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Guidance Note

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Plan Design Enable

Welsh Assembly Government
Risk-based Principal Inspections

Guidance Note

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Executive Summary

In June 2009, Atkins was commissioned by the Welsh Assembly Government's Roads and Projects Division to produce a proforma for the prioritisation of Principal Inspections of highway structures based on risk assessment. Fully compliant with BD 63/07 *Inspection of Highway Structures,* this proforma helps in identifying flexibility when applying inspection intervals, augmenting engineering judgment in the on-going management of structures.

The management of highway structures calls upon considerable resource. Six yearly inspection intervals have long been considered appropriate for highest risk structures within the stock. Structures in better condition and / or greater inherent robustness must be lower risk and a longer interval between Principal Inspection considered appropriate.

The proforma created allows a consistent national approach to be adopted, fully documenting the risks associated to structures, and providing quantifiable results. Importantly, it adds objective analysis to a process that can often be subjective.

The risk-based approach is evidence-based. Research undertaken by Atkins analysed 75 structures, covering a wide-range of structural type, age, location and use. Results indicated that 80% were found to be of sufficiently low risk that a 6-year interval was not warranted.

Taking a risk-based approach to inspections allows finite resources to be concentrated on those structures most in need of management and maintenance. Crucially, the frequency at which traffic management and inspection operatives are subjected to the hazards associated with inspection work can also be minimised.

To conclude, the Welsh Assembly Government and Atkins have created an accessible, simple and 'fit-for-*purpose'* computer-based proforma. It is very important to understand, however, that its role in bridge management is to assist and inform, not replace, engineering judgement on structures. If used in such a manner, it will add value and provide uniformity to the wider asset management process across Wales.

1. Introduction

Managing highways structures requires considerable resource. Balancing the need to minimise the risk to public safety (and maintaining sufficient data on structures) whilst also ensuring the effective and efficient use of resource is often a difficult task. Historically, despite allowance in BD 63/07 (Clauses 3.34 to 3.38), and past incarnations of it, to risk assess structures and flexibly inspect them, the arbitrary Principal Inspection interval of six-years has consistently been kept to. In doing so, it may be argued that the finite resources available to public bodies are not effectively used. Acknowledging this, the Welsh Assembly Government and Atkins have developed a simple risk assessment tool to inform engineering judgment and assist the on-going management of structures.

The frequency of Principal Inspections may be both increased and decreased, though the Welsh Assembly Government recognises that risk assessment is of particular value when looking to review the number of inspections required. Six-yearly inspection intervals have long been considered appropriate for highest risk structures within the stock. Structures in better condition and / or greater inherent robustness must be lower risk and a longer interval between Principal Inspection considered appropriate

A formal risk assessment process applied to all highway structures will allow engineering judgement to be documented fully with quantifiable results, adding an objective analysis to a process that can often be subjective.

This Guidance Note seeks to explain the background for this risk assessment. The objective for the Welsh Assembly Government and Atkins was to create an accessible simple and 'fit-for-*purpose'* computerised proforma, able to assist and inform (not replace) engineering judgement when analysing risk. It is anticipated that it will add value to asset management across Wales, providing consistency, country-wide, on how structures are viewed and managed.

2. Background

In June 2009, Atkins was commissioned by the Welsh Assembly Government's Roads and Projects Division, to produce a proforma for the prioritisation of Principal Inspections of highway structures based on risk assessment. It was to be fully compliant with BD 63/07 *Inspection of Highway Structures,* allowing flexibility in applying inspection intervals (clauses 3.34 to 3.38), provided that a fully documented risk assessment process was followed.

For all highway structures falling within the defined scope set out in BD 63/07 (see Table 2.1 below), all bridge owners are required to set up a mandatory inspection programme. In summary, these programmes enable any defects, which may cause an unacceptable safety or serviceability risk, or a serious maintenance requirement, to be detected at an early stage, thus safeguarding the public and the structure's future integrity. Where defects are found, remedial actions are proposed and should subsequently be effected.

Typically, a bridge owner's annual inspection programme will consist mostly of *General* Inspections and *Principal* Inspections. General Inspections must be undertaken every two years (+/- 6 months), whilst Principal Inspections, in almost all cases, are undertaken every six years (with a Principal Inspection replacing every third General Inspection).

In certain circumstances, more frequent Principal Inspections may be required. This can occur when a structure is known, or suspected to be subject to a rapid change in condition or circumstances (e.g. structures subject to Alkali-Silica Reaction or chloride-induced corrosion). If this is the case, BD 79/06 *Management of Sub-Standard Structures*, outlines the management process to be implemented and the default interval between inspections may be reduced accordingly. In following BD 79/06 guidance, more frequent inspections are often limited to a specific element or feature (e.g. half joints or post-tensioned elements).

Following BD 63/07, most bridge-owning bodies across the UK implement a continuous rolling programme of General and Principal Inspections. Programmes are planned and organised each year, taking into account a wide range of details. In many circumstances, a bridge owner will look to group structures together, based possibly on common location or overlapping traffic management requirements, which maximise the efficiency of the rolling programme.

Structure Type	Definition	Scope
Bridge, buried structure, subway underpass, culvert and any other similar structure	A structure supporting the highway as it crosses an obstacle (e.g. river, valley or flood plain) or a service (e.g. local road, railway or canal) OR A structure supporting the passage of a service (e.g. local road, railway, canal) over the highway	All structures with a clear span or internal diameter greater than 0.9m
Earth retaining structure	A structure associated with the highway where the dominant function is to retain earth	All structures with an effective retained height, i.e. the level of fill at the back of the structure above the finished ground level at the front of the structure, of 1.5m or greater
Reinforced/strengthened soil /fill structure with hard facings	A structure associated with the highway where the dominant function is to stabilise the slope and/or retain earth	All structures with an effective retained height of 1.5m or greater
Sign and/or signal gantry	Portal and cantilever gantries that support signs and/or signals	Structural aspects of all sign/signal gantries
Access gantry	A moveable structure providing access to a highway asset, typically for bridge inspection and maintenance	All moveable access gantries
Tunnels	An enclosed length of road of 150m or more	Structural aspects of all tunnels (refer to BD53 for other criteria relevant to tunnels, e.g. M&E requirements)
Mast	Cantilever mast for traffic signal	Structural aspects of all cantilever masts
	High mast for lighting	Structural aspects of all lighting masts of 20m or greater, i.e. the vertical distance from top of post to bottom of flange
	Mast for camera, radio, speed camera and telecommunication transmission equipment	Structural aspects of all masts
	Catenary lighting support system	Structural aspects of all catenary support systems
	Highway signs on posts	As agreed by the Overseeing Organisation
Other structures	Other structures that are within the footprint of the highway, e.g. service/ utility crossings	Structures providing service only crossings either above or below the carriageway
	Other structures not in above subgroup as agreed with Overseeing Organisation	As agreed by the Overseeing Organisation
Third Party structures	Any of the above categories but owned by others, e.g. private owners or utility companies	As agreed with the Overseeing Organisation

Table 2.1 - Defined scope of highway structures for Inspection (BD 63/07)

2.1 General Inspections

Every structure classified as being within the defined scope of BD 63/07 (see Table 2.1), is to have a General Inspection '*scheduled at 24 month intervals'* and *'not exceeding three years'*. The purpose of a General Inspection is *'to provide information on the physical condition of all visible elements on a highways structure.*' It comprises a '*visual inspection of all parts of the structure that can be inspected without the need for special access equipment or traffic management arrangements'*[1]. The frequency of General Inspections cannot be increased through risk assessment.

Given that it is based on visual inspection a General Inspection is obviously quicker and easier than a Principal Inspection. A General Inspection also poses less risk, as there is no requirement to inspect all of the structure within touching distance.

The Welsh Assembly Government requires that for every General Inspection undertaken, that a BE 11/94 Trunk Road/Motorway Structure Inspection Report is completed. This records details of the overall condition of the structure, as well as more detailed defect assessments for individual elements (e.g. foundations, bearings, main beams, expansion joints, and parapets). As part of this process the extent and severity of the defect is recorded, and the type of remedial work required specified (e.g. replace, paint, and monitor). Each defect is ranked in order of priority (i.e. *High* - work should be done during next financial year to ensure public safety/structural integrity; *Medium* - work should be done during next financial year as postponement will carry some cost penalty; *Low* - work should be done within the next two financial years). Alongside each defect, an estimate of the cost of undertaking the remedial works is also recorded.

2.2 Principal Inspections

The purpose of a Principal Inspection is *'to provide information on the physical condition of all inspectable parts of a highway structure*'. Consequently, a Principal Inspection is '*more comprehensive and provides more detailed information than a General Inspection*[2].'

A Principal Inspection should be of sufficient scope and quality to determine the condition of all parts of the structure, the extent of any significant change or deterioration since the last Principal Inspection and, any information relevant to the stability of the structure.

It should seek to establish the scope and urgency of any remedial works or other actions required before the next inspection. Moreover, it should highlight if there is a need to undertake any Special Inspections on specific areas of the structure. A further key role of a Principal Inspection is to audit the accuracy of the main inventory data held for the structure.

Although BD63/07 states that Principal Inspections are to be carried out at '*six-year nominal intervals'*, unlike General Inspections it allows substantial flexibility for increasing this time interval. A longer Principal Inspection interval is permitted following a Risk Assessment, but the interval must not, however, exceed twelve years for any structure.

[1] DMRB BD 63/07 Inspection of Highway Structures
[2] DMRB BD 63/07 Inspection of Highway Structures

2.3 Inspection Intervals

Clauses 3.34 to 3.38 of BD 63/07 states that: '*In certain circumstances more frequent Principal Inspections may be required and justifiable…. A longer Principal Inspection interval is permitted provided a risk assessment is undertaken. The risk assessment should give due consideration to all the element types on the structure. A longer Principal Inspection interval must be agreed by the Overseeing Organisation before being implemented by the Agent. The risk assessment and interval must be fully documented and agreed by the Overseeing Organisation. Principal Inspection intervals determined through risk assessment must not exceed twelve years*'.

Influencing a decision to vary inspection intervals must be based on the information being gathered by the biennial General Inspection. The BE 11/94 Form, therefore, is very important in informing the risk assessment process. In fact, the core of the risk assessment comes from the data recorded on the BE 11/94 and the Roads 277 Form. Any additional information on the structure serves to strengthen the risk assessment, as an aside.

Any misinformation held in a BE 11/94 or Roads 277 may manifest itself into the risk assessment giving false results. The risk assessment should only inform experienced engineering judgement, not replace it. Its output should make up only part of the overall picture, taking into account a wide-ranging and holistic view of any individual structure.

2.4 Risk Assessing Inspection Intervals

The objective of this work is to use biennial General Inspection data (amongst other information) to assess the risk of unacceptable changes in condition, thus informing judgement on how often a Principal Inspection needs to be carried out. In most cases, an engineer inspecting a structure will have a view as to what level of risk it represents. In doing so, they may feel it is correct that the structure has a Principal Inspection every six years (i.e. if relatively high risk) or may feel six years is unnecessary (i.e. if low risk). Formal risk assessment exists to confirm, challenge or guide this engineering judgement.

Whereas an engineer visiting site may look at only a limited number of criteria, such as current condition and age, a formal risk assessment takes a much more comprehensive outlook. The General Inspection considers the condition there and then, not the probability of failure in future. Any risk assessment must marry basic structural data, including condition, and judge what the *likelihood* of deterioration is and what the *consequences* of that would be.

3. Quantifying Risk - *Likelihood*

Quantifying the *likelihood* of deterioration and its *consequence* requires numerous criteria to be assessed each influencing the eventual outcome. When analysing the *likelihood* of deterioration for a given structure, and how rapid it may be, the criteria to be looked at are:

- ***Exposure severity*** – the structure may be subject to mild, moderate or severe exposure conditions. External influences of varying kinds may cause rapid deterioration or failure. Of course, if a structure has always been exposed to these conditions, then chances are high that it will have been designed for such problems. This, of course, is acceptable and so comprises neither a positive nor a negative influence on the risk assessment. What will negatively influence the risk assessment is if evidence exists of a structure being exposed to conditions that it may not have been originally designed for or a structure not performing as expected/required. For example, a significant change in use, above, adjacent or beneath, a bridge may create destructive conditions detrimental to its long-term durability. Other examples include the obvious over-loading of a structure, exceeding assessed load limits and restrictions.

- ***Current condition*** – deducing an overall picture of the structure's condition should be achievable using the BE 11/94 form from a recent General Inspection. As well as giving an assessment of its condition, this form should also detail specific defects to the main structural elements. Having such information is clearly a key facet of assessing the *likelihood* of any, or further, deterioration.

- ***Level of contamination*** – symptoms of alkali-silica reaction (ASR), alkali-carbonate reaction (ACR), thaumasite-sulphate attack (TSA) or any other form of concrete degradation will constitute major influencing factors when evaluating the likelihood of deterioration is. Identifying whether a structure is predisposed to concrete attack is difficult and this risk assessment does not attempt to do so. Other related factors, like age, can, however, be taken into account.

- ***Age*** - when evaluating the likelihood of deterioration, age clearly plays a part. Whilst a relatively new structure can have numerous unknowns, including the potential for concrete attack to initiate (see above) and unexpected design deficiencies, an old structure nearing its design life also has a number of obvious, age-related problems. The risk assessment, therefore, takes the view that very old structures and very new structures represent the highest risk. For the purpose of this risk assessment, then, a structure of an age between being 5% and 70% of its design life is seen as being least likely to deteriorate unexpectedly. Anything of an age under 5% of its design life or over 70% of its design life is seen as being most likely to deteriorate unexpectedly.

- ***Material type*** – the materials used for construction are important in how confident one can assess the likelihood of deterioration. This is based almost always on an historical understanding of what some materials offer, whether they be positive or negative properties. For example, reinforced concrete has a proven track record in bridge construction for more than 100 years and is known to be a durable material with longevity. Post-tensioned concrete, however, has had historical problems, particularly when present in some structural forms (i.e. segmental beam construction).

- ***Structural form*** – the form, whether it is an arch, a simply-supported slab or an integral bridge, often determines the extent to which local deterioration will affect the structure as a whole. For example, a slab or arch will historically undergo progressive, slow deterioration. A beam structure with independent members may be at higher risk of rapid deterioration, because a localised problem with one beam may compromise the integrity of the structure as a whole. The question under consideration when analysing structural form is whether the extent of any deterioration is local or global?

- ***Historical rates of deterioration*** - for any observed deterioration 'mechanism', some defects are known to take many years to develop to the point where they require maintenance or present a risk to structural integrity and public safety. The maintenance (or, perhaps, even strengthening) history of the structure must be taken into consideration and structure-specific characteristics such as fatigue-prone details and susceptibility to scour damage must be considered.
- ***Severity and extent of damage due to incidents*** – the potential for vehicular impact, scour (particularly following flooding) and vandalism, and whether this is likely to lead to further deterioration before it can be repaired must be taken into account.
- ***Potential modes of failure*** – do the materials, structural form or loading conditions subject the structure to the possibility of brittle or ductile failures occur? Is failure likely to be progressive following long-term deflection and crack propagation? What degrees of redundancy are present?
- ***Loading*** – It is possible for any bridge to experience loads higher than they are designed for. However, those bridges which have load restrictions in place are more likely to be overloaded as this can be caused by a higher number of vehicles.

4. Quantifying Risk - *Consequence*

The second part of assessing *risk* involves the consideration of the *consequences* of deterioration or failure. For example, deterioration may be likely (see Section 3) but if the structure being assessed is a disused culvert remote from the carriageway, the consequence of failure is minor. The other extreme is a multi-span motorway bridge, with a low likelihood of deterioration but having potentially catastrophic consequences, if unexpected deterioration were to occur. *Consequence*, clearly then, comprises a less technical, but also often less 'clear-cut' set of criteria than '*likelihood'*.

It may be said that there are two differing types of *consequence*, with the first looking at deterioration local and insular to the structure, whilst the second looks at the wider implications of potential failure. It is certainly not as straightforward as looking at location and usage of the structure, and then assuming what the consequences will be. A more complex blend of political, social, economic, technological, legal and environmental impacts can exist.

- ***'Localised' consequence*** – analysing the localised *consequences* of deterioration need a consideration of the potential failure modes associated with a structure, and the degrees of redundancy available. Where deterioration affects a deck comprising a number of individual members, for example, collapse can be instigated from weakness in one part of one member. The consequence of deterioration is, therefore, high. Conversely, for a continuous slab deck, collapse will require multiple progressive failures to occur. In this case, deterioration (e.g. cracking) will be identified at biennial General Inspection stage, giving enough time for adequate management processes to be instigated. Comparing the two cases, the *consequence* of leaving deterioration is much higher on a simply-supported beam structure than on a continuous slab structure.
- ***Wider, 'global' consequences***– with any structure, a number of stakeholders will exist, each with different expectations and different opinions on the structure's importance. For example, deterioration of a bridge leading to an 'out-of-town' industrial estate may have

little *consequence* to the structure's owner, or even the public at large, but failure may have major repercussions for those businesses, and wider stakeholders, that rely on it. Gauging *consequence* at a wider scale can be hugely subjective, and the owner of a structure can only measure its true strategic importance through years of experience and knowledge of its stakeholder impact. It cannot be determined quickly through a risk assessment, reliant on basic data from BE 11 and Roads 277 Forms.

How does the risk assessment deal with the complex nature of measuring *consequence*? Though never explicitly referred to by the risk assessment, the *consequence* of deterioration is implicit throughout. In spite of likelihood and consequence of being, in theory, two distinct parts of the 'risk equation', they are, more often than not, interlinked. For example, a structure subjected to vehicular loading is more likely to deteriorate than if that structure was not subjected to those loads. And, clearly, the consequence of failure is much higher when a structure is subjected to vehicular loads. Those attributes a structure has that make deterioration more *likely*, are also, frequently, the same factors that make the *consequence* of failure so much greater.

Likelihood and consequence are not mutually exclusive of each other, then. This is particularly true when analysing risk at a local level (e.g. failure mode effect analysis), and for that reason, it is much easier to quantify, or measure, consequence at smaller scales. As the scale increases, so does the complexity and the level to which a computerised risk assessment like this can inform judgement reduces considerably.

This risk assessment will not quantify the wider logistical, socio-economic impact of a structure failing, or needing to be closed. It gives a measurement of the risk, based on basic structural facts (e.g. BE 11 and Roads 277 Form), taking the structure in isolation. It analyses *consequence*, but only up to a point.

Gauging the wider importance of a structure is, and always should be, the domain of experienced engineers making measured decisions. For example, this risk assessment could classify a bridge as low risk, finding deterioration unlikely and the localised consequence of that deterioration to be minimal. Yet when the location of the bridge (e.g. if it carries the most heavily trafficked sections of the M4 or A55) gives that bridge huge strategic importance to the region, the consequences of failure become significantly higher. Taking a wide-ranging, holistic view of those factors affecting a structure is vitally important. Though this risk assessment can assist in forming that overall picture, it should not be left as a stand-alone source.

5. Risk Assessment

Taking into account the criteria listed in Sections 3 and 4, Atkins has developed a risk assessment based on a multiple-choice questionnaire format. There are six different risk assessments covering the major structural types. These are:

- **Culverts**
- **Single-span Bridges**
- **Multi-span bridges**
- **Gantries/Footbridges**
- **Retaining Walls**
- **Technology Structures**

Other major structural types not included for risk assessment are Tunnels and CCTV Masts. In the case of tunnels, they number few in comparison with other structural types, and with each constituting a major regional structure, they are considered to be too high risk for consideration by the risk assessment process described here. CCTV Masts, as relatively new additions to structural stock, have insufficient inspection data with which to confidently assess the risk associated.

Of the six structural types included, each has an individual risk assessment / questionnaire, divided into four main categories of questions. These cover the four main categories of structural factors and attributes which most heavily influence the likelihood for deterioration and the consequence of failure. There are **Historical** questions, **Inspection data** questions, **Condition** questions and **Usage** questions.

The **Historical** set of questions obtains information about the structure's materials and form and compares them against what we know, historically, about the performance of such properties. For example, engineers know that brick arch structures experience different maintenance/deterioration issues to those of steel structures.

The **Inspection data** set of questions evaluates how reliable our knowledge of the structure's current condition is. This is based on how effective we assume the last inspection was in obtaining information. For example, visually inspecting a motorway viaduct high over a river will prove more difficult than inspecting an access underbridge. The data obtained from the inspection of the former may, therefore, be less reliable than from the latter. The level of access achieved for inspection must be considered as part of the risk assessment, as the true condition recorded on the BE 11/94, may be compromised.

The **Condition** set of questions takes information about the bridge condition, mainly from the BE 11/94. Other documents also hold important information about a structure's condition. A Structural Assessment Report should be available for most structures, and will strengthen any risk assessment. If the structure has certain issues which have demanded further investigation, then any associated reports (e.g. Special Inspection Reports, BD 79 documents etc) should also be looked at.

The **Usage** set of questions is focused on capturing aspects which affect the significance of the loss of capacity and detectability. If there is a high live load element, such as wind, the capacity can drop below the required service strength with no visible signs of distress. In comparison, if the applied loading is primarily dead load, as the capacity reduces, due to deterioration for example, then distress is likely to be visible.

Each of these sets of questions has different levels of importance. Accordingly, they are weighted in order of importance. The greater the influence the 'set' has on the risk assessment, the greater the weighting it is given. The weightings of all four 'sets' add up to 100 (i.e. the percentage total). For example, a single-span bridge being risk assessed will be weighed as follows:

- **Historical** score – W = 20%
- **Inspection** score – W = 30%
- **Condition** score – W = 30%
- **Usage** score – W = 20%

In this case, points accumulated under **Inspection** and **Condition** questions are given greater influence in the overall risk assessment than those accumulated for **Historical** and **Usage** categories.

For every question asked in the risk assessment, there are a range of scores available. For attributes expected to return a low likelihood of deterioration or minimal consequence, **positive** (+) points are awarded. Any attributes expected to return a high likelihood of deterioration or significant consequence, **negative** (-) points are awarded. If an attribute is expected to have little net return on the likelihood of deterioration or on the consequence, **zero** points are awarded.

On completing the risk assessment, a number of points will have been accumulated. The overall risk is inversely proportional to the number of points scored (i.e. the more points accumulated the lower the risk associated to the structure). Conversely, the lesser the points accumulated the higher the risk associated to the structure.

What does this mean in practical terms? Trials undertaken by Atkins on a group of 75 structures in South Wales found that the aggregate scores from risk assessment could be categorised as shown in Table 5.1 below. Structures on the M4, A470 and A465 were assessed independently by two different teams in Atkins and the results compared. These results were analysed by Atkins' engineers with over 50 years combined experience of inspections. Cross-referencing risk assessment and engineering experience and knowledge, resulted in the classifications as detailed in Table 5.1.

Table 5.1 indicates that any structure scoring 20% or less as a result of the risk assessment process should have its Principal Inspection interval kept at six years. What this % score means is that from all of the positive attributes deemed achievable by any given structural type, the structure being assessed has that % proportion of them. For example, a structure scoring 100% has all the positive attributes available (according to the risk assessment) to that type of structure. Conversely, a structure with a 0% score has none of the positive attributes deemed achievable by the risk assessment.

Between 0% and 100%, therefore, there is clearly an upwards trajectory in terms of the decline in risk associated to the structures (i.e. 0% or lower representing higher risk structures and 100% representing lower risk structures). Evidence gathered by Atkins during the aforementioned trialling of the risk assessment found that any structure scoring between 20% and 40% should be considered for an interval of eight years. Any structure scoring between 40% and 60% or 60% and above should be considered for an interval of 10 years and the maximum 12 years respectively.

In comparison, a structure would require a Principal Inspection at a six-year interval if the requirements of BD 63/07 were implemented with no risk assessment, even if it was in a very poor condition with known load restrictions. The most appropriate way of dealing with this scenario is not to reduce the Principal Inspection but to either undertake a targeted Special Inspection of the specific areas of the structure or to carry out some emergency maintenance works in order to mitigate the risk.

Accumulated Score	Recommended Principal Inspection Time Interval
x < 20 %	Maintain at 6 years
20% < x > 40%	Consider increasing to 8 years
40% < x > 60%	Consider increasing to 10 years
x > 60%	Consider increasing to 12 years

Table 5.1 – Scoring guidelines for risk assessment

When completing the risk assessment, the scoring guidelines given in Table 5.1 should be used as being just that: a *guideline*. These results are to guide and inform the engineer's judgement, not replace it.

6. Conclusion

Adopting this risk assessment approach for reviewing the inspection intervals offers substantial potential benefits to the Welsh Assembly Government and its Agents across Wales. As well as optimising the inspection resources available (e.g. time, labour, cost), a reduction in demand for inspection work will cut the risk to traffic management and inspection operatives who carry out dangerous work, often in inhospitable conditions. It also will help to ensure that more resource can be concentrated on those structures (approximately 20% according to Atkins' research) needing close management and maintenance.

The findings from Atkins' work illustrate what can be achieved by following a risk-based approach to reviewing the timings of Principal Inspections. Being able to increase the inspection interval for an estimated 80% of bridge stock offers considerable flexibility when managing highway structures. Welsh Assembly Government approval of this risk assessment allows for a consistent pan-Wales management philosophy to be introduced, promising greater efficiency and visibility in inspection practice.

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