Comparison of bridge management practice in England and France.

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ABSTRACT
During the 1990s, an Anglo-French Bridge Liaison Group was set up to exchange information on topics of common interest. Over the last few years the Group has focused on bridge management and has prepared a report on current practice in the two countries. The report is concerned with the national road networks and this paper uses the information obtained to describe the bridge stocks and organisational structures, and contrast the differences in the approaches adopted for the management of bridges.

KEYWORDS Inspection, Assessment, Management.

INTRODUCTION
Bridge management has become a topic of increasing importance over the last decade. The increased traffic loads to which bridges are subjected, both the volume of traffic and the weights of individual vehicles, and deterioration of structures due to their aggressive environment have meant that many bridges are in need of repair. Consequently, the authorities responsible for managing bridges have developed systems for assessing the condition of their structures and prioritising the allocation of maintenance funds.

During the late 1990s the French and UK central government agencies set up a joint venture to review procedures for the management of highway bridges on the national road networks in the two countries [1]. The organisations involved were the Highways Agency (HA) and TRL Ltd in the UK and Service d'Etudes Techniques des Routes et Autoroutes (SETRA) and Laboratoire Central des Ponts et Chaussées (LCPC) in France. This paper uses the information collected to compare practice in the two countries. It describes the bridge stocks, gives an overview of the organisational structures for the management of bridges and compares procedures for inspection, assessment and maintenance planning.

BRIDGE STOCKS
An estimate of the number of highway bridges in the two countries is summarised in Table 1. It should be borne in mind that different authorities have different definitions of a bridge.
The age and construction type of bridges on the national road networks are shown in Figures 1 and 2, respectively.

The figures show that the majority of bridges were constructed during the second half of the last century. The type of construction is similar although there is a greater proportion of prestressed concrete construction in France, particularly in terms of surface area, and more steel and composite construction in England.
ORGANISATIONAL STRUCTURE

The trunk road network in England is maintained and operated by the HA on behalf of the Secretary of State for Transport. The HA is an Executive Agency of the Department for Transport (DfT) with a headquarters in London and a number of regional offices. For management purposes, the trunk road network is divided into a number of maintenance areas and the HA procures the services of a Maintaining Agent to manage and operate the network in each area. The Maintaining Agent is usually either a civil engineering consultancy, or a privatised section of an existing county council, or a consortium of both. Each separate Agent is supported by a Term Maintenance Contractor (TMC) who would undertake any actual maintenance or construction work.

Procurement methods are continually evolving. The practice of employing separate Maintaining Agents and Term Maintenance Contractors to work together, is being replaced across the network by forming single point responsibility contracts with “Managing Agent Contractors” (MACs). These are in effect consortia of civil engineering consultancies and construction contractors, and the first MAC contract came into operation in September 2001. The contract is based on a strong partnership approach with an integrated supply chain and the contract duration, of up to seven years, is significantly longer than traditional maintenance contracts. The contract allows the MAC organisation to design and undertake all projects up to a value of £500k. It also incorporates elements of performance specifications for routine and winter maintenance and includes the requirement to set annual targets, to measure and benchmark performance, and to achieve continuous improvement.

Rationalisation of the boundaries between maintenance areas is an on-going process. The HA is placing greater emphasis on route strategies and maintenance areas are being redefined to enable practical lengths of transport corridor to be maintained and operated by a single Managing Agent, therefore allowing better co-ordination of maintenance work along the entire route.

In France, the Roads Directorate (DR\(^1\)) is responsible for the construction and management of the national road network. The DR has around 100 regional public works departments (DDE\(^2\)s) each of which has eight to fifteen territorial subdivisions which are the local representatives of the DDE. Their particular responsibility with respect to structures is management of the work within their respective areas, surveillance (see below) and routine maintenance.

The DDEs develop and implement their own maintenance policies in line with objectives laid down by the DR and carry out the schemes selected by the DR. Each DDE contains one Bridge Management Team (CDOA\(^3\)) which is responsible for implementing structures management policy. It has the competence and authority to diagnose the condition of structures, propose priorities to the regional manager and provide technical support to the territorial subdivisions.

\(^1\) Direction des Routes  
\(^2\) Directions Départementales de l’Équipement  
\(^3\) Cellule Départementale Ouvrages d'Art
The organisation and work of the DDEs is supervised by a Regional Structures Engineer (IGOAs). There are five IGOAs and they also give recommendations to the DR on the selection of schemes proposed by the DDEs in order to draw up three-year work programmes.

Regional government offices and laboratories provide a technical network that plays a consultancy role for the DR and also provides consultancy services for the DDEs (for example regional laboratories may be involved in detailed inspections, investigations, etc.)

**INSPECTION**

The inspection regimes in both countries have developed from the recommendations given in the OECD report on bridge inspection [4]. In England, inspections rely on visual observations to record the severity and extent of any defects. Where appropriate, testing may then be recommended to investigate the cause and extent of any deterioration. In addition, particular types of structure or structural detail, such as post-tensioned concrete bridges, hinge joints or half joints, may be subjected to a programme of Special Inspections.

The inspection of structures in France is included in an operation known as “surveillance” [5]. There is no direct English translation of this term but it comprises visual inspection supplemented, where necessary, with testing and monitoring. There are various types of surveillance: continuous, organised, enhanced and close which are described.

**Continuous surveillance**

This is carried out by all highway authority staff as part of their day-to-day work. Its purpose is to detect the appearance of any obvious defects between organised surveillance inspections and is similar to Superficial Inspections in England.

**Organised surveillance**

This comprises a regime of inspections similar to the General, Principal and Special Inspections used in England. The different types of inspection are Annual, Appraisal, Special Periodic and Detailed Periodic. Annual Inspections are undertaken to look for obvious signs of deterioration. Appraisal Inspections are undertaken every three years by a trained inspector and involve a visual inspection of the structure which is carried out without the use of special access equipment. Special Periodic Inspections examine those parts of the structure that are not accessible during an Appraisal Inspection, such as bearings or submerged parts of a structure. These are undertaken every six years but this interval can be extended to nine or reduced to three depending on the circumstances. Detailed Periodic Inspections are undertaken on major bridges or bridges whose condition gives cause for concern. They are undertaken every six years but again this interval can be extended to nine or reduced to three or even one depending on the circumstances. The inspection team is led by an engineer who has received special training in deterioration mechanisms.

Other types of inspection include: an initial Detailed Inspection which is carried out on a structure after it has been commissioned to provide a reference; an End of Guarantee Inspection to check

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the condition of a structure before contractual or statutory guarantees expire and an Exceptional Detailed Inspection which is initiated by exceptional events such as flooding or the passage of abnormal loads.

**Enhanced surveillance**
The purpose of enhanced surveillance is to monitor the condition of a structure where further deterioration might compromise safety. Other reasons for enhanced surveillance might be to obtain more information on a particular problem, to gain a better understanding of a structure’s behaviour or to check the effectiveness of repairs. The structure is monitored for a defined period, usually at least one year.

**Close surveillance**
Close surveillance is undertaken where there is evidence of a risk of failure in the short-term. Implementing close surveillance involves an analysis of the structure to confirm that its integrity has been compromised and to identify possible failure mechanisms. The analysis is used to help select the physical quantities that could be meaningfully measured, to set thresholds, and to develop a management plan that defines the actions to be taken should any of the thresholds be exceeded. If there is a risk of brittle failure, close surveillance is not implemented and safety measures are put in place to ensure the safety of the structure.

**BRIDGE CONDITION**
The procedure used to obtain a measure of the condition of a bridge in England is to give an overall rating of good, fair or poor following a Principal Inspection but there is no indicator which provides a measure of the overall condition of the bridge stock. However a series of bridge condition indicators are being developed and will be implemented in the future.

In France a system has been developed that uses the results of visual inspections to provide an indication of the condition of the bridge stock and to determine how it evolves over time. The methodology, which is known as “Image Qualité des Ouvrages d’Art” (IQOA) [6], was first introduced in 1994 and it assigns structures into one of the five classes defined in Table 2.

<table>
<thead>
<tr>
<th>Class</th>
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<td>1</td>
<td>Structure in good apparent condition requiring only routine maintenance</td>
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| 2     | Structure in good apparent condition or with some minor defects, requiring specialist maintenance  
|       | • no urgency  
| 2E    | • urgent to prevent rapid development of distress in the structure |
| 3     | Structure has deteriorated and requires repair work  
| 3U    | • no urgency  
|       | • urgent because the structure’s bearing capacity is insufficient, or because the structure is likely to deteriorate rapidly |
| NA    | Not appraised |

**Note:** When defects are observed which could compromise safety, the grade “S” is added to the structure’s classification.
Table 2 Definition of IQOA Classes

The classifications are made either on the basis of an Appraisal Inspection or a Detailed Inspection carried out within the previous twelve months, possibly complemented by the results of existing calculations. The method allows separate classifications of the different structural elements (e.g. deck, supports) but the overall classification of a structure corresponds to the worst classification of any of its component parts.

Training Inspectors

Bridge inspectors operating on trunk road bridges in England work under the supervision of an appropriately experienced engineer. Inspectors should have experience of inspecting highway structures but there are no requirements for formal qualifications or training although this is currently under review.

In France, the training and skill of the personnel undertaking inspections is seen as an essential element of a successful structures management policy. A rigorous procedure has been established for the qualification of all staff responsible for Detailed Inspections and there are three levels of qualification as follows:

- the project manager, who is responsible for planning the work, preparing proposals for any further investigations that might be required, and checking the inspection report
- the inspector, who carries out the inspection, drafts the inspection report, and undertakes a preliminary diagnosis of any deterioration
- inspection officer, who assists the inspector or project manager.

Qualification is dependent on attending training courses and passing an examination, an on-site test (for inspectors), a professional examination (for project managers) and an interview with a panel of specialists. In 2002, a common training system was introduced for both private and public sector candidates.

ASSESSMENT OF LOAD CARRYING CAPACITY

In England, assessment standards have been developed for determining the load carrying capacity of highway bridges [7]. They were developed to support the 15 year Bridge Programme which was launched by the Department of Transport 1987. Its purpose was to restore highway structures to a good condition. This included a programme to check that bridges were capable of carrying the increased traffic loads. The assessment standards are based on design standards but have been modified to take account of the fact that some of the uncertainties present in design can be reduced when dealing with actual structures.

Bridges are assessed using a staged approach with five levels of assessment of increasing sophistication. The first level comprises a simple analysis and the use of standard material properties. If this indicates that a structure has insufficient load carrying capacity then a more sophisticated Level 2 assessment is undertaken which includes the use of in-situ material properties. Load testing can be used at Level 3, Level 4 includes bridge specific safety characteristics and Level 5 comprises a full reliability analysis although this is not widely applied.
In France, the load carrying capacities of bridges are not being systematically assessed. Furthermore, there are no standards for assessment of existing bridges. The assessment of structures is based on engineering judgement and adapting the design rules to suit the particular circumstances. Probabilistic methods are used where the engineer considers it appropriate, and tools are under development to facilitate the implementation of such methods.

**MAINTENANCE PLANNING**

Both countries use the results of inspections, testing and assessment to identify and prioritise maintenance needs. In England the information obtained from these investigations is used to assess the causes of defects and to propose maintenance options based on technical considerations. The feasibility of these solutions is then considered with respect to design constraints (such as access, traffic management and traffic disruption, as well as whole life cost and longer term issues) to select the most appropriate solution for each particular structure.

In practice there is insufficient budget to undertake all the schemes that are put forward for funding. It is therefore necessary to prioritise them to identify those that can be afforded in any particular financial year. This is done at Value Management Workshops. These are attended by stakeholders and each scheme is discussed and scored against a number of criteria which are given different weightings which may vary from year to year. Safety is given the highest weighting and structures that pose a safety risk are given the highest priority. Committed work (i.e. work that is already in progress and will continue into the following financial year) is also given a high priority. Other factors include planning for work on a group of structures on the same route to be undertaken at the same time and co-ordinating with maintenance work on the pavement. National structures programmes, which are a co-ordinated approach to a particular problem such as investigations to determine the condition of hinge decks and half-joints, are also given a high priority. Prioritising maintenance is not a mechanical process and one of the functions of the Value Management Workshops is to review the priority rankings and make changes where appropriate. For example it might be beneficial to bring forward deck re-waterproofing on a bridge if the pavement is due to be re-surfaced.

Another issue is affordability and where work on a structure clearly has a high priority, the solution chosen may not be the one originally proposed. In some instances, an alternative option which has a lower initial cost may be selected to release funds for work elsewhere.

In France, the budget allocated by the DR to the DDEs for structures maintenance is divided into two components:

- budgets allocated on an annual basis for maintenance and minor repair based on a rate per square metre for the bridges (and pavements) managed by each DDE. However the DDE has complete freedom over how the budget is spent on the different assets (structures, pavements, etc.).
- budgets allocated for urgent works, DDEs bid for these budgets by putting forward schemes for urgent investigations, major repairs, and strengthening for inclusion in a three-year rolling programme. The DR draws up the three-year plan in accordance with the recommendations of the IGOAs and the constraints of the annual budget.
The three-year programme has a rolling window, which means that every year the current works schedule and the planning of works for the following two years can be adjusted to take account of changing priorities.

**CONCLUSIONS**

Management and operation of the national road networks in both countries is the responsibility of central government. However, whilst in France the state maintains a strong control over the detailed works, in England much of the management is contracted out to the private sector working to standards produced by the state. In addition there is a move towards performance specifications which will give the private sector a greater control over what is done.

There are also differences in the procedures adopted for the inspection and assessment of structures. Both countries employ similar inspection regimes but in France they are more closely related to subsequent procedures for testing and monitoring to diagnose the causes and study the consequences of any deterioration. In England such studies are done on a structure by structure basis. In addition there are formal procedures for training and qualification of inspectors in France whereas in England no formal qualifications are required and inspectors are employed on the basis of experience. The converse is true for assessment of load carrying capacity. There are formal procedures and a set of assessments standards in England but in France it is done on a structure by structure basis.

Despite these differences, both countries have much in common. They have bridge stocks of a similar age and construction type which have to be kept in a serviceable condition whilst accommodating ever increasing traffic loads.

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