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## THE REFURBISHMENT OF THE LLANGOLLEN CHAINBRIDGE

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### Summary

The historic Chainbridge in Llantysillio near Llangollen has undergone a painstaking £345,000 restoration allowing it to be re-opened to the public for the first time in over 30 years, since safety concerns forced the bridge to close. Originally built in 1817 to open up a cheap transport route across the River Dee, the Chainbridge is thought to contain the oldest wrought iron chain links in the world. It was later rebuilt during the 1870s and in 1928 following heavy flooding, who rebuilt the suspension bridge that stands there today, still incorporating the original links.

The restoration works designed by Ramboll and carried out by Shemec Ltd. required the structure to be dismantled and each piece of metalwork to be carefully labelled so it could be reinstated in its original location. The restored bridge will now help re-establish the strong link between the Llangollen railway and the Llangollen canal, part of the Pontcysyllte World Heritage site and enhance the local tourism economy.

**Keywords:** historical; aesthetics; restoration; heritage



*Fig. 1. Complete Bridge viewed from downstream on the Hotel North Bank*

### 1. Introduction

The Llangollen Chainbridge crosses the River Dee approximately 2km north west of Llangollen, North Wales. A bridge has existed in this location since 1817 but the structure had fallen into disrepair resulting in its closure in the mid 1980's. In 2009 the Chainbridge was included in the World Heritage Site of Pontcysyllte Aqueduct and Canal. Llangollen Town Council appointment Ramboll assess the existing structure and determine the required restoration works (Figure 1).

The bridge is thought to comprise some of the oldest wrought iron still in use and therefore careful construction techniques and traditional methods were required for the works to conserve as much of the existing wrought iron elements as possible.

### 2. Background

Llantysillio Chainbridge was first built in 1817 to link two major transport routes in North Wales, the Llangollen Canal and the London to Holyhead Road. By 1870 the condition of the bridge was considered to be beyond repair and the structure was removed. It was replaced in 1876. On 16 February 1928, severe flooding washed away the majority of the bridge, although the supporting chains survived. It was rebuilt along the lines of the Menai suspension bridge, reportedly re-using the chains from the original chainbridge structure. Six of these chains were suspended to support the deck from above, while a further two lay underneath the deck. The current bridge comprises a two span chain suspension bridge carrying a footpath over the River Dee in Llangollen between Berwyn Station and the Chainbridge Hotel. One span crosses the

river and spans approximately 24m and the other spans approximately 9.7m over a bedrock outcrop. To the North of the bridge the suspension chains are anchored into the rock cutting above the Canal.

### 3. Assessment and Design

A 3D non-linear analysis of the structure was carried out to assess the existing loads in the structural elements and confirm their adequacy. The initial analysis took into account the poor condition of the structure and showed that the structure in its existing condition was incapable of carrying pedestrian loading. The structure was then re-analysed assuming that it had been repaired and that chains with a section loss greater than  $60\text{mm}^2$  were replaced. This allowed the deck to be opened for a pedestrian load of  $1.5\text{ kN/m}^2$ . Whilst less than current design standards would require, it was agreed with Llangollen Town Council that this reduced load capacity was acceptable.

An analysis was carried out to determine the required tensions in the chains for the bridge in its restored condition both for the suspension chains and the lower deck chains. This was used as a target force during the re-erection of the bridge although deck geometry was the defining factor in determining the tension in the chains. In the event, the final tension was within 10% of the theoretical target tension value for all chains.



*Fig. 3. Dismantled bridge elements labelled and painted in workshop*

was excessive or where they were beyond repair, new identical elements were fabricated from mild steel. The stanchions and anchor points were refurbished insitu. Once the metal elements were restored the bridge was reassembled and each element returned to its original position. Those elements that were deemed too corroded to be repaired were sent to the local Museum in Llangollen and replacement elements were forged from mild steel. All the bridges elements, old and new received a flexiblised epoxy paint system. Refurbishment works were designed so that the appearance of the bridge was as close to that of the 1928 structure as possible taking into account the requirements of modern safety standards.



*Fig. 3 Complete Bridge viewed from the south bank*

### 4. Restoration Works

The works involved restoring and repairing each iron element, providing a new timber deck and new handrail system. The bridge is thought to comprise some of the oldest wrought iron still in use requiring careful construction techniques and traditional methods for the works to preserve as much of the existing wrought iron elements as possible. Each metal element was labelled, the bridge dismantled, transported to the workshop by the local Welsh Highland Steam Railway and the metal elements stripped back to the parent material and recoated with a paint system in workshop conditions.

The condition of each element was inspected following dismantling. Where the corrosion of the wrought iron elements

### 5. Conclusion

The significance of Chainbridge is widely recognised and acknowledged. It is described as a landmark of a crucial part of British engineering history by the Royal Commission on the Ancient and Historical Monuments of Wales and is included in the Institution of Civil Engineers' database of historically important engineering structures. Its restoration was successfully completed and the bridge was officially opened to the public on 28 May 2015. Since opening it has become a regular commuter route for local people and has boosted tourism in the area thereby contributing to the local economy.