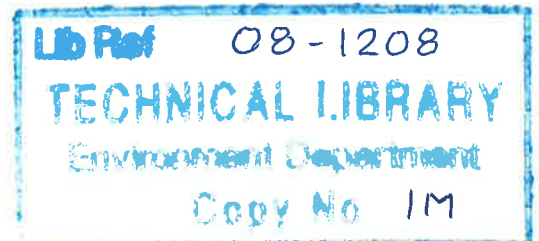




FUNDING FOR BRIDGE MAINTENANCE



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Report Prepared by CSS Bridges Group

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1. Introduction

Bridges and retaining walls are an essential component of any highway network and Highway Authorities are under a statutory duty to maintain them. Also as they represent a significant publicly owned asset with many bridges being prominent features in the environment and some either Listed Buildings or Ancient Monuments, it would not be in the public interest to allow them to deteriorate. Unless these are maintained in a safe condition the network will become a series of unconnected links which will be of little value to the public and will definitely not deliver the current aspirations for an Integrated Transport Network. This is recognised by the Government and in their White Paper⁽¹⁾ on 'A New Deal for Transport ; Better for Everyone' they state that they have matched spending outlined in the Comprehensive Spending Review to their priorities and that, for transport, one is to ensure that the existing infrastructure is properly maintained and managed.

This priority is supported by the CSS Bridges Group, but they were concerned from discussions at their meetings, that the reality on the Local Authority maintained highway network appears to fall far short of the above aspirations. They, therefore, set up a Working Party in January 1999 to research the matter and to submit their Final Report to the February 2000 meeting of the CSS Bridges Group. The following report outlines what has been discovered and, whilst recognising the need for further work in some areas, it forms a good basis for discussion with the Government on funding for this important issue.

The Working Party comprised the following members of the CSS Bridges Group:-

Dr Roger Cole - Lancashire County Council (Convenor)
Mr Steve Pearson - Derbyshire County Council
Mr Greg Perks - Northumberland County Council
Mr Steve Tart - Manchester City Council
Mr Mark Wyatt - Cheshire County Council

2. Scope

The term Bridge Maintenance will include the maintenance of retaining walls as well as all bridges on the adopted highway network and therefore the report will cover the maintenance of all these highway structures. It will not include the maintenance of structures on the Trunk Road and Motorway Network or on the Public Rights of Way Network, nor those which are privately owned by such bodies as Railtrack, Rail Property Limited, British Waterways, etc. Only those bridges with spans of 1.5 metres or above will be considered as smaller structures are considered part of road maintenance because they are maintained using techniques developed by drainage engineers. It is suggested that this demarcation is used by all Local Authority Highway Authorities to assist in the compilation of comparative statistics in the future. However, all retaining walls irrespective of height will be considered provided their dominant function is to act as a retaining structure.

Whilst the report will be written with regard to the situation in England, many of its conclusions will be applicable to Scotland, Northern Ireland and Wales where the funding mechanisms are different.

Also as retaining walls generally occur mainly in the upland parts of the United Kingdom and records for these walls are not of the same standard as for bridges the report has concentrated on the funding required for the maintenance of bridges. However, it has highlighted the fact that funding is also required for the maintenance of retaining walls and that for some Highway Authorities this is a major issue.

3. Definition of Bridge Maintenance

Bridge Maintenance is defined in the OECD Report⁽²⁾ as including all operations designed to maintain a bridge in a serviceable condition. This includes the following aspects:-

- a) **Regular Inspections**, eg General Inspections, Principal Inspections;
- b) **Routine Maintenance**, which is minor work carried out on a regular basis; eg removal of vegetation, cleaning out drainage systems, greasing of metal bearings;
- c) **Steady State Maintenance**, which can be split into⁽³⁾:-
 - (i) **Preventive Maintenance**, which is work to repair defects, replace components or otherwise slow down the rate of deterioration; eg repointing, repainting, rewaterproofing, minor concrete repairs, cathodic protection;
 - (ii) **Essential Maintenance**, which is rehabilitation work undertaken when part (or whole) of a structure is considered to be (or about to become) structurally inadequate; eg major concrete repairs, scour repairs, masonry repairs, replacing bearings, steelwork repairs;
- d) **Upgrading Work** (ie work to bring the structure up to current standards but not including strengthening), eg provision of waterproofing, upgrading parapets;
- e) **Management of Substandard Bridges Prior to Strengthening**, eg monitoring;
- f) **Replacement**, when a bridge reaches the end of its useable life.

Steady State Maintenance, Upgrading Work and Replacement are all defined as Structural Maintenance. Assessment and Strengthening following assessment have not been included in the above definition of Bridge Maintenance as traditionally these programmes have only been initiated nationally when significant increases have been proposed in the weight of vehicles using the roads. However, it is now becoming to be realised ⁽³⁾ that regular assessments

should be a feature of Bridge Maintenance in order that Bridge Maintenance Strategies can be safety related based on whole life performance techniques. This is further discussed in paragraph 9 below.

4. Census of Highway Structures

A census has been carried out of all highway structures owned by Local Authorities in England and the results of this are given in Appendix 1 with a summary below. Replacement Costs are also given and are based on information provided by Local Authorities which show that the average bridge has a replacement cost of £215,000 and the average retaining wall has a replacement cost £900,000 per km. These replacement costs do not include the cost of service diversions or traffic management as these can vary so much depending on the location of the structure. It should be noted that generally the average replacement cost of bridges is lower for Counties than for Metropolitan or Unitary Authorities because the former are more rural with narrower roads and generally have more smaller span bridges. Similar information is given for the rest of the United Kingdom where this is available from the relevant national bodies.

Country	Bridges		Retaining walls	
	No	Replacement Cost (£M)	Length (km)	Replacement Cost (£M)
England	52,060	11,193	3,038	2,734
Wales	8,239	1,648	205	185
Scotland	13,965	2,765	41	37
Northern Ireland	6,500	702	not available	

This census and the surveys of costs referred to later have shown that many Highway Authorities have inadequate records for highway structures if they are to be maintained efficiently using whole life performance techniques. There is a need for additional resources to be devoted to improving this situation. This is recognised by the Highways Agency⁽¹⁶⁾ who are devoting considerable resources to improve the records of trunk road structures. Improving these records and keeping them in a consistent manner will also assist Authorities in benchmarking for Best Value. Whilst the information for bridges is likely to be fairly accurate, that for retaining walls considerably underestimate the actual values as few authorities have records.

5. Current Funding for Bridge Maintenance

a) Sources of Funding

As stated before, Government policy regarding funding is not the same in all parts of the United Kingdom. In England funding for structural maintenance of road bearing structures is provided via the Local Transport Capital Settlement whilst funding for all other aspects of bridge maintenance is provided through the Revenue Support Grant. As all of this funding is not ring fenced the actual sources of funding will vary from

authority to authority depending on local priorities, but generally Regular Inspections, Routine Maintenance and Management of Substandard Bridges are funded from revenue budgets whilst all other bridge maintenance is funded from the capital allocation for Bridge Assessment, Strengthening and Structural Maintenance.

b) **Current Level of Funding**

A survey of highway authorities shows that whilst there is some variation in the current level of funding the average values per annum are as follows:-

Bridges - £695 per bridge (equivalent to 0.32% of average Replacement Cost)

Retaining Walls - £300 per km (equivalent to 0.03% of average Replacement Cost)

6. **Funding Required for Bridge Maintenance**

The following methods have been considered in order to determine the level of funding which is required to keep all highway structures in a safe condition for highway users and maintained on a whole life approach aimed at a 'steady state', avoiding disproportionate costs due to traffic delay. Funding levels also being such as to allow for retaining the visual appearance of easily visible structures, particularly those of significant or historical background.

(a) **OECD Report**

This report ⁽²⁾ concludes that 'An annual expenditure at least equal to 0.5% of the replacement cost of the bridges seems to be necessary to implement a rational policy of preventive maintenance'. However it also states that 'In the United Kingdom maintenance expenditure of about 0.5% per annum is sufficient to cope with essential work but may not be adequate to prevent long-term deterioration'.

It should be noted that the above figures exclude the cost of regular inspections and the cost of eventual replacement. Based on a survey of inspection costs it would appear that the annual cost of inspections is approximately 0.1% of the Replacement Cost. Also assuming that bridges have a useable life of 200 years (possibly optimistic - BS5400 : Part 1⁽⁴⁾ only gives a nominal design life of 120 years for modern structures) then the annual cost of replacing structures would be 0.5% of the Replacement Cost.

Therefore this method would recommend that the annual funding required for bridge maintenance should be:-

$0.5 + 0.1 + 0.5 = 1.1\%$ of the Replacement Cost.

The report does not cover the maintenance of retaining walls.

(b) **British Rail Commuted Sum Method**

This method⁽⁵⁾ has been used for many years and is based on calculating the annual cost of inspecting, maintaining and eventually replacing the highway structure when it reaches the end of its useable life. It gives the cost of this as a percentage of the replacement cost for different forms of construction for both substructures and superstructures. These percentages vary from 0.375% to 1.5% for individual components and from 0.41% to 1.39% for complete bridges. The former represents a short span masonry arch bridge whilst the latter represents a multi span steel bridge on reinforced concrete supports. However, as these will only represent a small proportion of the total bridge stock it is likely that the range for individual highway authorities will be from say 0.7 to 1.1% with a national average of say 0.9% of the Replacement Cost based on the typical mix of bridge types in Local Authority ownership.

For retaining walls this method would give a range from 0.48% to 0.61% with a national average of say 0.55% of the Replacement Cost.

(c) **Lincolnshire Method**

This method is given in the document on the 'Strengthening of Railtrack owned Highway Bridges'⁽⁶⁾. It gives a table of costs for all maintenance operations based on the experience of one highway authority. Using this document and including the eventual replacement of the bridge when it reaches the end of its useable life gives the following percentages of the replacement cost for an average size bridge (see paragraph 4):-

Steel composite deck	-	1.19%
Reinforced concrete deck	-	0.90%
Masonry arch	-	0.76%

This would give a national average of 0.87% of the Replacement Cost based on the typical mix of bridge types in Local Authority ownership.

For retaining walls this method would give a range from 1.26 to 1.39% with a national average of say 1.3% of the Replacement Cost.

The three methods give figures which are remarkably close so it is suggested that the required annual level of funding required for maintenance should be 1.0% of the Replacement Cost for Bridges and 0.9% of the Replacement Cost for Retaining Walls.

7. Current Backlog of Bridge Maintenance

A survey of highway authorities has confirmed the fears of the Bridges Group that the level of funding provided in recent years for Bridge Maintenance has fallen short of that which is required (see 6 above). Therefore, the condition of

structures has deteriorated and it is desirable in the short term to provide additional funding to overcome the backlog if even greater funding in the future is to be avoided.

The survey reveals that, whilst the backlog varies from authority to authority, on average it amounts to £6,875 per bridge (equivalent to 3.2% of the average Replacement Cost). Therefore if this backlog is to be overcome in a 10 year programme then the required funding for bridge maintenance would need to increase by 0.3% of the Replacement Cost above that normally required for the next 10 years (ie Required Funding = 1.3% of Replacement Cost).

Whilst considerable funding has been made available since 1991 in England for the Assessment and Strengthening Programme, this has not resulted in more bridges being replaced than should be done based on a useable life of 200 years (see paragraph 6(a) above). This conclusion is based on the experience of typical authorities and from an examination of the amount of funding made available nationally for the Strengthening Programme. So whilst this has helped in replacing the weakest structures in the past few years, it has not offset the problem of inadequate funding for Bridge Maintenance and also this programme was always considered by the Government to be of limited duration.

Records of the backlog of maintenance work on retaining walls are not generally available, but driving through the upland parts of the United Kingdom one is soon aware of the large backlog of maintenance work on many masonry retaining walls which are necessary to support the roads on sidelong ground. This is confirmed by the highway authorities in this area who only have sufficient funding to rebuild those collapsed walls, which cause the most disruption to highway users, and are therefore not able to fund a programme of inspection and preventive maintenance.

8. Indicator for Measuring Condition of Highway Structures

It will be essential to have a numerical indicator which can be used to determine whether the overall condition of highway structures is deteriorating or not in order to assess whether sufficient is being spent on Bridge Maintenance.

Some County Councils have developed a simple Bridge Condition Index based on work originally done by Berkshire County Council which uses the information provided from General Inspections. This uses a numerical indicator to express the condition of each component in a bridge and then calculates a weighted average for the whole bridge depending on the relative importance of each component to the integrity of the bridge. These values for individual bridges are then averaged (sometimes weighted according to the importance of the bridge in the network) to give Condition Index for the whole bridge stock.

The Highways Agency is developing a more complex Bridge Condition Index ⁽⁷⁾ which will use the information provided by the revised General Inspections ⁽⁸⁾ which will be introduced shortly. In these inspections the condition of individual segments making up a component is recorded and a complex algorithm is used to calculate the Bridge Condition Index.

CSS Bridges Group have had discussions with TRL about a possible research project which would develop the above ideas further and provide a nationally recognised Bridge Condition Index for Local Authority owned structures. The CSS Research Fund have agreed to finance this project and it is hoped that other Bridge Owners may be involved in order that the project may benefit from their expertise and also ensure that the indicator has wider usage than purely for Local Authority owned structures. This indicator could also be used to develop a Performance Indicator for Bridge Maintenance in the Best Value initiative taking note of alternative suggestions being pursued by the Highways Agency⁽⁹⁾.

The research project would also investigate how this indicator could be used in conjunction with deterioration models currently being developed by various bodies ^{(10), (11), (12)} to enable cost effective maintenance strategies based on whole life costing to be implemented.

9. Bridge Assessments

As the result of a Bridge Assessment remains valid only so long as the condition of the structure including the carriageway surfacing does not deteriorate or its use does not vary from that assumed in the assessment, there is a need to have an ongoing programme of assessments following on from the completion of the recent BD21 Assessment Programme.

British Waterways⁽¹³⁾ re-evaluate the Condition Factor used in their assessments when the 6 yearly Principal Inspections are carried out and review the assessment accordingly. Railtrack⁽¹⁴⁾ review their assessments whenever there is a significant change in condition of the bridge and have recently decided to review all assessments every 18 years.

The Highways Agency ⁽¹⁵⁾ have proposals to introduce a new steady state assessment programme. This will generally cover those bridges not in the BD21 Assessment Programme, revisit bridges that previously just passed their assessment and address any concerns, which may arise from research funding and experience.

In view of this it would be advisable if Local Authorities also had an ongoing programme of assessments. It is suggested that this will involve either reviewing assessments or completely re-assessing/assessing bridges if the use of the structure changed (eg lane marking altered, increased traffic flows due to development in the area) or at a frequency of between six to eighteen years. The assessment frequency will depend on whether there has been significant deterioration since the last assessment and the margin by which the bridge passed its previous assessment. It is estimated that this would require additional funding equivalent to 0.07% of the Replacement Cost of the Bridge Stock.

10. Conclusions

The main conclusions of this report are that:-

- there is a significant backlog of Bridge Maintenance in England;
- the current levels of expenditure on Bridge Maintenance are inadequate;
- the condition of both bridges and retaining walls will continue to deteriorate unless significant additional funding is provided in the future.

This will eventually lead to the need to weight restrict many bridges with the consequent increase in traffic congestion and effect on the economy. It will also then be necessary to inject considerably more funding to redress the situation than if it had been provided now.

There is also the significant risk that highway structures could become unsafe with possible catastrophic failures and loss of life. This danger has been highlighted in the recent report of the Standing Committee on Structural Safety ⁽¹⁷⁾ who said:-

'Although the number of structures that become unsafe has been quite small in recent times, the potential for safety loss to become widespread is substantial. The fact that the number is small is due largely to the skill and dedication of professional civil and structural engineers in averting recurrences. There is a strong tendency amongst those in Government and others who are responsible for structural maintenance and procurement resources to make the comfortable assumption that all is well and will continue to be well even if resource is reduced. The good record of structural safety may not be sustained in the future without adequate resources to maintain safety standards.'

The following detailed conclusions arise from the study carried out by the Working Party:-

- (a) There are 52,060 bridges and at least 3,038 km of retaining walls owned by Highway Authorities in England with a Replacement Cost of £11,193M and at least £2,734M respectively.
- (b) Currently an average of £695 per bridge (equivalent to 0.32% of average Replacement Cost) and £300 per km of retaining wall (equivalent to 0.03% of average Replacement Cost) is being spent annually on their maintenance.
- (c) An annual level of funding equivalent to 1.0% of the Replacement Cost for Bridges and 0.9% of the Replacement Cost for Retaining Walls is required in order to prevent their long term deterioration.
- (d) The total shortfall in maintenance expenditure on Bridges and Retaining Walls in England is currently at least £100M per year.
- (e) Currently there is a backlog of Bridge Maintenance in England of £6,875 per bridge (equivalent to 3.2% of the average Replacement Cost) or £357M in total. Additional funding equivalent to 0.3% of the Replacement Costs is required over a 10 year period to remove this

backlog. Figures are not available for the backlog of Retaining Wall Maintenance but it would appear to be at least of the order of £250M.

- (f) Additional annual funding equivalent to 0.07% of the Replacement Cost of the Bridge Stock in England (ie £7M) should be provided to implement an ongoing programme of Bridge Assessments.
- (g) Funding should be provided from the CSS Research Fund to enable TRL to carry out a research project into developing a Bridge Condition Index for Local Authority owned bridges.
- (h) Additional resources should be devoted to improving the records that Highway Authorities have for highway structures so that they can be managed more efficiently.
- (i) Records should be kept in a consistent manner to assist benchmarking for Best Value and to enable national statistics to be maintained.

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