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Analysis of visual inspection data for a sample of highway bridges in the UK

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ABSTRACT: The UK has a large stock of highway bridges that is ageing and deteriorating. This paper presents the results of a programme of work to understand the reliability of the visual inspection data that is used to inform the management of Highways England's structures. This paper presents a data set comprising evidence collected from presence at the principal inspection or testing of 200 bridges randomly sampled from Highways England's bridge network, coupled with asset management data for Highways England's entire bridge stock. Recommendations are made for future improvements in visual inspection practice and use of such data in future asset management efforts.

Keywords: Bridge Condition; Bridge Management; Visual Inspection

1. INTRODUCTION

1.1 UK Bridge Infrastructure

Much of the bridge stock that now forms critical links between UK cities is deteriorating and yet must also support increased demands in service (e.g., increased traffic loading). Responsibility for maintaining many UK bridges is devolved to organisations such as Highways England, Network Rail, London Underground and Local Authorities (e.g., McKoy (2016)). These 'client' bodies make extensive use of consultants and civil engineering contractors for design and management guidance and for repair and new construction. Such organisations inspect, assess, and maintain assets that are undergoing uncertain deterioration processes (e.g., Yanev & Richards (2013)) with uncertain or incomplete information on the true 'state' of a structure. Bridge condition is inferred from 'touching distance' inspections on typically a six-year cycle (Highways England, 2017). To achieve a sustainable and resilient network of bridge assets, a good understanding of the state of bridge infrastructure and how the stock is changing (deteriorating) is needed.

The operation of England's Strategic Road Network is the responsibility of Highways England. Highways England are also responsible for development of highway standards that may be adopted by UK local authorities, the devolved administrations in Wales, Northern Ireland and Scotland and many highway authorities worldwide. Highways England are the custodians of an aging stock of over 8000 bridges, many of which have been subject to significant deterioration and increasing traffic loads since their construction. The management of the structural and safety risks posed by the deterioration of highway structures is one of the key imperatives for Highways England and, given the nature and size of the stock, it is an achievement that condition-related incidents (i.e., collapses) are rare. The safety of the network is safeguarded by a comprehensive system of routine and detailed inspections, non-destructive testing, maintenance planning, design guidance and assessment standards.

1.2 Visual Inspection of Bridge Structures

Visual inspection is a common form of structural condition monitoring (e.g., Bennetts et al. (2020); McRobbie et al. (2015)). The primary aim of visual inspection is to assess the state or condition of a structure (i.e., 'damage detection' (Webb et al. 2015)), and potentially make assessments of how structure condition is changing with time (Bennetts 2019). Visual inspection cannot detect all potential bridge damage, e.g., Collins et al. (2017, 2019) give recent guidance for the detection of 'hidden defects' on highway bridges. There are many studies explaining the variability in the results of visual inspection due to 'human factors' (See et al. 2017) and differing opinions of the human inspectors (cf. Bennetts et al. (2020), Graybeal et al. (2002); Lea (2005); Lea & Middleton (2002); Moore et al. (2001); Middleton (2004)). Bennetts et al. (2020) report the results of a series of semi-structured interviews with a sample of individuals involved in Bridge Management in the UK. The results of this study reveal that visual inspection is still the most common form of structural monitoring for bridges in the UK. Reported practice is somewhat split between organisations on the uses of the data in bridge management and on the role of technology in bridge monitoring (Bennetts et al. 2020).

1.3 Background, Aims & Scope

This paper aims to study the trends in the quality of the bridge inspection processes and the performance of the bridge stock, including construction quality by e.g., structure age; bridge type; geographical indicators (maintenance area); structural form. This paper reports part of an extensive study on the state of UK bridge infrastructure detailed in Bennetts (2019) and Bennetts et al. (2017). This paper focusses primarily on the qualitative findings of a series of visual inspections and investigations on a representative sample of Highways England's stock. The detailed statistical analysis of Highways England's asset information data, including the production of 'importance dendrograms', has already been reported by Bennetts et al. (2018a, 2018b). The previous work has focussed on variation of the Bridge Condition Indicator scores (BCI_{ave} and BCI_{crit}) which aim to give a quantitative measure of bridge condition. The data set comprises detailed inspection and review of 200 bridge structures which were taken as a random representative sample of Highway's England's bridge stock (for further details on how the sample was obtained see Bennetts (2019) and Bennetts et al. (2017)). For the 200 bridges, both an inspector from WSP UK Ltd ('research team inspector') and an inspector from the relevant service provider were present on site for a Principal Inspection (usually undertaken every 6 years Highways England (2017)). The authors were involved with the planning and management of the programme of inspections and the lead author attended site as one of the 'research team inspectors' for a small portion of the site attendances (approximately 5%) to familiarise research team inspectors with the research and required data collection. Research team inspectors were all experienced professional bridge inspectors, briefed with a standardised set of guidance notes and data was collected on a standardised Benchmark Inspection Report. The research team inspectors attended Principal Inspections that were taking place on the UK Strategic Road Network as part of the continual programme of Principal Inspections carried out by Highways England's service providers. Highways England's inspections are contracted to third party 'service providers' in each of their Maintenance Areas, these organisations are not named here to maintain anonymity – the intention of the research was to understand the characteristics of inspection data and the performance of the UK bridge stock, rather than to 'audit' the service providers' performance. The research team inspectors questioned the service providers' inspectors prior to the inspection to appraise their experience, knowledge of the structure and preparation for the inspection, they then observed the inspection and made their own record of any defects making use of access provided for the PI (such as Mobile Elevated Working Platforms, or Underbridge units). For larger structures where the PI was carried out over a number of visits, the research team's inspector was typically present for only one of these. As reported in Bennetts et al. (2018a) the research team's inspectors noted 1373 individual defects from which 988 (72%) were directly comparable to those from the Service Providers' inspectors (compared on Figure 1). Figure 1 shows that, while in general there is strong correlation between inspectors' gradings, there were a considerable portion of defects where the inspectors recorded scores that were different. In some cases, the differences between scores were large.

2. METHODOLOGY: PROCESSING QUALITATIVE SITE REPORTS

At each of the 200 sample structures, the attendant Research Team Inspector was asked to complete a 'Benchmark Inspection Report', containing qualitative responses to questions on the topics listed in Table 1. These reports were completed by hand on-site and digitised. These documents, containing written descriptions and comments from WSP's inspectors were then all processed by the lead author, with review from the remaining authors.

2.1. Data Analysis

The objective when designing the methodology for processing this data was to ensure that the results were repeatable and auditable, and if the exercise were to be repeated the results would remain consistent. Good practice is to review interview transcripts or other qualitative text, highlighting excerpts of text that relate to each research question or theme (e.g., Fielding (2016)). This process was performed digitally by assigning ‘codes’ to the excerpts of text with a pack of virtual highlighters – a process referred to as Computer Assisted Qualitative Data Analysis, or CAQDAS (Lewis, 2016). The online CAQDAS package ‘dedoose.com’ was selected for use in this study because it has a streamlined interface for transcribing and coding audio files simultaneously.

The text records were coded into themes against a dynamically updated set of themes/research questions. The workflow adopted is given in Table 2. The process was iterative, repeating steps 2 to 5 by going through the files and adjusting the codes and coding until each file had been analysed against the same codes. For audio files, codes were applied by highlighting the relevant section of the audio and linked to the transcript. The software has functionality which allows a weighting to be applied to each assigned code. This was used for research question themes that required subjective judgement, with the weightings assigned to rate the extent to which the highlighted text supported the specific research question, or code. The scale used for each of these questions is presented in Table A1. For example, when coding evidence of poor-quality construction, a weighting from 0 to 5 was assigned depending on the strength of the evidence reported by the site engineers. Examples of reported evidence of poor quality construction ranged from visible tie-wire staining on concrete components and honeycombing to mis-aligned or missing components such as bolts. These weightings were reviewed alongside each other at the end of the process and calibrated to ensure consistent application across the sample of structures. For further details on the research methodology and analysis see the thesis of Bennetts (2019).

3. ANALYSIS OF BENCHMARK INSPECTION REPORTS

3.1 Quality of reviewed inspections

The research team’s inspectors were asked to comment upon whether the inspections they observed were in full compliance with BD 63/07 (Highways Agency, 2007). (BD 63/07 Highways Agency (2007) was the active standard at the time the work was completed but has now been superseded by BD63/17 Highways England (2017)) and whether they were, in the opinion of the research team’s inspector, ‘in the spirit’ of BD 63/07 – for example where an inspection where the service provider’s inspector did not manage to inspect every surface of the structure within touching distance, but made every reasonably-practical attempt to within a site’s access constraints would be deemed to be within the spirit of BD63/07 , but not on strict compliance. These responses were qualitatively reviewed and scored on a scale from 0 to 5, where 5 represents full compliance. Figures 2 and 3 present the results, sorted by maintenance area (Highways England divide the country into regions for the purposes of reporting and management. These regions, referred to as maintenance areas, have been anonymised in this paper). 81% of the inspections observed were found to be fully compliant with BD 63/07, and 93% were deemed to be ‘in the spirit’ of BD 63/07.

Of structures that were deemed to be in the ‘spirit’ of BD 63/07, but not fully compliant, the most common reason was that some areas of the structure could not be reasonably accessed to within touching distance. For example, for structures with a support adjacent to the edge of the carriageway, it may be impossible to access the deck soffit of the side spans with a Mobile Elevating Work Platform (MEWP) mounted on the carriageway. Similarly, the geometry of underbridge units may mean that it is not possible to achieve a full touching distance inspection of some sections of a structure. Failure to measure headroom was another common reason for inspections to be deemed non-compliant with BD63/07. There were a very small number of inspections where insufficient time or access equipment were dedicated to the inspection. Several inspections in one maintenance area, were noted to have been completed too quickly for a thorough inspection.

3.2 Trends in Construction Quality

3.2.1 Evidence of poor-quality construction

During the Benchmark Inspections, WSP’s inspectors were asked to comment on any evidence of poor-quality construction, such as poorly-compacted concrete or excessive tie-wire visible on concrete components. Relevant extracts from each Benchmark Inspection Report have been subjectively scored on a scale of 0 to 5, where 0 indicates no evidence of poor-quality construction and 5 indicates strong evidence. These scores are presented in Figures 4 to 8 and are plotted by ‘age group’; ‘condition’; ‘construction type’; ‘maintenance area’ and ‘structure type’.

Figure 6 reveals that significantly more evidence of poor quality of construction was observed during the Benchmark Inspections on concrete and composite bridges than on steel bridges. This aligns with the finding from the SMIS (the structures management information system used by Highways England at the time of writing) data that there were a larger number of construction defects per structure on concrete and composite bridges than on steel structures (Bennetts, 2019). Figure 7 illustrates a significant variation in the amount of evidence of poor-quality construction found in different maintenance areas. A similar observation can be made about structure types: more evidence of poor-quality construction was observed on most types of underbridges than on overbridges (Figure 8). Arguably, it is difficult to reliably identify the cause of some problems with structures, or it could be the case that there were many less severe defects related to construction issues which were observed by the research team’s inspectors but were not severe enough to have the defect cause recorded in SMIS. Alternatively, it could suggest that evidence of poor-quality construction does not necessarily mean that there are defects.

3.2.2 Water management

On the Benchmark Inspection Record sheets the research team's inspectors were asked to record evidence of whether bridge designs adequately consider water management and to comment on both the performance of water management and the adequacy of any maintenance to water management. These responses have been rated qualitatively on a scale from 0 for inadequate water management to 5 for excellent performance. A selection of the resulting scorings is presented graphically in Figures 9 to 11.

Reviewing the Benchmark inspection data relating to the perceived adequacy of maintenance to water management, the following observations were made:

- Adequacy of maintenance to water management appeared to be slightly better on newer structures than on older structures. This could either suggest that water management on newer structures is easier to maintain, or that water management on older structures has required more maintenance due to its age.
- Adequacy of maintenance to water management appeared to be better for steel bridges than for concrete or composite structures.
- Adequacy of maintenance to water management appeared to be better for footbridges and overbridges than for underbridges and subways. This could suggest that access for maintenance was easier for overbridges than for underbridges.
- Water management on newer structures did not appear to perform significantly better than on older structures (see Figure 9).
- There appeared to be a strong correlation between the performance of water management and the overall condition of the structure (as indicated by the BCI_{ave} score). This substantiates one of the conclusions from the Maunsell Report that water management is extremely important (Wallbank, 1989) (see Figure 10).
- Large differences were seen in the performance of water management on different deck types.
- There were noticeable differences in the recorded performance of water management between different maintenance areas. This could suggest that different areas implement differing maintenance regimes, of that there were favoured designs particular to each area (see Figure 11).

3.2.3 Performance of repairs

The research team's inspectors were asked to record on the Benchmark Inspection Records whether there were any repairs on the structure and, if so, to comment on how the repairs appeared to be performing. These responses have been rated qualitatively on a scale from 0 for poor performance to 5 for excellent performance. Repairs were noted on 71 (35%) of the bridges in the benchmark inspection sample, with the average score applied to the performance of these repairs being 2.8. There was more evidence of poor-quality repairs than of good quality repairs on the structures inspected. Most of the noted repairs were concrete repairs with many examples of cracking, spalling, and honeycombing observed. Figure 12 shows that there were significant variations in the performance of repairs in different maintenance areas which could suggest that different maintenance approaches have been employed. Alternatively, factors such as weather conditions and construction history may mean that the structures in some areas are predisposed to poorer repair performance.

4. DISCUSSION OF THE OBSERVED QUALITY OF VISUAL INSPECTIONS

4.1 Elements not inspected

During the Benchmark Inspections the research team's inspectors were also asked to note any structural elements for which data was not collected. At most inspections, it was reported that all elements were inspected. However, there were some cases where this was not the case, primarily for the reasons listed below:

- The most recorded reason for not inspecting all components was a lack of suitable access. In some cases, the design of the structure did not leave sufficient space for inspectors to access areas such as bearing shelves, half joints, and the top surfaces of beams. In other cases, access to locations such as the mid-span of beams was difficult or impractical with the access equipment available (in one location access for an underbridge unit was blocked by the position of a lighting column).
- Components such as waterproofing and foundations could not be inspected as they were buried. Cladding was also highlighted as a problem where it inhibited the ability to inspect the underlying structural members.
- There were a small number of instances where the reasons for not inspecting all structural elements appeared to be due to insufficient planning. In some inspections access to wingwalls was restricted due to the amount of vegetation present. During other inspections there were parts of the structure which could not be accessed due to the scope of the Traffic Management provided. Finally, there were two instances where steel thickness could not be measured as no suitable measuring equipment was brought to site.

4.2 Suitability of inspectors

During the Benchmark Inspections WSP's inspectors were asked to comment on the suitability of the Service Providers' inspectors. Except for a few isolated instances it was reported that most inspectors appeared experienced and competent to undertake the inspection being observed. The research team's inspectors' comments had also been subjectively scored on a scale from 0 to 5, with 0 indicating a low degree of suitability and 5 indicating a high degree of suitability. Most scores were very high, reinforcing the view that the suitability of inspectors appears to be good in most cases. Very little difference in the degree of suitability was recorded for structures of different conditions and construction types. This again suggests that most inspectors were suitably experienced and competent to undertake the inspections they had been assigned to. Some variation was observed between the apparent suitability of inspectors in different maintenance areas. However, there does not appear to be any correlation between these results and the variation in reliability of inspection data across different maintenance areas. The competency of bridge inspectors appears not be a significant factor influencing the apparent variation of inspection reliability observed between different maintenance areas of Highway England's network. It is noted that there is currently a lack of consistent guidance documents which are up to date with the system for defect reporting which is currently used in SMIS. This lack of universal guidance may have contributed to inconsistencies between different maintenance areas and arguably should be the subject of further work.

4.3 Effects of time of day and weather on inspection quality

There were significant differences in the number of benchmark inspections which were undertaken during day and night in each maintenance area. However, there does not appear to be any correlation between inspection timing and the observed variability of defect scoring in each maintenance area. Additionally, the time of inspection appeared to have very little influence on the perceived compliance with BD 63/07 (Bennetts, 2018b). These findings suggest that the quality of inspections undertaken at different times was relatively consistent. However, significantly stronger evidence of poor quality of construction was observed during daytime inspections than during those undertaken at night. Furthermore, there were a significant number of inspections, primarily undertaken at night, where insufficient lighting was highlighted as a hindrance to the inspection. This demonstrates the importance of providing sufficient lighting during inspections to ensure that defects are not overlooked. Stronger evidence of poor performance of water management was recorded during inspections undertaken during inclement weather. This is likely to be because ineffective water management will be much easier to identify during rain events. Inspectors should therefore take particular care when inspecting structures during fine weather conditions to ensure that defects relating to water management are not overlooked.

4.4 Noted areas for improvement of inspections

During the benchmark inspections the research team's inspectors were asked to comment on the reliability of inspection results and highlight potential areas for improvement. In many of the inspections, access difficulties were encountered, and it was suggested that vegetation clearance or routine maintenance undertaken prior to the inspection would have been beneficial. Additionally, there were several inspections where difficulties were encountered with the access equipment which was used. For example, there were situations when the MEWP employed was found to be too small to reach all areas of the structure, and others where the size of the MEWP made it impossible to get close enough to the structure. It would be beneficial for information relating to access arrangements and requirements to be stored within SMIS so that such problems are not encountered repeatedly.

5. SUMMARY & CONCLUSIONS

This paper has presented the findings of a detailed review of the inspection and performance of a sample of 200 bridges from Highway's England's stock. This work compares inspections from the research team and various service providers, along with the research team's inspector's reports on the quality of the inspection and the performance of the asset. The following conclusions are drawn:

(a) Most inspections (81%) were found to be in strict compliance with BD63/07 (93% were judged to be in the 'spirit' of the standard);
(b) Many identified structural defects were linked to issues related to bridge construction;
(c) Significant variation in the incidences of poor-quality construction and water management were identified across the maintenance areas studied;
(d) There was more evidence of poor-quality repairs than good quality repairs;
(e) Improved access to the structure was identified as a significant means to improve the quality of visual inspections.
(f) Competence of bridge inspectors was found to be similar across the network, however outputs from inspections varied. This could be due to a lack of consistent guidance.

Whilst some of these conclusions may not be entirely unexpected to engineers and asset management professionals, this study has provided a robust dataset to support all trends and observations. In the future this dataset should be compared with comparable datasets from other jurisdictions to understand the universality of the trends shown in this work.

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Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

(Table A1 here)

List Table & Figure Captions

Table 1: Question topics for WSP Inspectors

Table 2: Processing Steps for Text Records

Table A1: Codes applied to the Benchmark Inspection Records during the analysis of the inspection reports

Figure 1: Element condition score from Service Provider inspector compared with WSP inspector for the defects included in the study. Shading indicates the density of markers at any point on the plot. Linear regression shown: ECS(Research Team Inspector) = 0.42 [ECS(Service Provider)] + 1.43 (data on 988 defects from Bennetts et al. (2018a) and Bennetts (2019))

Figure 2: Qualitative weightings of the scoring from the research team's inspectors for strict compliance with BD63/07 (Highways Agency 2007). The widths of the bars have been scaled to indicate the number of structures in the sample within each maintenance area. The categories are displayed in order of average applied weight.

Figure 3: Qualitative weightings of the scoring from the research team's inspectors for compliance with the spirit of BD63. The widths of the bars have been scaled to indicate the number structures in the sample within each maintenance area. The categories are displayed in order of average applied weight.

Figure 4: Average scores for evidence of poor quality of construction, split into categories of 'age group'. The widths of the bars have been scaled to indicate the number of structures in the sample within each age group. The categories are displayed in order of age group.

Figure 5: Average scores for evidence of poor quality of construction, split into categories of 'condition'. The widths of the bars have been scaled to indicate the number of structures in the sample within each category of condition. The categories are displayed in order of average applied weight.

Figure 6: Average scores for evidence of poor quality of construction, split into categories of 'construction type'. The widths of the bars have been scaled to indicate the number of structures in the sample of each construction type. The categories are displayed in order of average applied weight.

Figure 7: Average scores for evidence of poor quality of construction, split into categories of 'area'. The widths of the bars have been scaled to indicate the number of structures in the sample within each maintenance area. The categories are displayed in order of average applied weight.

Figure 8: Average scores for evidence of poor quality of construction, split into categories of 'structure type'. The widths of the bars have been scaled to indicate the number of structures in the sample within each category of structure type. The categories are displayed in order of average applied weight.

Figure 9: Average scores for performance of water management, split into categories of age group. The widths of the bars have been scaled to indicate the number of structures in the sample within each age group. The categories are displayed in order of age group.

Figure 10: Average scores for performance of water management, split into categories of condition. The widths of the bars have been scaled to indicate the number of structures in the sample within each category of condition. The categories are displayed in order of average applied weight.

Figure 11: Average scores for performance of water management, split into categories of maintenance area. The widths of the bars have been scaled to indicate the number of structures in the sample within each maintenance area. The categories are displayed in order of average applied weight.

Figure 12: Average scores for performance of repairs, split into categories of maintenance area. The widths of the bars have been scaled to indicate the number of structures in the sample within each maintenance area. The categories are displayed in order of average applied weight.

Table 1: Question topics for WSP Inspectors

Topic	Examples
Inspection details	weather, time of day, duration, dates, equipment used, traffic management
Testing details	
Reliability of inspection data	suitability of resources, quality of inspection, any impediments to inspection, efficiency
Bridge design & construction	performance of the structure, quality of construction, water management
Bridge maintenance & repairs	status of maintenance actions, performance of repairs

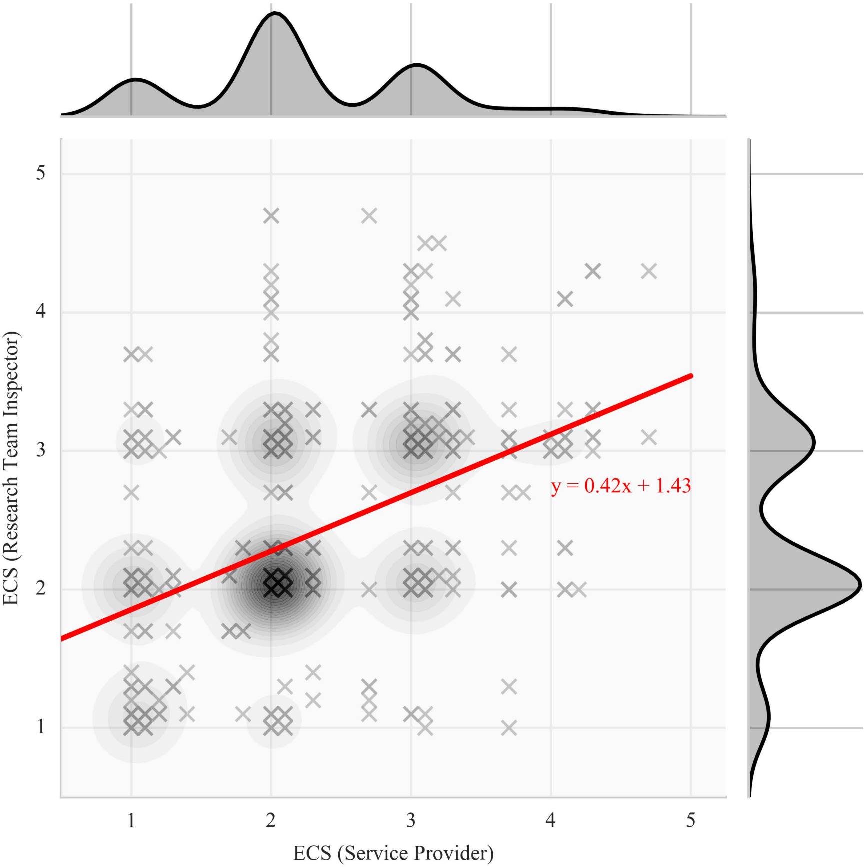
Table 2: Processing Steps for Text Records

Step	Description
1	The coding environment was set up with the research questions and themes.
2	The files were processed, highlighting snippets which relate to the research questions
3	The research questions and themes were refined and added to as each file was processed
4	The codes were reviewed and rationalised
5	Each file was re-analysed with the updated set of codes
6	Reports for the excerpts relating to each code were generated and used to build narratives and present findings.

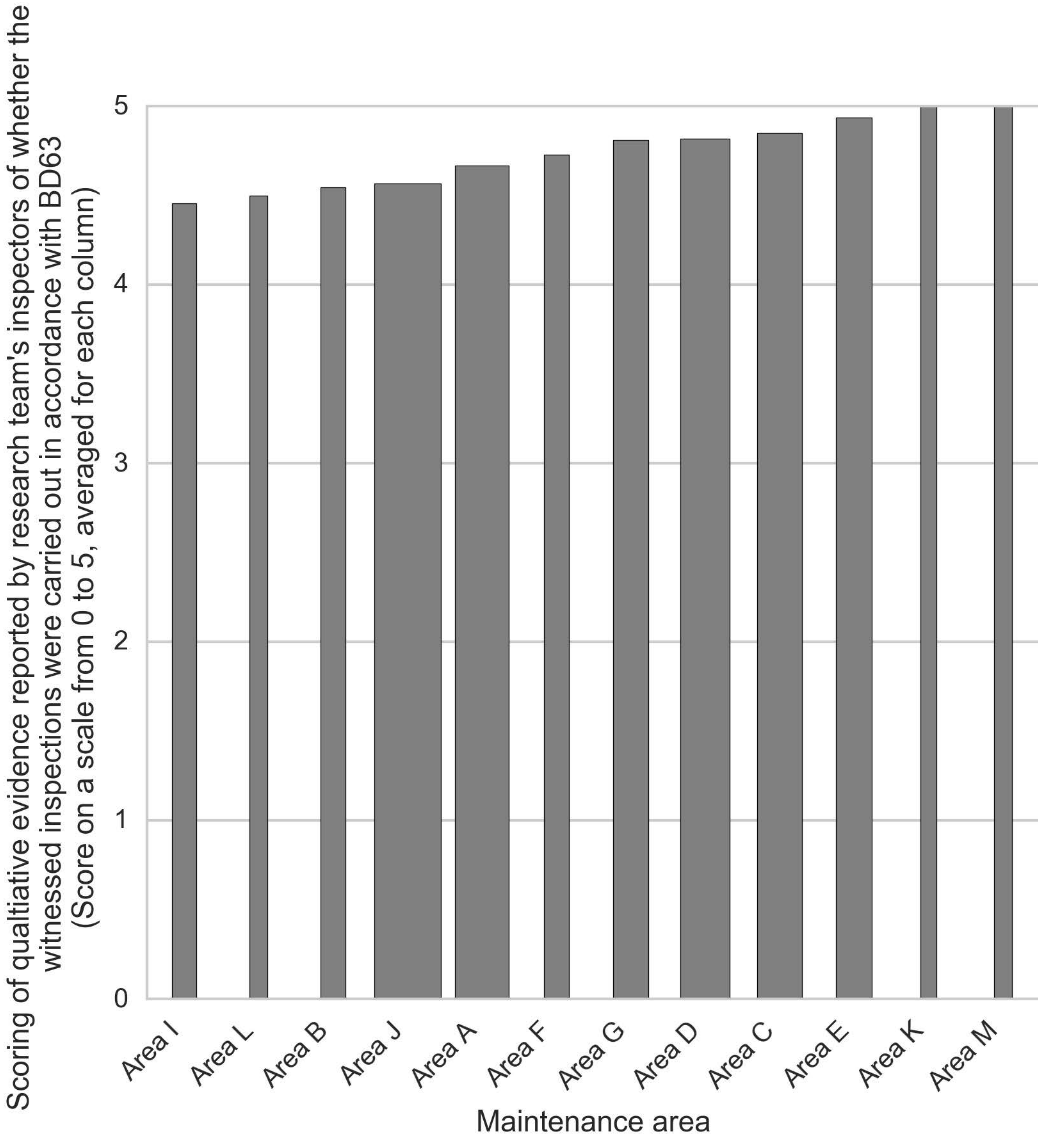
Table A1: Codes applied to the Benchmark Inspection Records during the analysis of the inspection reports

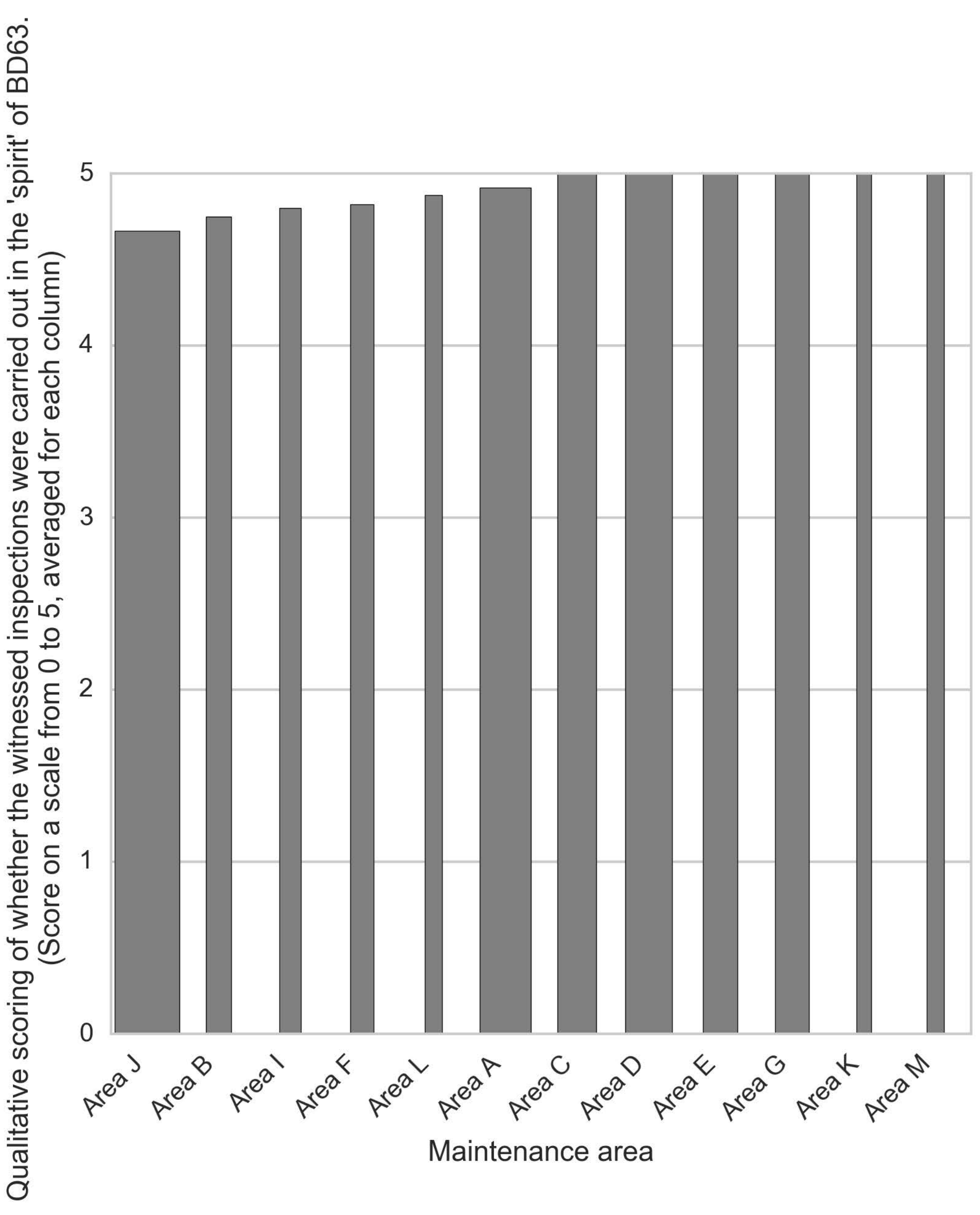
Key Question		Notes on qualitative scoring
KQ 01	Can guidance on design for durability be improved?	
	1. Defect Causes	
KQ 03	Do designs adequately consider maintenance and inspection needs?	
	1. Ease of inspection 1.1. Hidden details	
KQ 04	Do designs adequately consider water management	
	1. Performance of water management	0 inadequate
		5 excellent
	2. Adequacy of maintenance to water management	0 inadequate
		5 excellent
KQ 06	What are the trends in quality of construction?	
	1. Evidence of poor-quality construction	Scored from 0 for no evidence, to 5 for strong evidence.
KQ 08	How reliable are inspection results? Is there variation in practice that can be addressed?	
	1. Quality of inspection 1.1 Carried out in accordance with BD63 1.2 Carried out in the spirit of BD63 1.3 Structure review prior to inspection 1.4 Are defects being targeted?	
	2. Improvements to Inspection 2.1 Efficiency 2.2 Access 2.3 Equipment 2.4 Network Availability 2.5 Technique	
	3. Testing 3.1 Testing results as expected from visual	
KQ 11	Should the approach for inspections be targeted towards particular structure types and risks?	
KQ 13	Is there sufficient guidance regarding diagnosis of the cause of defects?	
	1. Use of guidance on site	Evidence of use of guidance on site. Scored from 0 to 5, with 0 being no use
KQ 14	Is there a need to do more to ensure the competence of inspectors?	

	1. Suitability of inspectors	5 for 'yes' suitable. Other answers scored based on judgement
KQ 16	Are there trends in performance of different maintenance interventions which can inform future decisions/prioritisation?	
KQ 17	Is the opportunity being taken to carry out maintenance at the same time as other network interventions and schemes?	
	1. No maintenance being carried out along with PI	
	2. Details of maintenance being carried out during PI	
	3. Are inspectors aware of maintenance needs?	
	4. Has maintenance from last PI been carried out? 4.1 Yes 4.2 No	
KQ 22	How effective has previous maintenance been in practice?	
	1. Performance of repairs	Evidence of performance of repairs 0 for poor 5 for excellent
KQ 26	How long do common components last? Are adequate plans in place to predict timings of renewals?	
	1. Are there different areas of the bridge that are performing differently? 1.1 No 1.2 Details of differences	
KQ 28	Is smart technology being used to inform maintenance effectively?	
	1. Smart monitoring 1.1 No evidence of Smart Monitoring 1.2 Details of Smart Monitoring 1.3 Opportunity for monitoring 2. Monitoring Inspections	
KQ 30	Are there particular standards or processes that are preventing best practice or service for the network and its customers?	
	1. Limitations on carrying out a better inspection 1.1 Processes 1.2 Standards	
00	Great Quotes	

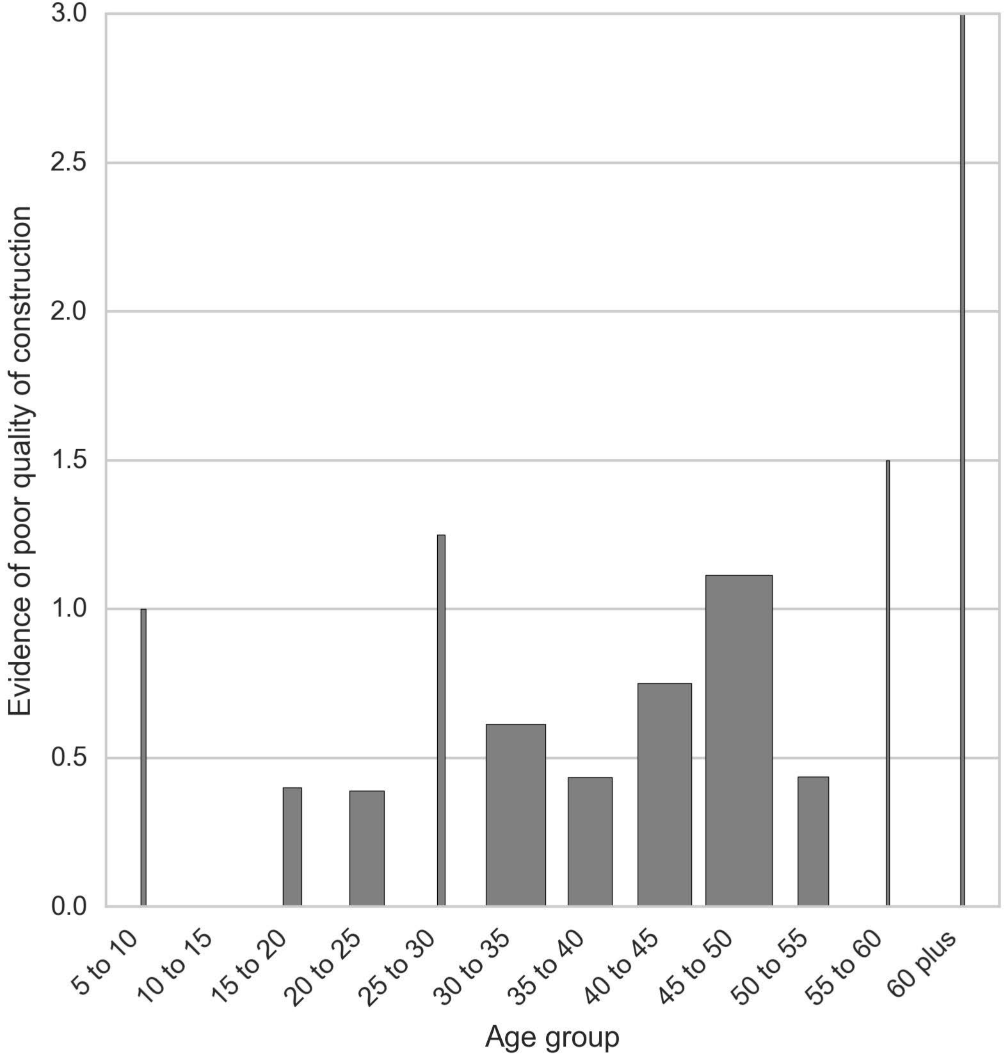


5
4
3
2
1
ECS (Research Team Inspector)
y = 0.42x + 1.43
1
2
3
4
5
ECS (Service Provider)

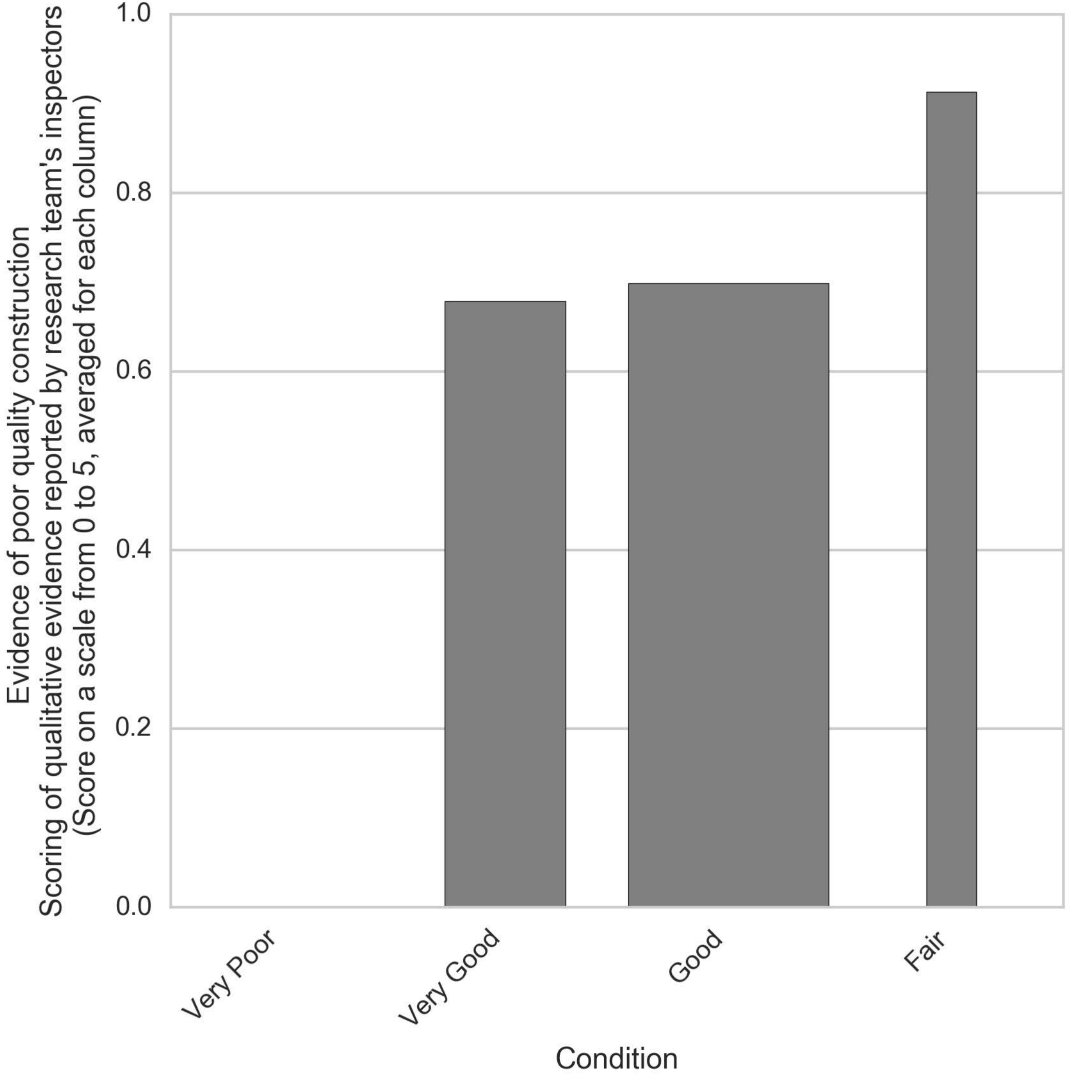

Scoring of qualtiative evidence reported by research team's inspectors of whether the witnessed inspections were carried out in accordance with BD63
(Score on a scale from 0 to 5, averaged for each column)
5
4
3
2
1
0
Area I
Area L
Area B
Area J
Area A
Area F
Area G
Area D
Area C
Area E
Area K
Area M
Maintenance area

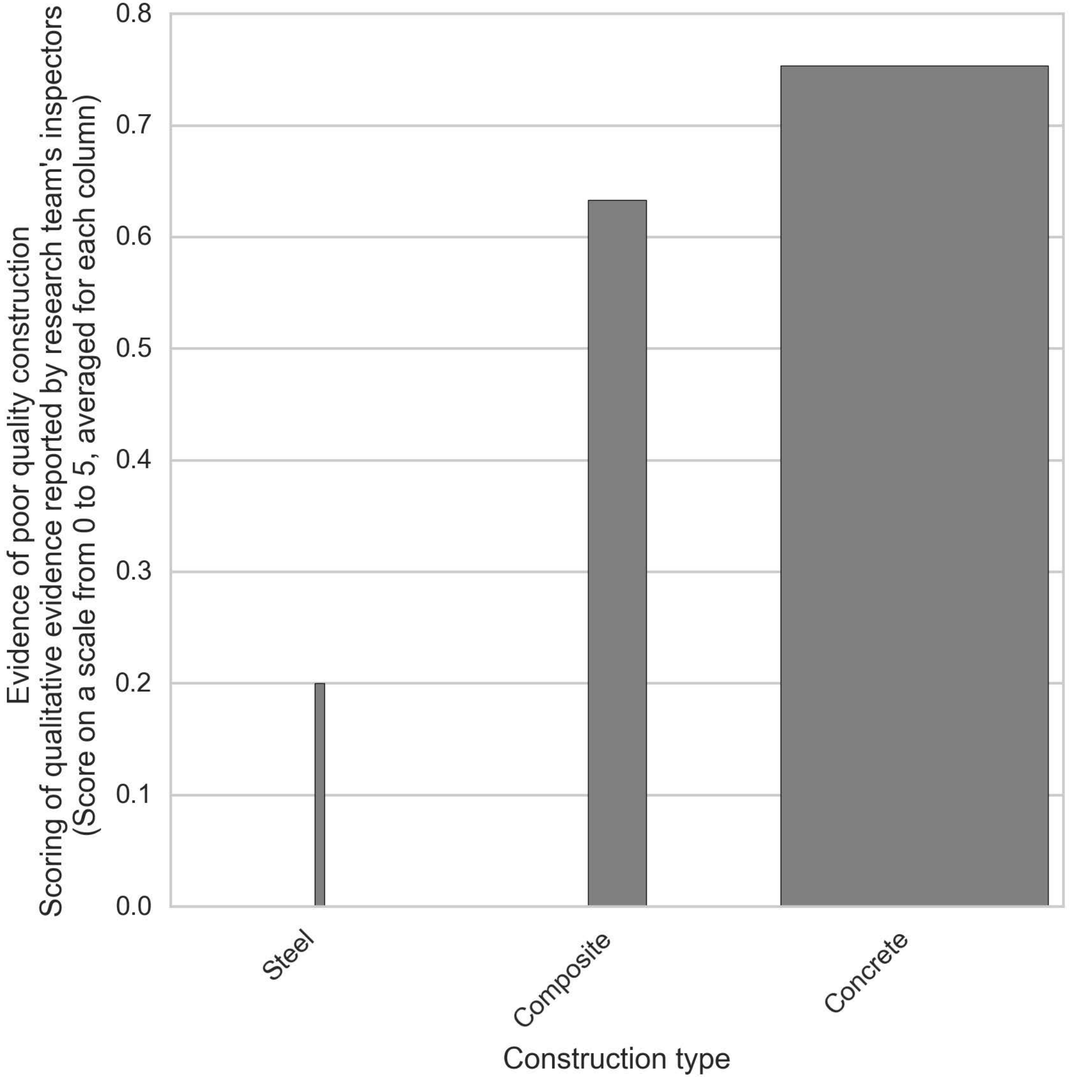


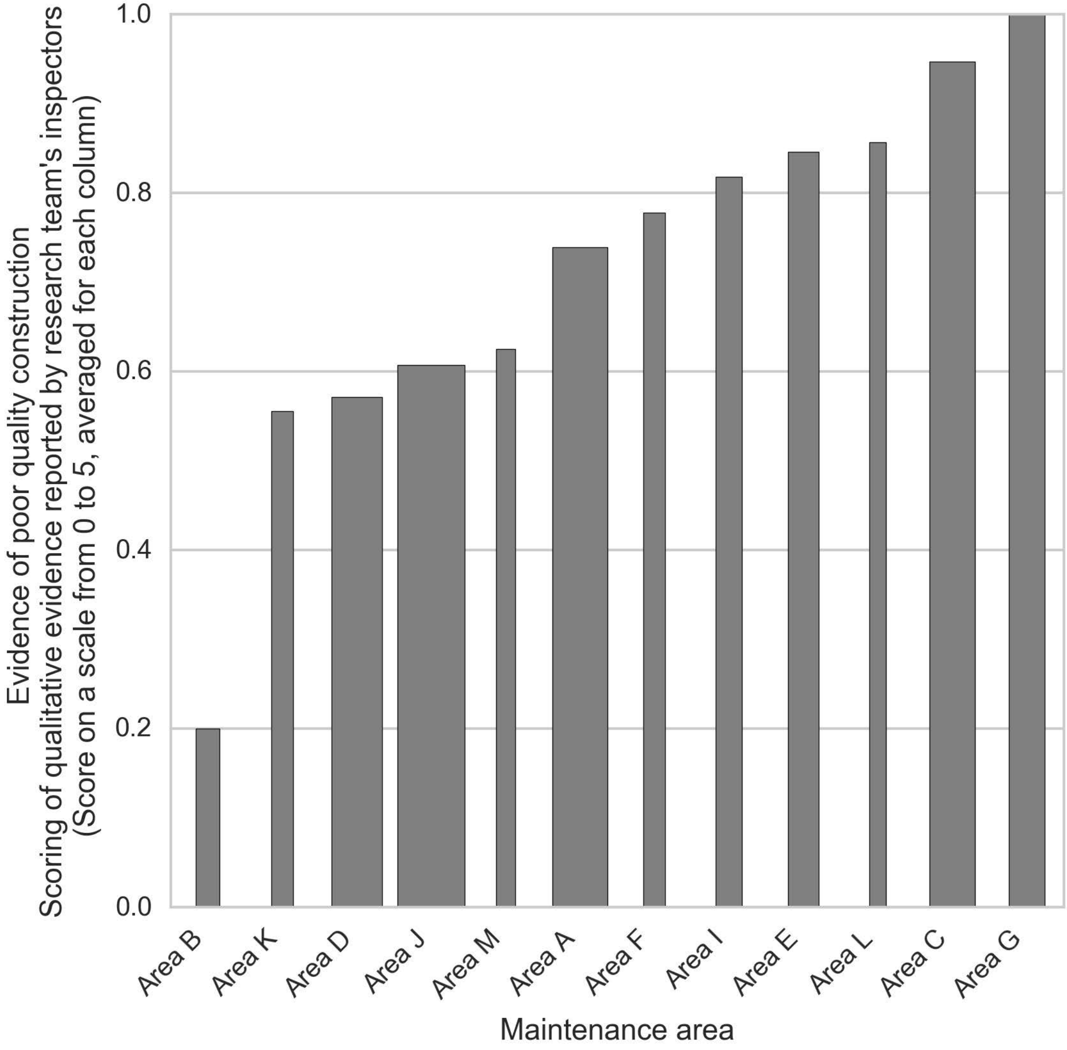
Qualitative scoring of whether the witnessed inspections were carried out in the 'spirit' of BD63.
(Score on a scale from 0 to 5, averaged for each column)
0
1
2
3
4
5
Area J
Area B
Area I
Area F
Area L
Area A
Area C
Area D
Area E
Area G
Area K
Area M
Maintenance area

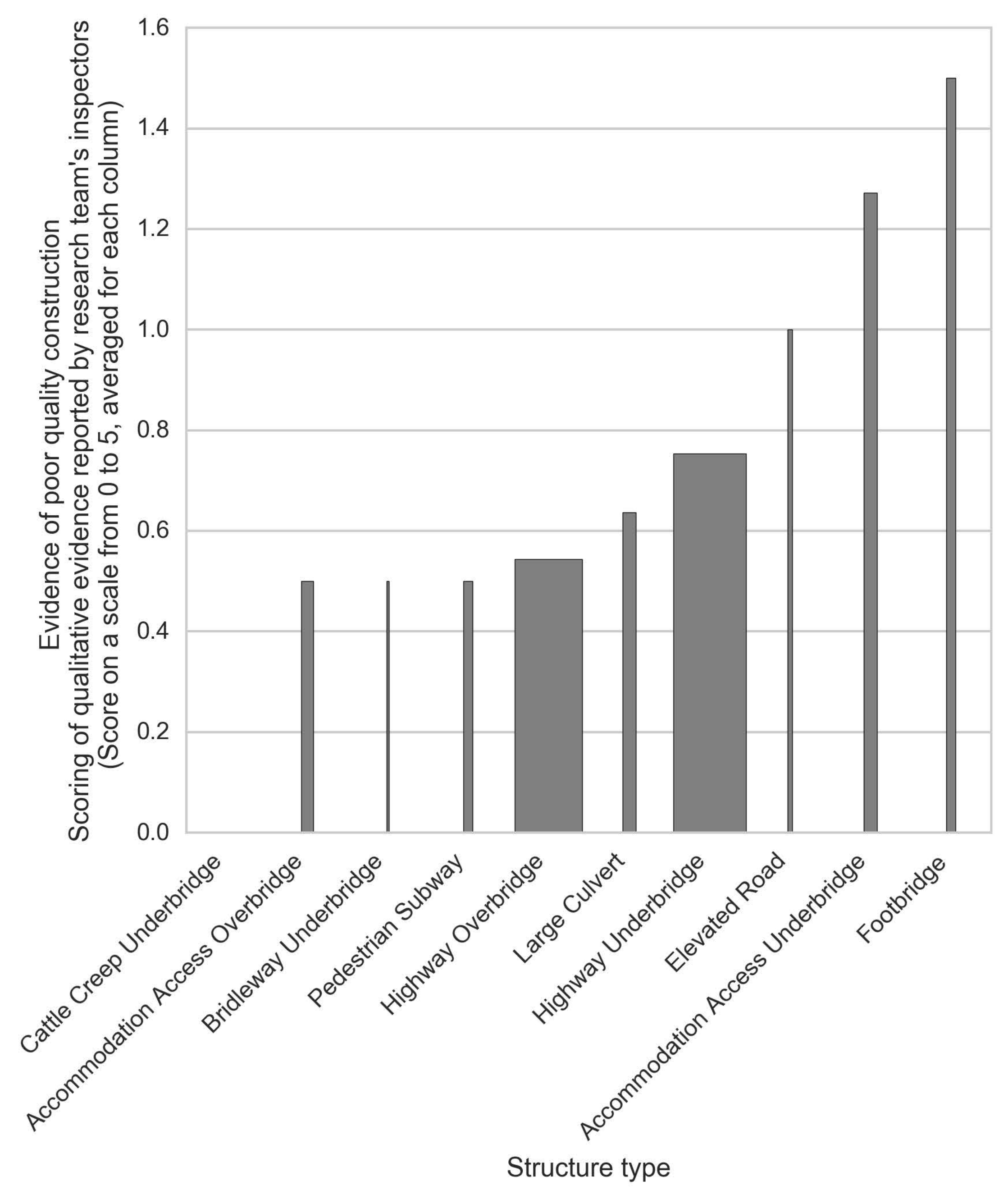


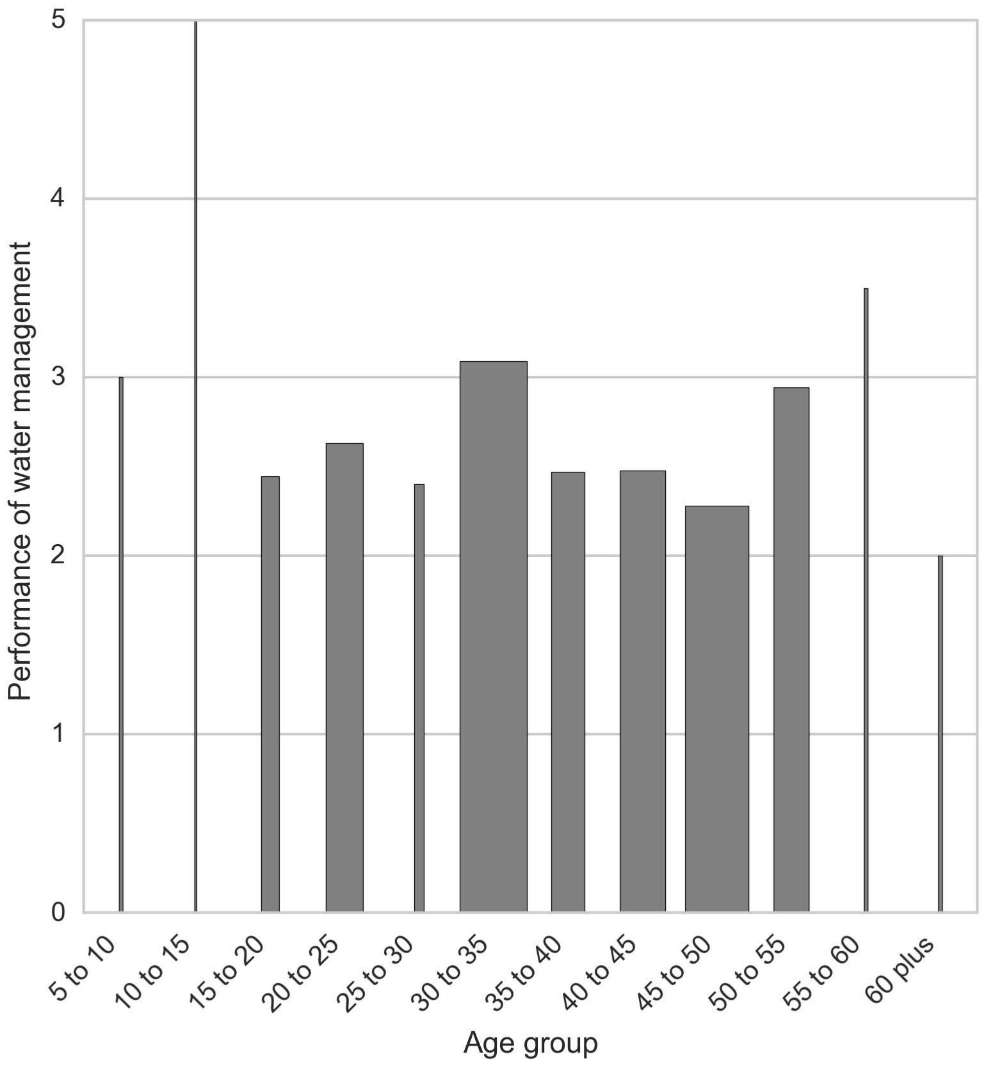
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Evidence of poor quality of construction
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 35
35 to 40
40 to 45
45 to 50
50 to 55
55 to 60
60 plus
Age group

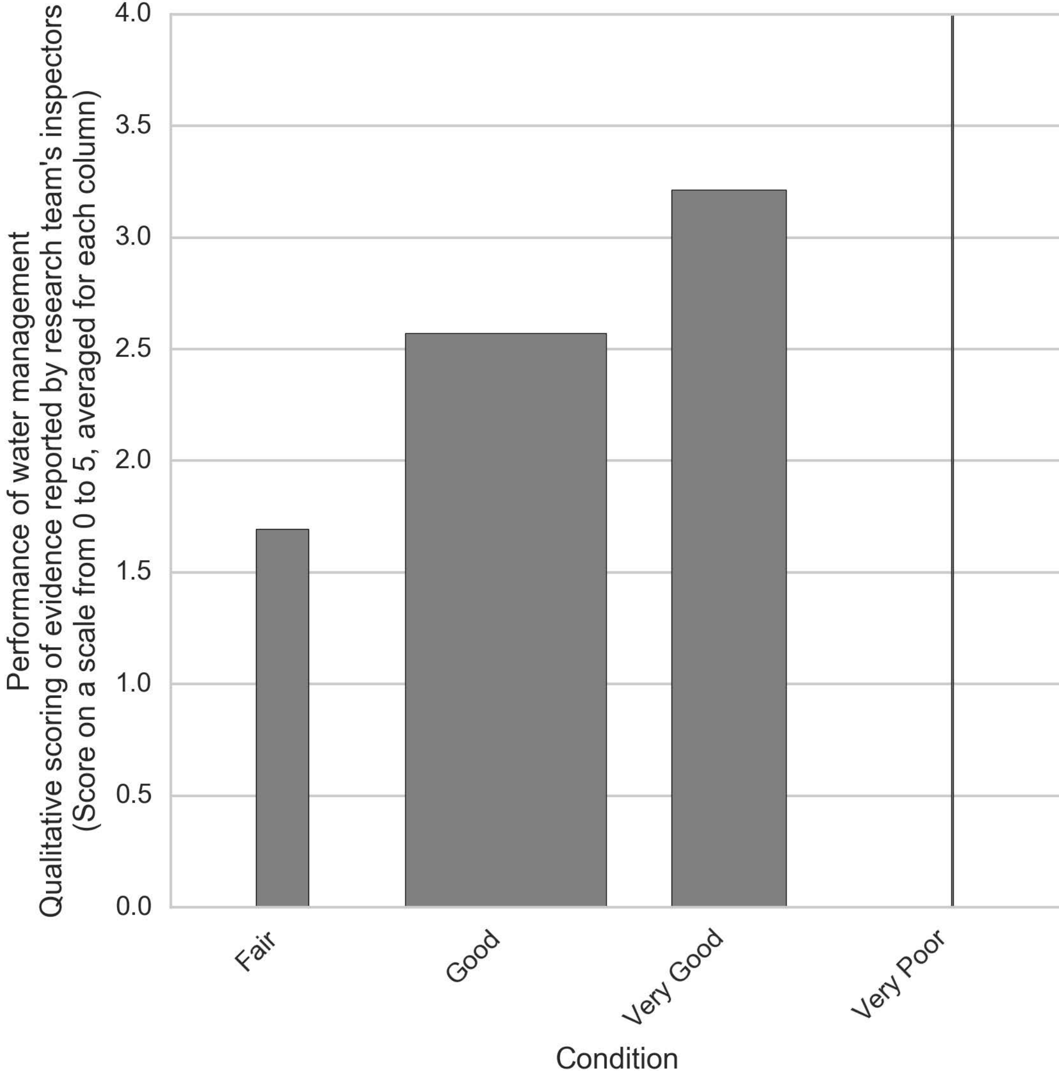

Evidence of poor quality construction
Scoring of qualitative evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
1.0
0.8
0.6
0.4
0.2
0.0
Very Poor
Very Good
Good
Fair
Condition


Evidence of poor quality construction
Scoring of qualitative evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Steel
Composite
Concrete
Construction type

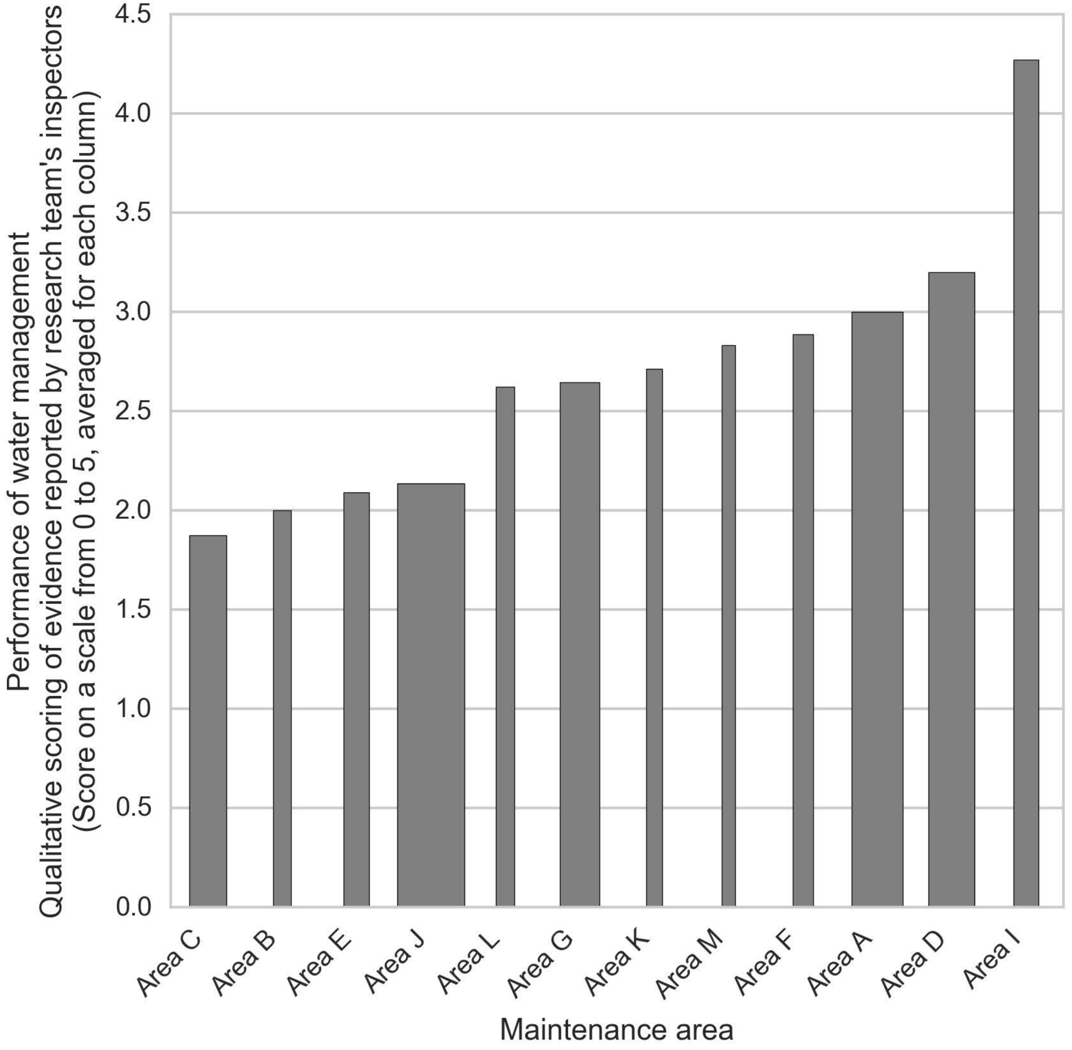

Evidence of poor quality construction
Scoring of qualitative evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
1.0
0.8
0.6
0.4
0.2
0.0
Area B
Area K
Area D
Area J
Area M
Area A
Area F
Area I
Area E
Area L
Area C
Area G
Maintenance area


Evidence of poor quality construction
Scoring of qualitative evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Cattle Creep Underbridge
Accommodation Access Overbridge
Bridleway Underbridge
Pedestrian Subway
Highway Overbridge
Large Culvert
Highway Underbridge
Elevated Road
Accommodation Access Underbridge
Footbridge
Structure type

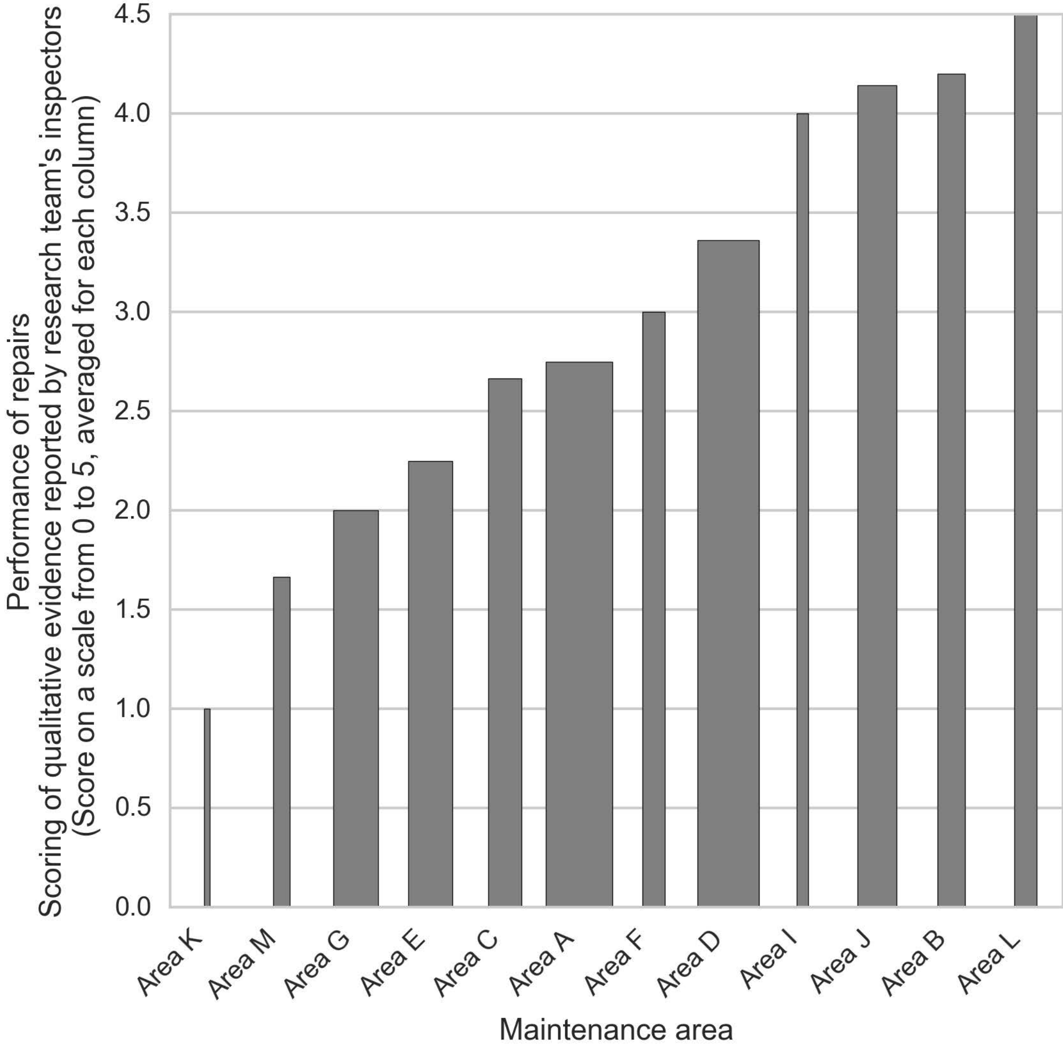

Performance of water management
5
4
3
2
1
0
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 35
35 to 40
40 to 45
45 to 50
50 to 55
55 to 60
60 plus
Age group



Performance of water management
Qualitative scoring of evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Fair
Good
Very Good
Very Poor
Condition



Performance of water management
Qualitative scoring of evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Area C
Area B
Area E
Area J
Area L
Area G
Area K
Area M
Area F
Area A
Area D
Area I
Maintenance area


Performance of repairs
Scoring of qualitative evidence reported by research team's inspectors
(Score on a scale from 0 to 5, averaged for each column)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Area K
Area M
Area G
Area E
Area C
Area A
Area F
Area D
Area I
Area J
Area B
Area L
Maintenance area