



Project history of Dublin's River Liffey bridges

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A significant geographical feature of Dublin, the capital of the Republic of Ireland, is that the River Liffey divides the city into the north side and south side. As there has always been significant traffic needing to cross the river, ancient fords and ferries gave way to a series of bridges. It is assumed that the first stone bridge across the River Liffey was built in the thirteenth century. Most of the surviving bridge infrastructure was built in the nineteenth century. Four road bridges were built in the twentieth century. The first bridge crossing in the twenty-first century was a footbridge commissioned in 2000. A further road crossing was completed in June 2003 and a sixteenth crossing is under consideration. A significant departure for Dublin was engaging an international designer for these latter bridges. The historical progression of river crossings is described and linked to a comprehensive set of 16 photographs. Historical reviews are provided of the approach used in bridge design and construction, the time and cost outcomes, the principals contracted to deliver the bridges, and certain aspects of the construction where such information was recorded. All original imperial measurements are also given in metric, and for ease of comparison all monetary values are given in Irish pounds (€1 = IR£0.78).

1. DUBLIN CITY AND ITS PRINCIPAL RIVER

The River Liffey, which is about 135 km long, has its source near Kippure in Co. Wicklow and its confluence with the Irish Sea at Dublin Bay, which forms the eastern boundary of Dublin City.¹ The source of the Liffey is at approximately 540 m elevation and only about 20 km south of Dublin in the Wicklow mountains. In its flow the river drains just over 1380 km² of catchment area and forms a huge arc as it flows first to the west, then in a general northerly direction and finally east through Dublin City. It flows over a range of different geological formations; from granite, to sandstone, to sandstone–limestone and finally pure limestone. Two reservoirs and three small hydroelectric power stations act as controls on the river flow.

Prior to the beginning of the seventeenth century, and within what would at that time be considered as the city limits, the Liffey was spanned at the city's westerly limit by a single bridge. This bridge, which was built during the eleventh century, was constructed from timber and was known as Dubhghall's Bridge.^{2–4} The bridge replaced a ford that had been

called the Ford of the Hurdles. A masonry bridge, which was known as the Bridge of Dublin (also referred to as the Old Bridge), replaced the original timber structure during the first quarter of the thirteenth century. This bridge was quite wide and was a 'living bridge'; it was lined with houses and shops and had towers at either end. The river was navigable by seagoing vessels as far as this bridge.⁵

The river's width within the city has over time been considerably modified and narrowed by land reclamation. Probably from the beginning of the thirteenth century and for the next five centuries the banks of the river underwent development through reclamation and earthen or timber riverbank construction. During the period from the first quarter of the eighteenth century to the second quarter of the twentieth century significant development work took place on training the river to accommodate shipping. In particular the second and third quarters of the nineteenth century were witness to significant development as quay walls on both the north side and south side were constructed to create deepwater berthing.^{6,7} Within the present Dublin City area the river has a width, between quay walls, generally widening in the downstream direction from about 30 m to over 300 m at its mouth.

The earliest recorded settlement on the banks of the navigable stretch of the River Liffey is given as the sixth or seventh century. The first landing by the Vikings was in AD 795, and by AD 841 they had created a permanent settlement, which was named Dubh Linn, 'the black pool'. Other settlements consisted of small clusters of habitation at different locations on both the north bank and south bank of the river. Initially movement from either side of the river would have been by fording it or by obtaining passage on whatever small craft was travelling from one bank to the other. The Norse built a fortification on the south side of the river. In 1170 the Normans arrived at a time when the population within the settled area was probably only a few thousand people. A building programme throughout the thirteenth century created two cathedrals and other secular buildings including a castle (Dublin Castle), many other stone buildings, and the building and conversion of the city walls to stone. The developing city walls contained six free-standing towers incorporating arches (or gates) located at junctions with streets, and the castle formed the south-east corner of, and was included within, the ramparts. However, adjacent to the Liffey the walls were incomplete, giving access to the quays.

The first census in Ireland in 1659 showed that the total population of Dublin was 8780. However, some 15 years earlier the population was believed to be between 20 000 and 30 000, but it had been stricken by plague on at least two occasions. Dublin's future population would increase and decrease with time for numerous reasons such as war, disease and immigration. By 1776 it had reached 150 000. This undulation of the city's population has continued to recent times: censuses have shown populations of 567 802 (1966), 481 854 (1996) and 495 101 (2002). Where in ancient times the population focus was on the south side of the river, the density of population is now higher on the north side. Throughout its history Dublin's population and those wishing to travel overland on a north-south axis adjacent to Ireland's eastern coast have needed to cross Dublin's geographical divide—the River Liffey.³

2. THE DEVELOPMENT OF BRIDGES OVER DUBLIN'S LIFFEY

There can be little doubt that in many ways the story of bridge building is the story of civilisation. By it, we can readily measure an important part of people's progress—Franklin D Roosevelt⁸

It would be difficult not to agree with this statement when examining the development of bridges across the River Liffey in Dublin.

Figure 1 shows the geographical locations of the 16 current and planned bridges across the Liffey within the city. The nomenclature used in this figure relates to the time order in which the bridges were initially built, number 1 being the earliest and number 16 being the latest. The diagram is a chronology showing significant dates and name changes.⁹ Name change appears to be a popular aspect of the Republic's means of demonstrating change 'from the old order', and there also seems to be an apparent need for commemoration. Thirteen of these bridges are road and pedestrian bridges, two are solely for pedestrians, and one is a rail bridge.

2.1. Father Mathew Bridge

This bridge is located at, or close to, the first millennium's site of the Ford of the Hurdles. It has been suggested¹⁰ that the original ford was in use up to and including the tenth century and was replaced by Dublin's first bridge, which was of timber construction. Little is known of this bridge, but circumstantial evidence of other timber bridges constructed in Ireland during the first half of the second millennium would indicate a simple framed structure without any form of cross or longitudinal bracing. Tree trunks were used firstly for creating sole plates that lay at the river bottom in line with the direction of water flow. Sole plates were laid at regular intervals across the width of the river, and from these bases vertical members were connected in or passed through into the underlying river bottom. The upper end of the vertical trunks within each sole plate would have been tied into a timber cross-member (transom) that would be in line with the sole plate. These transoms supported the deck and all other imposed loading. Rocks and stones placed on top would have protected the sole plates, and this would have helped to provide some lateral resistance to movement. It is somewhat surprising that this bridge lasted until at least 1315. It was rebuilt in 1320 but swept away in a flood in 1380. In the last quarter of the fourteenth century and the first quarter of the fifteenth century

a ferry plying between the north side and the south side had replaced, albeit temporarily, the timber bridge.

In 1428 the Dominicans, a religious order, constructed a masonry bridge, which was called the Bridge of Dublin (which became known as the Old Bridge) and provided a new permanent crossing at this location. The preachers in Ostman-town (north side) Friary funded the construction cost of the bridge. The concept of religious orders building and maintaining bridges was not, however, unique to Dublin.^{11,12} This stronger and wider bridge had four arches, and towers at either end. It was lined with shops and housing, and accommodated such buildings as a chapel, a bake-house and an inn. It carried all pedestrian, livestock and horse-drawn traffic across the river at that time. The tolls and chapel were recorded as still existing in 1762.

Between 1816 and 1818, indicating a lifespan for the bridge of 390 years, the Bridge of Dublin was replaced by a new 145 ft (44 m) long masonry bridge because of the collapse of the northern end of the Bridge of Dublin; it was called the Whitworth Bridge. This three-span, elliptical arch bridge was designed and constructed by George Knowles for the client, the Port of Dublin, at a price reputed to be about IRE26 000; the bridge is shown in Fig. 2. It was renamed in 1938.

2.2. Rory O'More Bridge

The Rory O'More Bridge had been built as the Victoria & Albert Bridge in 1863; it was renamed in 1939. It had two predecessors. In 1670 a timber bridge, the second across the Liffey, was constructed at this site and became known as Bloody Bridge. The timber bridge was replaced by a stone bridge in 1704, which in turn was replaced by the present day, 95 ft (29 m) single-span, 33 ft (10.05 m) wide, cast iron bridge supported off granite abutments. There are seven I-section beams that form the main span, and between each beam there is cast iron cross-bracing. The bridge is unusual in that its decking is of wrought iron. It was fabricated in St Helens, Lancashire, England. Today it carries two lanes of traffic.

George Halpin designed the bridge for the client, the Port of Dublin, and the contractor was John Killen of Malahide.¹³ The cost was reputed to be IRE13 710. The bridge is shown in Fig. 3.

2.3. Grattan Bridge

In 1676 the first bridge to be built on this site was a seven-arch stone bridge with piers from 9 ft (2.74 m) to 13 ft (3.96 m) thick, providing a total waterway width of 170 ft (51.82 m). The bridge was constructed from the ruined masonry of a nearby abbey; at completion it was named the Essex Bridge. In 1687 it was repaired after being damaged in a flood. In 1751 the second most northerly pier collapsed and damaged the adjacent arches; in May of the same year temporary repairs were undertaken, but it was decided to rebuild the bridge. The contractor who built the replacement bridge discovered that the piers of the old bridge had been built upon timber grillages, which were believed to have been constructed onshore and then sunk to the river bed at the required pier positions. The grillages were not founded on piles, and as they sat on the river bed without any apparent protection it was not surprising that the bridge suffered catastrophic damage on more than one occasion.

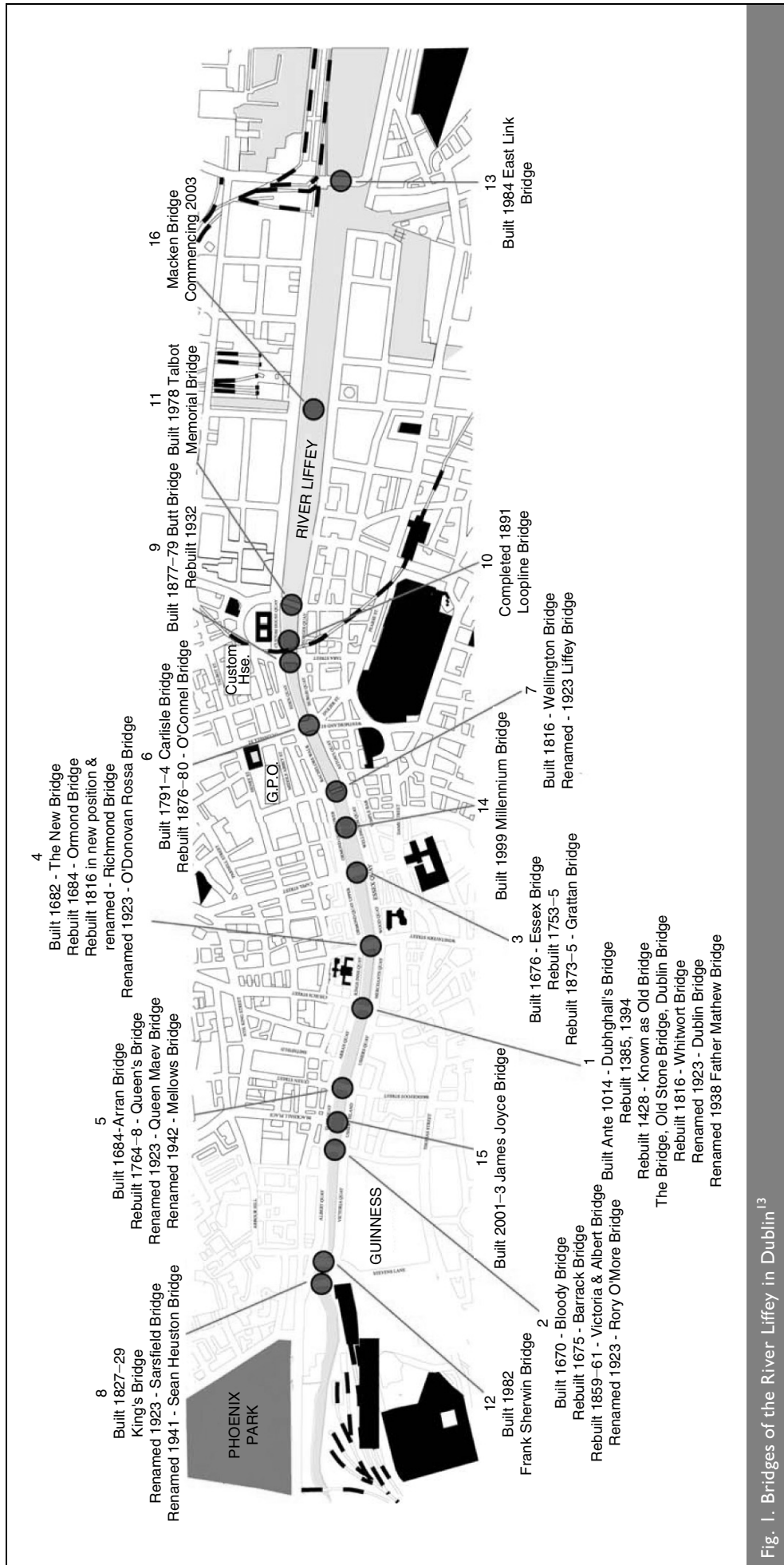


Fig. 1. Bridges of the River Liffey in Dublin¹³



Fig. 2. Father Matthew Bridge 1818



Fig. 3. Rory O'More Bridge 1863

The replacement Essex Bridge was constructed in 1753 to 1755, and its development is well recorded.^{14,15} The new bridge was a five-span semicircular stone arch design with two 8 ft (2.44 m) piers and two 9 ft (2.74 m) piers; this left a waterway width of 200 ft (60.96 m). The width of the bridge was 47 ft (14.3 m). It was designed and constructed by George Semple, who had undertaken the repairs on the previous bridge in 1751, for the City of Dublin. Semple was particularly interested to explore using the latest technology of 'enclosures' when constructing in water, to enable the removal of old foundations and replacement with new. Because 28 borings had shown depths of sand, mud, gravel and stones of less than 20 ft (6.1 m), but more often less than 10 ft (3.05 m), above bedrock, his plan was to cofferdam and remove the offending material. A cofferdam would have to be designed to keep out water at depths of 27 ft (8.23 m)—high spring tide. The timber-plank cofferdam extended beyond the midway point of the bridge's length and was connected to the bank at a considerable distance upstream and downstream of the bridge's centreline. The temporary works were undertaken by building first the northern cofferdam followed by the southern cofferdam. In plan the cofferdam formed a truncated V, and in elevation it consisted of five vertical compartments, a large middle section flanked by two narrower vertical spaces. All five compartments were filled with puddle clay when the cofferdam was driven to its required depth. The two piers at the north end were founded on oak bearing piles that were driven to rock, but because of the higher level of rock on the south end the two piers there were founded directly on rock and not piled.

Semple appears to have been a very competent project manager. He took responsibility for the bridge's design and

construction without any form of written contract. His public declaration of estimates stated that the bridge would cost IRE20 500 and take two years to complete. He delivered the bridge to the City of Dublin with a 1.1% overrun on the scheduled period (eight days over the two years) and with less than a 1% overspend (in fact 0.79%) on the cost budget (actually IRE20 661).¹⁶ Much later bridges have not been able to match this excellent result.

After about 120 years' use it was decided that the Essex Bridge should be widened and lowered because it was considered too narrow and had approaches that were too steep. Another reason for reshaping the bridge was the planned widening of the quays to accommodate a new main drainage system that Dublin Corporation was planning. The changes were included within a design that would create three central elliptical arches flanked by a single semicircular shorter span on each side of the river. The carriageway was to be widened, and footpaths were to be cantilevered from the face of each side of the bridge on wrought-iron lattice girders. The design was carried out by Bindon B. Stoney, Engineer of the Port of Dublin, in conjunction with the City Engineer, Parke Neville. The decision to proceed to tender was obtained in November 1872; the planned construction budget was IRE23 456.⁷ Between 1873 and 1875 the Essex Bridge was rebuilt by William J. Doherty, and the out-turn cost is reported to have been IRE25 380 7s 6d, which equates to an 8.2% overspend. Upon rebuilding the bridge it was renamed the Grattan Bridge, and is shown in Fig. 4.

During 2002, while upgrading the footpaths, the bridge superstructure was found to be deteriorating as a result of water leaking through the deck. The urgency of the works meant

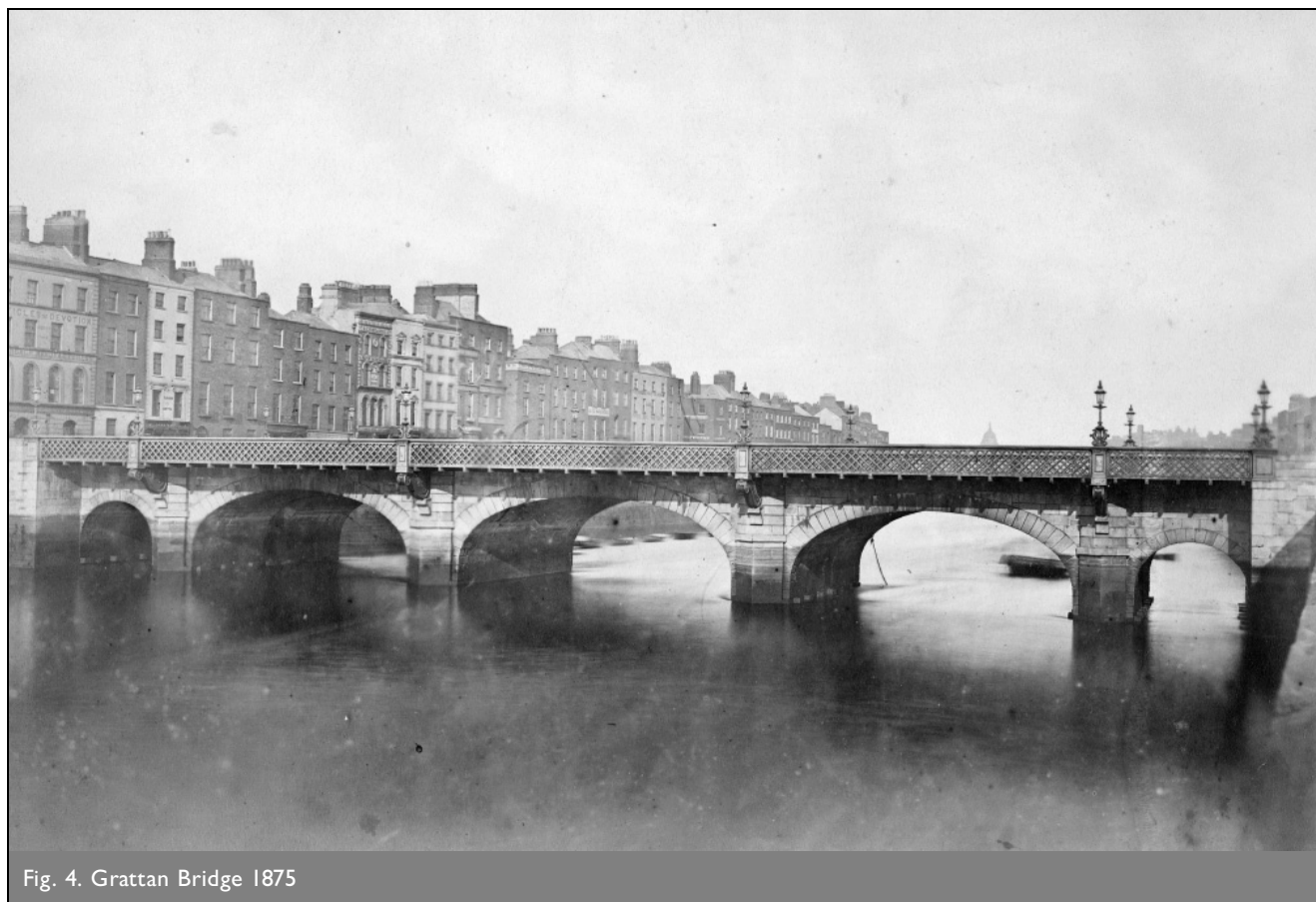


Fig. 4. Grattan Bridge 1875

there was not sufficient time to proceed with the normal tendering process. Messrs Pierse Construction Ltd, who were contracted to provide the adjacent cantilevered boardwalk over the river, carried out the work at a cost of €2.3m (IR£1.794m).

2.4. O'Donovan Rossa Bridge

What would have been Dublin's third timber bridge in a period of 14 years was built in 1682 and was called the Ormonde Bridge. It was paid for by the incumbent Lord Mayor of Dublin, Sir Humphrey Jervis,¹⁷ and cost IR£502 19s 7d. Without railings of any type it is not surprising that it was condemned and replaced in 1684 by a masonry bridge. The masonry bridge was designed as a five-span simple arch bridge, which is understood to have had an opening drawbridge or centre span that was arched over a few years after it was commissioned.¹³ In December 1802 the bridge was swept away during a severe storm.

In 1805 James Savage (1779–1852) won a design competition to rebuild the Ormond Bridge. This project was delayed, and in 1808 Savage developed a design for a bridge that was to be located about 165 ft (about 50 m) west of the original Ormond Bridge. This bridge was constructed between 1813 and 1816 and consists of three symmetrical, elliptical, arch spans in granite masonry. It spans 144 ft (44 m) between abutments and is 49.3 ft (15.034 m) in width. The bridge was completed with classical cast iron balustrades, moulded arch rings and sculptured heads on the keystones. The bridge was designed for the Port of Dublin and was constructed by George Knowles for IR£25950. The new bridge was originally named the Richmond

Bridge, but this was changed to its present name in 1923. See Fig. 5.

On completion of the bridge, Knowles designed and constructed the Whitworth Bridge (see Father Matthew Bridge).

2.5. Mellows Bridge

In 1683, a year after Jervis's timber Ormonde Bridge was built, a stone bridge called the Arran Bridge was built in a location between the upstream Bloody Bridge and the downstream Bridge of Dublin. This bridge was funded by the owner of lands on the north side, Mr William Ellis, with Dublin Corporation contributing £700. Ellis was also bound to maintain the bridge. The bridge stood for about 80 years, but was swept away by a flood in 1763.⁷ It was rebuilt between 1764 and 1768 as a three elliptical arch stone bridge 141 ft (43 m) long and 33.5 ft (10.2 m) wide, and was named the Queens Bridge. The bridge was designed and supervised by Charles Valency, a military engineer, for the Port of Dublin at a cost of IR£6000. At 235 years old it is the oldest of all the current city bridges. It was subjected to a name change in 1942 to its current name. The bridge is shown in Fig. 6.

2.6. O'Connell Bridge

Approximately 25 years after the opening of the Queens Bridge, another bridge was constructed downstream of the Essex Bridge. This was named the Carlisle Bridge: it would be the sixth bridge within the city to cross the Liffey and the fourth bridge (all masonry) to be built during the eighteenth century. It was, however, a bridge at a new site, as the other three bridges were rebuilds. The bridge was also closer to the mouth

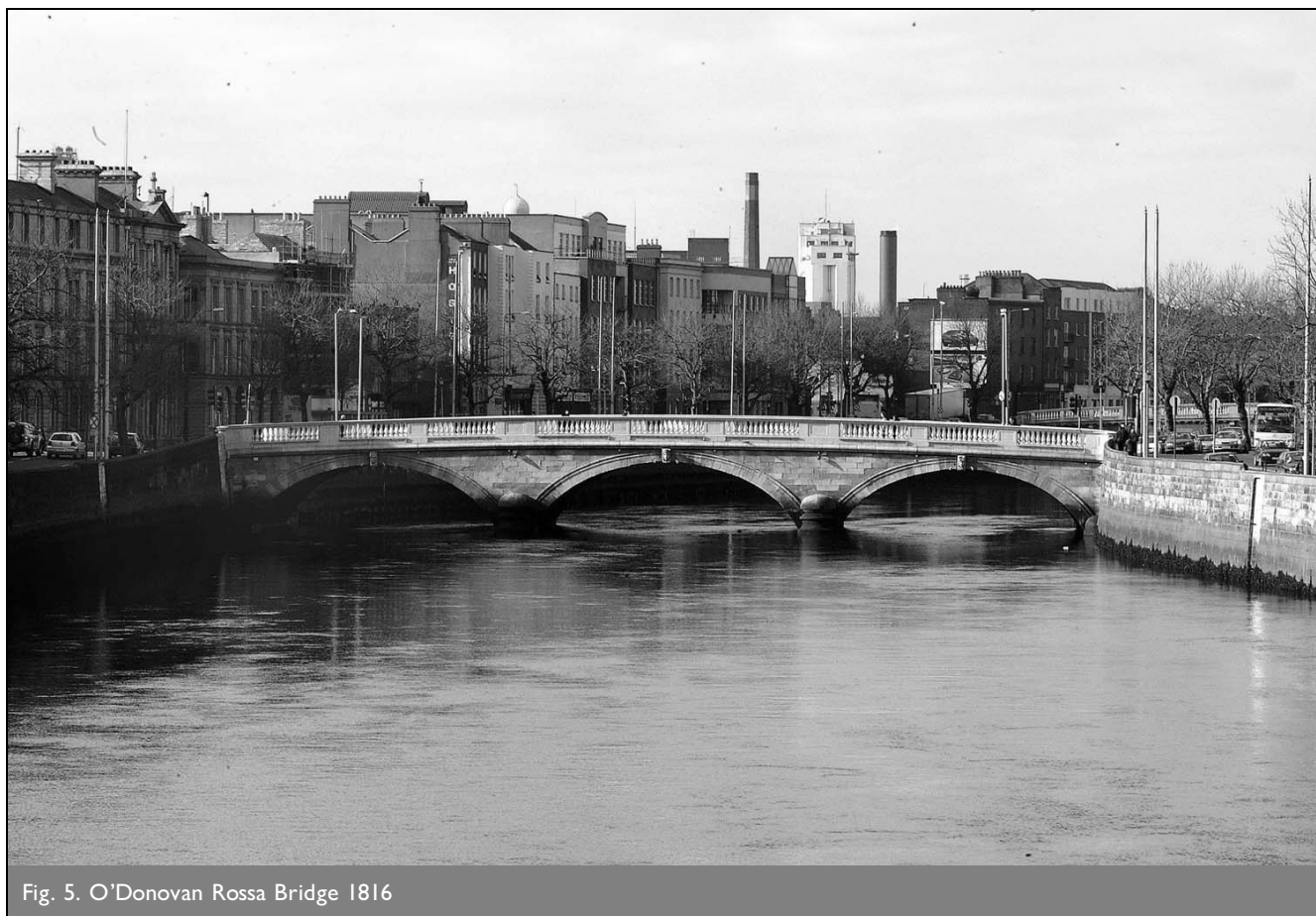


Fig. 5. O'Donovan Rossa Bridge 1816

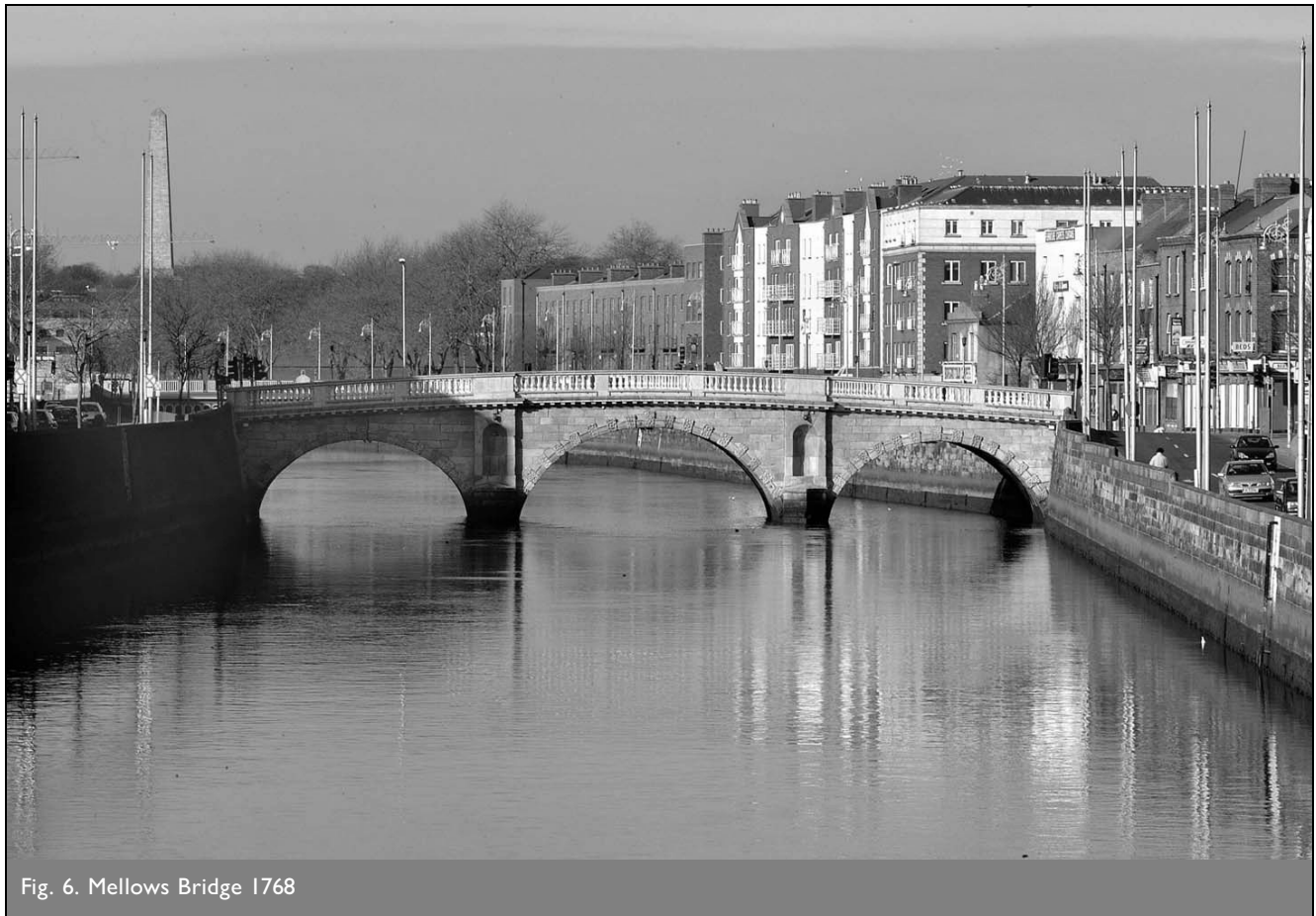


Fig. 6. Mellows Bridge 1768

of the river, and being a fixed span resulted in a general shift of the port of Dublin and eventually the city centre, to the east. This new bridge was designed by James Gandon in 1789,¹⁸ and was constructed between 1791 and 1794. It was a symmetrical, three semicircular arch structure constructed in granite with granite facings and Portland stone balustrade. The bridge was 210 ft (64 m) long and 40 ft (12.2 m) wide (Fig. 7).

Widening and lowering the Essex Bridge preceded a need to apply the same concept to the Carlisle Bridge. Sackville Street (now O'Connell Street), which formed the north side carriage-way connection to the Carlisle Bridge, was 230 ft (70 m) wide. To improve the streetscape and accommodate increases in traffic across the bridge it was decided to lower the bridge and widen it to the same width as Sackville Street.¹⁹ A census of traffic taken in 1860 showed that 1037 vehicles per hour passed over Carlisle Bridge compared with 1091 vehicles per hour over London Bridge. Conceptual designs, design competitions,²⁰ and various reviews including funding sources were undertaken during the period 1861 to 1875. In 1875 the Port of Dublin engineer Bindon Stoney, who had just completed the redesign of the Essex Bridge, was directed to redesign the Carlisle Bridge, and the bridge was constructed to that design by William Doherty.¹⁰

Cofferdamming of the two river piers was needed to extend the upstream and downstream pier length to accommodate the wider bridge arches. Riveted iron plate caissons were manufactured and lowered to the river bottom. Diving and dredging were used to clear the river bed down to bedrock, and the caissons were then filled with concrete. Once the piers were

extended the extensions to the arches were completed, and this allowed traffic to use the new extensions; records indicate that was in May 1879. The superstructure of the old bridge was then removed and reformed to match the extensions.

The estimate for the contract was IR£68 000, with a construction programme of two and a half years. A penalty of £30 per week was to be imposed for overruns. Construction work on the Carlisle Bridge commenced in May 1877 and was completed in August 1880 at a construction cost of IR£70 342 4s 1d. The bridge was renamed the O'Connell Bridge. There is no record of the penalty being imposed on the contractor, and this may be due to the fact that the new arches were opened to traffic in May 1879 while work on the existing arches progressed. The bridge under construction while still providing access for trams etc. is shown in Fig. 8. The difference in bridge widths is shown in Figs 9 and 10. At the same time as Doherty was appointed to build the redesigned Carlisle Bridge, he was also appointed to build the Butt Bridge (see section 2.9).

2.7. Liffey Bridge

The Liffey Bridge (otherwise known as the Ha'penny Bridge) was the first iron bridge across the Liffey within the city. This bridge has become the international icon by which Dublin is recognised.

It is a 141 ft (43 m), single-span, pedestrian structure of cast iron bolted segments and resting on a granite abutment on each bank. The bridge forms a low-rise elliptical arch with a rise to span ratio of 1 : 12.3; the pedestrian platform is 12 ft (3.66 m) wide, and the distance between the railings is approximately



Fig. 7. Carlisle Bridge (elevation) 1794



Fig. 8. O'Connell Bridge (under construction) 1879

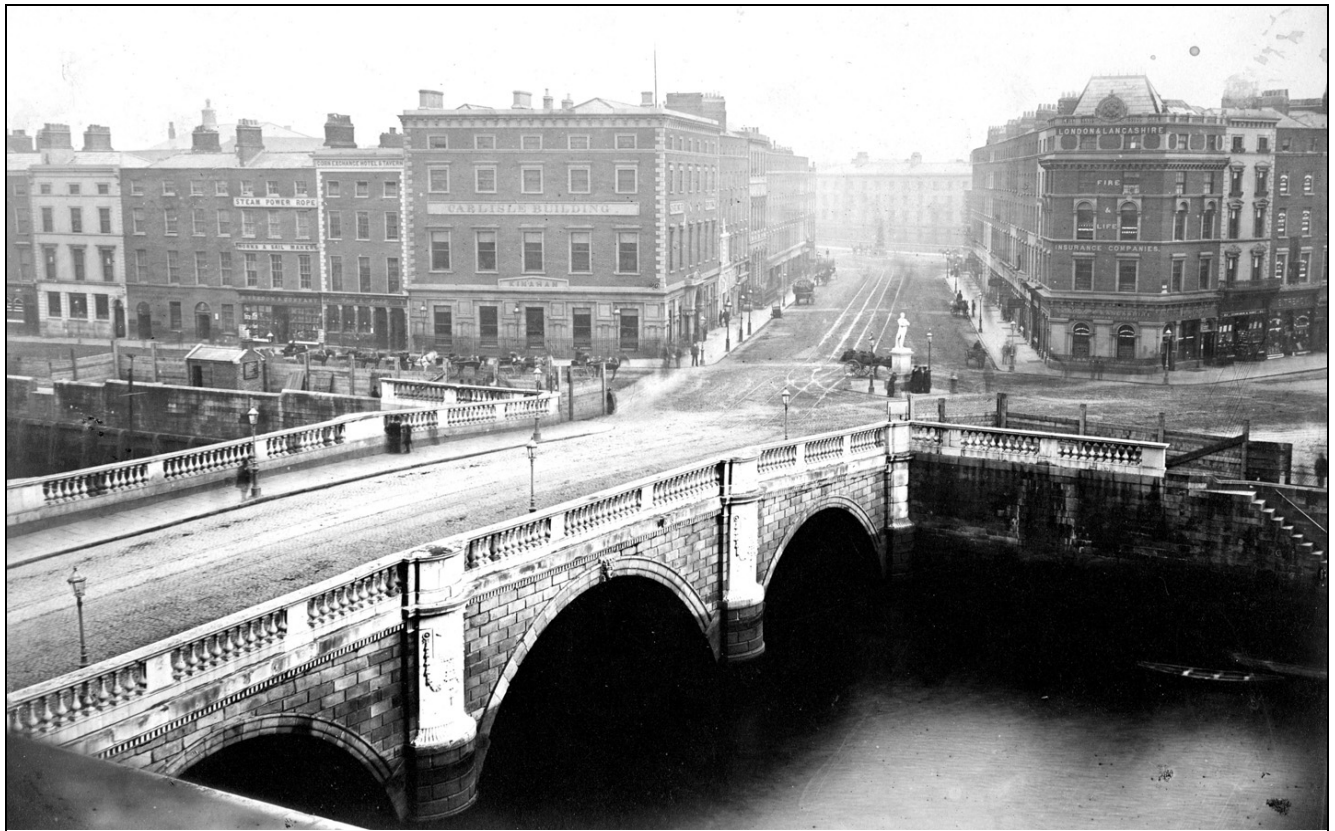


Fig. 9. Carlisle Bridge (completed) 1794



Fig. 10. O'Connell Bridge (near completion) 1880

10·25 ft (3·1 m). It was built as a toll bridge, hence the colloquial Ha'penny—the charge rate for crossing. The toll charge was not based on the cost of constructing the bridge but was conditioned to be the same as the ferry it replaced. In addition, if the citizens of Dublin found it to be objectionable within its first year of operation, it was to be removed at no cost to the city.

The bridge was named the Wellington Bridge when opened in May 1816 after a one-year construction period at a reputed cost of IRE3 000. It has been reported that John Windsor¹⁸ and the Colebrookdale Company of Shropshire, England, were the designers and manufacturers respectively. Colebrookdale is the site of the first iron bridge in 1779.

There are three parallel arched ribs that span the abutments;^{21,22} they are not built into the abutments but form a simple hinged arch. The arches are 6·25 ft (1·9 m) deep at the abutments and 1·65 ft (0·5 m) deep at the crown of the bridge. Each spanning rib is made up from six sections bolted together end to end, with each section measuring approximately 23·5 ft (7·2 m) in length. The ribs are laterally braced at the rib bottom and at rib mid-height by cross-stays (orthogonal distance pipes and associated screw pins), and with diagonal bracing on the same planes as the orthogonal bracing. The pedestrian deck is supported by T-sections that span across the arch ribs at about 7·75 ft (2·36 m) centres. The bridge is shown in Fig. 11.

The method of bridge erection does not seem to have been recorded. It is assumed that timber falsework was erected from the river bottom to create a platform, with an elevational

profile the shape of the underside of the bridge arches, as this was standard practice in the erection of iron bridges at that time.¹⁴ The falsework would have had to be designed to facilitate safe passage for river barges and other craft travelling up and down the river. The bridge was renamed the Liffey Bridge in 1923.

In 2001 the number of pedestrians using the bridge on a daily basis was 27 000. A structural survey indicated that modern safety standards were not being complied with. A major refurbishment, with conservation a priority, was carried out. The estimated cost was IRE780 000 (€1·0m) and the final cost was IRE1·25m (€1·6m). The contract programme was for 6 months, whereas the actual construction time was 12 months. The additional time and expense were as a result of focusing on conservation, rather than replacement and installing a temporary pedestrian Bailey bridge.²³ Mott McDonald EPO Ltd, Consulting Engineers, were appointed to carry out the structural assessment and to prepare contract documents. Messrs Irishenco Construction Ltd was the successful contractor. Messrs Harland and Wolff Ltd of Belfast was the steel subcontractor and had responsibility for refurbishment of the railings and deck superstructure.

The refurbishment of a bridge with such a large conservation input requires focused project management because of the continuous unfolding conservation demands and the multiplicity of specialists who do not react to normal site pressures, but often perceive 'time' as incidental to restoration. The quality of the work was recognised when it received a European Union Cultural Heritage/Europa Nostra Award in 2003.



Fig. 11. Liffey Bridge 1816

2.8. Sean Heuston Bridge

About 10 years after the erection of the Liffey Bridge another cast iron bridge called the Kings Bridge was commissioned, and this was sited at the extreme westerly end of the city area under consideration.

It was originally designed by George Papworth to carry horse-drawn traffic. Richard Robinson of the Phoenix Iron Works in Dublin constructed the bridge for a contract sum of £13 000. The funds to pay the contractor were apparently raised by public appeal to commemorate a visit by King George IV in 1821. The bridge, built between 1827 and 1828, is approximately 98.5 ft (30 m) long, 30 ft (9.145 m) wide, and is supported off a granite abutment on each side of the river. The bridge is shown in Fig. 12.

In 1923 it was renamed Sarsfield Bridge, and in 1941 it was again renamed as the Sean Heuston Bridge. In 1980 Dublin Corporation restricted its use to vehicles weighing 2 t or less. This bridge is currently being refurbished for use as part of the new light railway project.

2.9. Butt Bridge

Just downstream of Carlisle Bridge a structural steel swivel bridge designed by the Port Engineer, Bindon B Stoney, was built in the period between 1877 and 1879 by William Doherty for the sum of IRE44 662 6s 11d. The bridge was officially opened in August 1879. A condition in its approval to be built was that it should permit vessels to pass and berth in the river

as far upstream as the Carlisle Bridge. The design consisted of a single masonry approach span of 37 ft (11.28 m) from each bank with a central swing span of 127 ft (38.71 m), which provided two 40 ft (12.19 m) wide navigable openings each side of the central pier support structure. The carriageway was 18.5 ft (5.64 m), and there was a 5.5 ft (1.68 m) footpath on each side of the carriageway. The swing section, made of wrought iron and weighing 200 tons, was supported on and ran on a series of cast spoke wheels. The swing section was powered by a steam engine, which was housed on a timber pier at the downstream end of the central pier. The 1879 bridge is shown in Figs 13 and 14.

To minimise encroachment of the temporary works on the navigable width of the river the abutments and central pier were constructed using a single line of piles rather than the double or greater number of rows that had been the approach with earlier upriver bridge constructions. The single row approach, however, utilised group piledriving, where each pile consisted of two or three baulks of timber fastened together with dowels and wrought-iron collars.^{10,16} This approach was designed to minimise water leakage, and it appears to have been successful.

Provision was made in the original design for the removal of the swing section and its replacement by a single central stone arch.¹⁶ The swing bridge was decommissioned in 1888, and because of restricted road width and fairly steep on/off gradients a new reinforced concrete bridge was designed and



Fig. 12. Sean Heuston Bridge 1828



Fig. 13. Butt Bridge 1879

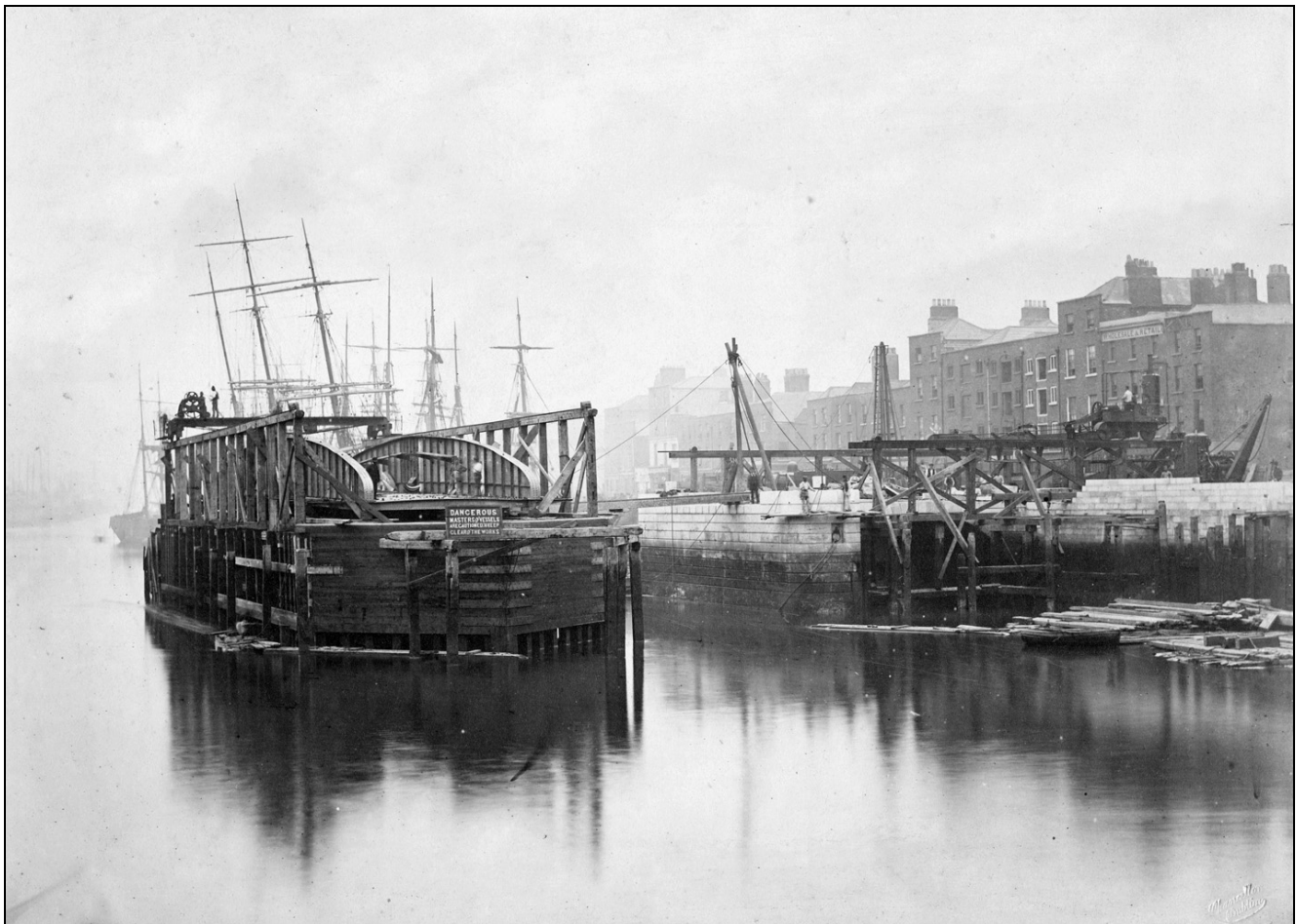


Fig. 14. Butt Bridge (under construction) 1879

constructed between 1930 and 1932; it opened to traffic in June 1932.

The new bridge, built in the same location as the original Butt Bridge, has a central span of 112 ft (34.13 m) and a single approach 40 ft (12.2 m) span each side of the central span. The central span was influenced by the span of the Liffey Viaduct river piers immediately downstream, as to repeat this span would provide a fixed channel for river traffic. The bridge is 66 ft (20.12 m) wide across the spandrels on the central span and carries a 40 ft (12.20 m) roadway and two 11.75 ft (3.58 m) footpaths.

Joseph Mallagh, chief engineer to the Port & Docks Board, and Pierce Purcell, Consultant, designed the bridge. The contractor was Gray's Ferro Concrete (Ireland) Ltd and the construction cost is recorded as IR£65 500.¹⁷ The current bridge is shown in Fig. 15.

2.10. Liffey Viaduct (or Loopline Bridge)

Just downstream of the Butt Bridge a steel lattice girder bridge supported on metal piers and carrying a local rail line was constructed during the period 1889 to 1891. This bridge was required to provide a rail link between north and south Dublin, and to facilitate the movement of transatlantic mail coming from—as they were named—Kingstown (Dun Laoghaire) and Queenstown (Cobh). The bridge was approved after 30 years of controversy,⁹ and was limited to five spans. J. Chaloner Smith, engineer to the Dublin, Wicklow and Wexford Railway Company, designed the bridge.

The bridge consists of wrought iron lattice girders on a double row of pier supports. Two pair of cylindrical cast iron piers support the bridge across the river; they are 10 ft (3.05 m) in diameter tapering to 13.75 ft (4.2 m) diameter at their base. These piers were used as caissons, sunk and dowelled into rock, and filled with concrete; the viaduct section is located on ornate white limestone piers. The viaduct is about 20 ft (6.1 m) above street level. The piers are braced with fish-bellied girders, above which are located the lattice girders. The main girders support cross-girders at 6 ft (1.83 m) centres, which carry a steel trough deck. The bridge and viaduct carry two lines of sharply curved ballast track. The bridge is shown in Fig. 16.

The contractor was Arrol Bros. The cost of erection of the whole loop line including the bridges was IR£350 000.⁹

2.11. Talbot Memorial Bridge

The Talbot Memorial Bridge (see Fig. 17) was constructed in 1978, and at the time was the bridge nearest the mouth of the estuary,²⁴ the most easterly of all the bridges. The purpose of the bridge was to create a gyratory movement on the north and south quays and remove traffic eastwards from the city centre.

It was designed to carry four lanes of traffic plus two footpaths, giving a total width of 72 ft (22 m). The bridge was designed by De Leuw, Chadwick and O'hEocha (now incorporated into Mott MacDonald EPO Ltd) Consulting Engineers and was built by Messrs Ascon Ltd. Design conditions were imposed by the Port Authority in relation to clearance for river traffic and aesthetic restrictions due to its proximity to the Custom House completed by Gandon in 1791. To provide for navigational requirements a



Fig. 15. Butt Bridge (1932)



Fig. 16. Loopline Bridge 1891



Fig. 17. Talbot Memorial Bridge 1978

single-span solution and a three-span solution were examined. A three-span solution was adopted for the 246 ft (75 m) wide river with a centre span of 111.5 ft (34 m). It was constructed by founding the bridge piers on rock using interlocking steel sheet piling to form cofferdams and precast, prestressed beams with an *in situ* deck for the superstructure. The contract programme was for 18 months and the actual construction time was 20 months (construction period was April 1976 to February 1978). The main delay was incurred as a result of difficulties in sealing and drying out the cofferdams. The tender price in 1975 was IRE725 380 and the final cost was IRE1.05m. The conditions of contract used for bridges constructed in the latter part of the twentieth century were the Institution of Engineers of Ireland standard conditions of contract (adopted from ICE conditions of contract). These included the standard price variation clause (PVC) and Clause 12 for unforeseen ground conditions. In the mid-1970s inflation was high, at 15%, and had a sizeable impact on the final cost of projects.

2.12. Frank Sherwin Bridge

When the Talbot Memorial Bridge was being considered on the eastern side of the city, it became apparent that the gyratory movement of traffic on the north and south quays could be greatly improved if a similar bridge was built west of the city centre. This would require the direction of the existing one-way system to be reversed. The location chosen for this bridge was adjacent to the main Heuston railway station and about 213 ft (65 m) east of Sean Heuston Bridge, where two main road arteries converge on the Liffey. The bridge was designed in house by Dublin Corporation's Road Design Division. Messrs

Irishenco Ltd were the successful tenderer appointed to construct the bridge.

The bridge is a three-span structure with a fully continuous reinforced concrete cast in-situ deck: see Fig. 18. The centre span is 72 ft (22 m), with two equal side spans of approximately 46 ft (14 m), and a deck width of 64.75 ft (19.7 m) between parapets. The piers were founded on rock within cofferdams. The project commenced on 8 October 1980 with a contract programme of 25.5 months. It was constructed in 23 months. Inconsequential delays were experienced due to grouting of rock, delay in access to south quay area and problems with the deck cladding units. The latter problem arose as a result of the shape of the precast cladding being fixed prior to casting the *in situ* deck. As a result it was necessary to redesign the cladding units. The high quality of workmanship was recognised when it was awarded the Irish Concrete Society Award in 1982. The tender price was IRE1.374m and the final cost was IRE1.8m.

2.13. East Link Bridge

A Dublin businessman, Mr Tom Roche, proposed in 1976 that a bridge should be constructed across the river at the boundaries of the developing modern deep sea berth area and the older declining cargo area. The Ports Authority approved an opening span bridge, and the local authority gave its permission for a connection into the public road network. The cost of the bridge was to be recouped through tolls, of which there was no history in Ireland in the modern traffic context. The bridge was

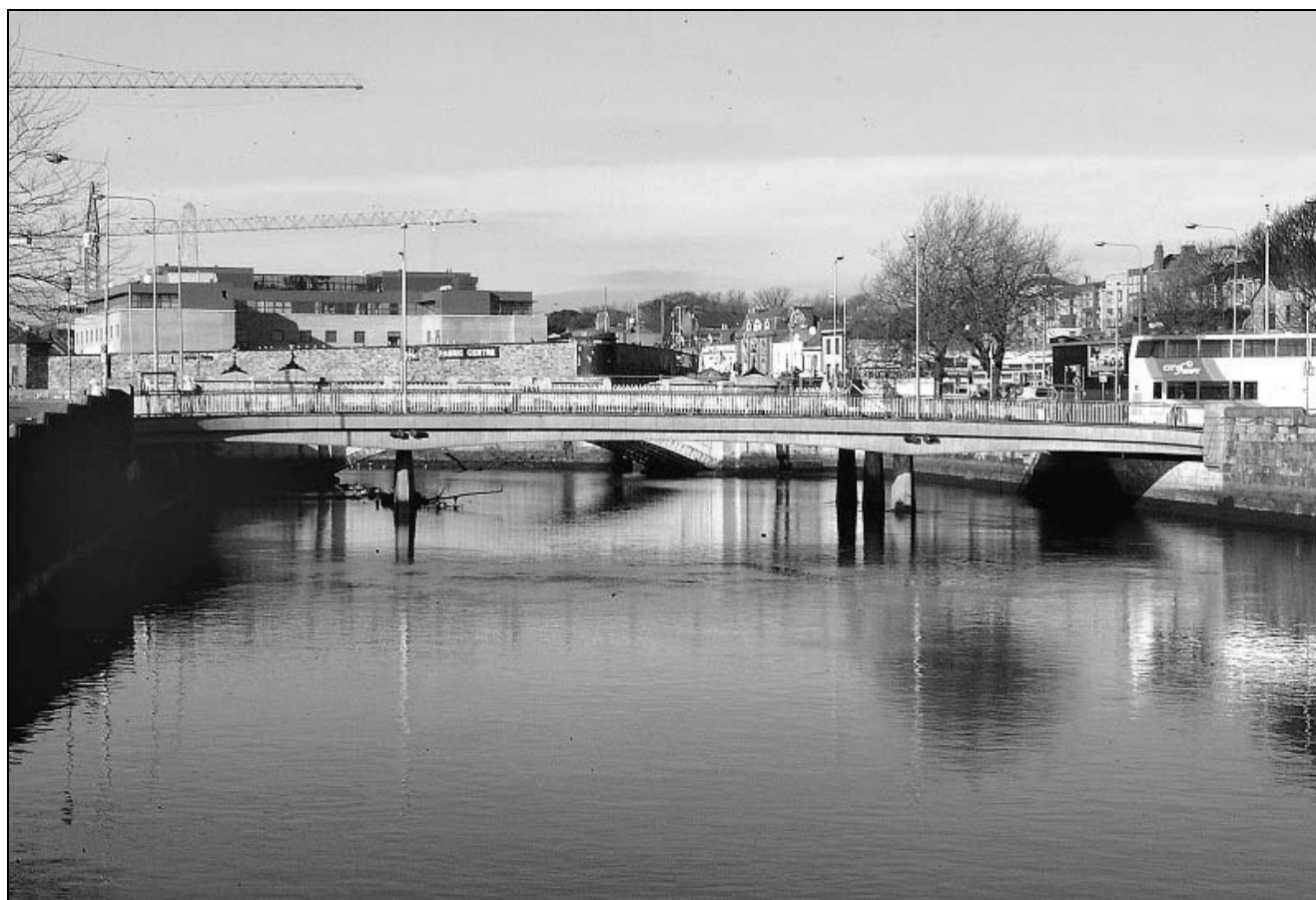


Fig. 18. Frank Sherwin Bridge 1982



Fig. 19. East Link Toll Bridge 1984

designed by McCarthy and Partners Consultants Ltd (now part of Atkins) and built by Messrs Irishenco Ltd.

The bridge traverses the Liffey and connects East Wall road with Ringsend; it is shown in Fig. 19. The width of the river at this location is 210 m (690 ft). The bridge comprises four fixed spans of 26 m (85 ft) each, an opening span of 45 m (148 ft), and an approach road of 1150 m (3773 ft). The bridge width is 10 m (33 ft). Simplicity of design and construction were essential criteria. This resulted in piling for the piers and standard prestressed beams with an *in situ* deck for the superstructure.

The initial tender was for a traditional contract with a price variation clause. Following the award of contract, a fixed price of IRE5.9m was negotiated. Construction started in April 1983 for a contract period of 80 weeks. The contract was completed on programme at the start of week 81, being opened on 21 October 1984. The cost of the bridge was IRE6.1m. By February 1985 a million vehicles had used the new toll bridge, and the predicted usage of 11 000 vehicles per day had been reached.²⁵

2.14. Millennium Bridge

The refurbishment of the city centre and Dublin City Council's policy of increased facilities for pedestrians resulted in a

competition for a pedestrian bridge over the River Liffey, 125 m upstream of the existing Liffey Bridge (Ha'penny Bridge). This latter bridge is internationally recognised as a symbol of Dublin, and the winning design was seen as complementing and respecting it. The winning team were Hewley Harrington (Architects) with Price & Myers as Consulting Engineers. The successful contractor was Messrs Ascon Ltd. The bridge, shown in Fig. 20, was designed as a lightweight steel truss that is 41 m (134.5 ft) long and 4 m (13.125 ft) wide. It was prefabricated off site by Messrs Thompson Engineering of Carlow, transported 90 km to Dublin and, despite weighing 60 t, was placed in position by a single crane. The contract programme was for six months, which the contractor achieved. The estimated cost was IRE1m, but the lowest tender was for IRE1.6m. Because of the location and prestige attached to this particular project, the contractor agreed to fix the price at the tender figure, and it was completed for this sum.

Such was the quality of the design and construction that the bridge received awards from the Institution of Structural Engineers (UK), RIAI, RIBA, Construction Industry Federation (IRL), Emerging Architecture Award and Opus Plan Expo 2000.

2.15. James Joyce Bridge

The publication of the Dublin Transportation Initiative (DTI)



Fig. 20. Millennium Bridge 2000

report²⁶ in 1995 recommended the creation of 'centre city environmental traffic cells' that would remove through traffic from the main thoroughfare, O'Connell Street. In order to achieve this, it was necessary for a further two bridges to be constructed across the River Liffey—one bridge 3 km to the west and the other 2 km to the east. The James Joyce Bridge is located between the single-span cast iron Rory O'More Bridge and the three stone arch Mellowes Bridge. The traffic on the north and south quays could not be interfered with, so a single tied-arch bridge was selected that permitted the abutments to be located in the river with minimum disruption to the river flow. In addition, it was decided that a landmark bridge should be built that would link and lead refurbishment on the north and south sides of the River Liffey. The new bridge is shown in Fig. 21.

Santiago Calatrava was appointed as architect/engineer for this bridge in 1998. The bridge is a single-span structural steel design, 40 m (131 ft) long, with the deck being supported from two outward angled arches, one each side of and above the deck. The deck provides double two-lane vehicular movement in each direction, and a pedestrian walkway is cantilevered from the deck on the outside of angled stringer supports between the deck and arches. This physical barrier between the pedestrians and traffic and the wide walkway (varies from 3 to 6 m) are designed to attract people onto the bridge to view the

city landscape and the River Liffey. The deck width between railings is 30 m (98.5 ft).

The contract was commenced in April 2001 for a tender sum of IR£4.416m (€5.608m). Messrs Irishenco Construction Ltd were the main contractor and Messrs Harland & Wolff of Belfast the steel fabricator. The contract programme was 11 months with an actual construction time of 26 months. Considerable delays were incurred as a result of extended piling due to a buried river and welding complexities with the steel fabrication. The final cost has not been agreed to date, but will be in excess of the tender sum. The bridge was officially opened on 16 June 2003.

2.16. Guild St—Macken Street Bridge

The bridge required to the east of O'Connell Street to complete the environmental traffic cell will be located between the Talbot Memorial Bridge and the East Link Bridge and will align with Guild Street on the north quay and offset Macken Street on the south quays. The proposed bridge, also designed by Santiago Calatrava, will be a cable-stayed structure with a span of 120 m (394 ft) between the north and south quays, and will be mechanised to swing horizontally as the river at this point is used by seagoing vessels. An asymmetric shape will be provided through positioning of the pylon outside the navigation channel at a point approximately 28 m (92 ft) from the



Fig. 21. James Joyce Bridge 2003



Fig. 22. Guild Street—Macken Street Bridge (proposed)

south quay. The cable-stayed pylon will have a curved profile leaning northward and rising to a height of approximately 48 m (157.5 ft) above the adjacent quays. The bridge deck will be structural steel, with side cantilevers supporting the footpath and cycle tracks. The combined width of the bridge will be 22 m (72 ft). A computer-generated image of the proposed bridge is shown in Fig. 22. The original estimated cost of this bridge is €20m; an independent review is currently being carried out to establish a recommended procurement strategy, the forecasted out-turn cost and predicted construction period.

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