

Managing
Change
in the Historic
Environment

Engineering Structures



Key Issues

- 1. Historic structures and works of civil engineering are often of significant architectural and historic interest in their own right. Listed building consent is required for any works affecting the character of a listed building and planning permission may be required in a conservation area. Scheduled monument consent is always required for works to scheduled monuments.**
- 2. Works to historic engineering structures must be based on a thorough understanding of their design, construction and use of materials. This is likely to require the involvement of structural engineers and others with relevant experience of dealing with such structures.**
- 3. Where remedial or strengthening works are found necessary, they must:**
 - be in sympathy to the way that structure performs;**
 - restore the structural strength and extend its life.**
- 4. Existing materials should be replaced only where essential to structural stability or other safety-related issues, and where the consequences of that intervention are understood. In general, existing material should be retained and augmented, rather than replaced, by new construction where stability or other safety-related issues are of concern.**
- 5. Some structures may not have an obvious alternative use, but should nonetheless be retained to give a sense of place to a development.**
- 6. Planning authorities give advice on the requirement for listed building consent, planning and other permissions.**

1. INTRODUCTION

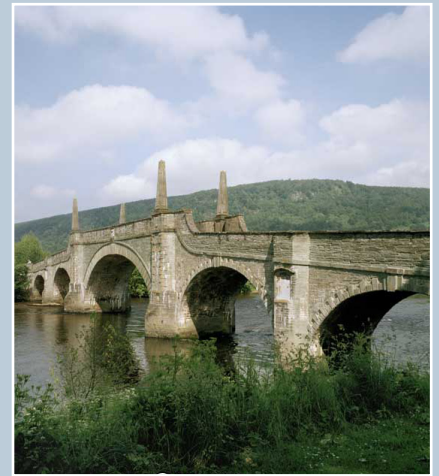
- 1.1 This is one of a series of guidance notes on managing change in the historic environment for use by planning authorities and other interested parties. The series explains how to apply the policies contained in the *Scottish Historic Environment Policy* (2009) ([SHEP](#), PDF 312K) and *The Scottish Planning Policy* (2010) ([SPP](#), PDF 299K).
- 1.2 This note sets out the principles that apply to alterations to structures and works of civil engineering. It should inform planning policies and the determination of applications relating to the historic environment, and replaces the equivalent guidance in *The Memorandum of Guidance on Listed Buildings & Conservation Areas* (1998).
- 1.3 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).

2. WHAT ARE ENGINEERING STRUCTURES?

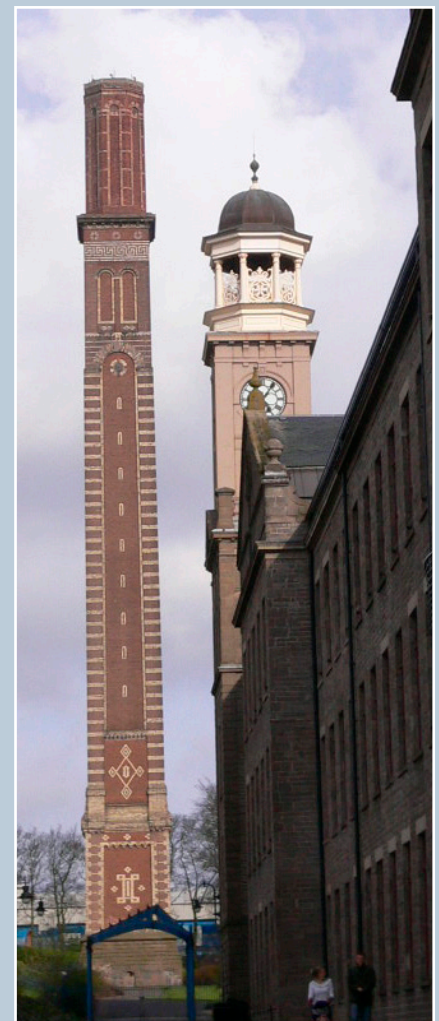
- 2.1 Scotland's industrial heritage is evidenced by our engineering structures. These include a wide variety of types and forms, such as bridges, tunnels, aqueducts, railway viaducts, harbours, canals and lighthouses. In many cases they can include individual structures as well as associated features, like railings, lamp-standards, breakwaters, lock-gates, machinery and fog horns.
- 2.2 Many buildings, such as mills, factories, warehouses and railway stations also contain historic structural engineering.

3. WHY ARE ENGINEERING STRUCTURES IMPORTANT?

- 3.1 Historic engineering structures make a major contribution to Scotland's historic environment. As well as contributing to town and landscape, they also illustrate advances made in communications and technology over time.
- 3.2 The wider context can also be of significance, for example the relationship of a structure to a larger group (e.g. a railway bridge is, or was, usually part of a group of structures along a line or network).



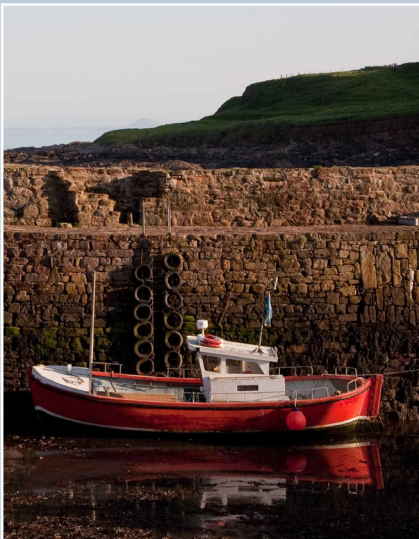
*Aberfeldy Bridge, Perth & Kinross, showpiece of General Wade's military road network, combines cutwaters with neo-classical quoins and obelisks that signal the springing point of the arch. © Crown copyright: RCAHMS.
Licensor www.rcahms.gov.uk.*



Cox's Stack: a 90-metre-high sentinel over Camperdown Works, Dundee, 1865. Red and white polychrome brick was popular in industrial buildings from 1860 to 1880.



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.



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



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.

4. IDENTIFYING THE INTEREST OF ENGINEERING STRUCTURES

4.1 Engineering structures encompass a very wide variety of types and forms. While this list is not exhaustive, the examples below indicate the elements of interest that are likely to contribute to character across a range of types.

Historic bridges

4.2 As well as being used for communication, bridges can be major architectural features in a town or landscape. Elements such as parapets, refuges, balustrades, railings, lamp-standards and plaques and historic road surfaces can all contribute to the character of a historic bridge.

4.3 The materials used, such as timber, stone, brick, iron, steel and reinforced concrete are also of interest and can be important to the history of engineering.

Harbours, piers, docks and ferry slips

4.4 Scotland's numerous harbours, docks and ferry slips show evolution in engineering technology as well as the nation's major maritime heritage. Historic fabric will often be important in showing the development of these structures. The coursing is often vertical in early harbours and wooden wedges might be used to give some resilience to wave action.

4.5 Associated elements, such as swing bridges, harbour lights, cranes, and hydraulic mechanisms can also give special interest to the character of a harbour.

Canals

4.6 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. Associated elements, such as a stable, bridge or towpath sign may also contribute greatly to the cultural value of the route as a whole.

Lighthouses

4.7 Lighthouses are designed to withstand inhospitable environments and were the pinnacle of structural engineering of their day. They made use of materials and techniques, such as interlocking masonry, Portland cement and coatings not usually found on stone buildings. Many were painted distinctively to make them prominent during the day.

4.8 Related details such as the lenses, the lanterns, the fog horn and associated compressors, and associated curtilage buildings all add to the interest of the structure.

Water, gas and power infrastructure

4.9 Water towers can be distinctive landscape features and associated water supply infrastructure can often form 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. This was key to the expansion of Scottish cities. It is possible that items of infrastructure that are ancillary to the main object of listing could be considered to fall into its curtilage.

- 4.10 Structures related to gas supply can also be significant, in particular those such as gasometers.

Chimneys and tall structures

- 4.11 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.
- 4.12 Chimneys also stand out as symbols of industry, including agriculture, and often make a major contribution to a skyline.

5. GENERAL PRINCIPLES FOR ALTERATIONS AND REPAIRS

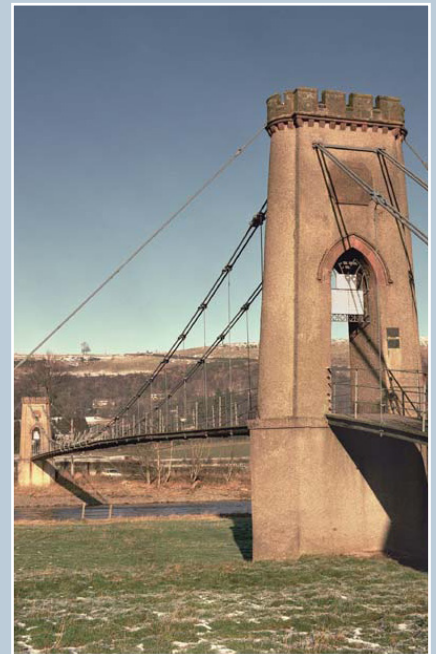
- 5.1 This section deals with general principles that relate to all engineering structures. However, given the variety of these, some structures are dealt with in more detail than others. Traditional structures will often require traditional repair techniques and appropriate technological advice should be sought from relevant professionals.

Character and interest of the structure

- 5.2 Alterations and repairs to historic engineering structures must protect their character and special interest. That character must therefore be understood before any intervention is made. Documentary research and fabric analysis can be useful in understanding the design and material properties of engineering structures.
- 5.3 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 historic significance.

Maintenance

- 5.4 Regular inspection, maintenance and appropriate repair are essential to maintaining the structural and visual integrity of engineering structures and their associated features.
- 5.5 Structures such as lighthouses were often painted in distinctive ways and the continuance of this practice is part of regular maintenance. Cast-iron structures and fixtures also require a regular schedule of painting to prevent corrosion, while other



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.



Manse 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. Certain works of maintenance to scheduled canals is covered by a class consent. © N. Haynes.



Moy Viaduct, Inverness.



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.

types of metal may require different maintenance regimes, plus periodic assessment of their structural strength.

- 5.6 Regular maintenance and inspection is particularly important for structures that are still in use, such as moveable bridges and canals. Although most Scottish canals are scheduled monuments, maintenance agreements can be agreed with Historic Scotland to allow certain repairs to be carried out without the need for individual consents.

Repair

- 5.7 The character and historic fabric of an engineering structure is best maintained by repairing components on a like-for-like basis. 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.
- 5.8 Many engineering structures were constructed using iron and steel. Work to these structures must respect and retain as much as possible of the original material. Here the actual fabric of blacksmiths' work may be central to the character of the structure.
- 5.9 Stone repairs should retain as much as possible of the original stonework and surfacing. Stone or brick strength, colour, tooling, coursing and jointing should be carefully matched in any new work and pointing and grouting should be undertaken with the greatest care. Any new pointing to stone or brick structures should match the strength, colour and finish of the original.
- 5.10 Timber repairs may be necessary to structures such as historic timber bridges. As survival of these structures in their original form is rare, any repairs should be carefully considered and sensitively carried out.
- 5.11 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.
- 5.12 Some highly decorated items of engineering structures are also functional. For example the top cornice, or 'oversailer' for smoke dispersal, on chimneys. This needs to be considered in any scheme for repairs.

Replacement of parts

- 5.13 Historic fabric will often be important in showing the evolution of engineering technology, but it is equally important to achieve continuation of use, which means honestly expressed new work as well as appropriate repairs. Where structural integrity is compromised and there is no alternative to the replacement of

original parts of a structure, the new elements should match the original.

- 5.14 A moveable bridge, for example, may justify some replacement of parts in order to stay in use and sustain the significance of the bridge. The continuing operation of a dock or canal lock may also be a supporting factor in the case for renewal of elements such as lock-gates. Particularly important historic gates might then be displayed nearby, if shown not to be repairable to working order.

Reinstatement

- 5.15 Generally, reinstatement of an element of a structure should only be considered where documented evidence of the original exists and reinstatement will not result in the loss of existing historic fabric that contributes to the character of the structure. Appropriate examples may be where replacement parapets or lamp-standards on bridges are out of character with the original design, or where there is evidence of an early or original decorative colour scheme.

Reinforcement and strengthening

- 5.16 Where reinforcement or strengthening is unavoidable, a solution which causes the least structural and visual damage must always be sought. Propping or strengthening a structure should only be considered as a short-term solution.
- 5.17 Within stone structures, such as an arch, distortions may have long settled into place, and form part of the character. Unless proven to be an ongoing problem, the distortion should stay rather than be corrected. Tests to destruction have often shown that assessed loads are far below actual loads at which the structure failed.
- 5.18 The use of carbon fibre to replace or strengthen missing material in a steel or iron structure is sometimes a minimal intervention option. Plate bonding can also add security to the underside of arches and girders.

Infilling

- 5.19 Stone arched bridges were sometimes designed to include voids to lighten loads and allow internal inspection. Inappropriate infilling can have both an aesthetic and structural impact that would be undesirable.
- 5.20 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.

Widening of bridges

- 5.21 Where the widening of a bridge may have an unacceptable impact on its character, it may be better to route a second bridge alongside to carry some of the traffic, still leaving the old bridge. Careful removal of previous widening may enhance its appearance.



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 panel. It was strengthened in 1996 by insertion of new steelwork. The repaired cast-iron parapet is protected from traffic by bollards.



Stow Packhorse Bridge in the Scottish Borders has been retained although it is now redundant.



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



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

Parapets

- 5.22 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 a bridge, it is usually best to raise the kerb or introduce standard modern parapets at the junction of road and footway, so protecting pedestrians. Where change results in the need to alter parapets, they should be retained and reinstated on the new alignment.

Alterations and Reuse

- 5.23 When the original use of a structure becomes redundant and a site or associated buildings are redeveloped, the old structure should be retained for possible new use. Any proposal for alteration or reuse of an engineering structure must take into account the character, design and material properties of the original.
- 5.24 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.
- 5.25 Many chimneys and tall structures have been lost, but some examples remain within residential or other conversions and 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.
- 5.26 Structures such as silos, while obviously requiring to be changed, are adaptable 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.

6. ARCHAEOLOGY

- 6.1 It is possible that archaeological resources survive within or beneath a structure. Advice on archaeological sensitivity should be obtained from the planning authority's archaeological adviser at an early stage. Planning authorities should seek to manage archaeological issues, such as recording or preservation in situ, through the use of conditions or agreements under Section 75 of the Town & Country Planning (Scotland) Act 1997.

7. RECORDING

- 7.1 When proposed works will result in a significant loss of fabric or changes to an engineering structure's character or function, it is recommended that the Royal Commission on the Ancient

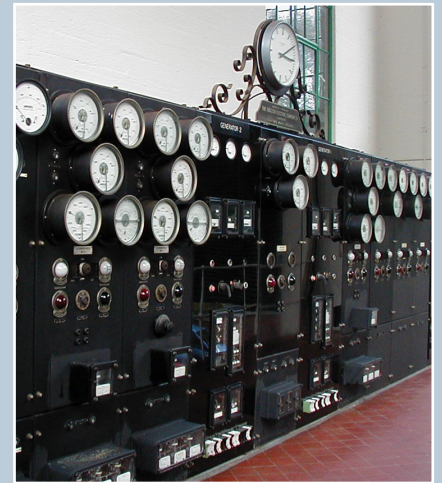
and Historical Monuments of Scotland (RCAHMS) is given the opportunity to record the site prior to works commencing. In addition to recording the structures themselves, RCAHMS' Industrial Survey also undertakes more in-depth recording of fixtures, machinery and industrial processes, which are part of an engineering or industrial site. Please contact the RCAHMS at the following address:

RCAHMS,
John Sinclair House,
16 Bernard Terrace,
EDINBURGH ,
EH8 9NX.

Tel: 0131 662 1456.

E: info@rcahms.gov.uk.

W: www.rcahms.gov.uk.



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

8. CONSENTS

- 8.1 Scheduled monument consent is always required for works to scheduled monuments. Applications for scheduled monument consent should be made to Historic Scotland.
- 8.2 Listed building consent is required for any work to a listed building that affects its character. The local authority determines the need for consent.
- 8.3 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 the proposed works in context. It is normally helpful to provide detailed technical information and photographs.

Other selected Historic Scotland publications and links

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

Inform Guide: Structural Cracks (2008)

Inform Guide: Foundations & Wall Footings (2008)

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

Inform Guide: Masonry Decay (2005)

Inform Guide: Repairing Brickwork (2007)

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](#)).

Roland Paxton & Jim Shipway (eds.), *Civil Engineering Heritage - Lowlands & Borders; Highlands & Islands* (2007)

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
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

The Institution of Civil Engineers' Panel for Historical Engineering Works, based on its extensive record coverage and specialist knowledge provides advice on the historical engineering merit of engineering works with a view to encouraging excellence in the conservation of significant examples:

Institution of Civil Engineers,
1 Great George Street,
Westminster,
London,
SW1P 3AA.

Tel: 020 7222 7722.

Email: engineering@ice.org.uk.

Web: www.ice.org.uk.

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www.historicscotlandimages.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.