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Oak Park Bridge: History & Restoration

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Introduction

Large country estates often include a natural or artificial water feature, such as a river flowing through the lands, or a shallow lake. In order to maintain communication between the portions of an estate located on either side of a water feature, one or more bridges were often required. Some were simply functional, whilst others of architectural merit enhanced the landscape of the estate. An example of the latter is the iron bridge at Oak Park, an estate some two miles to the north of Carlow town, and now the main administrative centre for Teagasc, the Agricultural Institute.

The former principal avenue to the neo-classical Oak Park House crosses an outlet from a natural shallow lake over an iron bridge – a rare example of a cast-iron parkland bridge and one of only two in Ireland supplied by the famous Coalbrookdale Company, based in Shropshire. The bridge had been closed for a number of years due to safety concerns.

This evening, I will first trace the history of the bridge and Dermot O'Shea of the David Kelly Partnership will then discuss the recent conservation work required to bring the bridge back into use for light vehicular traffic.

Cast Iron

Cast iron was discovered almost by accident in the 15th century, but it was not until the mid-1790s that a simple, quick, and relatively economical manufacturing process was developed. After 1800, iron became a workable alternative for many bridges and iron bridges ceased to be curiosities.

Cast iron cannot be forged or worked, but it can be melted and poured into moulds. Historic (gray) cast iron has a crystalline structure, so it acts as a strong metal under compression, but is brittle in tension. It has a carbon content of between 2.5 and 4%. It does, however, possess good corrosion properties. The casting process can result in flaws in the metal or holes ('blows'), both of which weaken the final result.

The Iron Bridge

The first structural use of cast iron was for the Iron Bridge on the banks of the River Severn at Coalbrookdale, erected in 1779. The structure functions as an arch. The dead load (i.e. the weight of the bridge itself) plus the live load (i.e. traffic) causes the arch to deflect. The arch shape distributes compressive forces over the entire arch and transmits the weight into a horizontal thrust restrained by the abutments at either side. There is scarcely any tensile force in an arch bridge. Cast iron is ideally suited to take compression and this is taken by the cast-iron members of the arch ribs of the bridge. Any tensile forces at joints are catered for by the connecting bolts.

Early iron bridges in Ireland

Early iron bridges in Ireland include the Liffey Bridge (1816), Oak Park Bridge (1818), Barrington Bridge (1818) and Sean Heuston (previously King's) Bridge (1828). The Liffey and Oak Park Bridges were cast in Coalbrookdale, Barrington Bridge by J.Doyle in Limerick, and Sean Heuston Bridge by the Phoenix Ironworks nearby in Dublin.

Oak Park

Oak Park House, and its accompanying estates, were purchased by the Bruen family in 1775. Henry Bruen I came to Carlow after a career spent in the USA, where he had reputedly made his fortune whilst employed in the Quarter Master-General's office in the US Army. One story has it that he supplied coffins with fake bottoms that facilitated re-cycling!

The present house at Oak Park is the result of four periods of enlargement and remodelling carried out between 1797 and 1902.

Following the death of Capt Henry Bruen in 1954, the estate was sold in 1957 to Brownes Hill Estates, but later sold on to the Land Commission. In 1960, the house and 850 acres was made available to Teagasc to provide a centre for crop research.

In or about 1817, Henry Bruen II created a 'New Garden' south-east of the main house. To provide adequate supplies of water for the garden, a channel was dug from the natural shallow lake and a pump installed.

In order to cross this channel and maintain access to the portions of the estate lying to the east, a bridge was provided, marked 'metal bridge' on the 1st edition Ordnance Survey map of 1840.

The Metal Bridge

Earlier, in 1815, the architect George Papworth, exhibited at the Hibernian Society of Artists in Dublin, a *'design for a cast-iron bridge intended to be erected in Oak Park, the seat of Henry Brien (sic), M.P., Carlow*', but sadly the exhibited drawing has not survived. Papworth was likely the architect retained by Bruen for the Carlow bridge: he was also the architect for Kings Bridge in Dublin in 1828.

The Coalbrookdale Company in Shropshire on the banks of the River Severn experienced a surge in orders following the peace of 1815, including the Wellington (Liffey) Bridge in Dublin and a bridge for Oak Park. The design of the latter bridge may have been influenced by the erection of the Liffey Bridge in 1816, the castings having been supplied by the Coalbrookdale Company.

There is strong evidence to suggest that Coalbrookdale was also the source of the castings for the Oak Park bridge. The records of the Coalbrookdale company after around 1808 for the remainder of the 19thC having been destroyed, evidence of bridge supply contracts and other activities comes only from other sources.

Coalbrookdale

Dr Samuel Spiker, the then Librarian to the King of Prussia, based in Berlin, visited England, Wales and Scotland between September 1815 and November 1816. He was in London until June 1816, following which he commenced his travels around the various countries. He recorded his travels in two volumes, first published in German, and later translated by him into English and published in 1820.

Of his visit to Coalbrookdale, Spiker wrote that he met the foundry foreman, John Windsor, who pointed out castings for two iron bridges: '*one of five ribs, four of which were already cast, of forty-foot span, six feet in height, and destined for a Mr Brewing (sic) of Carlow in Ireland, who intended to place it over a small stream on his estate'* (the price of the bridge was given as five hundred pounds*).*

The accounts of the Oak Park estate for the period 1817-1818 reveal that masons, carpenters, and labourers were being employed variously on the 'New Bridge', the 'Iron Bridge', and even the 'Mittle' Bridge, the last description I am assured by locals as being how 'metal' would have been pronounced in the Carlow area, and, I assume, what the clerk heard is what he wrote!

The Oak Park Bridge

The Oak Park Bridge consists of five parallel cast-iron arch ribs of 40ft span and 6ft rise and spaced 3ft 9in apart. Each rib is formed of two cast sections bolted together at the crown. The arch spandrels are formed of enjoined rings decreasing in diameter from the abutments to the crown. Each half-rib is cast in one piece, the bottom segmental arch and the top horizontal girder section being pierced with small holes of constant diameter in order to reduce the dead weight.

The inner ribs are of similar but somewhat simpler design to the outer ribs. The 15ft wide deck is formed of iron plates spanning transversely across the tops of the ribs, which were braced transversely at intervals. The iron railings forming the parapets are composed of vertical bars fixed between top and bottom rails, the bottom rail being supported on ball feet. There is a wrought-iron snake motif at regular intervals along the parapet railings. The railings are continued to the end of the curving abutments. The abutments are constructed from Leinster granite with a limestone core.

Estate records indicate that temporary dams (probably in timber) were erected at the site of the abutments to allow the work of laying their foundations to be carried out in the dry. In December 1817 and January 1818, there are recorded payments to land surveyors, presumably to bring the estate maps up to date following the various improvements to the estate.

The Oak Park Bridge is listed as a Protected Structure under the County Carlow Development Plan 2015-2021 and is included in the National Inventory of Architectural Heritage. However, both listings show an incorrect date for the bridge of circa 1835, rather than 1818.

Restoration

In 2005, David Kelly Partnership were appointed as part of a design team (with C.J. Falconer and Associates, Architects in Waterford and others) to assist Teagasc in relocating their headquarters to Oakpark in Carlow. The main element of this appointment was the construction of new offices and staff facilities for Teagasc. The works included the upgrade of various utilities, car parking and the estate roads. The repair and restoration works to the cast iron bridge proved a very enjoyable and interesting part of this project.

At that time, the bridge had been closed off to traffic for a number of years with steel barrels placed at both sides of the bridge and a pair of gates hung from the railings on the west side. Possibly as part of an earlier incomplete restoration project, the bridge had been stripped of its wearing course and the original fill material removed from the pans. The removal of this material had resulted in surface corrosion of the pans as well as some localised areas of damage to connections between the pans and the bridge structure. There was some significant corrosion to the underside of the bridge which was mostly confined to non-structural elements. The corrosion to the main ribs and pans was mostly surface corrosion. The paint finish to the underside of the bridge was in very poor condition. The finish to the railings was in better condition, possibly as they were more visual and also easier to

maintain over the years. There were, however, some bars removed and the cap section was very badly deteriorated.

With the assistance of my colleague David Kelly, I carried out an initial inspection of the bridge to determine its construction and condition. We soon realised that we were dealing with an important and historic bridge structure. As part of our investigation of the bridge we contacted the library at Engineers Ireland to request any information they might have on the original construction of the bridge. Coincidentally, the information we received back consisted of a Historic Engineering Works Record that had been completed by Dr Cox in 2002. This report gave us a lot of information in relation to the history of the bridge. We were not able to source any information in relation to the original fabrication and construction of the bridge structure.

At the request of the client, we carried out an assessment of the load carrying capacity of the bridge to determine the extent to which the bridge could be used following restoration. The visual inspection of the bridge did not uncover any significant defects with the bridge structure so we set about analysing the strength of the bridge. The bridge structure was simplified for the analysis and modelled as a 3-pin arch. We used compressive and tensile strength values for 'grey cast iron' in the analysis and employed a significant factor of safety in our assessment. Ultimately, we were satisfied that following restoration the bridge was capable of taking light vehicular traffic up to 3.5 tonne weight.

Following our assessment, Teagasc gave the approval to proceed with the restoration of the bridge. David Walsh Civil Engineering Ltd. was the contractor engaged by Teagasc for carrying out works to the roads within Oak Park Estate at the time. They were subsequently appointed to carry out the civil works element of the project as well as to oversee the various sub-contractors that would be required to carry out the restoration works to the bridge.

Scope of the Works

An initial scope of works was agreed with the contractor which included:

Construction of berms within the water to facilitate de-watering and inspection of the bridge abutments;

Erection of scaffolding around and under the bridge to facilitate the restoration of the bridge ribs and deck pans;

Re-pointing and grouting of the masonry bridge abutments at and below water level using natural hydraulic lime mortar and grout;

Cleaning and painting of the bridge structure;

Works to waterproof the bridge deck and install a wearing course to the bridge;

Works to repair the bridge railings including works to the badly deteriorated and missing rail capping, as well as replacement and repair of missing and damaged sections of the railings;

Works to the bridge approaches to reduce the risk of vehicular damage to the bridge structure (ramps, signs, road markings, etc.).

Bridge Abutment Works

In March 2005 the contractor commenced the works on site by constructing berms around the bridge abutments to facilitate de-watering of the area for inspection. The bridge abutments were generally in good condition. From our initial inspection we could see that there was some loss of mortar from the joints at the base of the abutment near the water line. We could also see that some of the corner stones had become dislodged.

When we de-watered the area around the abutments we found there were very shallow foundations to the abutments with significant erosion of the soil at the base of the abutments.

We re-instated the dislodged masonry at the corners of the abutment and we underpinned the face of the abutment with a discreet concrete plinth to prevent future erosion of the soil at the base of the abutment.

The open-joints in the masonry were repointed and voids in the structure grouted using natural hydraulic lime mortar and grout. Following on from this we set about restoring the bridge structure.

Works to the Bridge Structure

The works to the bridge structure were mostly cosmetic. There was only minor corrosion of the underside of the pans as well as the surface of the ribs of the bridge, however, the existing lead based paint finish was in very poor condition. Given the condition of the original paint finish and the difficulty of access for future maintenance, we made the decision to fully remove the existing paint finish so as to maximise the effectiveness of the new coating.

The existing paint finish was removed by blast cleaning. The toxicity of the lead based paint and the location over the lake required that the bridge be fully enclosed during the cleaning and that all cleaning by-products be collected and safely disposed. At the end of each day of cleaning the waste material was collected and stored in sealed drums for disposal by a specialist waste contractor.

Unfortunately for the contractor, the cleaning works to grit blast clean the bridge were carried out during a very warm spell at the end of the summer and this made for very difficult working conditions. To assist the workers and reduce the dust levels within the enclosure, the choice of blast material was changed to copper slag.

In relation to the choice of paint finish, we consulted with paint specialists, including Dulux and Advanced Coating Technologies. Ultimately, a modern styrene acrylic resin based paint was selected for use on the bridge ribs and the underside of the deck pans. A total of 5no coats of paint were applied to the bridge with special attention being paid to edges and areas where surfaces meet to provide as much protection as possible in these areas. Different colours were used in the various coats to ensure that areas weren't missed during the painting.

A coal tar epoxy based coating was specified for application to the top face of the deck pans to seal and protect the pans under the new wearing course finish.

Bridge Deck

The bridge deck wearing course and pan fill material had been removed some years beforehand and there was no record of what the original material was. We decided to fill the pans with a lightweight concrete to provide a strong base for the bridge deck surface and also to reduce the load on the bridge structure. We installed a geotextile membrane under the concrete for ease of removal afterwards, if required. The bridge deck was then finished with a tarmacadam wearing course.

Given the damage caused by water tracking down through the pans over the years, we incorporated a bituthene water-proofing layer between the tarmacadam and the concrete infill.

The restoration works to the bridge deck included the replacement of missing and damaged bolts and shims. Shallow channel drains were also incorporated at both sides of the bridge deck to protect against excessive water run-off from the deck on to the bridge structure. The bridge deck wearing course was removed some years beforehand and there was no record of what the original material was.

Railings Restoration

With the exception of the cap section, the bridge railings were generally in good condition. The small number of damaged and missing bars and decorative features were replaced but otherwise the works were mostly cosmetic to protect the railings into the future.

The railings were cleaned using scrapers and wire brushes and the new paint finish applied, again in 5no coats and concentrating on edge areas.

The railing cap section was found to be cast iron. The cap was securely bolted to the top of the railing with no capacity for expansion or contraction movement of the cap. The construction also allowed for water to sit between the cap and the top of the railing which resulted in significant corrosion build-up and deterioration of the cap section to the extent that many sections of the cap were missing and most of the remaining cap were significantly distorted out of shape.

We made attempts to repair the original cap but these proved unsatisfactory. Budget restrictions prevented us from replacing the damaged and missing cap with a new cap similar to the original. Ultimately it was decided that a new off the shelf steel cap plate would be fitted to the railings. The remaining sections of the original cast iron cap including some pieces recovered from the lake bed were removed for storage by Teagasc on site.

An interesting part of the restoration works was the discovery that the bridge had been repaired in the past. There were a small number of areas where the bridge ribs had cracked and in some instances split entirely. The damage was repaired by fitting pieces of wrought iron at both sides of the rib which were then bolted together through the damaged rib section. The repairs appear to date to around the time of the bridge construction or shortly thereafter. The repairs appeared to have done their job as there was no further separation of the split sections.

There was some significant corrosion build-up between the ribs and the repair plates, possibly as a result of bimetallic reaction between the cast iron ribs and the wrought iron repairs. The original sections were cleaned, re-painted and reinstated with appropriate isolation tape to reduce the risk of future deterioration.

The restoration works to the bridge concluded with some general tidying up, including the cleaning and re-setting of the granite piers of the bridge where they had been dislodged by vehicular impact in the past. The area of the lake around the bridge was also cleared and the approaches landscaped.

Conclusion

The bridge is now in good condition and is used by light vehicles up to 3.5 tonnes in weight.

Teagasc are to be commended for committing to restoring the bridge despite the obvious limitations on its future use as determined from the initial assessment and for maintaining the bridge for future generations.

Those involved in the project include Professor Jim Burke, Teagasc Head of Centre, Oak Park, and Mr Michael O'Kane, Teagasc Project Co-Ordinator; C J Falconer and Associates Architects of Waterford; Main contractor for the works David Walsh Civil Engineering Ltd; Pat Gaynor of Advanced Coating Technologies; as well as all of the other specialist cleaners, metalworkers and painting contractors.