Managing
Change
in the Historic
Environment

HISTORIC SCOTLAND

Engineering Structures

Consultation draft
August 2009

Key Issues

1. **Historic structures and works of civil engineering are often of significant architectural and historic interest in their own right.**

2. **Works to historic structures should be based on a thorough understanding of their design, construction and use of materials.**

3. **Where remedial or strengthening works are found necessary, they should:**

   - **be in sympathy to the way that structure performs;**
   - **restore the carrying capacity and extend its life.**

4. **Materials should only be supplanted where essential to structural stability, and where the consequences of that intervention are understood.**

5. **Where new construction is the only realistic course, retain the old structure for possible new use, such as by pedestrians and cyclists.**

6. **Some structures may not have an obvious alternative use, but may nonetheless be retained to give a sense of place to a development.**

7. **Local authorities give advice on the requirement for listed building consent, conservation area consent and other permissions.**

INTRODUCTION

This is one of a series of guidance notes on managing change in the historic environment. The series explains how to apply the policies contained in the *Scottish Historic Environment Policy* (SHEP, PDF 312K) and *Scottish Planning Policy 23: Planning and the Historic Environment* (SPP23, PDF 192K).

This note sets out the principles that apply to alterations to structures and works of civil engineering. It replaces the equivalent guidance in *The Memorandum of Guidance on Listed Buildings & Conservation Areas* (1998) and should be afforded equal weight in drawing up planning policies and determining applications relating to the historic environment.

Monuments scheduled under the Ancient Monuments & Archaeological Areas Act 1979 require scheduled monument consent for any works. Where a structure is both scheduled and listed, the scheduling controls have precedence. Separate advice is available from Historic Scotland's website: Scheduled Monuments: Guidance for Owners, Occupiers & Land Managers (PDF 718K).

WHY ARE HISTORIC STRUCTURES IMPORTANT?

Civil engineers gave Scotland her infrastructure. Bridges, aqueducts and railway viaducts, harbours, canals and lighthouses illustrate advances made in communications, and power, water and gas supply made daily life possible in the expanding cities of the industrial revolution.

Conservation decisions are based on an understanding of what gives significance to these structures. High importance is attached to historic fabric when it conveys information about how it was created and how it performed. In other cases the aesthetic form might justify a higher degree of intervention to restore that form or to help it perform a useful function that does not conflict with its heritage value.

Aberfeldy Bridge, Perth & Kinross, showpiece of General Wade's military road network, combines cutwaters with neo-classical quoins and obelisks that signal the springing point of the arch. © Crown copyright: RCAHMS. Licensor www.rcahms.gov.uk.

This bridge at Garve, Highland, is one of only four of its type to survive. Built during the late 19th century, the bridge is of timber trestle construction, and consists of eight spans, with six main truss spans. © Crown copyright: RCAHMS. Licensor www.rcahms.gov.uk.

Below: parts of a bridge, identified on the repaired road bridge at Orrin, Highland.

Union Bridge, Scottish Borders, 1821, the oldest suspension bridge still carrying a road, showing a clear distinction between the historic chain links and a 1920s wire cable. The deck is wooden and the parapets do not conform to modern standards. A weight limit and bollards exclude heavy vehicles.

Carron Bridge, Moray, 1863: a railway bridge that is now a road bridge. An application to build a new steel arched bridge, and fix the outer cast-iron ribs to it, was withdrawn after it was found by calculation at a public inquiry to be unnecessary. The cross spandrels read through from side to side, so facadism was not going to work visually.

Dalmarnock Bridge, Glasgow, is a series of wrought iron girders behind a gothic cast-iron spandrel. It was strengthened in 1996 by insertion of new steelwork. The repaired cast-iron parapet is protected from traffic by bollards.

HISTORIC BRIDGES

Attention to detail pays dividends in any conservation work. Parapets, refuges, balustrades, railings, lamp-standards and plaques and historic road surfaces contribute to the character of a building. Any damaged, decayed or missing item should be repaired or replaced in its original form and material. Substitute materials are seldom visually successful and may harm structural performance.

Stone

Stone bridges can carry loads far in excess of those originally anticipated. Stone strength, colour, tooling, coursing and jointing must be carefully matched in any new work. The pointing and grouting of masonry bridges should be undertaken with the greatest care. New pointing should match the strength, colour and finish of the original.

Timber

Timber bridges are rare and repairs should be carried out in matching timber with similar connecting joints. As timber may in time require piece-by-piece replacement it should be documented before and during the work.

Iron and steel

Iron and steel bridges are important to the history of engineering. Work to these should respect and retain as much as possible of the original structure. Here the actual fabric of blacksmiths' work may be central to the character of the structure. So does the lively nature of a suspension bridge. Cold metal stitching of cast-iron is preferable to welding. Steel requires more frequent painting than does iron. Plate bonding can add security to the underside of arches and girders. Rivets are sometimes replaced by cup-headed bolts unless the scale or significance of a structure justifies revival of riveting.

Mass and reinforced concrete

Reinforced concrete is prone to decay from carbonation or from insufficient cover to the reinforcement. Repairs must pay attention to the architectural form and finish. Patch repairs, cutting back the defective concrete, are normal. Sprayed repairs suit some concrete bridges but risk changing the profile of details like balusters. Plate bonding can be applied in inconspicuous places. Cathodic protection, desalination, hydrophobic coatings and re-alkalisation can prevent recurring problems.

Moveable bridges

Moveable bridges require regular maintenance and inspection while they continue to move, and this may justify some replacement of parts to sustain the significance of the bridge. Even if a moveable

bridge is to become fixed, the mechanism should be retained.

Parapets

Parapets may need to be protected against the possibility of vehicle accidents. Where they overlie a railway line, particular measures are required. Where the parapet is an important element of the character of the bridge, it is usually best to raise the kerb or introduce standard modern parapets at the junction of road and footway, so protecting pedestrians. In exceptional cases some cast-iron parapets have been re-cast in Spheroidal Graphite Iron (SGI). Additions to parapets may sometimes be approved where suicide is a strong risk.

Lamp-standards

Parapets or lamp-standards may already have been replaced. Where these are out of character or do not replicate the original pattern, reinstatement of the original design would be welcome.

Reinforcement

Reinforcement or infilling which would conceal any part of the bridge structure requires listed building consent. Where reinforcement is unavoidable, a solution which causes the least structural and visual damage is preferred. Infilling of an arch or propping a structure will often be unsightly and is not a long-term expedient.

Voids

Stone arched bridges were sometimes designed to include voids to lighten loads and allow internal inspection. Grouting these with a concrete fill may turn the bridge into a monolith with unpredictable results in terms of passage of moisture through the masonry. Sprayed lining is not recommended: the edge is difficult to conceal and the effect will be similar to that of cement on a stone wall.

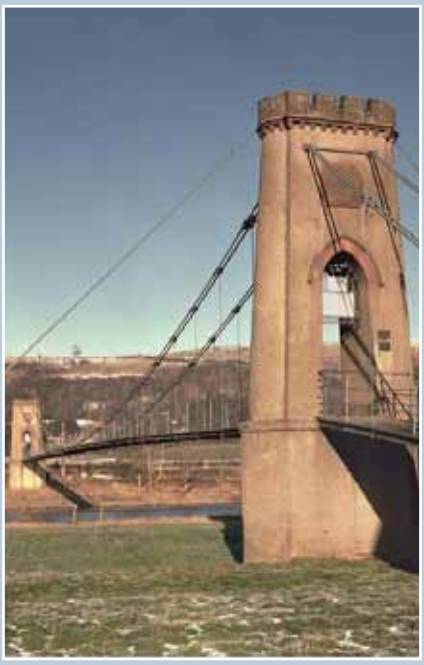
Widening

Proposals to widen bridges are considered on their merits, but should avoid creating a tunnel and should not result in a change to the rhythm of the members where that is significant to the character of the bridge. Nor should a historic parapet be lost.

It may be better to route a second bridge alongside to carry some of the traffic, still leaving the old bridge with a job to do. Careful removal of previous widening may enhance its appearance.

Weight-loads

Distortions, such as in an arch, may have long settled into place, and form part of the character of a bridge. Unless proven to be an ongoing problem, the distortion should stay rather than be reconstructed. Tests to destruction have often shown that assessed loads are far below actual loads at which the bridge failed.



Gattonside suspension bridge, Melrose, Scottish Borders, 1826, photographed in 1991 before reconstruction work. © Crown copyright: RCAHMS. Licensor www.rcahms.gov.uk.

The same bridge at Gattonside after its reconstruction in 1991–2. The parapet of the same bridge is so straight that it now acts as a girder. Chains and connections are much heavier and while some fabric has been retained its character is compromised.

Graving (dry) Dock in Dundee that escaped infilling. The port function has changed to a big mixed use development steered by a conservation plan required as a condition of planning permission.

Vertical coursed masonry at Pittenweem Harbour, Fife. © N Haynes.

A basin on the Union Canal at Linlithgow, West Lothian, which following the completion of the Millennium link, is seeing increasing leisure uses alongside and on the canal. Most maintenance work, such as to the puddle lining of a canal, is covered by class consents. © N Haynes

Reuse

Former railway viaducts and bridges make, with little adaptation, ready-made pedestrian and cycle routes. They are best conserved as part of a linear continuation of the routes they once served, not in isolation.

HARBOURS, PIERS AND DOCKS

Scotland has an exceptionally long coastline. Her numerous harbours and docks show evolution in engineering technology acquired as this maritime nation explored the world. Historic fabric will often be important in showing that evolution, but it is equally important to achieve continuation of use, which means honestly expressed new work and appropriate repairs.

Repairs

Repairs should retain as much as possible of the original stonework and surfacing. The coursing is often vertical in early harbours and wooden wedges might be used to give some resilience to wave action. Associated lock-gates, swing bridges, leading harbour lights, breakwaters, cranes, lamp-standards, bollards, capstans, slips, hydraulic mechanisms and other fixtures more than 30 years old give special interest to the character of a harbour.

Infilling

The infilling of wet or dry docks or the removal of dock gates would impact badly on the character of a dock, even if carried out reversibly with a loose fill. If a gate must be replaced, the continuing operation of a dock or canal lock may be a supporting factor in the case for renewal. Particularly important historic gates might then be displayed nearby, if shown not to be reparable to working order.

CANALS

All the major sea-to-sea (Crinan, Caledonian, Forth and Clyde) and city-to-city (the Union) canals are scheduled monuments, and buildings associated with them may be listed. A stable, bridge or tow path sign may seem modest in its own right, and yet may contribute greatly to the cultural value of the route as a whole. Class consents may allow specific works of maintenance without individual applications for scheduled monument consent, when first agreed by Historic Scotland. Some shorter and relict canals, and the reservoirs and feeders into the major canals, also have archaeological potential even if not scheduled or listed.

LIGHTHOUSES

Lighthouses are designed to withstand the least hospitable environments. Interlocking masonry, Portland cement and coatings not usually found on stone buildings are typical. Paint was and is often applied in distinctive ways to make them into daymarks, and the continuance of this practice is part of regular maintenance.

Related details such as the lenses, the lanterns, the fog horn and associated compressors, and the keepers' houses, walled gardens, byre and sundial add up to form an integrated light station. Modern devices needed for their continued function, from helipad to arrays of solar panels, are also usually seen as part of the infrastructure of a lighthouse. These might be removed when alternative uses are proposed.

Girdleness lighthouse, Aberdeen, 1833, has typical keepers' houses, flat-roofed to emphasise the height of the tower, a compressor house and foghorn. A radio mast makes it a key part of the UK Global Positioning System (DGPS) and is not out of place.

WATER, GAS AND POWER INFRASTRUCTURE

This guidance will not cover every eventuality. Much of what is said above about bridges applies to other engineering structures.

Water

Often water supply infrastructure forms a linear 'Heritage Corridor'. The water might be gathered for a power system, such as the Greenock Cut or a hydro-electric power station, or to feed canals or provide a city with its water needs. It is possible that items of infrastructure that are ancillary to the main object of listing could be considered to fall into its curtilage. The few Scottish water towers are either adapted as houses or still in use, responding well to floodlight.

The control panel at Bonnington Power Station, South Lanarkshire, 1927, was retained in situ by Scottish Power although superseded by a computer.

Gas

Gas supply came to Scotland in the early 19th century and was used to light factories, particularly where water power meant working at night. Most towns had gas works in the 1820s. Most of these were supplanted by larger gasworks. Their archaeological potential can be high, but appropriate precautions must be taken in the treatment of contaminated land. Gasholders conform to a number of types, the gas contained in a bell, sealed by water, rising and falling within a fixed frame or self supporting and spiral guided (so level with the ground when empty). Only a few are listed, but there are overseas examples of their adaptive reuse. The steel elements will require periodic painting and assessment of their structural strength.

Perth Water Works, now converted for use as the Fergusson Gallery, has a cast-iron cistern made in 1832 that has recently been refurbished.

Cox's Stack: a 90-metre-high sentinel over Camperdown Works, Dundee, 1865, is the focal point for a mixed use urban regeneration project. Red and white polychrome brick was popular in industrial buildings from 1860 to 1880. A proposal to fit a large dot matrix sign to the upper stage was refused following a public local inquiry.

CHIMNEYS AND TALL STRUCTURES

Chimneys

Chimneys – or 'stalks' as freestanding industrial stacks are called – stand out as symbols of industry. Many have been lost or are truncated, but there are some that remain within residential or other conversions. Some continued use to carry warm air or gases is beneficial to resist freeze–thaw action. It is important that repair to the top cornice or oversailer should be specified or conditioned in any proposal for adaptive reuse, even if they are disguised.

Tall structures

Tall structures can symbolise an industry and give a sense of place to a locality. The headgear of a coal mine, or the cantilever crane that installed marine engines into ships, may project a monumental value to a community even if it is hard to visualise a conventional reuse scheme. Some examples of each have now been adopted by their communities, repaired, imaginatively floodlit, and made accessible by the addition of new lifts and stairs clearly distinguishable from the historic artefact. A repair and paint scheme should aim to tackle foreseeable problems while access is available, and should ideally build in access arrangements for future maintenance.

Silos are also adaptable while obviously requiring to be changed if they are no longer used for bulk storage. Windows that might be cut into a reinforced concrete, steel or timber tower should be as contemporary in style as their function requires.

Almost no structure is non-habitable, but some are of such iconic value that their retention as part of an overall development justifies the investment, even if habitation or other use is not at present practicable.

CONSENTS

Scheduled monument consent is needed for all works to a scheduled monument. Application forms are available from Historic Scotland.

Listed building consent is required for any work to a listed building that affects its character. The local authority determines the need for consent. In the few cases where a structure is scheduled as well as listed, only scheduled monument consent is required.

Where listed building consent is required, an application is made to the local authority. This should include accurate scale drawings showing both the existing situation and proposed works in context. It is normally helpful to provide detailed technical information and photographs.

FURTHER INFORMATION AND ADVICE

Details of all individual scheduled monuments, listed buildings, designated gardens and designed landscapes, and designated wrecks can be obtained from Historic Scotland (see contact details below) or at: www.pastmap.org.uk. Details of listed buildings can also be obtained from the relevant local authority for the area.

Advice on the requirement for listed building consent, conservation area consent, building warrants, and other permissions/consents should be sought from local authorities.

Historic Scotland Inspectorate
Longmore House
Salisbury Place
EDINBURGH
EH9 1SH

Tel: 0131 668 8981 or 8717 Fax: 0131 668 8765
E-mail: hs.inspectorate@scotland.gsi.gov.uk
Web: www.historic-scotland.gov.uk

Advice on technical issues is available from Historic Scotland's Technical Conservation Group at the above address and website or at the following:

Tel: 0131 668 8715 or Fax: 0131 668 8669
E-mail: hs.technicalconservationgroup@scotland.gsi.gov.uk

Cover images

Titan Crane (1907), Clydebank, with access lift added, now the focal point of the masterplan for the redeveloped John Brown shipyard.

Mass concrete viaduct (1897–1901) at Glenfinnan, Highland. © Crown copyright: RCAHMS. Licensor www.rcahms.gov.uk.

Covesea Lighthouse, Moray. © N Haynes.

Other selected Historic Scotland publications and links

Guide for Practitioners 5: Scottish Iron Structures (2006) (available for purchase)

Inform Guide: Structural Cracks (2008) (PDF 934K)

Inform Guide: Foundations & Wall Footings (2008) (PDF 766K)

Inform Guide: The Use of Lime & Cement in Traditional Buildings (2007) (PDF 480K)

Inform Guide: Masonry Decay (2005) (PDF 367K)

Inform Guide: Repairing Brickwork (2007) (PDF 513K)

For the full range of Inform Guides, Practitioner Guides, Technical Advice Notes and Research Reports please see the Publications section of the Historic Scotland website.

Other selected publications and links

Highways Agency, BD89/03, The Conservation of Highway Structures (Vol. 3, Section 2, Part 4 of the *Design Manual for Roads & Bridges*) (PDF 192K on HA website)

Graham Tilly, *Conservation of Bridges*, Highways Agency/ Gifford and Partners (2002)

International Association of Marine Aids to Navigation and Lighthouse Authorities *Lighthouse Preservation Manual* (2004) (website: IALA).