REPORT

On

TWO

PEDESTRIAN FOOTBRIDGES AT

KINNITTY

CO OFFALY

For

COILLTE

Prepared by Christopher Southgate, FIEI

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1.0 Scope

We were instructed by Richard Jack, on behalf of the client, Coillte to advise on strategy for the restoration and conservation of two significant footbridges within the estate of Kinnitty Castle. The bridges form part of the landscape of the original castle which is currently operating as a hotel. The bridges are within Coillte's ownership and are presently closed due to obvious decay. A methodology and specification together with sketch drawings is provided. Indicative costs based on a visual inspection are also included at the end of the report.

We were unable to access parts of the bridge for obvious reasons and the recommendations of this report are provisional on a second inspection at the start of the works from scaffolding. This will substantiate the assumptions made in the initial appraisal,

The inspection was visual only and in the absence of physical works to the bridge or closer access we were unable to exactly predict the condition of the ironwork. However, the current proposal offers the most likely course of action based on visual inspection.

Inspection of the masonry showed that the abutments are in reasonable condition insofar as could be reasonably assessed from the Coillte side.

2.0 Background

It is outside the scope of this report to give a detailed historical background. The two bridges are part of the demesne of Kinnitty Castle, Protected structure. The castle is described as a detached Tudor style four-bay two-storey over basement house with attic storey. It is a former country house, built c.1833 by the Pain Brothers, with octagonal castellated three-stage corner tower to south-west and projecting entrance porch. The building incorporates an earlier castle. The castle was burned in July 1922 and subsequently rebuilt. It is of National Importance. As they are part of the curtilage of Kinnitty Castle, the bridges are also afforded the same statutory protection.

2.1 NIAH Listings

The suspension bridges are separately listed in the National Inventory of Architectural Heritage (NIAH), which describes them as set out below:

2.1.1 Bridge no 1 Wire suspension bridge

Reg. No.	14936017
Date	1830 - 1860
Previous Name	Castle Bernard
Townland	CASTLETOWN AND GLINSK
County	County Offaly
Coordinates	220388, 205778
Categories of Special Interest	ARCHITECTURAL TECHNICAL
Rating	Regional
Original Use	bridge

Description

Single-spire wire suspension footbridge, built c.1840, over the River Camcor within the demesne of Kinnitty Castle. Bridge is hung from cast-iron columns. The uprights are anchored to the ground behind with a pair of diagonal wrought-iron rods. Timber deck. Bridge accessed through wrought-iron gate with iron circular framing. Manufacturer's name 'T & D Roberts' on downstream upright.

Appraisal

It is one of only two suspension bridges in Offaly (the other is at Birr Castle demesne) and one of several footbridges with Kinnitty Castle demesne. It is a rare surviving example of a multiple-wire cable suspension bridge. It is significant because of its association with the Mountmellick Foundry. It lends interest the riverscape. This bridge together with the castle, outbuildings and gate lodges form an interesting group of related structures.

2.1.2 Bridge No 2 Lattice girder footbridge

Reg. No.	14936015
Date	1890 - 1910
Previous Name	N/A
Townland	CASTLETOWN AND GLINSK
County	County Offaly
Coordinates	220245, 206015
Categories of Special Interest	ARCHITECTURAL TECHNICAL
Rating	Regional
Original Use	foot bridge

Description

Single-span metal lattice footbridge, c.1900, over the River Camcor in the grounds of Kinnitty Castle. Lattice girders and diagonal braces. Timber deck to bridge. Bridge accessed from raised stone platform and accessed up steps.

Appraisal

Located in the woods adjacent to Kinnitty Castle, this is one of several footbridges built to span the River Camcor. Though no longer in use, the bridge survives as a contrast to the suspension bridge upstream

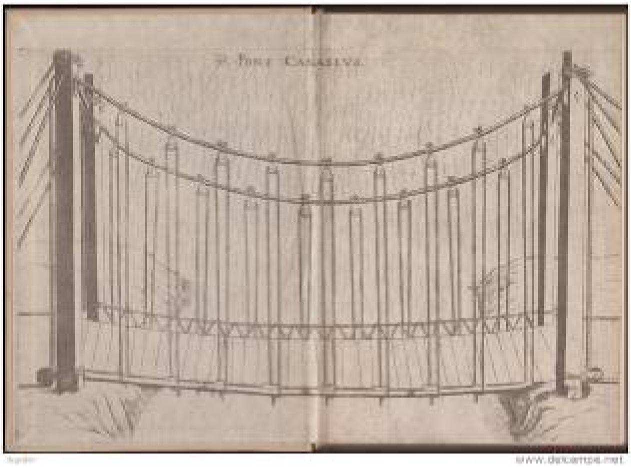
2.2 Fred Hannah's survey

A survey of all named bridges in Offaly was carried out by Industrial Archaeologist Fred Hamond in 2005 This survey covers all 407 named bridges in the county. In discussing bridge no1 at Kinnitty (Wire suspension bridge) he comments:-

Although not as old as the Birr bridge (of c.1826), it is of historical interest as an example of early suspension bridge construction and also on account of its association with the Mountmellick Foundry. It also lends interest to the riverscape hereabouts. Group value in context of Kinnitty Castle estate.

The 20th century lattice girder footbridge over Camcor River in grounds of Kinnitty Castle (formerly Castle Bernard). Replaced earlier footbridge erected in mid 1800s. Appraisal This bridge is one of several footbridges over the river in the grounds of Kinnitty Castle. It is of technical interest owing to its lattice girder construction, all seemingly original, and is an interesting contrast to the suspension bridge just upstream. Group value in context of Kinnitty Castle estate. Regional heritage significance. In theory, this bridge is a Protected Structure by virtue of the fact that it lies within the curtilage of Kinnitty Castle, itself a Protected Structure. recommended.

2.3 Discussion



Suspension bridge Fausto Feranzio 1595

Although the form of the suspension bridge had been invented much earlier, in the opinion of the author the fact that the wire suspension footbridge at Birr (1820-1826) is close by needs to take into account that both these bridges were comparatively early for wire suspension bridges and the first wire suspension bridge in England was built in 1823. The first wire cable suspension bridge in the US was not built until 1842. The spans are both small and the structures demonstrate the emerging form of the suspension bridge (the art of engineering) rather than the technology which would be required for the longer span bridges mentioned above.

In our opinion the cost of conserving these 2 bridges may not be as significant as anticipated by Fred Hannah for reasons given in Section 3.

3.0 Condition of the suspension bridge

3.1 Description

The bridge spans 9.2 m across the river from stone abutments. There are 2 cast iron frames at each end in a gothic style with wrought iron cross ties at the top.

At each side 2 wrought iron 1 ½ inch tension stays are embedded into the ground and pass through the cast iron from terminating in a hook on which 8 strand ¼ inch wire rope tension cables are strung. These appear to have been made on site and at each end are anchored by twisting under heat.

From these a series of 16 No ¼ inch hangers support the oak timber deck and there is also a ¼ inch lattice between the vertical members. These are fixed through 2-inch x 3/8-inch steel flats one above and one below the timber deck.

The overall effect is of elegance and lightness of form and the technology although simple is of significance from a technical and engineering perspective.

3.2 Masonry abutments

These are constructed of coursed rubble stone in lime mortar to a high standard. In general, a small amount of maintenance pointing is required.

On the Coillte side there is an area of stone missing and this should be replaced with similar stone on a like for like basis. Patch pointing will also be required in an NHL 3.5 lime mortar to Southgate Associates specifications.

The Wrought iron stays appear to be anchored in lime concrete to an unknown depth.

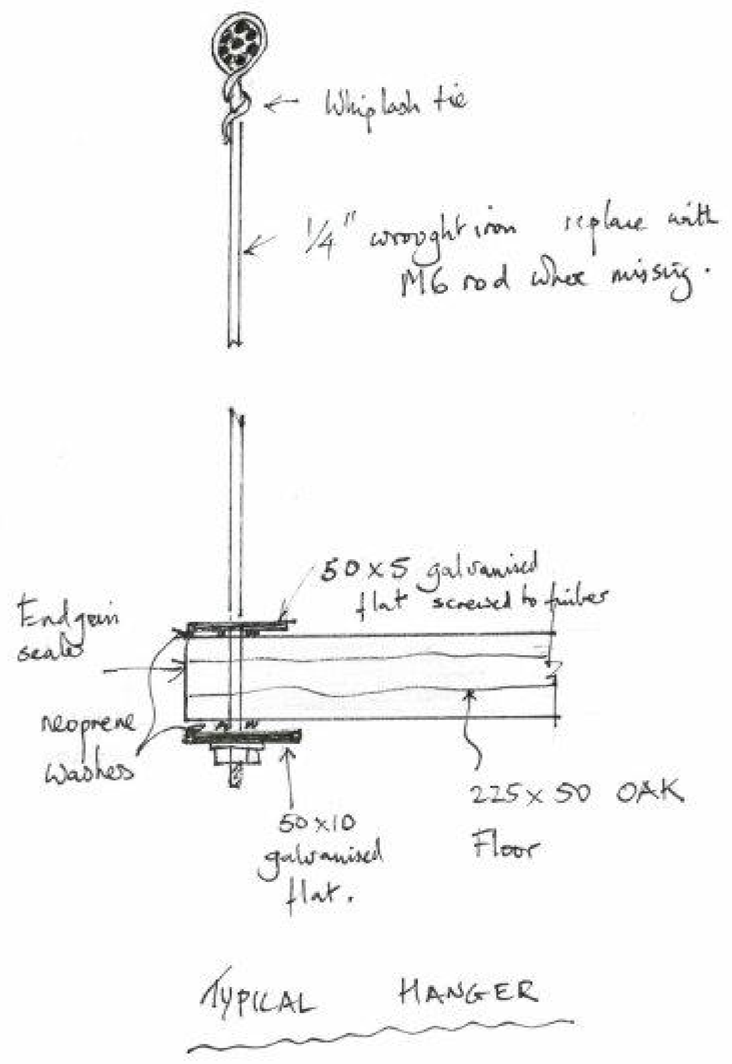
3.3 Timber deck and secondary steel flats

This will have to be replaced on a like for like basis using 9-inch x 2-inch oak from the Coillte forest. The wood should be slow growing and durable and should also be pressure impregnated. The stresses in the oak are not critical bit it is important to ensure durability. It is also recommended to treat cut ends with an end grain sealer. A galvanised washer spaced could also be used to prevent water lodging on the bottom flat as shown below.
It is suggested that the secondary timber flats are replaced with new 50x50x5 and 50x50x10 galvanised steel.

The slip resistance of the timber deck will need careful consideration and maintenance and it may be possible to add a stainless-steel mesh to provide a durable working surface. Any solution should be discussed with Coillte and will also be subject to routine maintenance.

3.4 Wire hangers and deck support system

These comprise around 16 No ¼ inch rods threaded at the base and wrapped around the cable like tying wire. Where these have corroded, they should be replaced on a like for like basis. They are stressed to about 1/3 of capacity.



Note : In order to release the nuts from the hangers these will need to be heated on site and quenched with WD40. This may have to be carried out several times. The thread is to be checked for corrosion and hangers will need to be replaced if required.

3.5 Wire tension cords

These have 8 No ¼ inch rods formed on site into a wire rope. This construction is both simple and has the advantage of additional safety in that it is unlikely to result in progressive collapse.

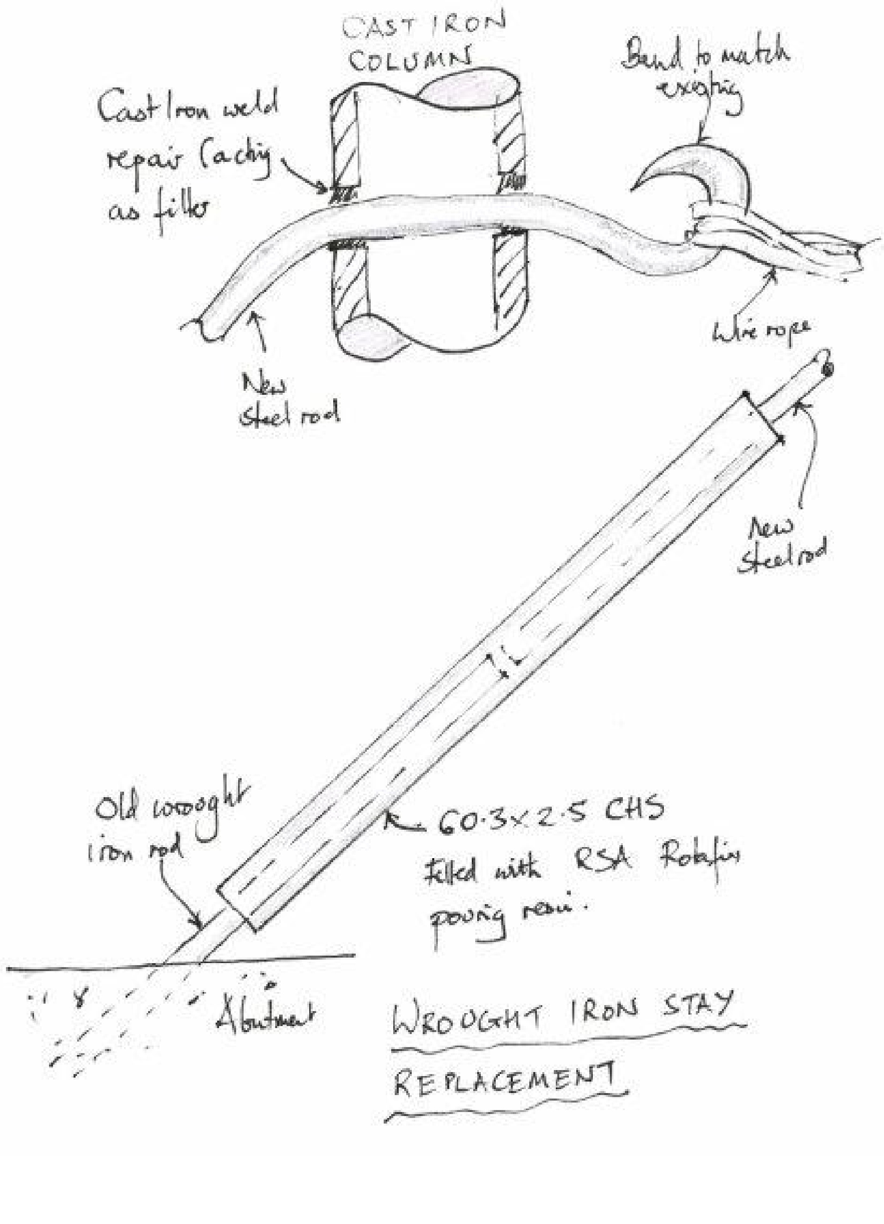
Once the bridge is scaffolded a thorough inspection of the wire cables for corrosion is recommended. We feel that it is unlikely that further problems will be found, and the critical members are the 1 ½ inch solid bars at the supports which we feel will need to be replaced.

3.6 Cast Iron Arches

The condition of the cast iron arches at each end is good and these are well capable of carrying the loading. No work is anticipated other than painting.

3.7 Wrought Iron stays and their link to the abutments

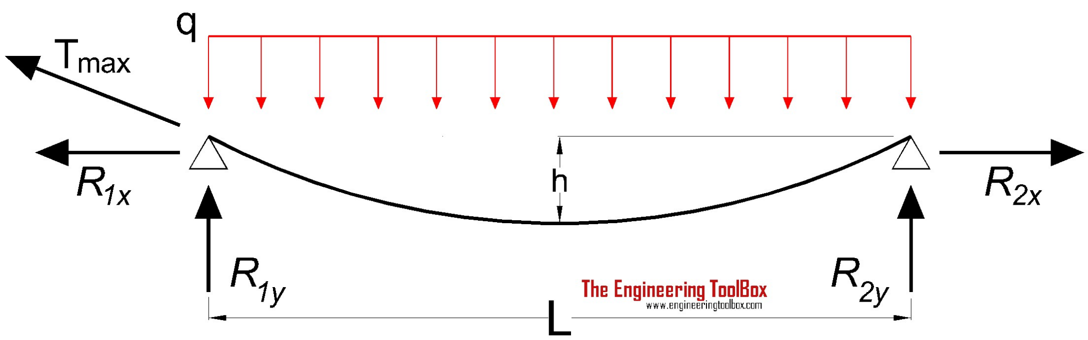
These require strengthening as shown below, either by replacement in one instance or by providing additional safety cables. A final decision on the methodology will be made when both ends of each cable are carefully studied for corrossion.



3.8 Guarding and approach

There will be a responsibility if the bridge is open to the public to ensure adequate safety measures in the approach. This will involve non-slip finishes to the pathways and adequate guarding to prevent falls around changes in level.

3.9 Load capacity calculations



The midspan cable and horizontal support forces with uniformly distributed load can be calculated as

$R_{1x} = R_{2x} = R_x = q\,L^2 / (8\,h)$ *Where* $R_{1x} = R_{2x} = R_x =$ *midspan cable or horizontal support forces (kN) q = unit load (weight) on the cable (k N/m) L = cable span (m) h = cable sag (m)*

The vertical support forces at the end of the cable can be calculated as

$R_{1y} = R_{2y} = R_y = q\,L / 2$ *where* $R_{1y} = R_{2y} = R_y =$ *vertical support forces (kN)*

The resultant forces acting in the support ends - and in the direction of the cable close to the supports - can be calculated as

$T_{max} = (R_x^2 + R_y^2)^{0.5}$ *where* T_{max} *= resultant force at the support (kN)*

Eurocode 1991 EN 1991-

Eurocode 1991 EN 1991-2 “Traffic Loads Traffic Loads on footbridges” recommends a characteristic live load of **q^{fk}=5.0 kN/m²**. The dead load is small and less than **0.5 kN/m²**

Wire Cable stresses

Applying this to the above formula for the bridge gives a cable tension of around 40kN. This leaves the stress in 8 No ¼ inch wire strands as 176 N/mm^2 which is far too high for wrought iron. The live load needs to be reduced to about one third the current code standard **q^{fk}=1.5 kN/m^2** which implies semi public access to special interest groups only.

It is not considered feasible to allow more that 5 or 6 people on the bridge at any one time and vibration should be avoided implying some form of supervision.

Stresses in corroded wrought iron diagonal stays

The tension stress in these members (1 ½ inch diameter wrought iron) are calculated for the reduced live load recommended **q^{fk}=1.5 kN/m^2** and in this case the characteristic allowable tension stress is 100 N/mm^2 based on there being no corrosion. Where corroded these members will require replacement or strengthening. The assumption that no corrosion is present is not true for at least one stay and since the corrosion not only affects the stress in the bar but also the fracture toughness it is likely that 4 tension stays will have to be replaced.

The general live load reduction proposed to **q^{fk}=1.5 kN / m^2** is equivalent a domestic live load. The working live load recommended is equivalent to around 12 people on the bridge at one time whereas only 5 or 6 would be permitted.

Testing

In order to justify opening the bridge after repairs (Including replacement of tension stays) a load test would be required, and it is suggested to test to **2.0 kN / m^2** This is equivalent to 10 No 20kg blocks per metre. Blocks are laid on flat and have a nominal **spacing of around 25mm between them.**

The deflection would be measured from scaffolding which would also offer support if necessary, and the load displacement graph checked to ensure that the bridge remains within the elastic range.

4.0 Condition of Bridge No 2

The condition of this bridge is generally polarised into areas that need to be replaced and other areas in good condition. The bridge is less critical than the suspension bridge in that no members are structurally critical, and the completed project will not be critically loaded even when subjected to modern loading requirements. Furthermore, the advances in material technology by 1900 ensure that the materials are ductile.

4.1 Cast steel tee top chord (3-inch tee)

This is in good condition and does not require much work other than painting.

4.2 Diagonal bracing

This is generally in good condition but at each end several members have corroded and require replacement on a like for like basis. Original rivets are to be replaced with domed headed bolts to match the existing fasteners.

4.3 Angle bottom chord (3-inch x 3-inch angle)

This is badly corroded due to water lodgement and we recommend complete replacement as shown in the sketch below.

4.4 The three stabilising cross beams

These are so badly corroded that we recommend complete replacement as shown in the sketch below.

4.5 The timber deck

This will have to be replaced on a like for like basis using 9-inch x 2-inch oak from the Coillte forest. The wood should be slow growing and durable and should also be pressure impregnated. The stresses in the oak are not critical bit it is important to ensure durability. It is also recommended to treat cut ends with an end grain sealer. A galvanised washer spaced could also be used to prevent water lodging on the bottom flat as shown below.

It is suggested that the secondary timber flats are replaced with new 50x50x5 galvanised steel.

The slip resistance of the timber deck will need careful consideration and maintenance and it may be possible to add a stainless-steel mesh to provide a durable working surface. Any solution should be discussed with Coillte and will also be subject to routine maintenance.

4.6 Guarding and approach

There will be a responsibility if the bridge is open to the public to ensure adequate safety measures in the approach. This will involve non-slip finishes to the pathways and adequate guarding to prevent falls around changes in level

4.7 Load capacity calculations

Preliminary calculations show that the bridge is capable of withstanding normal footbridge loading once repaired.

4.8 Testing

Not needed.

5.0 Corrosion protection

Once structural repairs are complete consideration should be carefully given to long term protection.

A specification for this work has been included in the appendix. This involves the following measures;-

1. Careful design to ensure drainage
2. Careful preparation in accordance with SA specification
3. Use of galvanised steel and etch primers for new steelwork
4. Use of specially designed marine standard paint specification
5. Use of mastic (Sikaflex 11 FC) as additional protection in critical areas where water may lodge of corrosion concentration cells may exist
6. Careful repair or replacement of badly corroded members which are critical to stability.

PHOTOGRAPHS

BRIDGE 1

1. **Approach to Suspension Bridge from Coillte side**

2. **View up river**

3. Ditto

4. Main cable and some missing lattice work

5. Main cable consists of 8 No ¼ inch wrought iron rods and is in reasonable condition

6.Serious corrosion to critical 1 ½ inch tension stays implies replacement

7. It is hoped to connect to the original cable above ground, but corrosion will have to be checked at the interface with the abutment all 4 upper rods are likely to require replacement

8. View of the same wrought iron stay on the land side to be replaced

9. Wire cable appears in reasonable condition. Wire hangers are simply wrapped around and bent to suit on site presumably using heat. This is a good sign that they have not cracked or failed during considerable bending.

10. Wire hangers pass through 2 iron flats which support the oak floor. These are to be replaced with galvanised steel flats.

11. The structure on the far side has to be inspected once scaffold is available but appears reasonable

12. General arrangement on Coillte side

13. View of underside of bridge

14. Flats appear to be bolted at hanger positions

15. Masonry collapse in abutment stonework on Coillte side

16. Far side stonework requires pointing only

17. Detail of iron support to flats (not critical structurally)

18. Stone tower folly at Bridge 2

PHOTOGRAPHS OF FOLLY ADJACENT TO BRIDGE 2

19. Ditto showing fake arrow loupe

20. The stonework is coursed rubble and dates from the early 19th century

PHOTOGRAPHS BRIDGE 2

21. The lattice bridge (Bridge 2) replaced an earlier bridge and dates to circa 1900

22. Deck required complete replacement

23. A few diagonal lattices require replacement, but the top member is in good condition

24. The bottom 3-inch x 3-inch angle requires replacement together with the non-structural flat above since water has lodged in the deck area causing extensive corrosion

25. 3 cross beams also require complete replacement on a like for like basis. New steel members should be galvanised and etch primed to receive the decorative paint coats

26. General view showing ridge has not deflected in spite of corroded members

27. View up river

28. Guarding will be required at approach edges