VOLUME 3 HIGHWAY STRUCTURES: INSPECTION AND MAINTENANCE

SECTION 1 INSPECTION

INTERIM ADVICE NOTE IA.3 POST-TENSIONED CONCRETE BRIDGES, BA 50/93

PART 3

BA 50/93

SUMMARY

This DMRB Interim Advice Note provides additional advice to BA 50/93 in the light of findings from the initial stages of the programme of special inspections of post-tensioned concrete bridges, and the lessons learned from the reports received.

INSTRUCTIONS FOR USE

1. This Interim Advice Note should be placed at Volume 3, Section 1, Part 3 after BA 50/93.

2. Annotate Index to Volume 3 to show IA.3.

3. Annotate document contents page of Volume 3, Section 1, Part 3.

4. Archive this sheet as appropriate.

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CONTENTS

1. INTRODUCTION

1.1 This document emphasises some aspects of Advice Note BA 50/93 and modifies the guidance in the light of the inspections carried out to date.

1.2 Most bridges inspected in the programme to date have been found to be in good condition. Although many contain voids in the ducts, these are generally dry; and where corrosion has been found in the prestressing system it is not enough to indicate a risk of imminent collapse. A primary aim of the inspection programme is to identify areas where deterioration may occur and establish the basis for future management decisions.

2. PROCEDURES

Three Phase inspection

2.1 The three-phase approach given in BA 50/93 has proved effective and is retained. It is important to emphasise that the inspection should remain a flexible process that can respond to circumstances as they arise.

2.2 The Phase 3 site investigation includes an initial testing stage and may include further testing. The amount of work in the initial testing stage should be specified in the Phase 2 report with due regard for the nature of the structure and its condition as observed during the site inspection. In general the aims should be:

- To obtain sufficient data in terms of types of test, elements inspected and sample rates such that no further testing should be necessary if the structure is found to be free from problems.

- To provide for a limited amount of extra testing in the event that problems are found. When serious problems are found, a further testing stage may be required.
  Consideration should also be given to re-grouting in the Phase 2 report if it is proposed to undertake this within the Phase 3 investigation period.

Risk of collapse

2.3 The potential risk of collapse based on structure type is assessed and stated in the Phase 1 report. After Phase 2 inspection and Phase 3 investigation, a revised assessment should also be given, which may be lower or higher, based on the condition as found.

Critical sections

2.4 A critical section is one at risk from water ingress or corrosion, one where yield points may form in a collapse mechanism or both. At the initial testing stage an examination should be carried out at a sufficient number of tendons at the critical sections to give an adequate assessment of their condition at these points. Critical points on tendons should be classified for type and the number present for each type stated. A reasonable sample of points should be inspected from each type.

2.5 It has generally been found impractical to examine a significant number of tendons at all critical sections. Instead, it is acceptable for critical sections of similar type to be grouped together so that a representative sample of inspection points may be taken from this larger population. If serious defects are found the investigation needs to be broadened, and all critical sections might then be examined.

Number of points to be inspected

2.6 In most inspections between 3 and 10 percent of the critical points have been examined. A recent statistical study has indicated that it is the absolute number of points inspected that matters, and that this number is only weakly dependent on the number of critical points. When there are very few tendons, it may be necessary to inspect most of them at the critical points. It is advantageous to group similar critical points together to form a larger population when deciding how many to inspect.

2.7 In practice the number of critical points inspected is based on practicality and accessibility rather than statistics. Not all points are equally critical, and some tendons may be more important to structural integrity or more liable to corrosion than others. The number of points selected from each type should reflect this. The extent of an inspection has to be increased significantly when serious problems are found.

Initial testing stage

2.8 The detection of voids by drilling in, followed by an internal examination of ducts and tendons will form a part of the initial inspection for virtually every bridge, and tests on materials in tendon ducts (grout and/or water) should also be included.

2.9 Detection of corrosion activity and concrete sampling in the main body of the structure is carried out in accordance with BA 35/90. This investigation may not be required, or its scope may be reduced, if there has been a recent Principal Inspection which included testing in accordance with BA 35/90 and covered the areas that are the subject of the Special Inspection.

Further testing

2.10 When significant faults are found, further testing may be necessary to investigate specific problems identified during the first round of tests and/or to increase the sample rate. In the latter instance the aim is to establish the overall condition of the post-tensioning system with an appropriate level of confidence. A limited amount of further testing should be allowed for in the site investigation where site/traffic conditions are suitable and contractual arrangements can be made to permit.

2.11 If a larger amount of further testing is required, the timing of this may be dictated by constraints such as traffic management requirements, other work nearby, costs, etc, and it may not be possible or desirable for it to be done immediately following initial testing. An interim report should be obtained from the Project Manager in this case. The report should include the results of the tests carried out to date, reasons for further tests, the extent and type of tests to be carried out.

3. METHODS OF INSPECTION

Non destructive testing

3.1 When BA 50/93 was drafted it was envisaged that non destructive testing (NDT) would play a significant part in the inspection process - for the location of tendons, the detection of voids prior to drilling in, and possibly the detection of corroded or fractured tendons. This has not been the case: NDT methods have not developed sufficiently during the early stages of the programme.

Detection of voids

3.2 Radiography has been applied in anchorage regions or thin sections where the engineer aimed to avoid damaging the structure by coring. Horizontal radiography is better suited to void detection. Apart from this, no effective NDT method has yet been developed for detecting voids, particularly for metal lined ducts. In general, therefore, the only option is to drill in at selected critical points for a full tendon inspection without prior knowledge of the presence of a void.

Tendon location

3.3 In the inspections to date this has generally been done by reference to structural drawings with assistance from a cover meter for finding shallow tendons and identifying the position of reinforcing bars. Ground radar has been used for tendon location in some cases with mixed reports of its success.

3.4 A probe type cover meter has been used in a few instances to locate tendons with some success. This involves the drilling of a pilot hole into which the probe is inserted. If the hole is near enough to a tendon (< 100mm) the readings given will indicate the distance and direction to the tendon. A surface-scanning type of covermeter is also available and in trials has appeared to give reliable results, operating to a greater depth than the conventional covermeter.

Access to tendons/ducts

3.5 Access holes for intrusive inspection should be made into the top of a duct where possible. If access is into the bottom of the duct there is a possibility that partial voids, which tend to occur in the top of the duct, will remain undetected. Access holes to tendon ducts should be a minimum of 25mm diameter to allow viewing of the inside of tendon ducts and adequate grout sampling. Subsequently it may be found to be necessary to enlarge access holes for a better view and/or to take an adequate grout sample, particularly where the tendon lies deep within the concrete.

3.6 Overcoring the original access hole may lead to the ingress of water, particularly when entry is in a downwards direction from above. This is undesirable, and may be avoided by coring to one side of the access hole and stopping short of the duct, completing the hole by hand chisel.

Intrusive inspection

3.7 The tendon should be inspected whether there is a void or not. This will entail the removal of grout where present. It is suggested that, at each inspection point, measurements are taken of volume of void and leakage irrespective of whether or not a void is visible. This will determine whether an apparently blind hole is concealing a narrow passage linking it to a nearby void or leak to atmosphere - a potential source of water ingress in the future.

3.8 When a void is encountered its volume should be determined. A record of the void volume at each critical point examined may be sufficient to gauge the overall quality of grouting, but in itself does not provide a complete inspection of the tendons affected. In selected instances, particularly where there is leakage, dampness and corrosion, further information may be obtained by inspecting at additional access holes and checking for the continuity between voids. When an extensive void is encountered, a flexible videoscope will give a better view than a rigid endoscope and allow the extent of the void to be investigated in conjunction with additional access holes where appropriate. Water contained within a duct should always be collected for analysis.

Anchorages

3.9 Anchorage inspection can be costly and disruptive, and in general is expected to be carried out selectively, targeted to the most vulnerable positions. Factors that indicate the need for anchorages to be exposed include:

- Practicality and ease of accessibility to some anchorages
- Water seepage / staining
- Poor visual condition of capping mortar
- Large proportion of voided ducts
- Voids in ducts near anchorages
- Vulnerable design details and/or poor construction
- Experience of defects with similar inspections
- Adverse consequences of local loss of prestressing force

3.10 In some cases it is possible to inspect the tendon behind the exposed anchorage by inserting an endoscope down an empty grout pipe or drilling it out if blocked. When it is possible to gain access to the duct sufficiently close to the anchorage, and a void is found, it may be possible to inspect behind the anchor plate using a flexible endoscope or videoscope.

Fault classification

3.11 For the purpose of summarising the tendon condition at each inspection point it is suggested that duct voids and tendon corrosion are classified each according to a four point scale, 1 being a small void or light corrosion and 4 being a large void or tendon fracture. Void size should be related to the cross section and exposure of tendons, not volume. Classifications of this type can be used in Form A7. In addition, on this form, information on duct leakage, the presence of duct water and its analysis should also be entered.

Stress determination

3.12 Information on the state of stress in the structure can be obtained from the concrete by slot cutting or coring. Unless it is judged necessary to obtain stress from the tendon directly, concrete cutting methods should be given preference to tendon cutting or drilling because they give overall information on the effective prestress and are less damaging. Specialist advice should be sought before specifying direct measurement of stress in the tendons.

4. REPORTING

Phases 1 and 2

4.1 Reports from Phase 1 and 2 of the special inspection should contain an assessment of the risk of sudden collapse based on structural type. The Phase 2 report should also contain a revised assessment based on condition. It would be helpful if the priority rating is quoted. The Phase 2 report should contain a summary of critical points in the structure together with the number of each type that it is proposed to inspect.

Phase 3, project managers report

4.2 A final appraisal of risk of sudden collapse should be given in the form of two assessments based on the structure type and also the condition as found in the inspection. It is important to complete Form A7 to provide a concise record of the site investigation. The form should also be used to summarise the inspection: ie state numbers of each type of critical point in the structure, the number inspected and the result, preferably using a fault classification system.

Re-grouting recommendations

4.3 The need to re-grout voided tendons is a matter of judgement, and may depend on the presence of exposed tendons, leakage to atmosphere, dampness and corrosion. It should be borne in mind that the inspection may only have covered a small proportion of the tendons and relatively little may be achieved by grouting just these. An alternative that has been adopted is to plug the access holes but leave the duct ungrouted and able to be re-inspected though a small monitoring port. If the structure is in need of extensive re-grouting, a major exercise may be required involving many practical difficulties.

4.4 It is suggested that a trial is undertaken before a re-grouting method is applied widely. In view of the time necessary to complete such work, it may be better that a separate contract is used, but sufficient time should be allowed for proper trials to take place. If it is imperative to re-grout immediately, for example for reasons of restricted access, the method of re-grouting should be established in advance. This possibility should be anticipated in the Phase 2 report.