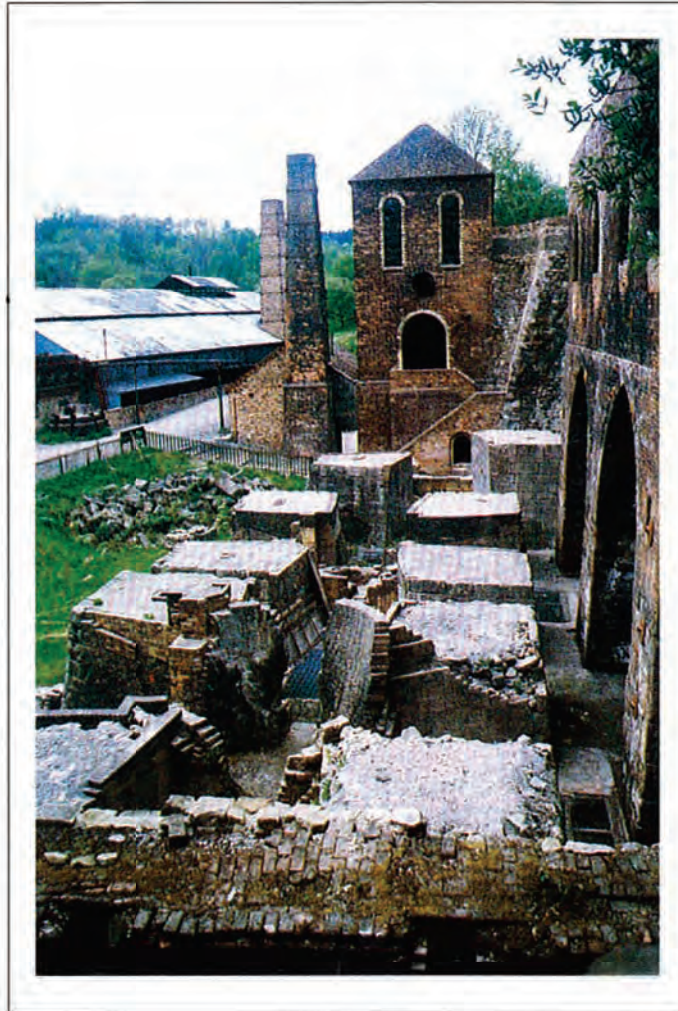


CASE HISTORY

THE RESTORATION AND STABILISATION OF THE BLISTS HILL FURNACES, TELFORD, ENGLAND, U.K.



Introduction

The repair and restoration of the Blists Hill Furnaces, which form part of the Blists Hill Open Air Museum Site near Ironbridge, Telford, has recently been completed. The works were instigated as part of a major repairs programme designed to renovate and restore, numerous structures within the Ironbridge Gorge Heritage site.

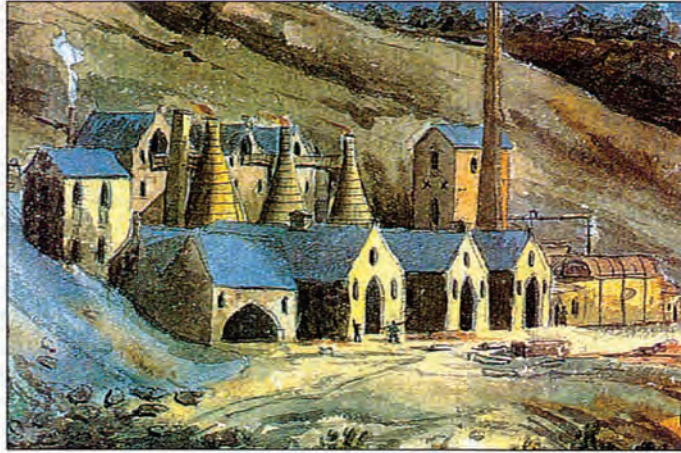
A detailed repair schedule was prepared for each of the sites by a working party, including architects, civil and structural engineers, surveyors and archaeologists and the work funded by the Department of the Environment.

The purpose of the repair work was to restore and renovate the properties and structures to an acceptable condition whereby the ownership and future maintenance of the structures would pass into the care of Ironbridge (Telford) Heritage Foundation.

In order to bring about the restoration and stabilisation of the Blists Hill Furnaces, it was necessary to undertake remedial work on the existing brickwork and stonework, together with the introduction of extensive ground anchors and tie bars.

Work required to prevent further ingress of surface ground water into the furnaces was undertaken as a separate, but integral, phase of the works.

CASE HISTORY



Background history *

The Madeley Wood Company was formed in 1756 when the ironworks at Bedlam, one mile west of Blists Hill, on the River Severn, was founded. The Bedlam Furnaces were owned by this company, which held mineral leases in Madeley Parish, enabling it to extract coal and iron ore. Upon its opening in 1790, the Company had access to the Shropshire Canal, the Blists Hill section of which ran immediately to the east of the Blists Hill works site. Proximity of raw materials and the means of transporting the finished product persuaded the Company to build a blast furnace at Blists Hill in 1832.

Additional furnaces were added in 1840 and 1844, making a total of three, and the site remained active in the production of pig iron until 1912, when the ironworks ceased production, following the blowing in of two of the furnaces.

The site history through the 20th century is less well documented. Dense vegetation cover was allowed to establish itself amongst the ruins until the late 1950s when the site was subject to spoil dumping which completely buried the furnace bases. In the 1970s the Ironbridge Gorge Museum Trust began clearing and restoring the works.

Structural defects

The buildings had fallen into poor repair due to the ravages of time and ingress of ground water. This dereliction and general instability of the furnace structures represented a hazard to the preparation of a specification for the repair. It was, therefore, necessary to undertake the design and installation of an extensive scaffold propping scheme to enable the facade of the structure to be stabilised sufficiently to enable the appraisal and detailing of repair work.

The scale of works was restricted due to the nature, historical and archaeological importance of the site. Problems were encountered during the design stage of the scheme due to the presence of many underground tunnels and chambers which linked the furnace bases back to the main engine houses.

By buttressing the supporting scaffolding back onto the old furnace bases, and utilising heavy concrete blocks as kentledge, sufficient dead weight was applied to stabilise the temporary propping. Prior strengthening of the furnace bases was required to ensure that the high loads from the buttresses could be transferred to the sub-strata without distressing the superstructure.



Drilling



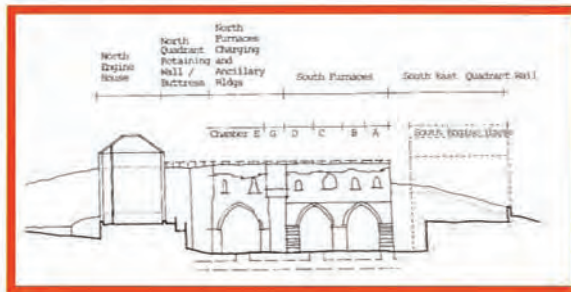
Restoration work in progress

CASE HISTORY

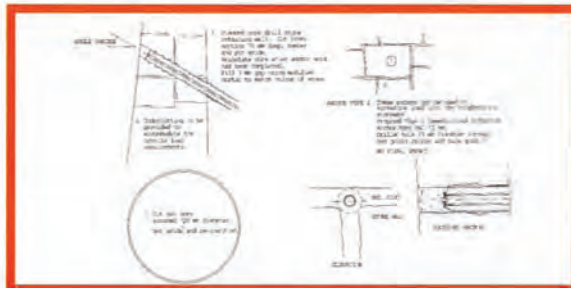
RESTORATION & STABILISATION OF THE BLISTS HILL FURNACES, TELFORD, ENGLAND, U.K.

Following completion of the propping scheme a detailed visual and photographic inspection of the site structures was undertaken to ascertain and record the condition of the walls and to determine the cause of the damage, enabling the formulation of a repair and stabilisation strategy. This appraisal concluded that the damage which had occurred could be generally summarised as follows :

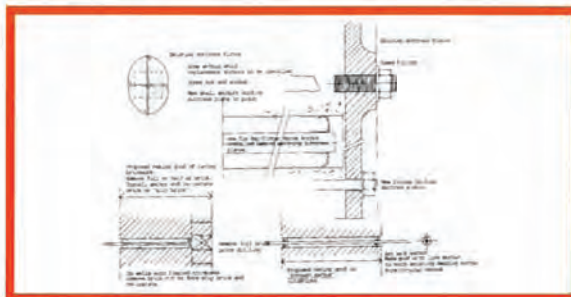
- Superficial damage of the masonry and stone walls cause by the presence of vegetation and water ingress. This was most evident at the top of the structure, where significant loosening of the brick and stonework had occurred with subsequent loss of the retained material. Water penetration, in conjunction with frost action, was also causing significant deterioration to the fabric of the brickwork and stonework.
- Differential settlement in the south wall of the south furnace charging building resulting in westward rotation of part of the wall and consequent vertical and diagonal cracking through the superstructure supported by it.
- Cracking and spreading movements in the superstructure, resulting in outward displacement of walls.
- Distress cracking, loss of material and localised collapse of the stone masonry retaining walls which were up to 13m high.



West elevation



Making good anchor holes in stonework



Making good anchor holes in brickwork



Completed renovation

The geology of the retained ground was investigated, using shell and auger holes, with subsequent laboratory tests to determine the characteristics of the subsoils. The investigation concluded that the site is overlain with topsoil on fill materials form 6 -11 m deep. The fill is principally ash containing one or more of brick and tile discards, blast furnace slag and coal. It is deposited on mudstones containing strata or lenses of sandstone and hard clay. The mudstone at the fill interface is frequently softened to a medium clay due to weathering caused by the presence of ground water.

Rates of deformation and crack development

Since the excavation of the structure in 1980, a number of structural movements appear to have taken place, as evidenced by cracking and distortion of early repairs undertaken by the Ironbridge Gorge Museum Trust. No long term records exist, but during the preparation of reports for the repairs brief, it was visibly noticeable that movement and cracking was worsening, confirming that it was progressive.

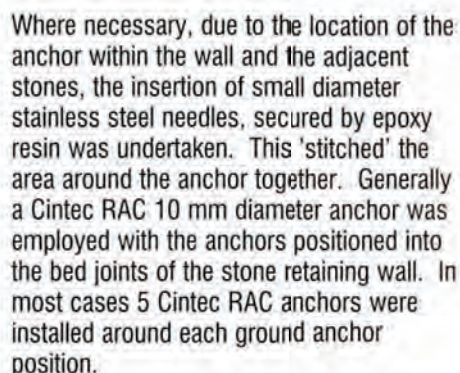
In addition to this cracking, rusting of the cast and wrought iron plates, lintels and tie bars within the structure was continuing, due to the ingress of ground water, with a consequent splitting and heaving of masonry. This in turn caused increased water penetration to the structure.

Remedial measures

Following detailed discussions with English Heritage, a series of remedial measures to stabilise the structures was proposed. This work included the general consolidation of voided and eroded brickwork and stonework in conjunction with the installation of new tie bars and ground anchors. The selection of the ground anchor and tie bar was the subject of careful consideration, due to the very significant archaeological and historical importance of the structure.

Acknowledgements: 1. *The Ironbridge Gorge Museum Trust* Archaeological Unit 2. *W.T. Specialist Contracts Limited* Sub-Contractor 3. *Weaver Construction Limited* Main Contractor 4. *Wheatley Taylor Stainburn Lines Architects*

The ground anchor installation required a 100 mm diameter core to be taken out of the centre of a selected stone within the retaining wall. Drilling was then undertaken with or without a steel casing, using an air flush drilling system, to a designed anchor position and length of embedment into the underlying mudstone. The anchors were installed at a downward angle in order to reduce the depth of drilling necessary to penetrate the mudstone. Even with this angular adjustment the length of the Cintec Anchors was in excess of 20 m. The Cintec Anchor was then inserted in the hole with the sock positioned around the anchor. The whole anchor was then pressure grouted to within 100 mm of the face of the wall. Finally the original core was refitted into the core hole and resined into position so as to mask the end of the anchor.



Within the south and north furnaces where vault tie bars were to be replaced, the use of the Cintec Anchors was once again adopted. The new ties were inserted adjacent to the locations of the existing patress plates initially removed to enable drilling to take place. The anchors were installed in 50 mm diameter holes cored through the brickwork and where necessary into the mudstone strata behind the structure. The anchors and socks were inserted and grouted within the brickwork/mudstone, leaving the exposed areas of tie bar clear of any grout. The existing patress plates were re-fixed in their existing position so as to mask the repair works and leave the structural appearance of the building apparently unaltered.



Conclusions

logical and historical structure to be achieved. enabling all the operations to be fully impact on the structure which remained