Regular summaries of urgent work highlighted by inspections. Summaries, defect by defect, which may highlight incorrect maintenance techniques, inappropriate materials, etc.

A maintenance diary of work needed and work carried out, listing for example, bridges inspected this month, bridges to be inspected next month, etc.

Work schedules for different gangs, provided either on an area by area basis, or a work type by work type basis.

COMPUTER FIELD RECORDING

2.22 Microcomputer-based loggers are not recommended for bridge inspection. When an inventory is very well established and all inspectors are familiar with its operation, it is possible that such a system could be considered, provided suitable training is maintained. Even then, such a system could not fully replace the manual one recommended here.

3 BRIDGE INSPECTION

3.1 In some districts there will be few bridges and the district engineer may be able to carry out the inspection work himself, or he may have other qualified staff to do the inspection on his behalf. In this case, the organisational aspects covered in this chapter will be of interest, but not those parts referring to unqualified inspectors. However, the inspection report form presented in Appendix C is a comprehensive list of items to check, and can be used by all inspectors, whatever their experience.

THE BRIDGE INSPECTOR

3.2 Where there are many bridges and few bridge engineers, the district engineer has the choice of either:

- making infrequent inspections himself, or
- entrusting routine general inspections to others, and concentrating his own time on larger difficult bridges, and where the routine reports suggest that there are problems.

3.3 Staff suitable for routine bridge inspection are likely to be already in the employ of the district engineer. They may be junior engineers, technicians, or road foremen. Both older, experienced road men and younger, better qualified technicians have performed well in field trials of the procedures advocated here.

THE BRIDGE INSPECTOR'S HANDBOOK

3.4 Volume two of this note, the Bridge Inspector's Handbook, has been compiled specifically for inspectors who are not engineers, and who may not have English as their first language. It has been written in simple terms to teach the basic information needed to understand the task, and to guide the inspector through his work.

3.5 Part I of the handbook gives instruction on bridges. It can be used for formal, classroom instruction or private reading.

3.6 Part II guides the inspector through the report form presented in Appendix C of this note, item by item, explaining how relevant measurements or observations are made. It can be carried and used for reference, if required, during an inspection.

THE ROLE OF THE ENGINEER

3.7 The purpose of the general inspection is to provide the engineer with detailed information about the condition of each bridge to enable him to:

- assess maintenance requirements.
- determine if a more detailed inspection is required.
3.8 He should therefore:

- ensure that each inspector fully understands his duties and responsibilities.
- ensure that each inspector has access to all necessary equipment, including safety equipment.
- ensure that prior to an inspection, the inspector is given the necessary documents. (see paragraph 3.30).
- occasionally carry out inspections with each inspector; this will help ensure consistent marking by inspectors.
- read each inspection report carefully so that the significance and possible inter-dependence of isolated defects can be assessed. For example, the inspector may have noted cracking in the road approaches, and elsewhere he may have noted damage to the abutment ballast wall. These maybe unconnected faults, but together they may indicate forward movement of the abutment, the damage to the ballast wall having been caused by thrust against the deck.
- be prepared to seek expert advice, particularly if the report indicates that the bridge may have potentially serious defects. District engineers will rarely have sufficient knowledge or experience to assess the importance of all defects reported
- ensure that the records are updated.
- determine what maintenance is required, categorise priorities, and prepare work schedules.

THE ROLE OF THE INSPECTOR

3.9 The inspector must record as clearly as possible any defects found at a bridge so that the district engineer may decide on the appropriate action.

3.10 The inspector should not, in general, have to take decisions beyond giving his view of the severity and extent of problems he finds, if he is not a qualified engineer. Leaving any significant decisions to the inspector could lead to serious mistakes and places an unfair responsibility on him.

3.11 The inspector should be given specific responsibilities according to the discretion of his engineer.

If the inspector finds a defect which he believes is so serious that the bridge may collapse, he should be empowered to close the bridge immediately. The inspector may of course be wrong, but closing a bridge unnecessarily is better than allowing it to collapse and possibly cause injury or loss of life.

The inspector may be empowered to order or undertake specific maintenance tasks. Typically these tasks could include clearance of blocked drains or movement joints; minor repairs to parapets; repairs or replacement of signs; removal of debris in the river; and repairs to damaged gabions, rip-rap or stone pitching, etc. The defects should still be recorded on the report form, and noted as rectified.

SELECTING INSPECTORS

3.12 In selecting suitable personnel for training as bridge inspectors, the district engineer should look for the following qualities:

RELIABILITY

3.13 The engineer must be able to depend on his inspectors to carry out a task according to instructions given, and to inform the engineer promptly of any unusual circumstances.

TECHNICAL SKILLS

3.14 Although inspectors may not necessarily have any formal technical training, they should possess practical experience of construction. They must be able to observe and measure accurately and to draw simple sketches of any deficiencies found.

LANGUAGE SKILLS

3.15 Inspectors must be able to read the simple technical English, or other language, used on the inspection report; they must also be able to write clearly in the same language.

HEALTH

3.16 Inspectors should be physically fit, so they are able to inspect difficult places without taking unnecessary risks; it is advisable to check that the inspector has good eyesight, as he will be required to detect small defects in conditions of varying light and shade.

ATTITUDE

3.17 Good inspectors are methodical in their work and must be willing to inspect items thoroughly and critically; they must also be continually aware of safety so that they do not take risks and do not endanger the safety of others.

TRAINING INSPECTORS

3.18 Training of inspectors is crucial to the successful operation of a bridge inspection system and should be tailored to the ability and experience of the trainees. Training should, ideally, be carried out initially by a skilled instructor from the authority's training school. The Bridge Inspector's Handbook can be used as a textbook for formal classroom instruction of inspectors.

3.19 The next step in training an inspector is for the district engineer or an instructor to go to several different bridges with the trainee inspector, or a group of trainee inspectors, and to go through the inspection step by step. When completing the inspection report form, an inspector must make decisions about how bad? and how much? and on-site training periods are needed to teach the inspector how the engineer would answer these questions and to develop his note-taking and sketching skills. As the inspector will probably be dealing with several different types of bridge, he should inspect at least one of each type with an engineer before working on his own.
INSPECTION FREQUENCY

3.20 The district engineer is responsible for establishing the frequency of inspection of bridges under his management, although his highway authority may issue guidance. No fixed rules can be given, but if the bridge inspection is carried out by a road maintenance foreman, the engineer should consider the benefits of coordinating the inspection of roads and bridges.

3.21 How often a particular bridge should be inspected depends on a number of factors. These include: age, type of construction, traffic volume and type, structural condition, climate, and availability of resources for carrying out inspections. For example, an old timber bridge now carrying heavy traffic and known to be in a poor condition should be inspected much more frequently than a new short span concrete slab bridge. In an area known to suffer extremely heavy seasonal rainfall, it may be sensible to carry out an inspection both before and towards the end of each wet season, even if only those parts of the bridge likely to be affected by flood are inspected.

3.22 Limited human resources are likely to be a serious constraint on how often bridges can be inspected. However, an appropriate frequency can be based on the use of different types of inspection, as described in paragraphs 3.23 to 3.29.

TYPES OF INSPECTION

3.23 Inspections can be divided into four basic types:

- Informal
- General
- Major
- Special

INFORMAL INSPECTIONS

3.24 All personnel involved with bridge maintenance (particularly the inspectors) should be encouraged to keep their eyes open whilst travelling around, and to report anything unusual about any bridge. Telling engineers to ‘stop and have a general look when crossing a bridge’ is the best way to obtain progress reports on potentially serious defects, such as a river changing its path and undermining an abutment in the interval between routine inspections.

GENERAL INSPECTIONS

3.25 This is the type of inspection that can be accomplished by a less experienced inspector using the pro forma in Appendix C. General inspections should be carried out on a routine bases at least once a year, preferable at a time of low water to permit inspection of the substructures, the river bed and any bed protection. In areas where there is a very pronounced wet and dry season it is recommended that, as well as the inspection during the dry season, an inspection for flood damage is carried out at the end of the wet season.

MAJOR INSPECTIONS

3.26 Major inspections should also be carried out on a regular basis, although less frequently than the general inspections, to provide more detailed reports on the structures than the general inspections. For example, at a major inspection all bolts on a steel structure might be checked for tightness, whereas at a general inspection, the engineer may ask the inspector to check bolts only at selected joints. If possible, the district engineer should arrange for a qualified engineer to visit the bridge during a major inspection, or go himself, to ensure that the inspector’s assessment of problems is the same as his own. Parts of Appendix C may also be used for major inspections.

3.27 The time interval between major inspections for a particular bridge should be established initially by an engineer, based on the age, condition and construction materials employed. From the rate of deterioration which he subsequently observes, an optimum time interval can then be determined. If there are a number of bridges of one type and age, a common time interval for the group can be used.

SPECIAL INSPECTIONS

3.28 Special inspections may be needed either when a bridge is at risk, or when there is a problem which requires further investigation. Additional risk may derive from the bridge being in poor condition, or from a series of unusual loading events. The frequency of special inspections can vary from daily to six-monthly, and the inspection report form can be used in all or in part. Some examples of when this type of special inspection may be required are:

- A bridge in poor condition, but considered safe for a relatively short time, is due for reconstruction in 2 or 3 years.
- A low capacity bridge on a minor road which is normally adequate, but has to carry diverted heavy traffic when a bridge on the main road is closed.
- An old steel bridge which is believed to be at risk from fatigue due to increases in traffic volume and vehicle weight, in this case, the inspector concentrates on the fatigue risk areas.
- A bridge which has been damaged by a major flood, but immediate repair is prevented by a continuing high water level; inspection might need to be daily in this case.
- Low cost, temporary structures.

3.29 Sometimes, during a general or major inspection, a problem is discovered whose cause is not immediately obvious. It may then be necessary to carry out a further special inspection in order to investigate the cause of the problem. Often this will involve inspection by experts, and specialised materials sampling and testing. In this case, a special report.
will be prepared, not using the standard inspection report form. Examples of situations when this type of special inspection is required are:

Paint on a repainted steel structure is showing signs of premature deterioration.

'Pop-outs' and 'map-cracking' on a concrete structure.

Cracking of prestressed concrete beams.

**ORGANISING THE INSPECTION**

**3.30** The district engineer should supply the inspector with the following documents prior to undertaking an inspection:

- Appropriate parts of a blank: inspection report form (Appendix C).
- A copy of the previous inspection if any.
- A copy of the bridge record card.
- A list of maintenance work that has been completed since the last inspection.

**3.31** The district engineer uses the inspection report form to:

- instruct the inspector to inspect a particular bridge.
- transmit any special instructions to the inspector.
- receive and record inspection data.
- receive any urgent notes from the inspector.

**3.32** When the inspection of a bridge is due, the district engineer, or a member of his staff, compiles sufficient copies of the appropriate pages of the form. The form page numbers and the required number of each page are recorded on the bridge record card. Any sections of a page which are not required should be crossed out.

**3.33** The following sections of the first two pages should be filled in before the form is given to the Inspector.

**Page 1**
The identification and location details, abstracted from the bridge record card.

Any special instructions to the inspector.

**Page 2**
The construction details, abstained from the bridge record card.

Details of signs abstracted from the highway signs inventory, or the bridge record card.

**3.34** The identification and construction details enable initial identification of the correct bridge. By checking each of the construction details at every inspection, the inspector reduces the risk of confusion between similar bridges. This risk cannot be overstated. It is very easy, even for experienced bridge engineers, to be confused between two similar bridges.

**3.35** Re-reading the construction details will help the inspector understand the structural principles of the bridge: this is particularly true of 'foundation type' and 'movement'. Such an understanding will greatly assist him in properly completing the inspection report.

**3.36** The sketch on page one of the form is for two purposes:

- It enables the inspector to mark points of particular interest, eg an area of scour.
- It helps to establish a reference system if the inspector records adjacent town names.

**3.37** It is vital that a clear reference system is used in reporting, if the district engineer is to understand which part of the bridge is referred to in each part of the report. This point must be strongly emphasised to each inspector.

**3.38** The inspector should be encouraged to make additional notes and sketches or take photographs. These should be referenced in the final column. Very brief notes may be written in this column.

**3.39** The district engineer should review the inspection report as soon as possible after submission by the inspector. He should ensure that he understands any notes or sketches and that the form has been properly completed. Whenever a potentially serious problem has been reported, the district engineer should instigate the appropriate action without undue delay and inform the inspector that he has done so.

Inspectors' enthusiasm and commitment will be greatly improved if a quick response results from his efforts.

**MAJOR OR UNUSUAL BRIDGES**

**3.40** Major bridges need special consideration for the following reasons:

- They represent a large capital investment.
- The collapse of a major bridge would cause an unacceptably long disruption to traffic since the design and reconstruction of a major bridge is a long process.
- The inspection of a major bridge or a bridge of unusual construction, eg moving bridges, is beyond the technical
capability of an unqualified inspector. Such structures must be inspected by an engineer with sufficient relevant experience.

3.41 Major or unusual bridges are outside the scope of this Note. Inventory systems must, of course, cover bridges of all types, but a major or unusual bridge will need a special version of the bridge record card and the inspection report. The guidelines in this Note on bridge record cards and inspection reports may assist the engineer in preparing such special versions.

4. REFERENCES

Transport and Road Research Laboratory, Crowthorne, Berkshire, RG1 1 6AU, United Kingdom.

Overseas Road Note 1.
Transport and Road Research Laboratory, Crowthorne, Berkshire, ROll 6AU, United Kingdom.

Overseas Road Note 2.
Crowthorne, Berkshire, ROll 6AU, United Kingdom.