridge. The firm regarded the process as ‘a real piece of engineering’ worthy of congratulation. Norah M. Jeans reported in the Woman Engineer, a journal written by women engineers for a readership of women engineers, that approximately 75,000 tons of material was removed in about one tenth of the time that was spent in talking about it.
1.3 Constructing the New Waterloo Bridge
1937–42

Herbert Morrison’s requests for financing a new bridge were finally agreed by parliament in 1936, making popular suggestions for naming the new bridge ‘The People’s Bridge’ redundant. Designs had already, in 1934, been commissioned from Giles Gilbert Scott, together with plans by engineers Rendell, Palmer and Tritton. Scott’s original design had large Egyptian-Deco pylons at the entrances to the bridge but these soon disappeared and the final scheme was a sleek, modern structure very unlike Scott’s early proposal. The project went out to tender early in 1937 and Peter Lind and Company won the main contract with a tender coming in at £647,624: over £57,000 less than that of Sir William Arrol and Co. Work began in October the same year. Herman Peter Thygesen Lind (1890–1956) was born in Silkeborg, Denmark, qualified as a civil engineer in 1911 and in 1913 won a scholarship to study reinforced concrete structures in Belgium, Germany and England. He set up Peter Lind and Company in Westminster in 1915 and the firm gradually grew, specializing in reinforced concrete work, until its first big building contract in 1926 for the Michelin Tyre Works. Up until the 1960s the company board consisted mainly of Danish engineers including Axel Moller (Symes 1955).

The new design was functional and without ornamentation but in order to achieve the elegant lines and wide spans it was structurally complex and in particular the supporting piers needed to be narrow to give maximum clearance for river navigation. Longitudinally, the bridge is symmetrical about its centre and each half consists of a twin two-span girder continuous over the first river pier (pier 1 or pier 4) and cantilevering shorewards from the abutments into the centre span from the second pier. The gap in the centre span, between the cantilevers extending from the north and south, is filled by a suspended section. (Buckton and Cuerel 1943). The so-called arches are thus not arches but function as beams or to be precise, cantilevered girders. The engineer who devised this solution was John Cuerel, who later became a senior partner at Rendell, Palmer and Tritton. From the outset it was recognized that this design would require high levels of skill and workmanship.

To realize the desired slimness of the structure a high concentration of steel reinforcement was necessary. It was decided that electric arc butt-welding, then infrequently used, would avoid the congestion of conventionally lapped bars. The elimination of laps, splice bars, and hooks, would enable dead weight to be reduced to the minimum and allow the simplest layout of steel reinforcement in relation to concrete placing. Closely spaced grids of reinforcement, welded at the laps, proved successful in controlling surface cracking (Lane 1989). Although arc welding had for many years been used in the manufacture of ships and railway locomotives, and also in the construction of Quarry Hill flats using the Mopin system, it had not been used in this way in London. Before it was introduced for bridge construction a series of experimental tests were carried out under the supervision of Rendell, Palmer and Tritton to determine the viability and extent of arc-welded joints for the steelwork. The experiments tested the strength and of the welds as well as forming a basis for estimating time and cost of the tasks. As part of the second objective it also aimed to ‘examine the effect of the employment of unskilled welders’ so that each joint was produced both by a trained welder of average skill and also ‘a complete novice’ (L.C.C. 1936). The results confirmed the strength and suitability of both spot and butt weld joints, with timings for each type, the engineers also claiming that even the ‘complete novices’ joints were remarkably strong. They did however insist that precautions should be put in place on site with the requirement for a trained inspector and testing for welders making critical joints. It was also noted that the experiments were not made under site conditions. Based on these tests the L.C.C., in December 1937, introduced a set of regulations for the use of arc-welding in building structures as an addition to existing building regulations (Inst. Welding Quarterly Transactions 1938). An editorial in the Concrete & Constructional Engineering magazine of May 1938 stated, that “the application of electric welding in the construction of buildings and bridges is a recent development in which rapid progress has been made. In Great Britain the development has been advanced almost entirely by commercial firms and there is little doubt that a high degree of efficiency has been attained.” It goes on the note that “a panel of the Steel Structures Research Committee has been working on the subject for eight years and a report has been issued by the Department of Scientific and Industry Research in which there is a large amount of valuable information relating to the technique of welding and the strength of welding joints”. This was ‘Welding of Steel Structures’ (London: HMSO).

The first phase of building was the erection of a high level gantry spanning the river alongside Arrol’s temporary bridge and from which the contractors two cranes could run. The bridge was essentially being built from the top down and bottom up because there was very restricted room on the embankments for the contractor’s plant and yard. The Times reported in September 1938 that ‘steady progress’ was being made with about
350 men on site and work already started on cofferdams for piers 2 and 4. However there were a number of strikes in the early stages of construction initiated by the steel workers who were members of the Steel Benders and Fixers Section of the Transport and General Workers Union. The welding industry journal, ‘The Welder’, in an editorial in 1937 noted that while the industry now included trained specialists, such as metallurgists, it was the ‘the practical welders and supervisors’ mainly using ‘rule of thumb methods’ who had brought the industry to its present stage (The Welder 1937). It predicted a future for ‘welding engineers’ trained in both practical and scientific aspects. On Waterloo Bridge the welders were all card carrying union members, and it was only in the same year that steel benders and fixers had been recognized as skilled workers, so when the steel superintendent began to lay off union members and take on non-unionised labour the 50 welders working on the bridge called a strike in October 1938. The men argued that the welding work was very precise and had to be carried out in very difficult conditions and at height and objected to attempts to speed up the job by the supervisor and the employment of non-union welders. It was very quickly resolved when Peter Lind himself came down to talk to the workers and agreed that all steelworkers should have a fully paid up card showing that they were members of the Steel Benders and Fixers Section of the TGWU, but also that they must be prepared to take a test. When the dispute was written up in the New Builder’s Leader it was remarked on how reasonable Peter Lind had been in listening and acting on the men’s demands, stating (in capital letters) “IF ONLY MORE EMPLOYERS WERE LIKE THAT” (New Builder’s Leader Oct.1938).

Despite a number of strikes in 1938 and 1939 by the time war was declared a substantial amount of work had been completed. Peter Lind immediately applied for the scheme to be designated of national importance to try and stem the outflow of labour. Nevertheless by early in 1940 acute labour shortages were evident when the initial workforce of 500 men was reduced to 150 and at one point only 50 men were on site. Later in the year the workforce increased to 350 but between late 1940 and mid 1941, when heavy bombing occurred, the workforce dropped again to around 150 (Buckton and Cuerel 1943).

1.4 Bomb damage

The family papers of Peter Lind provide details of numerous war damage claims made to the Board of Trade after bomb damage sustained between September 1940 and April 1941: the Blitz period during which London suffered extreme levels of air-raid attacks. As Juliet Gardiner points out, the Thames at night when all around it was blacked out, acted “like a seductive, sinuous thread that couldn’t be pulled out, [and] mapped the targets for German bombers” (Gardiner 2010). Full moons became known as ‘bomber’s moons’ but the river, its bridges and its banks, was an easy target even during the day. When the air raids began the concrete construction of the southern half of the bridge was complete but the northern half was only partially built and entirely dependent on support from the centring (Alderman and Prior 1947). The bridge and adjacent works were hit nineteen times and during the blitz every site of the firm’s holdings suffered damage, beginning with an incendiary bomb on the 27th September 1940, which fell on the railway sidings at Shepherd’s Bush where the firm stored plant and machinery, and resulting in a claim of over £1,000 for the loss of cranes and derricks, scaffolding, hoists and timber sheds and offices.

On the 8th October 1940 the bridge suffered a near miss, which was written up by one of the employees –probably the site foreman:

“During the first warning in the working day our spotter noticed planes approaching from the south. The ‘take cover’ signal was given and almost immediately a bomb dropped on a warehouse nearby on south bank. Blast from the explosion...
was felt on the deck of the superstructure. Several of our employees complained of minor injuries sustained in their hurried scramble for shelter and an employee of Evans Welding Co. appeared to be suffering from slight concussion due to heavy fall resulting from blast.” (Lind/Jaeger family papers)

The bridge sustained a direct hit in May 1941 when a high explosive bomb penetrated the deck of the bridge and exploded in the tram subway beneath. Betty Jaeger recalled that five young people who had been sheltering there were killed instantly. By March 1942 Peter Lind had put in claims that totalled £4,808 for bomb damage sustained in raids on the bridge. The company continued to suffer damage to property and plant from flying bombs during the ‘little blitz’ with two hits at their depot in the East India Docks in September and December of 1944. The family papers reveal how the bombing raids caused not only a very substantial amount of time lost in working hours but also in extra paperwork required by staff to audit the losses and make insurance claims. No workers lost their lives during air raids but two men died accidental deaths during the eight years the contractors were on site (Alderman and Prior 1947).

Shortage of skilled welders was dealt with by adapting the type of weld used on the steelwork to one using moulds and newly developed electrodes, the Secrom method. This change of method was approved for the majority of the remaining welds on mild steel bars. It is at this point, after 1941, that it is highly likely that women became employed on the bridge. Popularly known to Londoners as ‘The Ladies’ Bridge’ because of the women who worked on its construction during the war this story has been kept alive in the commentary of riverboat pilots on tourist excursions up and down the Thames, although often embellished with some quite ludicrous statements, it does hold some truth. In an interview I recorded in 2007 with Betty Jaeger, née Lind, and Peter Lind’s daughter, she told me without hesitation that women did work on the bridge and that she had seen women working there when she had visited with her father. She did not consider this unusual during the war and this is confirmed with statistical evidence that shows over 25,000 women workers in the construction industry during the war (Wall and Clarke 2010). Personal correspondence with Keith Barnard, grandson of Peter Lind’s foreman steel-fixer and son of a wages clerk who was also based on site, substantiates Betty Lind’s memories. He remembered how both men,

“At this present time no documentary records revealing the numbers of women employed or the nature of their employment have been discovered mainly because when the firm of Peter Lind and Company went into receivership in the 1980s its records were destroyed.

Photographic evidence has recently emerged from the Daily Herald archive consisting of photographs of women welders taken in 1941 by J. Appleton, staff photographer. The newspaper daybook describes two photographs of one individual as, ‘Miss Dorothy Robertson, aged 19’ and ditto ‘wipes the grime from her face’. The group photograph shows women, who have removed their protective helmets to reveal their faces, dismantling the temporary bridge rather than building the new one, which by 1941 was nearly finished and had opened to two lanes of traffic in 1942. Nevertheless, these photographs go a long way in providing evidence that women did, indeed, work on the bridge during the war. They can be viewed at the BBC News website (http://www.bbc.co.uk/news/uk-england-london-33238462).

In 1945 Peter Lind and Co. submitted a claim to the LCC due to a fall in output of 30% due to wartime conditions and asking for an extension of contract in both time and payment, which was agreed by the Finance Committee of the Town and Planning Committee. The firm claimed that:

“The effects of [this] lower quality of labour have been most marked in carrying out the construction of the new bridge to a highly scientific design requiring a very high standard of workmanship and precise organisation of the sequence of operations. …. Not only has the unskilled labour available been mostly unsuitable, both physically and by experience, for the class of work, but the skilled workmen employed have been inadequately supplied with unskilled assistance” (LMA archives)

It is possible to interpret this acerbically worded claim as referring to women workers. In this case Peter Lind and Company, although seen as an enlightened employer in relation to unionised labour, would be similar to other contractors, including Arrol, who were keen to employ women, on lower wages than skilled men, in the shipyards and building sites of wartime Britain but had no use for them when the war ended (Clarke and Wall 2009). When Herbert Morrison formally opened New Waterloo Bridge on Monday December 10th 1945 women were not mentioned and he thanked the ‘fortunate men’ who built it knowing that their work was going to be of pride and use to London for many generations to come. He concluded that the new bridge was ‘a monument to their skill and craftsmanship’.

“spoke of just how many women worked on the bridge and confirmed that it was justly nick-named The Ladies Bridge. My grandfather was supervising them and my father was paying them.”
2 CONCLUSION

The site between Somerset House on the north shore and the approach to Waterloo Station on the south has seen a succession of bridges built and dismantled: Rennie’s old bridge, Arrol’s temporary bridge, the gantry built by Arrol to demolish the old bridge, Peter Lind’s bridge carrying cranes for construction, and finally the New Waterloo Bridge. In each case there was close collaboration between contractors and engineers in order to ensure safe working practices on a congested site in central London where constant traffic not only passed over the bridges but also underneath. Careful workmanship ensured that material from these structures was not wasted but reused. American elm from the piles of Rennie’s bridge made up the doors of the Coronation Annex to Westminster Abbey and stone for the new bridge, while Arrol’s temporary bridge was dismantled and shipped in 1942 via Antwerp to Remagen where it was re-assembled as a Rhine crossing (Best 1943; Washington Post 1945). While high standards of workmanship were only revealed on the demolition of Rennie’s bridge the standard on new Waterloo Bridge, although also hidden, is demonstrated in the quality of the concrete. The design aimed to produce a ‘crack-free structure’, and recent inspections have confirmed that the concrete elements are still in excellent condition although remedial work is required at some points (Astin 2017). There were over a million and half welds on the intersections and joints of the steel reinforcement on New Waterloo Bridge (Best 1943) and this, together with careful workmanship on the mixing and placing of concrete, and masonry work on the Portland Stone cladding has resulted in a beautiful addition to the Thames bridges. The contractors regarded themselves as a team, with the LCC and consulting engineers ‘working together for a common end’ (Alderman and Prior 1947). The modern structure they produced under such difficult conditions is indeed a monument to the hundreds of men and women engaged on its construction.

ACKNOWLEDGEMENTS

Many people have assisted over the years spent on this research which began in earnest when Karen Livesey and Jo Wiser contacted me to help with research for their film The Ladies Bridge premiered at the BFI in 2005. I would also like to thank those who have helped on this paper, in particular Carol Morgan at the ICE archives, Paul Jones at the Institute of Welding archives, Edwin Trout archivist of the Concrete Society, my CHS colleague Nina Baker for passing on items of interest from her own research in the Women’s Engineering Society archives, the Jaeger family for allowing me access to the papers they have kept from their grandfather’s company and introducing me to their mother, and Keith Barnard for getting in touch to add his own family history.

REFERENCES


Clarke, L. and Wall, C., 2009, ‘A woman’s place is where she wants to work: barriers to the retention of women in the building industry after the Second World War’ Scottish Labour History 44, 16–39.


Institute of Welding Quarterly Transactions, 1938, v1 p68, Institute of Welding Archives.


London Metropolitan Archives, LCC/CL/Hig/2/66 Labour claim to LCC by Peter Lind and Company Ltd., 5th November 1945.


Murphy, Hugh, 1999, ‘From the crinoline to the boilersuit’: Women workers in British shipbuilding during the Second World War.” Contemporary British History 13, no. 4 82–104.


New Builders Leader, “Waterloo Bridge Won for Steelbenders and Trade Unionism”October 1938 v4 1 p3, TUC Library Collections.


