INSPECTION AND ASSESSMENT SYSTEM OF HIGHWAY BRIDGES IN SRI LANKA

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DECLARATION

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ABSTRACT

Highway Bridges play a key role in the road based transportation system. There are 4456 highway bridges in Class A, Class B and Class AB roads in Sri Lanka, as per the "Annual Report, Road Development Authority – 2015". Significant portion of those bridges are reaching their design life. Therefore, a proper maintenance system, which includes preventive maintenance for these highway bridges is an essential requirement.

Road Development Authority (RDA) is the principal organization, which handles the road related infrastructure in Sri Lanka. RDA conducts inspection on bridge structures, assesses their functionality, and carries out repair and rehabilitation works. The current method of inspection and assessment has been followed since 1997. RDA is in the process of upgrading their Bridge Management System (BMS) and still practicing the old system, which was implemented in year 1997.

The current method of inspection and assessment is not comprehensive enough to grasp the necessary distresses. Only basic information, with respect to distresses, are collected in the process of bridge inspection. The present study provides a detailed review of the current method of inspection, which is followed by RDA, Sri Lanka. The current local system is compared with the advanced Bridge Inspection Systems in several other countries. At the same time, necessary feedback about the current method of inspection is sought from the bridge inspectors at RDA. This study revealed several shortcomings of the current system. Hence, an improved Bridge Inspection and Assessment System, which overcomes most of the shortcomings in the current system is proposed with the present study.

ACKNOWLEDGEMENT

The study took nearly 18 months to finish. Large number of people helped me with guidance, comments, advices and facilitating. I offer my sincere gratitude to all of them.

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RDA - Road Development Authority, Sri Lanka

AE - Acoustic emission

AHP - Analytic Hierarchy Process

BCV - Bridge Condition Value

BMS - Bridge Management System

CIV - Component Importance Value

CMCV - Critical Member Condition Value

DIV - Distress Importance Value

EL - Extent Level

GPR - Ground penetration radar

IE - Impact echo test

MCV - Member Condition Value

MIV - Member Importance Value

NDT - Nondestructive testing

RDIV - Relative Distress Importance Value

SIV - Structure Importance Value

SL - Severity Level

WSM - Weighted Sum Model

WPM - Weighted Product Model

1. INTRODUCTION

1.1. Overview

Highway Bridges play a key role in the road based transportation system. There are 4456 highway bridges in Class A, Class B and Class AB roads in Sri Lanka, as per the "Annual Report, Road Development Authority (RDA) – 2013"[1]. Significant portion of those bridges are reaching their design life [2]. Therefore, a proper maintenance system for these highway bridges is an essential requirement.

RDA is the principal organization, which handles the road related infrastructure in Sri Lanka. RDA conducts inspection on bridge structures, assess their functionality, conduct repair and rebuild works. The current method of inspection and assessment has been implemented in year 1997 [3]. RDA is in the process of upgrading their Bridge Management System (BMS) and still practicing the old system, which was implemented in year 1997. The current system works as follows:

- Executive Engineers Division runs “Routine inspection”, once in 3 months.
- If “Routine inspection” identifies a suspicious bridge, “Condition inspection” on that bridge is conducted.
- Inspector straightaway provides a rating value for different components of the bridge.
- If the rating is poor, bridge is undertaken by Maintenance Division for repair/ rebuild works.

Several issues can be observed in the current method of inspection and assessment, which is followed by RDA.

- Current system collects only a minimum information and it may not be detailed enough to identify actual issues related to bridge structure.
- Rating given by the inspector is based on minimum information.
- The rating highly depends on personal perspective of the inspector.

Although, once in a while, failures of bridges were reported in Sri Lanka, there were no tragic bridge failures recorded. The main reason is most of the highway bridges in Sri Lanka are either short span bridges or series of simply supported spans at which a single span is about maximum of 15m [1]. There are only a few numbers of bridges, which can be truly categorized as long span bridges. But with the policy decision of the government to construct an expressway network covering the entire country, there are more and more long span bridges emerging. Inspection and assessment of such long span bridges are more crucial as we look into the failures of bridges worldwide [4].

A bridge worth a vast amount of money, which is built mainly from tax paid by general public. Hence, as civil engineers, it is our duty to make sure the bridge lasts till the end of its design life whilst performing its intended functions.

Therefore this research focuses on developing a new Bridge Inspection and Assessment System, which is suitable to Sri Lankan context, to eliminate key drawbacks in the existing system.

1.1.1. Aim of the research

Develop a comprehensive Bridge Inspection and Assessment System for Sri Lanka. The proposed method should be,

- Comprehensive enough to identify defective bridges in advance.
- Suitable for local context (workable with available staff and funds).

1.1.2. Objectives

- Understanding the key aspects of Bridge Inspection and Assessment Systems by studying advanced Bridge Management Systems in other countries.
- Detailed study on Bridge Inspection and Assessment methods in Sri Lanka.
- Learn historical failures of bridges and failure mechanisms of different types of bridges.
- Understanding key steps in the process of developing and implementing of a Bridge Inspection and Assessment System.

1.2. Outline of the report

The report contains five sections. Section 1 of the report presents an introduction to the project, describes the background of the current method of bridge inspection, which is followed by RDA.

Section 2 of the report presents “Literature Review”. Failures of bridge structures, key aspects of Bridge Management Systems (BMS), Nondestructive Testing Methods related to bridge inspection are extensively discussed under this section.

Section 3 of the document is the "Methodology". This section presents a detailed review of the current method of inspection and assessment of bridges, which is followed by Road Development Authority. Based on the findings a "New inspection and assessment method for concrete bridges" is proposed.

Section 4 of the report is the “Analysis and Discussion”. Calculation of some of the parameters and analysis of some of the data are presented under this chapter. Further, a detailed discussion is presented based on the outcomes.

Section 5 of the report presents conclusions and possible areas of study, which can extend the present study.

2. LITERATURE SURVEY

Bridges are designed at least for about 100 years of design life in general. In Sri Lankan context, normally the design life is considered to be about 120 years. Hence, the bridge is expected to function whilst performing its intended purposes throughout that period of time. Once a bridge is constructed, it becomes an asset of the economy as it provides access to millions of passengers and goods. Yet, failures of bridges have been recorded once in a while due to several reasons. Joachim Scheer [4] presents 356 cases of bridge failures reported throughout the world in history. He categorized failures in accordance with the cause of failure and summarized the percentage of failures with respect to the cause as listed below.

- Dynamic loads and collisions – 41 %
- Structure overload – 19 %
- Material defects (corrosion, fatigue) – 14 %
- Deficiencies in inspection and maintenance – 12 %
- Foundation problems – 5 %
- Improper methods of construction – 2 %
- Unknown causes – 7 %

Hence, it can be noted that, 12 % of failures could have been addressed with proper bridge management systems. Several selected cases related to bridge inspection and assessment, directly and indirectly, have been extracted from above study and summarized below.

Table 2-1: Failures due to improper inspection, assessment and maintenance [4]

Year	Bridge	Country	Failure	Total/ partial collapse
1933	4 span plate girder bridge over Ancostia river in Pennsylvania	USA	Erosion of a river pier gone unnoticed and displacement. Cause : poor inspection	Total
1967	Silver Bridge between Virginia and Gallipolis over Ohio (Chain suspension bridge with eye bar chain members)	USA	Fatigue fracture of an eye bar as a result of poor repair and maintenance	Total
1976	Reichs Bridge over the Danuve in Vienna	Austria	Gradual destruction of unreinforced concrete at the base of a pier had remained unnoticed. Cause : poor inspection	Total
1985	4 span suspension bridge in Sully-sur-Loire	France	Brittle fracture	Total

Table 2-2: Failures due to flooding [4]

Year	Bridge	Country	Failure	Total/ partial collapse
1933	Suspension bridge near Hidalgo	USA	Pier foundation failed due to flooding	Partial
1972	Bridge in Katerini	Greece	Scoured pier	Partial
1982	Bridge between Linz & Selzthal	Australia	Scoured pier	Partial
2001	Bridge in Ponte de Castelo de Paiva	Portugal	Scoured pier	Partial

Table 2-3: Failures due to vehicle collision [4]

Year	Bridge	Country	Failure	Total/ partial collapse
1979	2 span steel bridge in Duisburg	Germany	A detached excavator arm cut through a steel girder	Total
1989	Pedestrian and cycle bridge	Germany	A heavily loaded lorry hit the pier	Total
1991	Truss bridge in Shepherdsville, Kentucky	USA	A garbage truck got stuck in a trestle	Partial
2002	Overpass in Richland, Texas	USA	A truck hit 2 supports	Total

It can be seen that there are common causes of defects, as listed below, which contribute to such failures.

- Aging of material.
- Corrosion of steel.
- Fatigue.
- Brittle fracture of steel.
- Natural disasters like earthquake and flood.
- Scour of foundation bed.
- Elements of bridge are hit by vehicles.
- Fire.
- Overloading.

With the same study, it can be seen that, some of the above distresses, foundation scour, brittle fracture, earthquake etc, lead to total collapse of bridges whilst some distresses lead to partial collapse.

Chiou et al. [05] presents several highway bridge failures occurred in Taiwan and found out that most of those failed bridges have suffered exposure of pier foundation due to scour. After several flooding, foundation-bearing capacity had reduced due to scour and lead to damage or even collapses. In 2000, a pier of the Kao-Ping Bridge settled because its pile foundation was seriously exposed due to scour, leading adjacent decks to drop. Figure 2-1 presents collapsed decks of Kao-Ping Bridge. In 2008 a pier of the Hou-Fong Bridge tipped over because of the significant scour of its caisson foundation, also causing adjacent decks to collapse as illustrated in figure 2-2. In 2009 Shuang-Yuan Bridge experienced severe foundation scour and were destroyed during a major flood induced by the record-breaking rainfalls. Fourteen numbers of piers settled due to exposing piles as supporting soil was washed away, reducing load carrying capacity of piles. Figure 2-3 shows the remaining of the Shuang-Yuan Bridge after collapse of decks.

Figure 2-1: Collapse of Kao-Ping Bridge, Taiwan in year 2000 [5]

Figure 2-2: Collapse of Hou-Fong Bridge, Thaiwan in year 2008 [5]

Figure 2-3: Collapse of Shuang-Yuan Bridge, Thaiwan in year 2008 [5]

It is more meaningful to say the combination of erosion and scour in the local context although there is a certain difference between the two actions. Erosion is the wearing off of the river bed over a period of time due to the momentum of flowing water where as scour occurs due to flowing of water around an obstacle [6].

In order to avoid such failures, it is important to have a proper Bridge Management System (BMS) to maintain bridges in proper condition.

"Bridge management is a term covering all the actions that need to be carried out to ensure that the bridge remains fit for its purpose throughout its design life without the need for excessive maintenance" [07]. A good bridge management system has several components.

- Decision making during design stage with respect to geometry of a bridge while considering possible difficulties faced at inspection during service life of the bridge, introducing proper detailing, which are supportive for durability of the bridge.
- Inspection system with bridge inventory, collecting data, inspection on distresses etc.
- Assessment of stability, strength and forecasting safe working life etc.
- Proper action plan with Integrating inspection data and assessment criteria.

2.1. Bridge inspection

Bridge inspection system is only a single component of a BMS. Even a traditional bridge inspection system may consists of [08],

- Preliminary inspection–To identify visible signs of deterioration and distress (Macro level).
- Plan detail inspection considering procedures, equipment and machinery required etc. - (Micro level). At this stage, it may need to collect design data, as built drawings etc. The purpose of this inspection plan is to make sure

collection of required data (crack width, deflection etc) and safety of the inspectors.

- The inspection process may collect data with some simple tests like,
  - Hammering for delamination detection
  - Bar location and cover
  - Depth of carbonation and chloride penetration
  - Measuring thicknesses
  - Bond of painting
  - Loss of section due to corrosion
  - Cracks in welding
  - Checking for any loosen of bolts

- Or some special tests like,
  - Test for alkali-silica-reaction
  - Absorption, porosity, diffusion or permeability
  - Strength
  - Measurement of live loads act on bridge
  - Displacements, acceleration

In the present, with the advances in technology, especially with the use of computers, bridge inspection has been taken into a fully automated level as well [09]. Sloan [09] proposed a fully automated Remote computer –Aided Bridge Performance Monitoring system, which is able to run under direct operator control or unattended. The system was developed for the Foyle Bridge, Londonberry during the period of year 1984 – 1990. The system measures,

- Deflection at midspan point of the centre span.
- Strain at midspan and at the intermediate supports.
- Temperature changes in the structure.
- Wind speed and direction.
- Movement of the expansion joint.

They have used Heliun Neon Lasers as an indicator to measure movements, where the change of laser spot was tracked using a solid-state camera in which the film carrier is replaced by a light sensitive computer chip.

An anemometer was used to record the wind condition. Movement of the expansion joints was monitored using a linear potentiometer. The relative movement between the two girders at midspan was also measured using a rotational potentiometer.

Different countries have their own bridge inspection systems, which have been developed to suit their local conditions. But in most cases it can be observed that the framework of such inspection systems are more or less the same, though there are differences in way of recording, data collection etc. Basic framework of such inspection systems is described below summarizing following bridge inspection manuals,

- Ohio Department of Transportation, Manual of Bridge Inspection, 2006 [10].
- Mississippi Department of Transportation, Bridge Safety Inspection Policy and Procedure Manual, 2009 [11].
- New York Department of Transportation, Bridge Inspection Manual, 2016 [12].
- Iowa Department of Transportation, Bridge Inspection Manual, 2014 [13].
- Queensland Department of Transport and Main Roads, Structure Inspection Manual - part 1, 2016 [14].
- Highway Agency, United Kingdom Inspection Manual for Highway Structures , 2007 [15].

Mainly there are following types of inspections carried out:

- Initial inspection
- Routine inspection
- Damage inspection
- In-depth inspection

- Special inspection
- Specific access related inspections
    - Confined space
    - Fracture critical
    - Underwater

2.1.1. Initial inspection

This is the first inspection of a new bridge after construction or after a rehabilitation of an existing bridge. The purposes of conducting this initial inspection are,

- To setup initial baseline conditions of the structure, such as designed load carrying capacity etc. As built drawings of the bridge will be very important.
- To collect the inventory information.
- To list out elements, which need special attention during service life of the bridge, such as fatigue prone details, underwater elements, fracture critical elements etc.

2.1.2. Routine inspection

Purposes of routine inspection are,

- To determine the physical and functional condition of a bridge.
- To identify changes from the previously recorded condition.
- To determine the need of revising weight restriction on a bridge.
- To determine improvements and maintenance needed.
- To identify concerns of future conditions.

During Routine inspection, every element of a bridge does not require a hands-on inspection. The inspection may be conducted from the deck, ground, water level, ladder, work platform or walkways. The main requirement of a Routine inspection is to provide an acceptable level of assurance of the bridge's ongoing safety. Irrespective of the difficulty, following areas/ members are needed to be inspected in each Routine inspection:

- Load carrying members in poor condition.
- Scour critical substructure units.
- Redundancy retrofit systems.
- End regions of steel girders.
- Cantilever portions of concrete piers.
- Ends of prestressed concrete beams.

Underwater elements are interested only when visible signs of excessive scour are observed. The frequency of Routine inspection is adequate to be once a year.

2.1.3. In-depth inspection

A close-up, hands-on inspection is conducted under In-depth inspection. This can be done on certain selected elements only. This can be done either alone or as a part of the Routine inspection.

It may need to inspect underwater elements also during an In-depth inspection. Following may be required for an In-depth inspection:

- Special tools, equipment and machinery such as safety equipment, measuring tools and bridge cranes etc.
- Some additional tests such as Nondestructive tests, carbonation depth etc.
- Sometime, a structural analysis for load carrying elements.

For a major bridge structure, the frequency of In-depth inspection is adequate to be once in 5 years.

2.1.4. Damage inspection

A damage inspection shall be conducted immediately after an extreme weather event, vandalism and traffic collision.

2.1.5. Special inspection

If an element of a bridge suspected with deficiencies, a special inspection is carried out till the repairing works correct the recorded deficiency.

2.1.6. Fracture critical inspection

This inspection is important specially in steel bridges. Due to repeated application of loads, fatigue failure develops at stresses well below the material's yield point. A fracture critical member shall be,

- A steel member.
- The member must be in tension.
- Failure of the element must result in a partial or total loss of structure.

Frequency of fracture critical inspection on a member is adequate to be once in 2 years.

2.1.7. Underwater inspection

Underwater inspection may be done with the aid of divers. The frequency can be about once in 5 years. This can be done during low flow durations. In addition to above manuals, U.S. Department of Transportation, Underwater Inspection of Bridges, 1989 [16] provides a comprehensive guideline with respect to underwater inspection, testing methods, safety etc. Common non destructive methods can be used for underwater inspection as well with the aid of divers.

Almost all the bridge inspection manuals recommend using Nondestructive testing methods in bridge inspection. Literature provides extensive studies and reviews on Nondestructive testing in relation to bridge inspection [17 -22].

2.2. Nondestructive testing (NDT) in bridge inspection

Aging of the materials, excessive use, overloading, climatic change, lack of sufficient maintenance, and difficulties encountered in proper inspection methods could lead to deteriorated infrastructure [18]. NDT can be used to monitor and detect problems related to structural elements from the very beginning of a problem, which will not be detected from naked eye, to a severe stage without making any damage to the element.

2.2.1. Chain drag [17]

ASTM D 4580-86 provides the guidelines for the chain drag test. Delamination in bridge decks can be identified with this test. A set of chains attached in accordance with the standards, is dragged on the bridge deck. Dull sound indicates the areas, which delamination started due to corrosion of reinforcement. Hence, it is well understandable that the results highly depend on the human factor. At the same time, it can be noted that it is a good, indeed economical, test to differentiate the delaminated areas. Conducting the test with two people will help to improve the reliability of the test results [17].

Based on literature, some agencies use this test to map the delaminated areas [17]. But understanding its limitations is important especially the results highly depend on personal judgments. The test can surely be used to identify delaminated slab areas, yet doubtful its application in mapping the delaminated areas. The test is possible to be performed on the top face of the slab only.

2.2.2. Coin tap test & Tap hammer test [17]

The concept behind coin tap test is more or less same as in the case of chain drag. In this method, the surface of the area which is going to be investigated, is tapped with a coin or a lightweight hammer. This impact generates a wave and while this wave goes through or hit a cavity or a defected area, a significant change in the frequency can be noticed. This is one of the oldest test methods used in inspection in civil infrastructures. It has been widely used in UK in inspection and investigation of defects during tunnel linings [17]. While noting that this test method is also highly depend on human factor, it should also be noted that it is a much easier test to be carried out with a great speed of work. Further this test will be difficult to be carried out with the disturbing noises from continuous traffic.

To eliminate the effect of operator and the effect of background noise from the conventional hammer test, Rehman et al. [17] developed a low cost tap hammer, which is able to provide a quantitative measurement. Hence, it can be noted that the improved tap hammer test is having several advantages over the chain drag such as ability of using in any concrete surface, working in noisy environment and quantitative output rather than judge by inspector himself.

2.2.3. Acoustic emission (AE) [17, 18, 20]

AE works with a transient elastic wave generated from plastic deformation within materials such as grain boundary slip, cracks etc. The energy releases due to these dislocations can be detected using transducers [17, 18]. Schematic diagram of the principle behind the AE is presented in Figure 2-4.

This method can be used to monitor material yielding, fatigue, corrosion, stress concentration, and crack detection. A unique property of AE is that it has a memory of previously experienced maximum loading known as Kaiser Effect, thus, no AE will be produced until the previously experienced load is surpassed. This unique feature is used to monitor propagation of cracks [17, 18].

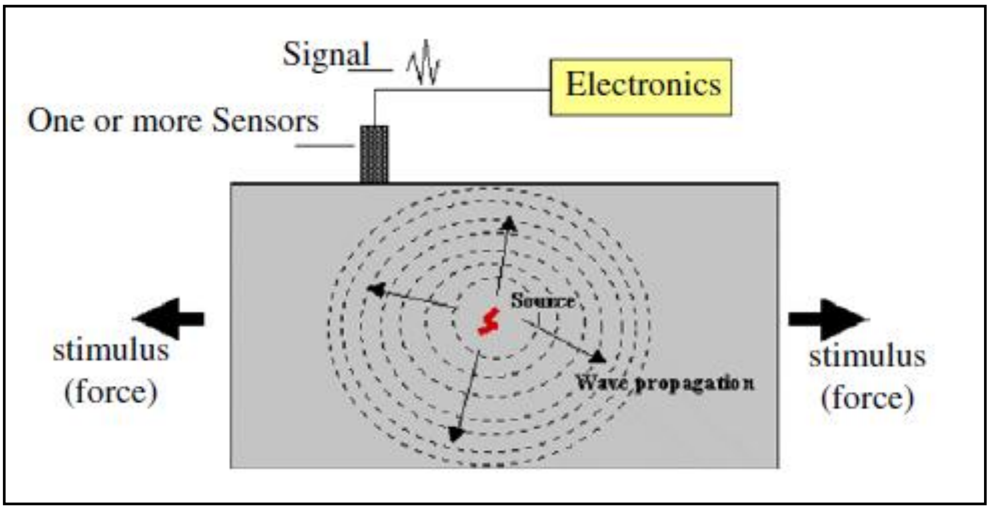


Figure 2-4: Principle of acoustic emission [20]

The major advantage of AE is that it can be used for both global and localized monitoring of damage portion. This method can be used for continuous monitoring and detecting the activity from considerable distance.

The most important advantage of AE is that, it can be used without any obstruction to the traffic. Further transducers do not require difficult surface preparation as well, which will not make inspectors work difficult.

The major disadvantage of AE is that, there is no standard procedure available, which can be applicable to all types of the structures and specifically bridges.

2.2.4. Impact echo testing [17, 21]

Impact echo testing is one of the most commonly used NDTs in detecting delamination in concrete. In impact echo test, an impact is introduced to the surface of the testing element, which generates a stress wave and the generated wave is measured using a nearby receiver [21]. In the case of an element with sound material, the wave will be reflected by the opposite surface of the element. When cracks, voids and delaminations are present within the element, the wave will be reflected by those and the return wave shows higher peak values [21]. Schematic working principle of impact-echo method is shown in Fig. 2-5.

Impact echo method has been widely used to detect anomalies in concrete piles during early 1970s and has been used to estimate quality of bonding in overlays and determination of depth of cracks during 1980s with certain advancements [17].

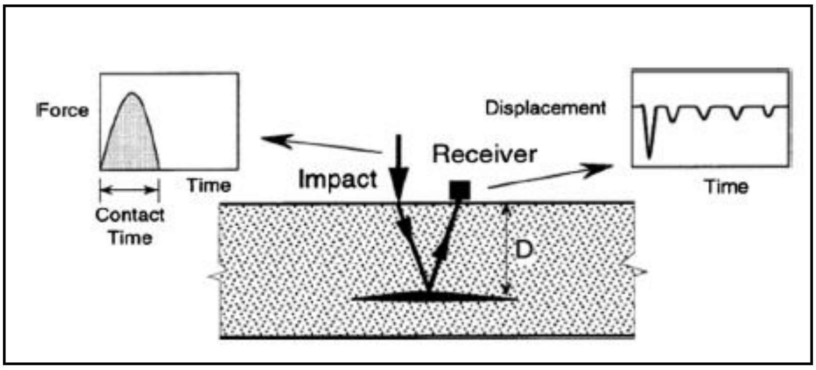


Figure 2-5: Schematic of impact-echo method [17]

Figure 2-6: Void detection at bridges using impact echo test [17]

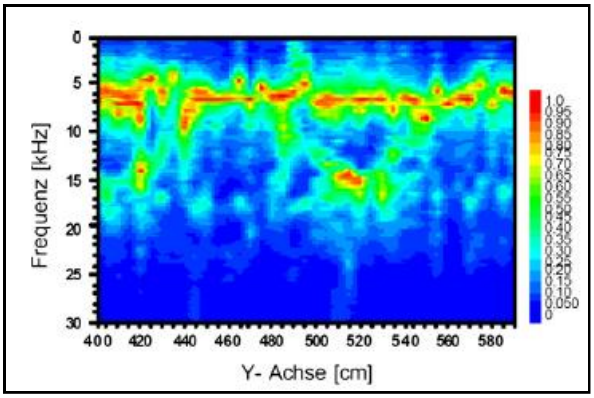


Figure 2-7: Results showing delaminated areas using impact echo test done at a bridge

The researchers concluded that the combination of IE with ultrasonic wave method is more effective in detecting and locating the defects within concrete slabs [17].

2.2.5. Sonics [17]

More or less the same concept, which a wave is transmitted through the element and observing the received wave, as in the impact echo test is used in Sonics as well. Instead of an impact, a mechanically stressed wave is transmitted in this case. When the wave reaches any discontinuity, it starts to reflect back and collected by receivers. This will be done by changing the location of the emitter and receiver at a dense grid as shown in the Figure 2-8. The efficiency of results is increased with the density of the grid system [17].

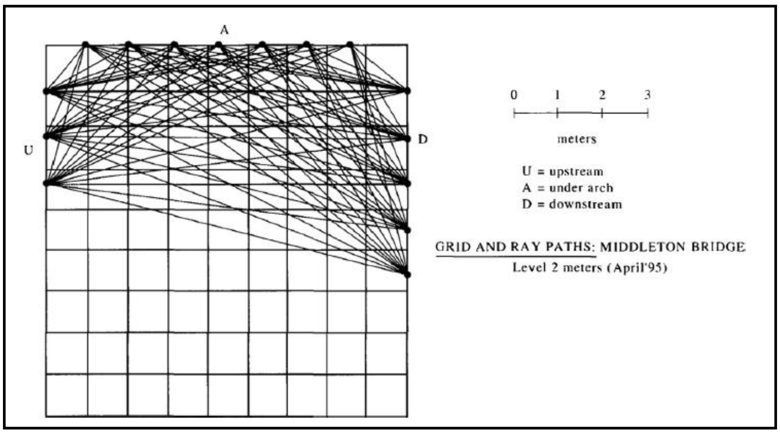


Figure 2-8: Arrangement of grids and sonic ray paths [17]

"Sonic methods can be utilized for evaluation of material uniformity, void detection, depth of surface crack, internal properties of fill material or structure, average compressive strength, internal dimensions and shape of the structure" [17].

2.2.6. Ultrasonic pulse velocity [17, 18]

The ultrasonic device consists with a transmitting and a receiving transducer. The transmitting transducer introduces a stress pulse in the object and the pulse propagates through the element. The signal is then received by the receiving transducer and the results are displayed in the form of lapsed time. A small part of the emitted energy is reflected back to the surface when the wave meets any in-homogeneities within the element, such as cracks, voids, corrosions etc. According to the reflected wave, the defect and the location of the defect can be identified [17, 21]. Equipment, the way of use the equipment in inspections and the typical output are presented in Figure 2-9.

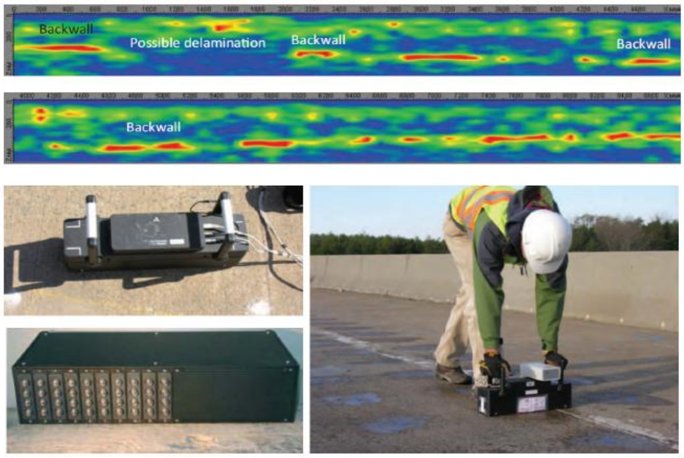


Figure 2-9: Deck survey using ultrasonic equipment and typical results output [17]

2.2.7. Ground Penetration Radar (GPR) [17]

This is an Electro-magnetic method. GPR has been successfully used to investigate bridge decks and pavements [17]. Its ability to provide a graphical presentation of the environment with an electromagnetic wave-reflection survey, has lead its advancements and extensive use in structural health monitoring in bridges, tunnels and buildings. "GPR is rapid and quick method for assessing in-depth characteristics of subsurface layers and can be used for detecting damages, delaminations, voids (more than 1 in. deep and 1 in. diameter), cracks and their lengths, cavities, recognizing steel reinforcement and its diameter, thickness of member, identifying regions of high moisture content, settlement of layers and monitoring of deformation induced by strain" [17].

The GPR equipment is moved along the area, which need to be monitored. The system normally consists of an antenna, a control unit (may be a computer processor), a display unit and a data recorder [17]. Short pulse of electromagnetic energy is transmitted, through the element under investigation, by the antenna. The wave travels through materials, which have similar dielectric properties whilst reflect back to the antenna when meet a dielectrically dissimilar material. This identifies the boundaries of different materials. "The data obtained (arrival time and energy level of reflected electromagnetic pulse) can be analyzed by various techniques such as cluster analysis, quantitative peak analysis, and topographic plotting. The velocity and travel time of the electromagnetic pulse signals provide information about the location and depth of the discontinuity" [17].

Figure 2-10: Bridge deck survey using GPR [17]

2.2.8. Half-cell potential [17]

Corrosion risk of reinforcement is measured with Half-cell potential test. The equipment mainly consists of a voltmeter, a half cell and connecting wires. "Half-cell" usually consists of a copper rod, which is submerged in copper sulfate solution. There are other types of half-cells available such as silver-silver chloride etc. Figure 2-11 shows the standard equipment of half-cell potential [17]. One end of connecting wire has to be connected to a reinforcement, which is exposed by taking off some cover concrete. Then the half-cell is placed on the concrete face and readings are taken, which is corresponding to the corrosion risk of the reinforcement. Hence, it's an indication of the state of concrete at that particular location. The voltmeter reading is taken with millivolts (mV). These readings are usually a negative value. Higher negative reading (higher absolute value of the negative reading) indicates greater risk of corrosion.

The results of the survey can be prepared in the form of equipotential contour maps to assess corrosion activity on concrete bridge and can then be used for the maintenance and repair work [17]. It needs to be pointed out here that the testing and interpretation of results must be done by experienced personnel. There are some limitations of this method, which include,

- The wire has to be connected to the reinforcement.
- Concrete surface has to be cleaned well to remove dust, oil epoxy or any paint.
- Correction factor has to be applied if the test is performed outside.

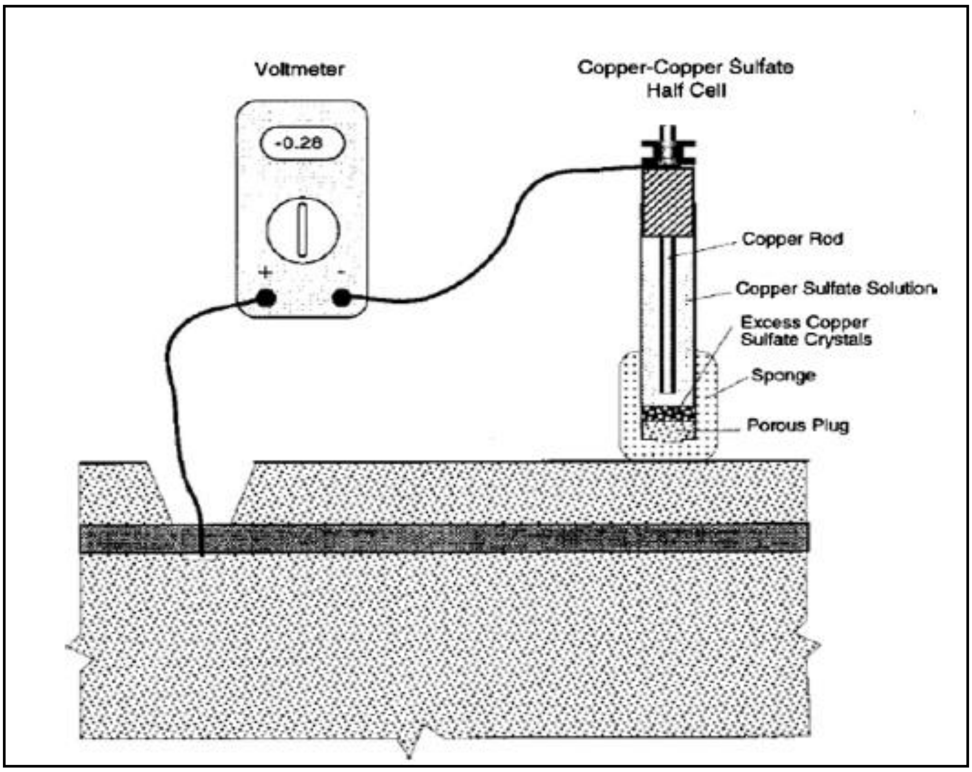


Figure 2-11: Apparatus of half-cell potential method [17]

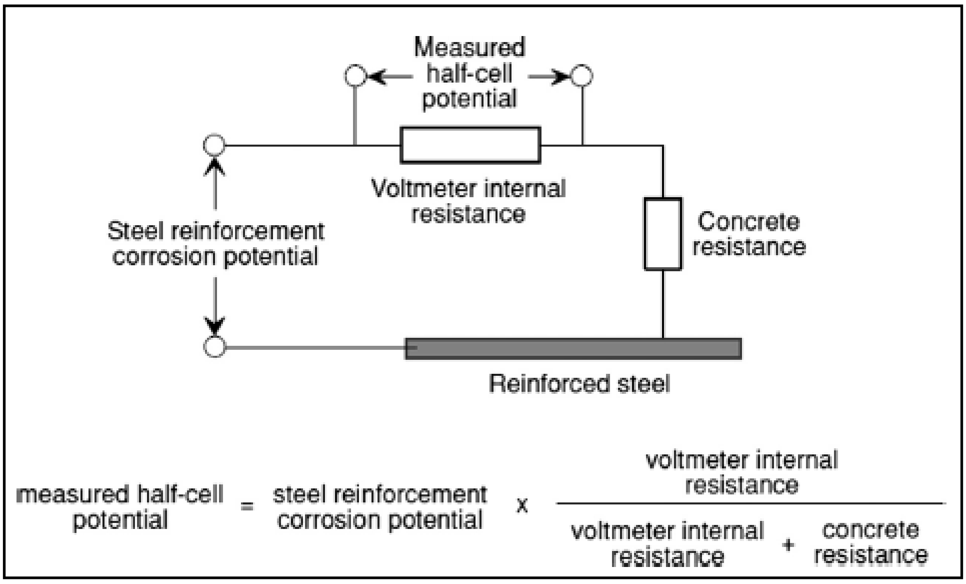


Figure 2-12: Schematic illustration of half-cell measurement [17]

2.2.9. Polarization resistivity measurement

Same equipment, which is used in the Half-cell potential, is used. The test measures the rate of corrosion in reinforcement. The half cell is replaced with an electrode, in modern days combination of four electrodes. Readings are taken with kilo ohm centimeter (kΩ-cm). Lower magnitude of reading indicates higher rate of corrosion.

2.2.10. Infrared thermography [17, 18, 19]

Infrared thermography can be used to detect both stress concentration in an element, delaminations and anomalies [17, 18, 19]. Since infrared radiations are not visible to human eye, special sensors are required to detect these radiations. Heat flow through concrete is affected by subsurface anomalies, such that delaminated areas heat up faster and cool down quickly when compared with concrete [17]. These delaminated areas are indicated with white areas in infrared thermogram, which are hotter (during daylight hours) than the surrounding area of solid deck which are cooler and appear dark in the thermogram [19].

The advantages of applying Infrared thermography are that, it is safe, efficient, cost effective in terms of time, and non-contact [17]. Some of the limitations of this method include,

- The equipment is very expensive.
- It cannot give the depth of the defects because it takes the image of a surface.
- The testing is influenced by environmental conditions such as wind speed, solar radiation, moisture content and surface emissivity, hence, corrections are required for these parameters.
- Trained operator and analyst are required to capture data and interpret it correctly. Therefore, it is suggested to use this method with ground penetrating radar.

2.2.11. Proof load test [17, 22]

Proof load test provides the actual load carrying capacity of structures [17, 22]. This test is appropriate only when either unsatisfactory load rating is indicated by the analytical procedures or it is not possible to perform analytical test on structure due to lack of structural documentation or deterioration. Therefore, it is suggested to perform proof load test on all those structures on which assessment is not possible due to absence of data and parameters such as insufficient structural drawings. Acoustic emission is the useful method to follow up the loading process to control the load increment before propagation of any damage to the structure.

However, the main risk involved in performing this test is that if the test becomes unsuccessful, the structure may damage or collapse. Moreover, the testing procedures for proof load test are not well documented.

Figure 2-13 shows the way proof load test was conducted on New Elizabeth Bridge, Budapest, Hungary in year 1964. They had used buses, trams and lorries, which were filled with sandbags, resulting total load on the bridge 2000 metric tons.

Figure 2-13: Proof load test on New Elizabeth Bridge in 1964 [17]

2.3. Assessment of bridges

During recent past, truck weights have grown enormously [23]. Hence, safe passage of heavy vehicles over deteriorated bridges is in question. This makes a proper assessment method of bridges an essential requirement. The ultimate assessment method has to be a detailed structural analysis considering the number of distresses estimating their severity. But, even a small country like Sri Lanka has more than 4000 bridges and conducting detailed analysis on each and every bridge is not possible. Hence, ranking of bridges based on their soundness or the degree of overall deterioration, based on the data collected with bridge inspection system, is the best option to a way out.

It is clear that the process of assessment involves certain levels of decision making. In most cases the data involve in this process are imprecise and fuzzy [24]. The procedure of quantifying and processing such linguistic information is tedious. Hence, some sorts of decision making methods are essential. There are several powerful methods to rank alternatives in a systematic way.

Weighted Sum Model (WSM) is considered to be the best and widely used method of decision making, especially in single dimensional problems. When there are several alternatives and selection criterion in a decision making problem, weights are assigned to each criteria and performance of each alternative with respect to each criteria are taken with the assigned weight [24]. Thus the summation of the product of performance of each alternative and the weight of relevant criteria provides the relative quantitative value of each alternative [24].

Weighted Product Model (WPM) is also a method of decision making and, is very similar to WSM [24]. The main difference is that the multiplication is used instead of addition in the process of ranking alternatives.

Analytic Hierarchy Process (AHP) is another such tool, which can be used to assess alternatives. In AHP a matrix is constructed with number of alternatives and number of criteria [25]. Three main levels are defined at which the top level represents the goal. Criteria and alternatives are represented subsequently in second and third levels. Then criteria are ranked considering relative importance of criterion with pair-wise comparisons. This exercise provides a quantitative value to each criterion. Then alternatives are put into pair-wise comparison under each criterion. Finally the matrix is constructed at which rows representing alternatives and columns representing criterion and thus the priority values are calculated for each alternative.

Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is a bit advanced analytic method developed from the traditional AHP and, is able to provide more sufficient descriptions than that of in traditional AHP [26].

There are several attempts to use above methods for condition assessment of bridges. Several bridge assessment methods have been proposed using Analytic Hierarchy Process and Fuzzy Analytic Hierarchy process [27-31].

A detailed and a systematic method of assessment has been proposed [24] using Fuzzy logic based Analytic Hierarchy Process. Though the assessment method is systematic, still the inspector provides the rating to individual members.

Analytic Hierarchy Process has been used to propose a method of condition assessment of bridges [32]. Although the study has not been gone into very detailed analysis on possible defects, indeed the proposed method is very simple and makes a good ground to develop. Defects, extent levels of defects and severity levels of defects are considered in the process of assessment.

An attempt has been made to propose a defect based condition assessment method using Fuzzy Hierarchical Evidence Reasoning approach [33]. Study has been narrowed down to concrete bridges. Severity levels of distinct identified defects have been defined by categorizing severity levels into several possible groups.

A systematic method of assessment has been proposed [34] considering predetermined defects, extent of those defects and severity of the defects. Condition states have been proposed for the considered defects by categorizing the extent levels of defects, which leads to defining relative weight and ends up with introducing a quantitative assessment for a bridge with an “Urgency Index”.

A detailed method of condition assessment has been proposed for Thailand [35]. General distresses have been identified and severity and extent of distresses have been divided into groups. Distresses are recorded at "Element level of bridge", which is the lowest broken down level of a bridge. Elements are the sub-division of "Components" at which bridge deck, accessories, pier, abutment and foundation are being the components. Importance values of distresses are considered with an assigned weight. As the predetermined severity level and extent levels are weighted based on the subdivided group, "Distress Rating Value" is derived. Then the "Distress Rating Values" of "Elements" are summed with respect to the components and drives "Members Condition Rating". Considering weights, which were assigned to "Components", a condition index for a bridge, "Bridge Condition Rating", is derived. Although the procedure does not clearly link to Analytic Hierarchy Process or similar decision making method, it appears that the procedure has a basis of similar nature.

The concept of assessment, which is proposed in the above study, is used in the present study, with modifications and alterations to suit the findings of the study as presented in later chapters.

3. METHODOLOGY

This study was done with a view of two main objectives.

- Propose a new method of bridge inspection for Sri Lanka.
- Propose a systematic method of assessment based on condition inspection.

In order to meet the above, the study was conducted with several key steps as follows.

- Understanding the current method of inspection and assessment used by RDA.
- Identifying issues in the current method of inspection and assessment.
- Proposing a method of inspection for highway bridges.
- Proposing a method of assessment, which can be interlinked with condition inspection.

The study was narrowed down to following types of bridges.

- Reinforced concrete bridges.
- Prestressed concrete deck with reinforced concrete substructure.
- Prestressed concrete deck with mass concrete or masonry substructure.
- Reinforced concrete deck with mass concrete or masonry substructure.

3.1. Study the current method of inspection and assessment used by RDA

RDA conducts inspections and assessments based on the "Bridge Maintenance Manual" [3] of RDA since 1997. Executive Engineers Division in RDA has to conduct "Routine Inspection" on bridges once in 3 months. These inspections are carried out by civil engineers or technical officers based on the staff availability. If a bridge appears to be suspicious with critical signs of distresses during the stage of "Routine Inspection", next level of inspection, "Condition

Inspection", has to be carried out on the identified bridge. There are formal forms of inspection for the Condition Inspection and the form is included in "**Appendix i**" of the report. Irrespective of distresses and condition, carrying out a detailed inspection on each bridge, once a year, has become a formal practice for a long period of time. Condition Inspection is limited to visual inspection and the bridge inspector himself assign a condition rating value to components of the bridge at site. There are predefined four categories of condition levels as,

- Rating 1 - Component is in good condition with little or no deterioration.
- Rating 2 - Component shows deterioration of a minor nature with primary structural material, which is first sign of being affected.
- Rating 3 - There is significant damage and a detailed survey needs to be carried out to establish whether repair work is to be carried out or not.
- Rating 4 - There is substantial damage and urgent repair or the bridge has to be closed to traffic or restriction on vehicle weight to be imposed.

Several photographs are attached to the inspection form in order to refer back to the condition of the bridge in further procedures. In order to quantify the overall condition of the bridge, predefined weighted factors are used with respect to the importance of components of a bridge are presented in Table 3-1.

Table 3-1: Weighted factors for components, used by RDA [2]

Part	Component	Weighted factor
Superstructure	Deck slab	**0.8**
	Main beam, Main frame	**1.0**
	Painting	**0.5**
Substructure	Abutment	**1.0**
	Pier	**1.0**
	Wing wall	**0.5**

Minor repairing works are carried out by the "Executive Engineer’s Division" itself based on the outcome of the inspections. If a major deterioration is found, the case is transferred to the "Maintenance Division". In the event of a major deterioration is found, a detailed structural analysis may be done based on the situation and the method of repairing or rebuilding is decided with the aid of "Bridge Design Division".

With general observations, several major deficiencies can be seen in the system used by RDA.

- Inspection form does not facilitate to collect sufficient amount of information.
- Four conditions are not broad enough to evaluate the distresses in detail.
- The condition ratings, which are assigned by an inspector to components are highly subjective to the perspective, knowledge and experience of the inspector.
- Breakdown of the bridge components for the assignment of weighted factors are not comprehensive enough and missed out some components.
- There is no proper way of prioritization of bridges for the detailed assessment.

Other than the above mentioned general observations, there can be more deficiencies in the system which are hard to be figured out from outside. Hence, a questionnaire survey was conducted among randomly selected twenty numbers of bridge inspectors. The questionnaires are included in "**Appendix ii**" of the report.

Findings from the questionnaire survey are listed below.

- Rating system can be highly subjective to the inspector.
- Inspection form is not supportive to collect sufficient information.
- Maintaining the data for future inspection or assessment is not followed in a systematic manner.

- Absence of a systematic assessment method from condition inspection.
- Frequency of inspection is deviated from the specified frequency due to,
  - Insufficient staff dedicated to bridge inspection.
  - Bridge inspectors have other commitments as well, since there is no separate group dedicated for bridge inspection alone.
- Absence of proper tools, equipment in inspection process.
- Inability to reach all the elements of a bridge due to absence of proper and safer accessories and vehicles. Hence, more often, the inspections are limited to surface level inspection.
- Not conducting any underwater inspection.
- No "Damage inspection" is conducted after disaster situations like flooding.
- Same frequency of inspection on each bridge irrespective of their age, condition and importance.
- Inability to track the level of deterioration of a bridge with time with the current system due to,
  - No provisions are provided in the inspection forms to maintain such information such as crack width.
  - Adopted system is not practicing such evaluation on level of deterioration.
- Lack of experienced and lack of trained personals in inspection.
- Frequent resigning of engineers from maintenance division and joining development projects due to attractive salaries and allowances in projects.

Responses to some of the crucial matters, relating to the current method of inspection and assessment, are graphically presented in Figures 3-1 to 3-4.

Majority of the selected bridge inspectors had a negative opinion of the current system, which they follow. About 70% had an opinion of a complete change of the current system into a comprehensive system. Another 20% were pleased to, at least, have some improvements to the current system. Figure 3-1 graphically represents the percentage responses on matter of improving the current system.

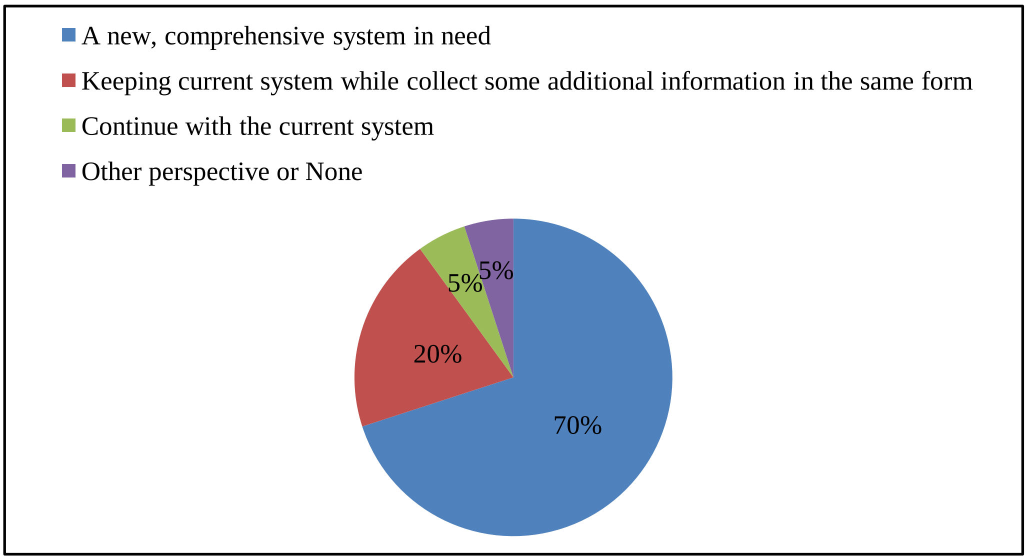


Figure 3-1: Bridge inspectors' opinion on improving the current system

Responses made to the matter of meeting the specified frequency of inspection and level of inspection, are represented graphically in Figure 3-2. Only 5% of the inspectors are able to conduct inspection to required level whilst meeting specified frequencies. The variation shown in Figure 3-2 is mainly due to the differences of the workloads on particular areas. Insufficient staff is the main reason behind this majority being unable to conduct detailed inspection with appropriate frequencies.

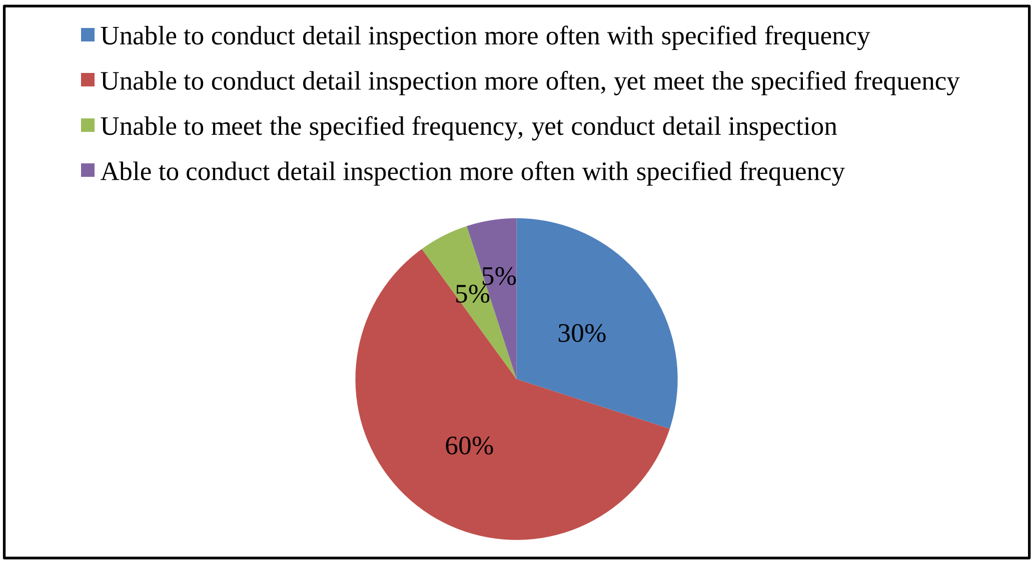


Figure 3-2: Bridge inspectors' experience on level of inspection and frequency

As it comes to the matter of inspectors experience about underwater inspections, 50% of inspectors are unaware of guideline related to underwater inspections. Another 40% is not very enthusiastic to make extra effort to investigate underwater elements as the current system does not persuade as such. Inspectors' responses to the matter of underwater inspection are presented graphically in Figure 3-3.

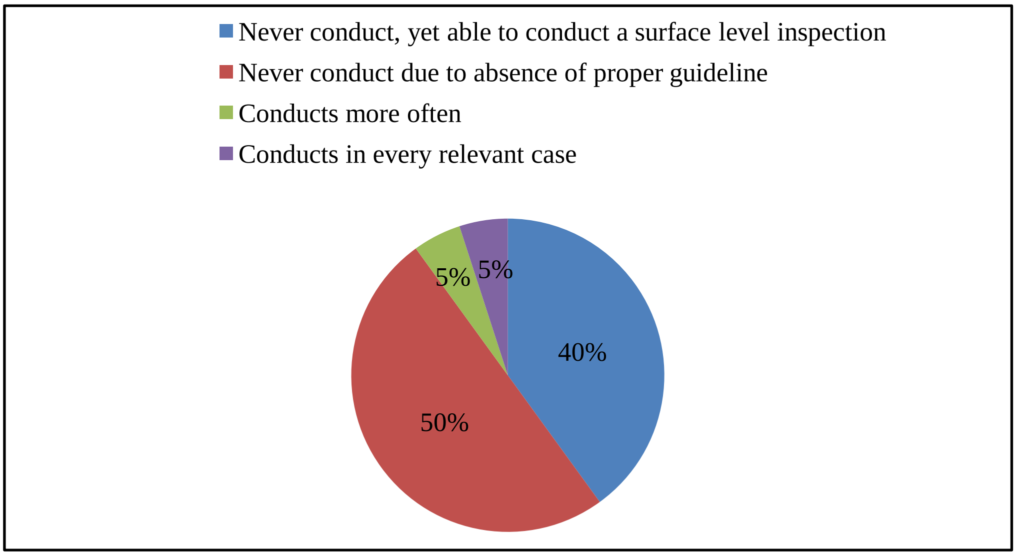


Figure 3-3: Bridge inspectors' experience in underwater inspection

Inspectors never miss "special inspections", after a reported accident or a fire at the bridge as presented in Figure 3-4. But 90% of them ignore "special inspections" after a flood situation.

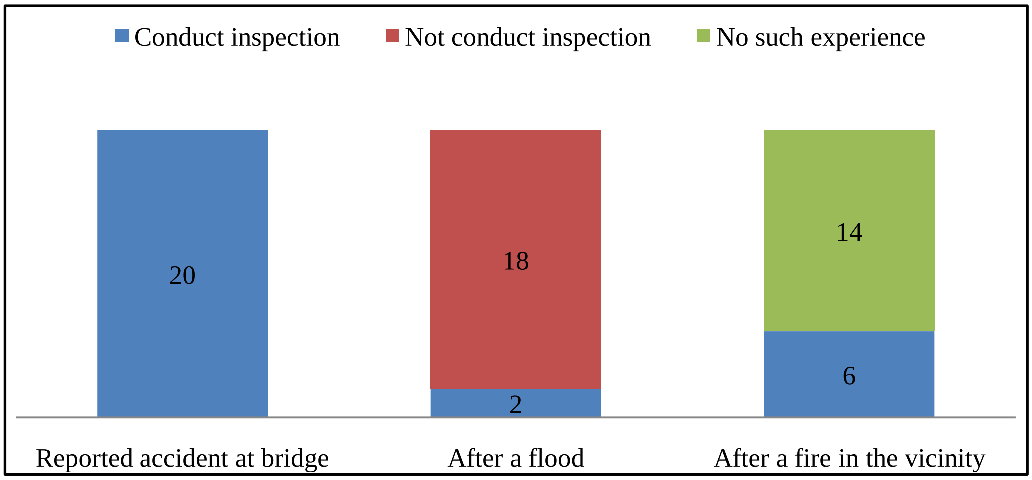


Figure 3-4: Bridge inspectors' opinion on "Damage inspection"

3.2. Development of a new inspection and assessment method

Based on the findings from the study through the current system of inspection used by RDA, it is obvious that thinking of an inspection method alone is not worthy. An efficient system has to be implemented such that the method of inspection is correlating with the method of condition assessment in order to make use the data from inspection to prioritize the bridges for the purpose of subjecting them to a detailed assessment when they suffer with critical distresses.

Defect based condition assessment approaches proposed by Moufti et al. [32], Rashidi and Gibson [33] and Dabous et al. [34] seem to a fine platform to develop a system such that, inspection method and assessment method can be easily interlinked. The essence of above studies is ranking predefined distresses while considering their severity level or extent level or both. The process leads to a quantitative figure for the condition status of the bridge. But above studies describe only the framework of the concept and not dealing with actual scenarios in detail. Sakuwan and Hadikusumo [35] is presenting a method of assessment, which is in the same nature, yet describes things in much detailed manner. The study is quiet comprehensive and method of assessment is very systematic. Yet, still there are significant amount of deficiencies and unsolved practical issues in the study. Hence, the intended proposed method of inspection and assessment is developed using the framework proposed by Sakuwan and Hadikusumo [35].

There are several key considerations in the process of development of the method of inspection and assessment.

- Must be able to tackle deficiencies of the current method used by RDA as much as possible.
- Special attention is paid in human factor in the process of providing a rate to a bridge or a component of a bridge.
- Method of inspection has to be implementable from the current stage inspection and assessment with a minimum capital investment.

- System has to be flexible for the purpose of modifying and developing as per the arising requirements of the users.

Since the intended method is a defect based method, as much as possible distresses related to considered types of bridges are required to be identified. Distresses were identified with field inspections and interviewing experts in RDA.

3.2.1. Identification of possible distresses in local context

Field inspections were carried out on 105 numbers of randomly selected bridges in macro level to get a preliminary understanding about common distresses, which are associated with bridges in the country. Out of those, 13 numbers of bridges, which were found to be representative of all the 105 bridges with the variety of distresses observed in those, were selected for further detailed study. Selected bridges for the detailed inspection were representing the all types of bridges, which we anticipate to study and were representing different geographic conditions of the country, as listed below.

- Bridges in Western Province – Not far from coastline
- Bridges in central area of the country
- Short span bridges
- Long span bridges
- Different abutment types
- Different superstructure types

Table 3-2: List of bridges selected for the detailed inspection

Bridge number	Location
A001(1/1)	Colombo
B435(4/1)	Colombo
B435(6/1)	Colombo
B425(6/2)	Negambo
B208(16/3)	Gampaha
B225(8/4)	Gampaha
B225(11/3)	Gampaha
B444(6/3)	Nittambuwa
B472(11/2)	Kirindiwela
B063(4/1)	Mirigama
B300(12/1)	Kurunegala
B300(6/7)	Kurunegala
B300(11/2)	Kurunegala

3.2.1.1. Equipment and tools used

Tap hammer, crack gauge, digital camera and pole camera were used during the process of identification of common distresses. Use of pole camera was helpful to observe the areas of bridge where physical access is dangerous. A smart phone can be connected through "Wi-Fi" wireless technology with the camera. Hence, a person can handle the camera attached to poles moving to required locations whilst another person can observe the camera view and capture required images through the smart phone. Figure 3-5 shows the assemblage of pole camera during field inspections.

Figure 3-5 : Assemblage of pole camera during field inspections

3.2.1.2. List of identified distresses

A list of defects was identified with the help of field investigations and interviewing experts in bridge maintenance. The identified distresses are listed below.

Corrosion of reinforcement, delamination and spalling of concrete

Corrosion of reinforcement in concrete is an electrochemical reaction. Fe converts to Fe^{2+} ions at anode where as O_2 and H_2O form OH^{-1} ions at cathode. Concrete contains pores and when moisture is there in pores, this OH^{-1} dissolve in pore solution. Connected pores facilitates the reaction between Fe^{2+} and OH^{-1} and form $Fe(OH)_2$. $Fe(OH)_2$ is unstable and get converted to $Fe(OH)_3$ with O_2 and H_2O. This $Fe(OH)_3$ get converted to $Fe_2O_3.H_2O$, which is a very stable product and get increased its volume. This expansion leads to "delamination" of cover concrete and finally ends up with "spalling" of cover concrete. Diffused chlorides in cover concrete act as a catalyst in the reaction. Figure 3-7 shows the initial signs of spalling in a reinforced concrete bridge beam where as Figure 3-8 shows a stage of complete spalling in a beam of the same bridge. Figure 3-6 shows excessive corrosion of reinforcement of a slab bridge due to exposing of reinforcement after spalling.

Figure 3-6: Corrosion of reinforcement underneath a slab bridge

Figure 3-7: Initial stage of spalling due to corrosion of reinforcement

Figure 3-8: Spalling of cover concrete

Flexural cracks

There must be cracks in hairline level to measurable levels in reinforced concrete when a section is subjected to a bending moment. Cracking alone does not mean a failure of the section but, needs attention when the crack width is visible. The scenario of cracking in prestressed concrete sections is not that straightforward as the cracking in prestressed concrete must be discussed considering the design class of the member as well. But, practically, the chance of knowing the design class of a member of an old bridge in local context is almost null. By the way, regardless of the design philosophy of a member, cracking facilitates the carbonation of cover concrete, which leads to corrosion of reinforcement. There will not be a single flexural crack in most cases but multiple cracks at close intervals, unless a crack occurred during the early age during the construction. Figure 3-9 shows a flexural crack developed in a prestressed concrete bridge beam.

Figure 3-9: A flexural crack on a bridge beam

Shear cracks and torsional cracks

These cracks need more attention as they can lead to a brittle failure of a section. The inspector must be knowledgeable enough to distinguish shear cracks from the other sort of cracks. Shear crack can appear as a single crack or multiple cracks. A shear crack in a deck slab at a joint between a beam and slab is shown in Figure 3-10.

Figure 3-10: Shear cracks of deck slab at beam slab joint

Shrinkage cracks

Plastic shrinkage cracks may appear in concrete during the construction stage and those are addressed before the commissioning of the bridge. Still long term drying shrinkage cracks are possible in relatively thicker sections. Figure 3-11 shows several spots of map cracking due to moisture movement in a reinforced concrete wing wall of a bridge.

Figure 3-11 : Map cracking due to moisture movement

Relative vertical displacement between pretensioned beams due to malfunction of tie rod

In order to have a proper lateral distribution of live loads among beams, a tie rod in certain intervals is used in local context. Due to a loosening or any malfunction of this tie rod, a relative displacement can be seen between beams. This can be identified from parallel longitudinal cracks at wearing surface as shown in Figure 3-12.

Figure 3-12: Relative vertical displacement between beams due to malfunctioning of diaphragm

Vegetation

Although it does not feel serious, poor maintenance and ignorance have escalated certain cases with vegetation into an alarming level. Roots start to run through some cracks and voids and a significant pressure is applied to the element as the roots grow up. Edge of the abutment of the bridge shown in Figure 3-13 could completely dislocate in several months unless the roots and trees are removed. Similar scenario is shown in Figure 3-14.

Figure 3-13: Effect of vegetation

Figure 3-14: Effect of vegetation at an old handrail

<u>Distresses at wearing surface</u>

In local roads, during rehabilitations, an overlaying of asphalt is a common practice. This overlaying, sometimes, covers older expansion joints. Since the underneath movement of the joint is still live, a crack along the expansion joint is common in local roads as shown in Figure 3-15. Figure 3-16 shows the bridge piers, which have stain marks caused by leaking of water through such cracks at expansion joint locations.

Pot holes and alligator cracks are very common distresses as a road is aging. All these lead to leak through the wearing surface, which is a significant concern with respect to durability of the reinforced concrete elements especially.

Flushing is also a common issue with respect to aged roads. This is a dangerous situation as skidding could lead to serious accident situations.

Figure 3-15: Cracking at an expansion joint, which is covered with asphalt

Figure 3-16: Leaking through expansion joints

Expansion joint malfunction

Broken expansion joint is not a rare case in local roads as replacement of aged accessories is ignored. At the same time expansion joint can be choked with debris due to poor maintenance and especially after flooding.

Distresses in sidewalks and railings

Breakages, dislocation and misplacements can be seen in many bridges. A common scenario in local road bridges with broken railing is shown in Figure 3-17. This is a concern especially for the pedestrians other than the appearance. There is another concern at which falling down broken fragments to the vehicles in overpass bridges.

Figure 3-17: Damaged handrail

Drainage malfunction

Functioning of the drainage system is important from durability aspects especially in reinforced concrete bridges. Blockages can happen due to poor maintenance.

Mortar dislocation in masonry elements

Random rubble masonry works and dressed stone works have been widely used for abutments and piers in short span bridges in Sri Lanka. As the structure gets older, mortar starts to give away. Abutment wall, which is shown in Figure 3-18, is a good example to elaborate the scenario. This is a concern especially for abutments as soil starts to pass though these gaps. This ends up with settlements at the approaches.

Figure 3-18: Dislocation of mortar at an abutment wall

Movements and cracks of rubble walls

Lateral pressure induced movement and differential settlement induced movement in rubble walls are common. It will be bit hard to identify some movements with naked eyes and may only appear with certain cracks initially. The danger of this distress is a sudden failure can be triggered with an excess vertical load. The dressed stone wingwall, which is shown in Figure 3-19, is critically deformed due to excess lateral pressure.

Figure 3-20 shows another common type of crack in rubble wingwalls. In fact the crack is not on the wingwall, but at the interface between abutment wall and wingwall, and the crack must be expected since there will be lateral deformations in both abutment wall and wingwall due to lateral earth pressure and surcharge induced by live load.

Further, vertical cracks in rubble walls and dressed stone walls due to settlements are also common in local bridges. Figure 3-21 shows a rubble abutment wall with several vertical cracks.

Figure 3-19: Lateral movement of dressed stone wingwall

Figure 3-20: Cracking at wingwall due to lateral earth pressure

Figure 3-21: Vertical crack at a RRM abutment wall due to settlement

Distresses in bearing pads

Rubber pads (actually speaking strips) of 12mm in thickness have been used as bearing pads in most of the short span bridges in Sri Lanka. It was noticed, during the field visits, that those rubber strips have been completely deformed. These rubber strips are not replaced as aged. They must have been subjected to their strain capacity in no time.

Elastomeric bearings have been used in long span bridges (simply supported span more than about 20 m) in almost all the cases. Based on the expert's experiences, washing out of pads during flooding, corrosion of metallic accessories, deterioration of Teflon layer and excessive movements have been encountered in local context.

Other than that, there are some concrete hinge bearings in couple of very old bridges as per the local experts. Crushing of concrete and corrosion of reinforcement are the main issues with such type.

Weathering of substructure due to water pressure

Severe weathering of cover concrete in several areas were observed during field investigations. Momentum of the flowing water caves into the element slowly with the time. Figure 3-22 and figure 3-23 show the effect of weathering in a pier column and an abutment wall. Fortunately there is a protective layer of concrete on the foundation of the pier, which is shown in figure 3-22, and it can be seen that the protective layer of concrete is severely weathered.

Figure 3-22: Weathering of cover concrete in a pier

Figure 3-23: Weathering of cover concrete in an abutment wall

Foundation scour

The impacts of scour and river bed erosion were discussed comprehensively under the "literature review" section. Several cases of scour were observed during the field investigation. Figure 3-24 shows a foundation of an abutment, which is critically scoured.

Figure 3-24: Scouring of foundation bed

Deterioration of foundation element

It seems that investigating in foundation deterioration have completely been ignored in local practice. In fact the matters are not visible at first point, which makes those are unattended and ignored.

Considering findings from literature, opinions from experts and field works, a new method of inspection, which can be interlinked with the assessment, was developed and the inspection form is included in "Annexure C" whilst Table 3-3 and Table 3-4 show some of the specimens. With referring to Table 3-3 and Table 3-4, the first column of the inspection sheet refers to the respective “Member” of the bridge. Second column of the inspection sheets provides major distresses associated with the respective “Member”. Third column of the inspection sheet provide subdivision and detailed aspects of distresses, and the last columns provide space for data recording with respect to distresses.

Table 3-3: Inspection sheet for deck slabs

Deck slab	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Cracks at mid-span (moment cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage cracks)	Maximum crack width (mm)	
		Good condition		
	Vegitation on surface	Several spots	Neglegible impact	
			Considerable impact	
		Significant area covered	Neglegible impact	
			Considerable impact	
		No vegitation		

Table 3-4: Inspection sheet for bridge beams and girders

Girders	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	% Area		
		Stain marks of rust - potential to corrosion	% Area		
		Good condition			
	Cracking	Closely spaced cracks at mid-span (moment cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Torsional cracks	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Diaphragm malfunction	Relative displacement between girders	Hardly visible	Clearly visible	Severe
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

There are several key aspects of the proposed inspection method.

- Check list concept was used in the inspection form. Possible distresses are predefined under each component of a bridge. Bridge inspector has to inspect each element of a bridge against the given list of distresses. This helps in several ways.
    - Inspection form becomes comprehensive enough and inspection becomes complete.
    - Bridge inspectors must be knowledgeable enough to distinguish different distresses by the nature. Hence, the inspectors get necessary trainings, which improve the reliability of the system.
- Inspector records "Extent" or "Severity" of a distress over a bridge "Member", without providing his own ranking as per in the old system, as much as possible. In this system also, inspectors have to provide a qualitative recording under several cases, which are not practical to quantify, for example the "Extent" level of vegetation. Most of the cases the inspector may record a length, width or an area of a distress over a bridge "Member". This makes the systems more reliable as the final ranking is determined by the system.
- Several very important distresses have been measured, which were ignored in the older system. For example, crack width, degree of reinforcement corrosion, rate of corrosion, carbonation depth etc. These are essential measurements to decide the condition of a bridge.
- New inspection system encourages using several non destructive tests, which were not used in old method, yet which are used by all good bridge management systems in the world.
- Bridge inspectors are encouraged to investigate the condition of the foundation as well.
- Bridge inspector doesn’t have to repeat filling inventory information, which has been prepared during base line inspection with the as built drawings of the bridge at commissioning stage.
- Inspection form has a greater flexibility for addition and improvements.

3.2.1.3. Comments on the proposed system by RDA bridge inspectors

The proposed system was briefed to several experienced bridge inspectors at RDA and got their perspective about the proposed system. Most of them were enthusiastic with the proposed system. Use of non destructive tests, quantitative measurements by the inspector and the chance of improving themselves with new knowledge were highly appreciated. Yet, several drawbacks and challenges also were highlighted.

- Since the system is more like a complete transition from the current system, initial cost could be significant.
- Requirement of a proper training program for the bridge inspectors since a significant number of inexperienced inspectors are in duty at the moment.
- Inspection form seems to be very long and thus the inspection could be time consuming.
- Inspection on foundation elements seems to be troublesome.

When above mentioned comments are considered, it is obvious to accept first two points as a new and complete system is introduced over a basic system. System change will be hard, yet has become essential at the moment. Comment about inspection form being long and foundation inspection were reconsidered. Hence,

1. An actual inspection session was carried out on a randomly selected two span bridge, which is a representative bridge for the local context. The exercise provides self assessment about the new inspection method too in addition to estimating approximate time for an inspection session. The inspection data is included in “Appendix iv”. The inspection was completed in 130 minutes, with a single inspector and a helper. Hence, the statement on the length of the form is not that reasonable. Taking readings with half cell

potential and cover meter, during the field investigation are shown in Figure 3-25 and 3-26.

Figure 3-25 : Taking readings with half cell potential on an old bridge deck

Figure 3-26 : Taking readings with cover meter on an old bridge deck

2. Field inspections were carried out to discuss the statement about inspection on foundations. Almost all the bridges in local context are over waterways. Some of the waterways have a heavy flow with water depths of more than 20ft. Yet most of the waterways having less than 10ft of average water level at least a single dry season per year is common in Sri Lanka [38]. Bridge management system in Ohio [10] recommends foundation inspection for scour is required only if the average water level exceeds 5ft. Hence, following can be considered as solutions.
   i. Identify waterways, which get completely dry during dry season and make use of that time for such bridges.
   ii. Identify waterways, which are having average depth less than 5 ft and keep less attention on foundation scour risk on those bridges.
   iii. Conduct underwater inspection using divers for bridges over waterways, which have significant depths and still not falling into above two categories.

Since the possibility of having inexperienced bridge inspectors, in certain cases, possible basic crack patterns and their possible locations of common components of bridges have been graphically represented in "Appendix v" as a guideline. This would help the young engineers to distinguish some of the crack types.

3.3. Development of a condition assessment method based on condition inspection

The assessment process has some defined terms and calculation steps. The method of assessment is explained with the aid of actual or hypothetical examples where necessary. The method directly links with predefined distresses in the condition inspection form.

3.3.1. Determination of relative importance between distresses

3.3.1.1. Distress Importance Value (DIV)

An important variable is defined as "Distress importance value"(DIV) in the proposed assessment method. In fact the idea here is to quantify the importance of each distress with respect to the safety and the performance of the bridge. The ideal way to determine such value is analyzing failures and accidents related to bridge structures in history of Sri Lanka. Unfortunately, the incidents have not been properly recorded and maintained.

Hence, the DIV values were determined with the aid of a questionnaire survey among experts in highway bridge related fields such as bridge designers, bridge inspectors etc. The idea behind this exercise was to rank the importance of distresses based on experiences, events and incidents that they witnessed. As some of the distresses, which were added to the system based on the literature, were not personally witnessed by the selected group yet possible to occur, they were asked to rank based on their perceptions. The questionnaire, which was used for the survey is included in "Appendix vi". Calculated DIVs with respect to distresses in deck slab are presented in Table 3-5. Detailed analysis procedure to determine DIVs are discussed in Chapter 4 of the report.

Table 3-5: DIVs for distresses in deck slab

Member	Distress	DIV
Deck slab	Corrosion of reinforcement due to depassivation	0.3
	Cracks at mid-span (moment cracks)	0.36
	Cracks closer to supports (shear cracks)	0.46
	Map cracking (thermal – shrinkage cracks)	0.19
	Vegetation on surface	0.16

3.3.1.2. Relative Distress Importance Value (RDIV)

Distress Importance value (DIV) is then converted to Relative Distress Importance Value (RDIV), which is a more useful form.

$$RDIV_{distress\ i} = \frac{DIV_{distress\ i}}{\sum_{i=1}^{n,for\ member} DIV_{distress\ i}} \qquad \text{.................................eq}^{n}\ (1)$$

For example, Table 3-6 presents DIVs for a deck slab and calculated RDIVs for the same accordingly.

Table 3-6 : DIVs and RDIVs for deck slab

		DIV	RDIV
Deck Slab	Corrosion of reinforcement due to depassivation	1	0.53
	Cracks at mid-span (moment cracks)	0.6	0.32
	Cracks closer to supports (shear cracks)	0.3	0.16
	Torsional cracks	0	0.00
	Map cracking (thermal - shrinkage cracks)	0	0.00
	Vegetation on surface	0	0.00
		1.9	1.00
		∑ (DIV)deck	∑ (RDIV)deck

3.3.2. Subdivision of the bridge

Bridge structure is subdivided into several levels as "Structure", "Component" and "Member" as shown in Table 3-7 and Table 3-8. Then relative importance values "Structure importance value (SIV)", "Component importance value (CIV)" and "Member importance value (MIV)" were assigned to each subdivision as shown in Table 3-7 and Table 3-8. Table 3-7 represents a bridge with several spans whereas Table 3-8 represents a single span bridge. The relative importance values for SIV and CIV are based on current practice whilst MIV were assigned based on expert opinions.

Table 3-7 : Case 1 – A bridge with all components - Subdivision of bridge and weights of relative importance

Structure (SIV)	Componenet (CIV)	Members	(MIV)
Superstructure 0.55	Bridge deck 0.85	Deck slab	0.4
		Girders	0.6
	Accessories 0.15	Wearing surface	0.3
		Expansion joint	0.3
		Side walk	0.15
		Railing	0.15
		Drainage	0.1
Substructure 0.45	Pier 0.45	Pier column or wall	0.45
		Pier capping beam	0.45
		Bearing pad	0.1
	Abutment 0.15	Abutment wall or column	0.35
		Wing wall	0.35
		Capping beam	0.25
		Bearing pad	0.05
	Foundation 0.4	Pile cap, Pile, Spread footing	1

Table 3-8 : Case 2 - Single span bridge - Subdivision of bridge and weights of relative importance

Structure (SIV)	Component (CIV)	Members	(MIV)
Superstructure 0.55	Bridge deck 0.85	Deck slab	0.4
		Girders	0.6
	Accessories 0.15	Wearing surface	0.3
		Expansion joint	0.3
		Side walk	0.15
		Railing	0.15
		Drainage	0.1
Substructure 0.45	No pier -	Pier column or wall	-
		Pier capping beam	-
		Bearing pad	-
	Abutment 0.27	Abutment wall or column	0.35
		Wing wall	0.35
		Capping beam	0.25
		Bearing pad	0.05
	Foundation 0.73	Pile cap, Pile, Spread footing	1

But each and every bridge does not have all these "Members". Then a correction has to be made from the original MIV in the absence of one or several "Members". If a bridge "Component" does not have one or several "Members", the original MIVs of such missing members will be distributed to remaining "Members" based on the original MIVs. Possible cases of such absenteeism were identified and MIVs have been calculated accordingly as shown in Table 3-9. For example, consider a pier with all “Members”, such that pier column, capping beam and bearing pad are carrying original MIVs of,

- Pier column = 0.45
- Capping beam = 0.45
- Bearing pads = 0.1

Then consider a bridge pier without capping beam as stated under case 2 in Table 3-9. Hence, the original MIV value of capping beam, which is 0.45, shall be redistributed between pier column and bearing pads based on their original MIVs in a complete case. The new value of MIV of pier column for the above case shall be then calculated as shown below.

$$MIV_{pier\ \ column} = Original\ MIV_{pier\ \ column} + \frac{Original\ MIV_{capping\ \ beam}\ xOriginal\ MIV_{column}}{Original\ MIV_{column} + Original\ MIV_{bearing\ \ pad}}$$

$$MIV_{pier\ \ column} = 0.45 + \frac{0.45x0.45}{0.45 + 0.1} = 0.82$$

Table 3-9 : Calculation of MIV in absenteeism of members

Componenet	Members	Original MIV	Case 1 MIV	Case 2 MIV	Case 3 MIV
Bridge deck	Deck slab	0.4	1	No deck slab	N/A
	Girders	0.6	No girder	1	N/A
Accessories	Wearing surface	0.3	0.33	0.43	0.50
	Expansion joint	0.3	0.33	No exp. Joints	No exp. Joints
	Side walk	0.15	0.17	0.21	0.25
	Railing	0.15	0.17	0.21	0.25
	Drainage	0.1	No draingae	0.14	No draingae
Pier	Pier column or wall	0.45	0.5	0.82	1
	Pier capping beam	0.45	0.5	No cap. beam	No cap. beam
	Bearing pad	0.1	No bearing pad	0.18	No bearing pad
Abutment	Abutment wall or column	0.35	0.37	0.47	0.5
	Wing wall	0.35	0.37	0.47	0.5
	Capping beam	0.25	0.26	No cap. Beam	No cap. Beam
	Bearing pad	0.05	No bearing pad	0.07	No bearing pad
Foundation	Pile cap, Pile, Spread footing	1	N/A	N/A	N/A

3.3.3. Determination of nature of a distress

A scoring method to have a quantified score for distresses is defined. As discussed previously, the proposed inspection form works with predefined distresses. The inspector fills the provision in the inspection sheet with the data related to those distresses such as crack width, length of a crack. Some distresses can be representing a severity sign where as some others may sign the level of extent of the distress over a member of the bridge based on the nature of a distress. Some distresses may have both these natures. For example consider a dressed stone abutment wall as shown in Figure 3-27. The mortar starts to give away with aging.

As per the proposed inspection form an Inspector may record 20% of mortar dislocated, which is a sign of extent level of the distress. At the same time based on the description of this distress, the inspector has to choose whether the gaps created by dislocated mortar allow soil to pass through the wall, which is a sign of severity of the same distress.

Figure 3-27: Mortar dislocation of a dressed stone abutment wall

Four condition states have been defined as, "Very high", "High", "Medium", "Low / Negative" for each distress under both severity and extent categories. Then relative scorings are defined for different condition states as,

- Very high - carries 1.0
- High - carries 0.6
- Medium - carries 0.3
- Low/ Negative - carries 0.0

Condition state of each distress is included in "Appendix ix". Table 3-10 explains the categorizing process for identified distresses at a rubble masonry abutment wall. For example, consider an abutment wall at which 60% of mortar dislocated and yet not possible for soil to pass through the cracks. Then the distress of "Mortar dislocation" for the considered element scores "Severity level" of 0.3 and "Extent level" of 0.6.

Table 3-10 : Categorizing distresses into defined conditioned states

		Severity level				Extent level			
		Very High (1.0)	High (0.6)	Medium (0.3)	Low/Negative (0)	Very High (1.0)	High (0.6)	Medium (0.3)	Low/Negative (0)
Rubble Abutment wall	Mortar dislocation leading to soil passing through	Soil passing through	Possible for soil to pass through	Not possible for soil to pass through	Good condition	Area >75%	Area >50%	Area> 25%	Good condition
	Horizontal cracks indicating development of tensile stress	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks indicating settlement	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Lateral movement of abutment wall	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vertical deformations of abutment wall	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

Moufti et al. [32], Rashidi and Gibson [33], Dabous et al. [34], Colorado Department of Transportation (1995) [36] and Pavement Distress Identification Manual of Department of Transport, USA (2006-2009) [37] provide some guidance for the procedure. In certain cases expert opinion was obtained.

Now consider a hypothetical bridge of several spans and consider "deck slab 1 of span 1" as an element. Table 3-11 presents the inputs from the inspection for the "deck slab".

Table 3-11 : Inspection sheet entry of a deck slab of a bridge

Deck slab 1 of Span 1	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	**7 % Area**
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	**-375**
			Concrete cover to reinforcement - cover meter (mm)	**42**
			Carbonation depth -Drill and phenolphthalein (mm)	**31**
		Delamination - hammer tap	**50%** Area	
		Stain marks of rust - potential to corrosion	**5%** Area	
		Good condition		
	Cracking	Cracks at mid-span (moment cracks)	Maximum crack width (mm)	**0.25**
			Length of the crack (mm)	**1000**
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	**0.01**
			Length of the crack (mm)	**20**
		Torsional cracks	Maximum crack width (mm)	-
			Length of the crack (mm)	-
		Map cracking (thermal - shrinkage cracks)	Maximum crack width (mm)	-
		Good condition		
	Vegitation on surface	Several spots	**√** Neglegible impact	
			Considerable impact	
		Significant area covered	Neglegible impact	
			Considerable impact	
		No vegitation		

Above inspection entry is then referred against the defined distress categories for the deck slab as shown in Table 3-12. With that "Severity level" and "Extent level" for each distress can be determined as summarized in Table 3-13.

Table 3-12 : Categorizing distresses in deck slab into condition states

		Severity level (SL)				Extent level (EL)			
		Very High (1)	High (0.6)	Medium (0.3)	Low/Negative (0)	Very High (1)	High (0.6)	Medium (0.3)	Low/Negative (0)
Deck slab 1 of span 1	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Cracks at mid-span (moment cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Cracks closer to supports (shear cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Torsional cracks	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Negligible impact only	Significant area covered	N/A	N/A	Several spots

Table 3-13 : Determination of "Severity level" and "Extent levels" for the considered deck slab

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Deck slab 1	Corrosion of reinforcement due to depassivation	1				1			
	Cracks at mid-span (moment cracks)		0.6			1			
	Cracks closer to supports (shear cracks)			0.3		1			
	Torsional cracks				0				0
	Map cracking (thermal - shrinkage cracks)				0				0
	Vegetation on surface				0				0

Then we have to calculate the multiplication between SL and EL of each distress under each "Member" of the bridge. The product of SLxEL for the above case is calculated in Table 3-14.

Table 3-14 : Calculation of SLxEL product for the considered deck slab

		SL	EL	SLxEL
Deck slab 1 of span 1	Corrosion of reinforcement due to depassivation	1	1	1
	Cracks at mid-span (moment cracks)	0.6	1	0.6
	Cracks closer to supports (shear cracks)	0.3	1	0.3
	Torsional cracks	0	0	0
	Map cracking (thermal - shrinkage cracks)	0	0	0
	Vegetation on surface	0	0	0

3.3.4. Member Condition Value (MCV)

Conditions of individual "Members" are quantified with the use of RDIV, SL and EL.

$$MCV_{member\ \ j} = \sum_{i=1}^{n}[RDIV_{distress\ \ i.memeber\ \ j}\ x\ (SLxEL)_{distress\ \ i}] \text{ ....eq}^{n}\ (2)$$

Table 3-15 presents MCV calculation for the same deck slab.

Table 3-15: Calculation of MCV for deck slab

		RDIV	(SLxEL)	MCV
Deck slab 1 of span 1	Corrosion of reinforcement due to depassivation	0.53	1.00	0.53
	Cracks at mid-span (moment cracks)	0.32	0.60	0.19
	Cracks closer to supports (shear cracks)	0.16	0.30	0.05
	Torsional cracks	0.00	0.00	0.00
	Map cracking (thermal - shrinkage cracks)	0.00	0.00	0.00
	Vegetation on surface	0.00	0.00	0.00
			MCV of deck slab 1-span 1	0.76

When a bridge is considered, there can be several numbers of "Members". For example, there can be several deck slabs in different spans within one bridge. Since the safety of the road users is the dominant consideration, maximum value of MCV is taken to next level. The maximum value of MCV for a single "Member" is defined as "Critical Member Condition Value (CMCV)". Table 3-16 presents the way of obtaining CMCV for deck slabs and girders.

Table 3-16: Obtaining CMCV from MCV

Member		MCV	CMCV
Deck Slab	Deck slab 1 of span 1	0.76	0.76
	Deck slab 2 of span 1	0.72	
	Deck slab 3 of span 1	0.61	
Girder	Girder 1 of span 1	0.55	0.55
	Girder 2 of span 1	0.45	

3.3.5. Bridge Condition Value (BCV)

Finally "Bridge Condition Value (BCV)" is defined with the use of SIV, CIV, MIV and CMCV. BCV is an index, which indicates the condition state of a bridge with numerical figure, which is from 0-100%. 100% indicates a perfect bridge.

$$BCV = [1 - \sum_{j=1}^{n} SIV_{structure\ \ l} . CIV_{component\ \ k} . MIV_{member\ \ j} . CMCV_{member\ \ j}\ ]\ x\ 100\%$$

.....eq^n(3)

Table 3-17 presents the calculation of BCV for a bridge

Table 3-17: Calculation of BCV

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.550	Bridge deck 0.850	Deck slab	0.400	0.580	0.108
		Girders	0.600	0.520	0.146
	Accessories 0.150	Wearing surface	0.300	0.200	0.005
		Expansion joint	0.300	0.220	0.005
		Side walk	0.150	0.210	0.003
		Railing	0.150	0.120	0.001
		Drainage	0.100	0.110	0.001
Substructure 0.450	Pier 0.450	Pier column or wall	0.450	0.610	0.056
		Pier capping beam	0.450	0.540	0.049
		Bearing pad	0.100	0.520	0.011
	Abutment 0.150	Abutment wall or column	0.350	0.610	0.014
		Wing wall	0.350	0.250	0.006
		Capping beam	0.250	0.520	0.009
		Bearing pad	0.050	0.520	0.002
	Foundation 0.400	Pile cap, Pile, Spread footing	1.000	0.240	0.043
				∑SIV.CIV.MIV.CMCV	0.459
				BCV	54 %

3.3.6. Verification of the proposed assessment method

A systematic method of assessment was proposed with the present study. The health level of a bridge is determined with the proposed Bridge Condition Value (BCV).

RDA is in the process of developing a new Bridge Management System. Although the system is not fully implemented as they are still in the process of recording of data, a bridge assessment method has been developed. A parameter called “Evaluation Value” is set in the proposed RDA system to represent the health level of a bridge.

A comparison was done between the “Evaluation Value” in the RDA method and “Bridge Condition Value (BCV)” of the proposed method with this study in order to observe any similarity or a matching. “Evaluation Value” and BCV were calculated for the 10 numbers of bridges, which were used in the detailed inspection. The results comparison is presented in Table 3-18. Summary of calculations of BCV are included in "Appendix x".

Table 3-18– Comparison of results in two systems

Bridge No	RDA Evaluation Value (%)	Bridge Condition Value (%)
B 435 (4/1)	32	59
B 435 (6/1)	28	52
B 425 (6/2)	82	89
B 208 (16/3)	95	98
B 225 (8/4)	62	63
B 225 (11/3)	84	69
B 444 (6/3)	92	98
B 472 (11/2)	83	93
B 063 (4/1)	85	84
A 003 (38/1)	97	86

It is hard to see a similarity or a match between two systems with the data shown in the Table 3-18. However, an important observation can be made between the results; such that, although the values appear to be scattered, the order of the health indexes are more or less the same in both system. The variation of health index values is graphically presented in Figure 3-28.

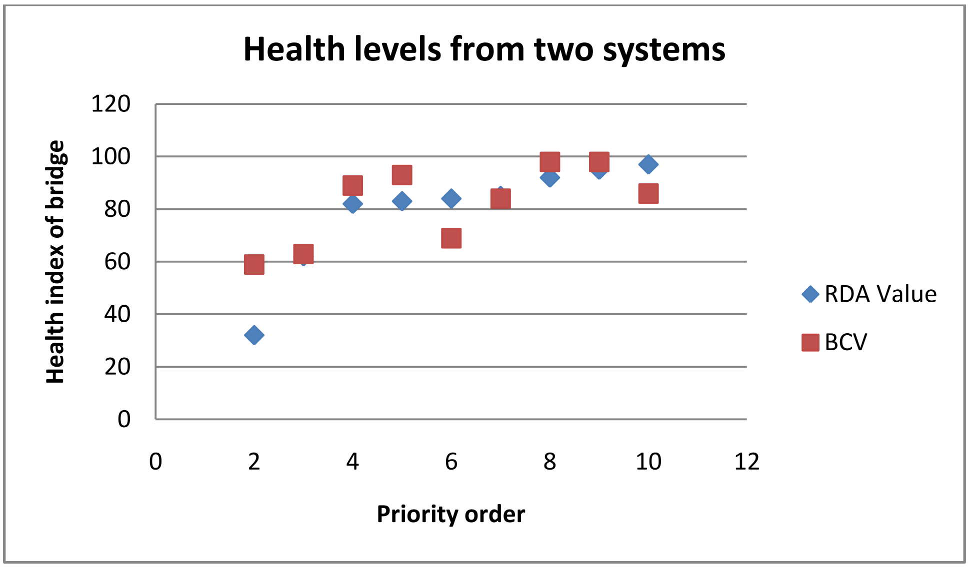


Figure 3-28: Variation of health indexes of two systems

3.3.7. Key features/advantages of the proposed assessment method

The proposed method of assessment has following features and advantages.
Method is more systematic and well structured. Human factor has been eliminated from the assessment to a vast extent as inspectors have become data collectors only and not allowed to make their own assessment in all possible cases.

The assessment provides a quantitative figure about the condition status of bridges, which can be easily used to prioritize bridges for the purpose of repair and rebuild works.

Once a bridge is found to be ill with a low BCV value, the same assessment summary sheet provides condition ratings of "Components", and individual "Members" as well. This makes the life much easier to come up with action plans etc for the purpose of repair works.

The assessment system can be easily programmed and thus possible to automate the whole system due to the logical and systematic behavior of the assessment system.

Most importantly, the system is very flexible for the improvements and upgrades. Improvements can be made at any point without any difficulty. The relative weights proposed in this study can be altered or modified by the user at their own view and experience.

4. ANALYSIS AND DISCUSSION

4.1. Analysis

Identifying recorded and possible distresses in highway bridges in Sri Lanka and determining respective Distress Importance Values (DIVs) can be considered as two major achievements with the present study. The determination of DIVs was a tedious process as the questionnaire was considerably lengthy as the list of distresses identified was significantly long.

It is given an effort to elaborate the process of determination of DIV in the following section of the document.

The DIV values were determined with the aid of a questionnaire survey among experts in highway bridge related fields such as bridge designers, bridge inspectors etc. The idea behind this exercise was to rank the importance of distresses based on experiences, events and incidents that they witnessed. As some of the distresses, which were added to the system based on the literature, were not personally witnessed by the selected group yet possible to occur, they were asked to rank based on their perceptions. The questionnaire, which was used for the survey is included in "Appendix vi". Four criteria were used in the process of determining the influence of a distress to the performance of the bridge and relative weights were defined for each criterion as shown below.

- Possibility of short term failure of a bridge - relative weight 0.6
- Leading to durability issues - relative weight 0.25
- Leading to physical discomfort to road users - relative weight 0.125
- Disturbing appearance - relative weight 0.025

Twenty experts were chosen and asked them to mark the influence of each identified distress from "High" to "No impact", as shown in Table 4-1, with respect to the performance of a bridge considering above criteria. Relative weight factors were defined to impact levels as,

- High - relative weight - 0.6
- Moderate - relative weight - 0.3
- Low - relative weight - 0.1
- No impact - relative weight - 0.0

Table 4-1 : Basic format of the questionnaire used

Distress	Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Distress 1																
Distress i																
Distress n																

Table 4-2 presents a specimen of a filled questionnaire by an inspector whilst all the filled questionnaires are included in “Appendix vii” of the report. The last column is the weighted average based on the inspector’s input, which is “DIV” for individual distresses based on the entries provided by individual inspector. Then the actual “DIVs”, considering all 20 inspectors, are calculated as shown in Table 4-3.

Table 4-2 : Specimen of filled questionnaire by an inspector for deck slab, girders, wearing surface and expansion joint

		Possibility leading to sudden/short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating (weighted avg)
Deck slab	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Cracks at mid-span (moment cracks)	1				1							1				1	0.51
	Cracks closer to supports (shear cracks)	1				1							1			1		0.5125
	Torsional cracks		1			1							1			1		0.3325
	Map cracking (thermal - shrinkage cracks)			1			1						1				1	0.135
	Vegitation on surface			1			1						1	1				0.15
Girders	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Flexural crack at mid-span	1				1							1			1		0.5125
	Single shrinkage crack at mid-span		1				1						1				1	0.255
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks	1				1							1				1	0.51
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1						1					1	0.5225
	Vegetation on surface			1			1						1	1				0.15
Wearing surface	Cracking at expansion joint			1		1					1				1			0.255
	Pot holes, crocodile cracks and other damages			1			1			1				1				0.225
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface			1		1							1				1	0.21
Expansion joint	Broken			1		1				1				1				0.3
	Aged			1			1					1				1		0.15
	Choked with debris			1			1				1				1			0.18

Table 4-3: Calculation of final DIVs for individual distresses

Member	Distress	Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean (DIV)	STDV
Deck slab	Corrosion of reinforcement due to depassivation	0.25	0.23	0.21	0.33	0.53	0.14	0.21	0.23	0.28	0.56	0.53	0.16	0.26	0.33	0.38	0.23	0.25	0.38	0.28	0.25	**0.30**	**0.12**
	Cracks at mid-span (moment cracks)	0.37	0.23	0.52	0.51	0.35	0.28	0.33	0.26	0.28	0.3	0.33	0.42	0.29	0.44	0.3	0.53	0.37	0.56	0.28	0.37	**0.36**	**0.10**
	Cracks closer to supports (shear cracks)	0.6	0.35	0.52	0.51	0.35	0.26	0.51	0.35	0.28	0.6	0.33	0.38	0.48	0.44	0.6	0.53	0.6	0.59	0.28	0.6	**0.46**	**0.13**
	Map cracking (thermal - shrinkage cracks)	0.26	0.17	0.21	0.14	0.35	0.09	0.21	0.23	0.1	0.21	0.21	0.09	0.24	0.14	0.22	0.16	0.26	0.26	0.1	0.26	**0.19**	**0.07**
	Vegitation on surface	0.16	0.18	0.22	0.15	0.16	0.11	0.23	0.09	0.02	0.3	0.17	0.42	0.24	0.15	0.13	0.02	0.16	0.05	0.02	0.16	**0.16**	**0.10**
Girders	Corrosion of reinforcement due to depassivation	0.25	0.35	0.21	0.33	0.53	0.09	0.33	0.23	0.15	0.59	0.51	0.11	0.41	0.33	0.56	0.15	0.25	0.35	0.15	0.25	**0.31**	**0.15**
	Flexural crack at mid-span	0.37	0.35	0.51	0.51	0.27	0.28	0.51	0.24	0.1	0.59	0.21	0.28	0.28	0.51	0.6	0.53	0.37	0.53	0.1	0.37	**0.37**	**0.16**
	Single shrinkage crack at mid-span	0.38	0.09	0.14	0.26	0.1	0.1	0.33	0.23	0.1	0.04	0.21	0.04	0.04	0.26	0.23	0.27	0.38	0.28	0.1	0.38	**0.20**	**0.12**
	Cracks closer to supports (shear cracks)	0.42	0.53	0.51	0.51	0.27	0.28	0.51	0.35	0.1	0.56	0.21	0.1	0.13	0.51	0.6	0.51	0.42	0.53	0.1	0.42	**0.38**	**0.17**
	Torsional cracks	0.26	0.23	0.33	0.51	0.27	0.27	0.51	0.23	0.1	0.38	0.21	0.1	0.13	0.51	0.42	0.26	0.26	0.35	0.1	0.26	**0.28**	**0.13**
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	0.53	0.2	0.3	0.52	0.11	0.3	0.52	0.15	0.18	0.6	0.29	0.18	0.14	0.52	0.6	0.41	0.53	0.56	0.18	0.53	**0.37**	**0.18**
	Vegetation on surface	0.16	0.17	0.09	0.15	0.1	0.09	0.15	0.04	0.03	0.36	0.15	0.42	0.16	0.04	0.13	0.14	0.16	0.05	0.03	0.16	**0.14**	**0.10**
Wearing surface	Cracking at expansion joint	0.17	0.2	0.12	0.26	0.18	0.13	0.26	0.23	0.13	0.3	0.09	0.31	0.07	0.26	0.23	0.17	0.17	0.13	0.13	0.17	**0.18**	**0.07**
	Pot holes, crocodile cracks and other damages	0.17	0.12	0.16	0.23	0.14	0.18	0.23	0.12	0.13	0.3	0.17	0.3	0.3	0.23	0.23	0.17	0.17	0.12	0.13	0.17	**0.19**	**0.06**
	Flushing	0.17	0.08	0.16	0.23	0.1	0.14	0.23	0.07	0.13	0.23	0.17	0.3	0.3	0.23	0.23	0	0.17	0.07	0.13	0.17	**0.16**	**0.08**
	Leakage through wearing surface	0.17	0.08	0.09	0.21	0.27	0.1	0.21	0.18	0.1	0.03	0.15	0.35	0.23	0.21	0.26	0.21	0.17	0.15	0.1	0.17	**0.17**	**0.08**
Expansion joint	Broken	0.12	0.17	0.16	0.3	0.23	0.18	0.3	0.23	0.3	0.6	0.11	0.42	0.18	0.3	0.18	0.18	0.12	0.24	0.3	0.12	**0.23**	**0.12**
	Aged	0.12	0.12	0.16	0.15	0.14	0.13	0.15	0.08	0.3	0.38	0.11	0.1	0.42	0.15	0.18	0.18	0.12	0.09	0.3	0.12	**0.17**	**0.10**
	Choked with debris	0.08	0.2	0.1	0.18	0.18	0.13	0.18	0.08	0.18	0.6	0.11	0.3	0.14	0.18	0.13	0.15	0.08	0.12	0.18	0.08	**0.17**	**0.12**

What is shown in Table 4-3 are only DIVs related to distresses in deck slab, girders, wearing surface and expansion joint. DIV values for all the distresses are included in "Appendix viii" of the report.

This exercise reveals or further proves the effect of different personal perspectives in the process of ranking. Here they rank the importance of distresses same as the way inspectors rank condition of bridge components straightaway in the current method of inspection and assessment. The ranking provided to several distresses at deck slab are shown below graphically in Figures 4-1 to 4-5, which illustrate the whole story of personal perceptions. As Figures 4-1 to 4-5 elaborate, it is more clear that, there is a significant variation in individual's perceptions towards the distresses on different elements.

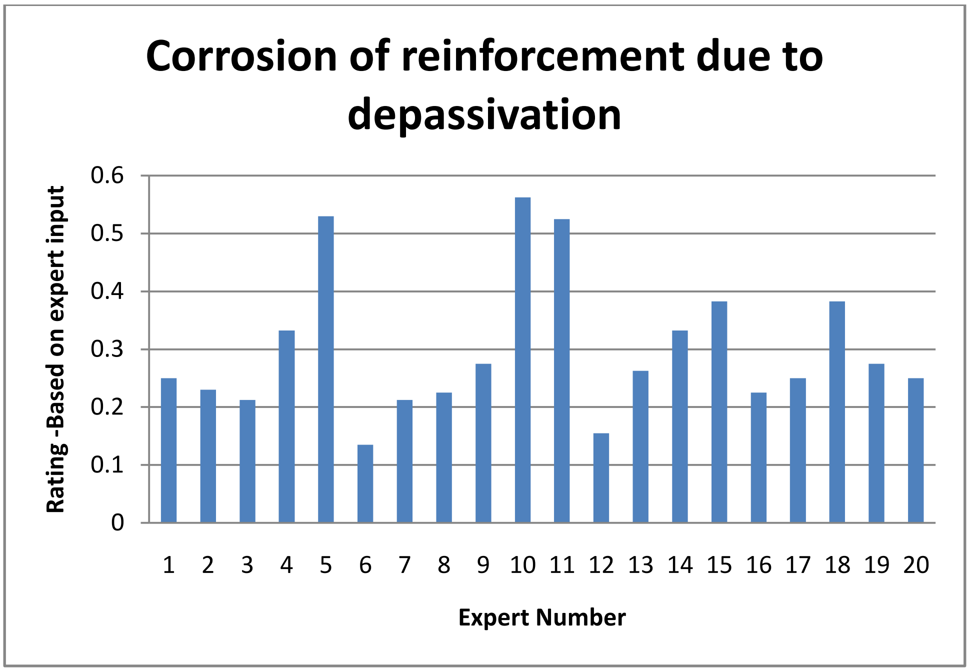


Figure 4-1: Expert ranking - Corrosion of reinforcement - Deck slab

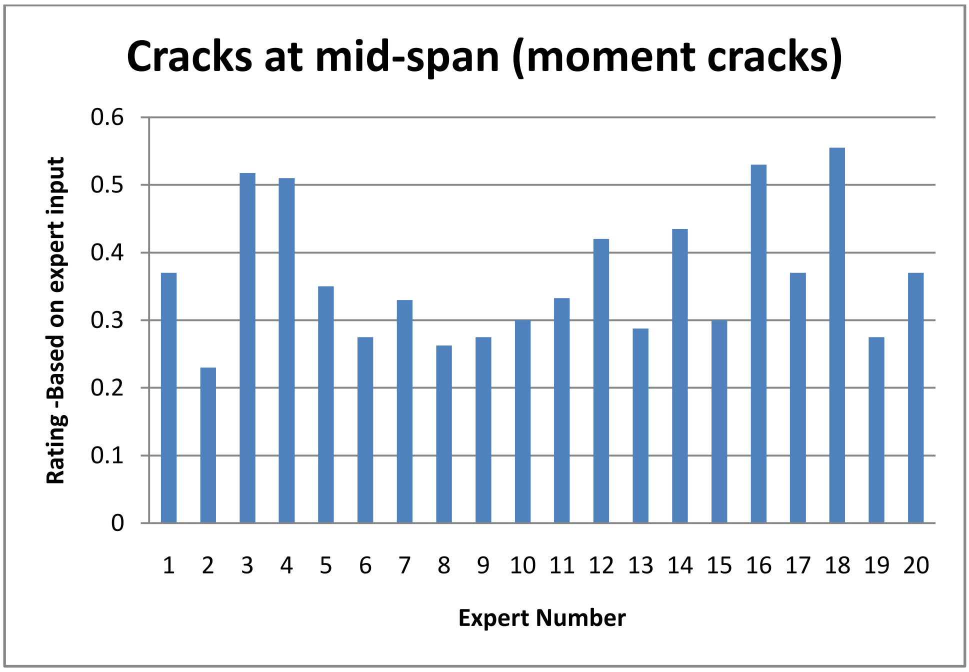


Figure 4-2: Expert ranking - Flexural cracks - Deck slab

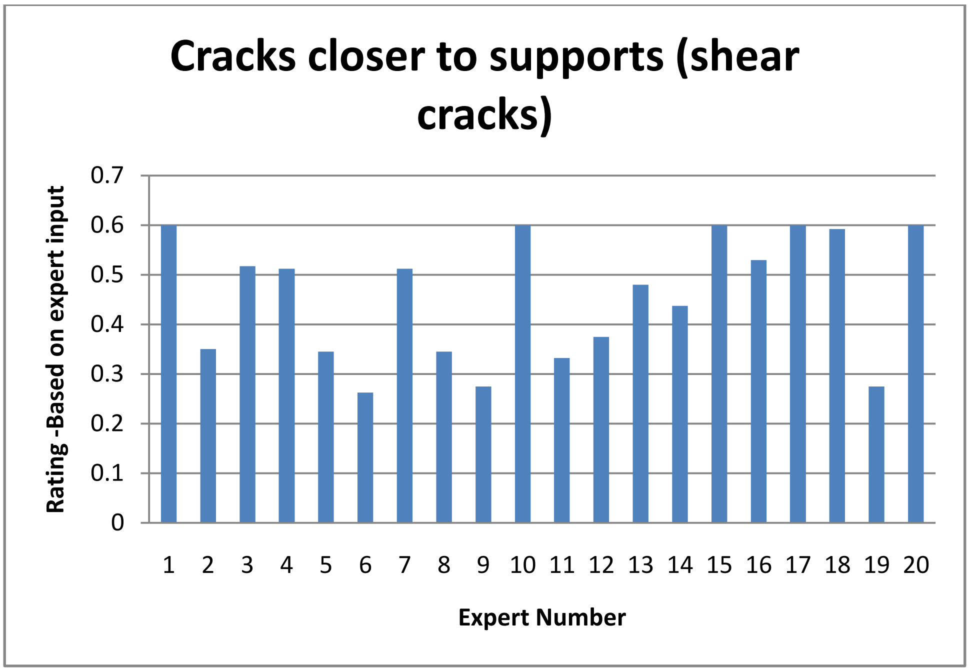


Figure 4-3: Expert ranking - Shear cracks - Deck slab

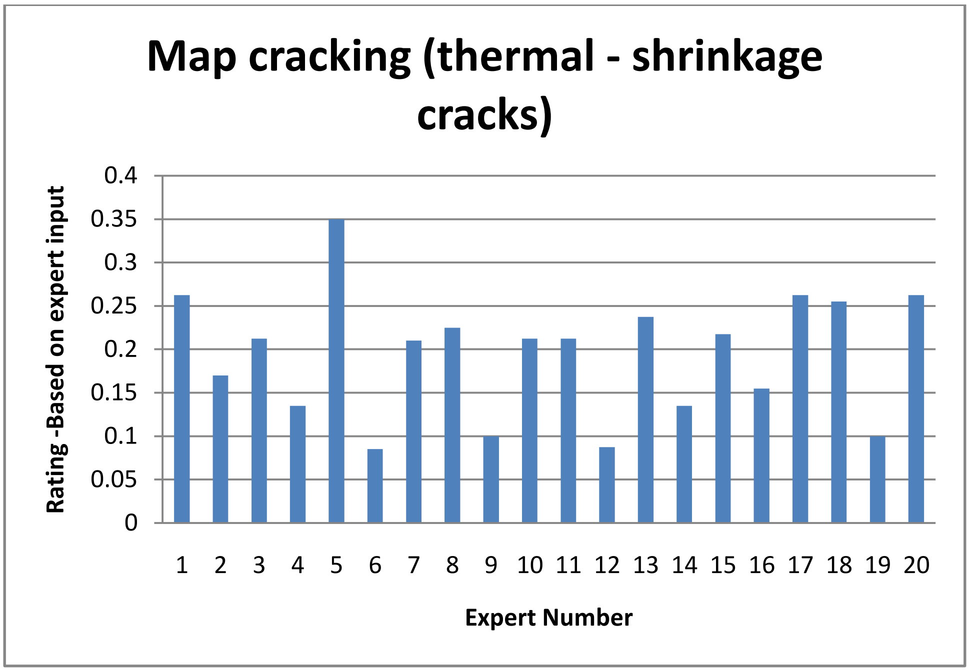


Figure 4-4: Expert ranking - Thermal shrinkage cracks - Deck slab

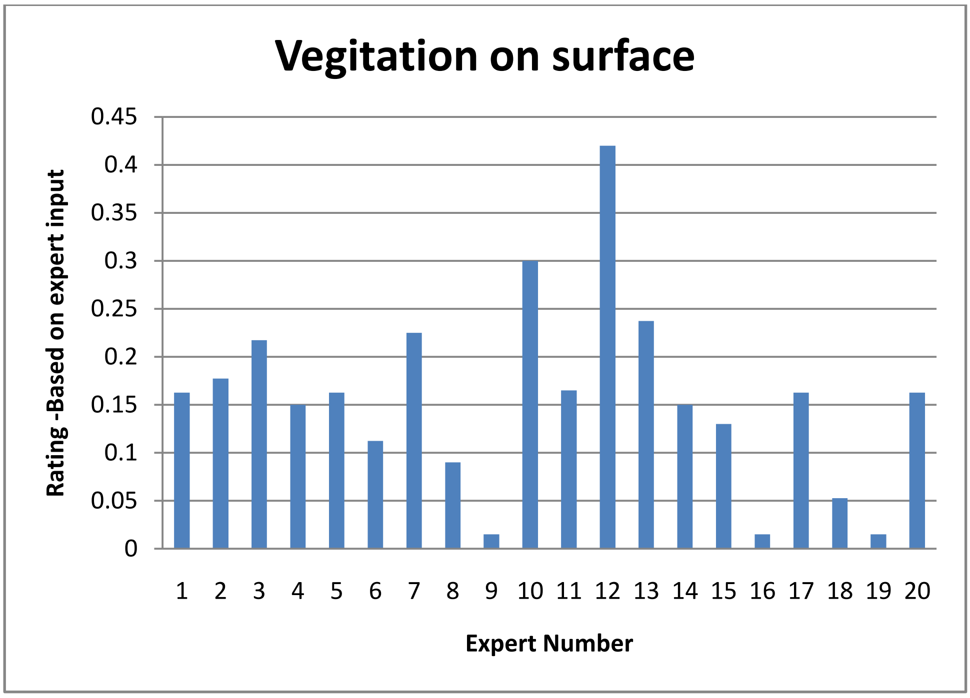


Figure 4-5: Expert ranking - Vegetation - Deck slab

4.2. Discussion

It is very much clear with the above results, the current method of ranking of status of bridge elements by individual inspectors during the inspection process leads to incorrect conclusions about the health status of the bridge. Based on the graphs presented above illustrate the variation of personal perceptions of individuals on distresses of bridge members. Hence, the approach presented with the present study, which is agreeing to certain reasonable values of DIVs based on the perceptions of individual, and making use of such predetermined DIVs in the evaluation process, whilst letting the inspectors to identify correct distresses and record in an appropriate manner shall lead to a more reliable system.

Further, level of inspection, amount of distresses are observed, limiting to visual observations, absence of non-destructive tests are some of the other key technical issues of the current system. Use of inexperience young engineers without proper training, ignorance of the safety of the inspectors due to absence of proper safety measures, lack of financial benefit for the engineers in maintenance division, lack of engineering staff in the maintenance division are several key administrative issues.

An effort was made to see any similarity or a match, in terms of health index values of 10 numbers of bridges, between the proposed assessment method and the proposed assessment method in the RDA's new Bridge Management System, which is not yet implemented. No clear match was observed between two systems in terms of health index values of the selected bridges. However, an important observation can be made between the results; such that, although the values appear to be scattered, the order of the health indexes are more or less the same in both system.

The new method of inspection and assessment is proposed considering Reinforced concrete bridges, Prestressed concrete deck with reinforced concrete substructure, Prestressed concrete deck with mass concrete or masonry substructure, Reinforced concrete deck with mass concrete or masonry substructure. This is a comprehensive framework and RDA can easily adopt and modify the proposed system as the system is very flexible for modifications. At the same time, the procedure can be extended to other types of bridges as well.

Herewith recommend to change the current system in a systematic way.

1. Continue "Routine inspections" with a frequency of once a year for a bridge. Avoid the current inspection forms during this exercise. Introduce a simple checklist to regularize the inspection. Avoid repetitive process of collecting inventory information of the bridge. Omitting advanced equipment during the "Routine inspection" is advisable, yet the inspector should witness the status of all the key components of a bridge. It is worth to recommend to use a "pole camera" to capture the situation of the soffit of the bridge deck. If the inspector is not comfortable with the condition of the bridge or any danger is felt during “Routine inspection", he may call a "Special inspection".

2. The proposed inspection method can be used as the first step of the "Special inspection". If the bridge is found to be critically distressed with this exercise, load carrying capacity of the bridge has to be determined with the help of Bridge Design Division of RDA.

3. The proposed method of inspection shall be used as an "In depth" inspection with a frequency of once in six years.

4. RDA shall forecast the maintenance schedule based on the "Bridge Condition Value" (BCV) of the proposed assessment method. RDA could establish a separate priority list based on the importance of individual bridges. Simple criteria can be defined to rank this importance of bridges based on number of vehicle movement across the bridge per year etc.

5. RDA shall maintain the records of inspections and assessments without overwriting the records. These records can be stored as electronic copies. However, a summary sheet, which is linked to the assessment data, shall be maintained to track the information, and to make the things easier. A simple format, as shown in Table 4-4, is adequate in such case. However, it is worth to track the condition states of members in addition to the final BCV, to have a complete picture of the transformation of the bridge with time.

Table 4-4: Proposed format of summary of assessment data

Bridge No	Member	Year 2018		Year 2024	
		SIV.CIV.MIV.CMCV	BCV	SIV.CIV.MIV.CMCV	BCV
A001(1/1)	Deck slab	0.0185	93 %		
	Beams	0.0159			
	Wearing	0.0049			
	Exp. Joint	0.0054			
	Side walk	0.0026			
	Railing	0.0005			
	Drainage	0.0009			
	Pier column	0.0056			
	Pier capping beam	0.0092			
	Bearing pad	0.0005			
	Abutment wall	0.0044			
	Wing wall	0.0029			
	Foundation	0.0002			

6. It is worthwhile to assign a separate group of engineers dedicated to the bridge inspection and maintenance. A proper training and an attractive salary scheme may be considered with a signed bond for a certain period of time to avoid frequent departure of engineers from the scheme.

The proposed system helps to establish a systematic bridge inspection and assessment system while ensuring the enhancement of professionalism among the bridge inspectors.

5. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORKS

5.1. Conclusions

It is come to following conclusions with the present study:

1. The current method of inspection and assessment, which is used by Road Development Authority (RDA), has following major issues:
    - There is no proper inspection form to carry out “In depth” inspection or “Special” inspection, and the available inspection form is worth to carry out “Routine” inspection only.
    - The available inspection form is not comprehensive enough to collect sufficient amount of information about distresses and the health status of bridges.
    - Several essential aspects had been ignored, such as non-destructive testing, underwater inspections etc.
    - The condition ratings, which are assigned to components of bridges by inspector himself during the inspection process, are highly subjective to the knowledge and experience of the inspector. Hence, the system is less reliable.
    - There is no systematic way to determine the health status of a bridge using the data collected by inspectors.

2. The present study proposes a complete inspection method with introducing a set of comprehensive inspection forms, which can be used both in “In depth” inspection and “Special” inspection. The proposed inspection forms have following advantages:
    - Inspection forms lead the inspector to reach each and every “Member” of the bridge and lead the inspector to record all the necessary data in terms of all possible distresses.

- Inspection form itself guides inspector to distinguish correct distresses.
- A third person can have a complete and correct idea about both overall health status of a bridge and individual distresses on different “Members” of a bridge. Hence, even if an inspector makes a critical mistake during identification of distresses, it can be easily observed by an experienced person just by going through the inspection forms.

3. A detailed and systematic method of assessment has been proposed with the present study. The proposed assessment method has following advantages:
    - Inspectors making decisions on the health status of components of bridge has been minimized.
    - The proposed method of assessment has been developed such that there is systematic link between condition inspection data and hence, the system can be updated and modified easily as per the experience and perception of the authority.

4. A comparison was done between the “Evaluation Value” in the RDA method and “Bridge Condition Value (BCV)” of the proposed method with this study in order to observe any similarity or a matching. “Evaluation Value” and BCV were calculated for the 10 numbers of bridges. No clear match is observed between two systems, in terms of the health indexes of the selected bridges. However, it is observed that the order of the health levels is more or less the same in both systems.

5.2. Recommendations for future works

The study was narrowed down to following types of bridges.

- Reinforced concrete bridges.
- Prestressed concrete deck with reinforced concrete substructure.
- Prestressed concrete deck with mass concrete or masonry substructure.

- Reinforced concrete deck with mass concrete or masonry substructure.

Yet, there are several other types of bridges, such as steel truss bridges, stone arched bridges, concrete arched bridges and a few numbers of steel beam bridges, can be seen in Sri Lankan highway network. There will be different distresses or at least same sort of distresses at different nature in these bridge types. Hence, such distresses can be identified for those other types of bridges and relevant inspection forms can be developed. Then it is easy to update the proposed assessment method accordingly.

Underwater inspection and foundation inspection are difficult exercises from the practical field work point of view. It is worthwhile to focus on foundation elements alone and conduct a detail study about the distresses in foundation elements. Developing a practical approach to investigate foundations and a set of well structured criteria, for the local context, will be very useful.

There is a chance that the abutment walls and wingwalls are subjected to cantilevered bending moment due to lateral earth pressure. Hence, there can be flexural cracks develop on the wall at the opposite side, which are undetected. For the sake of completeness the cracks at opposite side of the abutment walls and wingwalls were kept in the proposed inspection system. It will be interesting to further investigate on this matter.

References

[1] Sri Lanka. Planning Division of Road Development Authority. *Annual Report*, 2015

[2] M. Karthika, "Manual Inspection and Assessment Method of Highway Bridges," M.S. thesis, Dept. Civil. Eng., University of Moratuwa, Sri Lanka, 2011

[3] Bridge Maintenance Manual, Road Development Authority, Sri Lanka, 1997

[4] J. Scheer, *Failed Bridges: Case Studies, Causes and Consequences,* Ernst & Sohn, Berlin, 2010.

[5] J.S. Chiou, C.Y. Wang, and H. Wang, "Evaluation of flood-resistant capacity of scoured bridges," *Journal of Performance of Constructed Facilities*, vol.28, no. 1, pp. 61-75, Jan. 2014.

[6] *Erosion, Scour, and Foundation Design,* Department of Homeland Security, USA, 2005.

[7] K. Srikandan,"Bridge Management – An Overview," in Bridge Management, J.E. Harding, G.A.R. Parke, and M.J. Ryall, Eds. Surrey: E & FN SPON, 1990, pp. 17-27.

[8] J. Appleton, "Bridge inspection and assessment," presented at IABSE Symposium, Rio de Janeiro, Brazil, 1999. Available: https://www.e-periodica.ch/digbib/view?pid=bse-re-003:1999:83::122#405

[9] T.K.J.T.A. Sloan, "Remote Computer-aided Bridge Performance Monitoring," in Bridge Management, J.E. Harding, G.A.R. Parke, and M.J. Ryall, Eds. Surrey: E & FN SPON, 1990, pp. 361-371.

[10] *Manual of Bridge Inspection*, Ohio Department of Transportation, USA, 2006.

[11] *Bridge Safety Inspection Policy and Procedure Manual*, Mississippi Department of Transportation, USA, 2009.

[12] *Bridge Inspection Manual*, New York Department of Transportation, USA, 2016.

[13] *Bridge Inspection Manual*, Iowa Department of Transporation, USA, 2014.

[14] *Structure Inspection Manual – part 1*, Queensland Department of Transporat and Main Roads, Australia, 2016.

[15] *Inspection Manual for Highway Structures*, Highway Agency, United Kingdom, 2007.

[16] *Underwater Inspection of Bridges*, U.S. Department of Transportation, USA, 1989.

[17] S. Rehman, Z. Ibrahim, S. Memon, and M. Jameel, "Nondestructive test methods for concrete bridges: a review,"*Construction and Building Materials*,vol. 107, no. 1, pp. 58-86, Mar. 2015.

[18] L.R. Kevin, J.W. Terry, and F.W. Klaiber, "Review of nondestructive evaluation techniques of civil infrastructure," *Journal of Performance of Constructed Facilities*, vol. 11, no. 4, pp. 152-160, Nov. 1997.

[19] D.G. Manning and T. Masliwec, "Application of Radar and Thermography to Bridge Deck Condition Survey," in Bridge Management, J.E. Harding, G.A.R. Parke, and M.J. Ryall, Eds. Surrey: E & FN SPON, 1990, pp. 305-317.

[20] C.S. Cai and A. Nair, “Acoustic emission monitoring of bridges: review and case studies,” *Engineering Structures,* vol. 32, no. 6, pp. 1704-1714, June. 2010.

[21] H. Azari, S. Nazarian, and D. Yuan, “Assessing sensitivity of impact echo and ultrasonic surface waves metthods for nondestructive eveluation of concrete structures,” *Construction and Building Materials,* vol. 71, no. 7, pp. 384-391, Nov. 2014.

[22] V. Saraf and A.S. Nowak, “Proof load testing of deteriorated steel girder bridges,” *Journal of Bridge Engineering,* vol.3, no.2, pp. 61-75, May. 1998.

[23] *Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding,* ASTM D 4580-86, 1992.

[24] S. Sasmal, K. Ramanjaneyulu, and N.R. Iyer, “Condition rating of bridges using fuzzy logic,” Mar. 2012. Available: https ://www.intechopen.com/books/fuzzy-logic-emerging-technologies-and-applications/condition-ranking-and-rating-of-bridges

[25] R.W. Saaty, “The analytical hierarchy process – what it is and how it is used,” *Mathematical Modelling,* vol. 9, no. 3, pp. 161-176, Jan. 1987

[26] Y.M. Wang and K.S. Chin, “Fuzzy analytic hierarchi process: a logarithmic fuzzy performance programming methodology,” *International Journal of Approximate Reasoning,* Vol. 52, no. 4, pp. 541-553, June. 2011.

[27] S. Sasmal and K. Ramanjaneyulu, “Condition evaluation of existing reinforced concrete bridges using fuzzy based analytic hierarchy approach,” *Expert Systems with Applications,* vol. 35, no. 3, pp. 1430-1443, Oct. 2008.

[28] C.B. Brown and J.T.P. Yao, “Fussy sets and structural engineering,” *Journal of Structural Engineering.* vol. 109, no. 5, pp. 1211-1235, May. 1983.

[29] C.G.E. Boender, J.G. de Graan, and F.A. Lootsms, “Multicriteria decision analysis with fuzzy pair-wise comparisons,” *Fuzzy Sets and Systems.* vol. 29, no. 2, pp. 133-143, Jan. 1989.

[30] A. Kaufmann and M.M. Gupta, *Introduction to fuzzy arithmatic, theory and applications*, Van Nostrand Reinhold, New York, 1985.

[31] M.T. Liang, J.H. Wu, and C.H. Liang, “Multiple layer fuzzy evaluation for existing reinforced concrete bridges,”*Journal of Infrastructure Systems*, vol. 7, no. 4, pp. 144-159, Dec. 2001.

[32] S.A. Moufti, T. Zayed, and S.A. Dabous, “Defect-based condition assessment of concrete bridges fuzzy hierarchical evidence reasoning approach,”*Transport Research Record Journal of the Transportation Research Board,*vol. 10, no. 1, pp.88-96, Jan. 2014.

[33] M. Rashidi and P. Gibson, “Proposal of a methodology for bridge condition assessment,” presented at Australian Transport Research Forum, Adelaide, Australia, 2011

[34] S.A. Dabous, K. Hamad, and R. Al-Ruzouq, “Defect-based urgency index for bridge maintenance ranking and prioritization,” *International Journal of Civil and Environmental Engineering,* vol. 10, no. 5, pp. 605-609, May. 2011.

[35] N. Sakuwan and B.H.W. Hadikusumo, “Condition rating system for Thailand's concrete bridges,” *Journal of Construction in Developing Countries,* vol. 15, no. 1, pp. 1-27, Jan. 2010.

[36] *BMS/Pontis Bridge Inspection Manual*, Colorado Department of Transportation, USA, 1995.

[37] *Pavement Distress Identification Manual for NPS Road Inventory Program*, Federal Highway Admistration, USA, 2009.

[38] *River water level*, Irrigation Department of Sri Lanka, http://www.irrigation,gov.lk/index.php?option=com_gmapfp&view=gmapfp&layout=categorie&catid=126&id_perso=0&ltemid=222&lang=en

Appendix i

Inspection form, which is currently used by RDA for concrete bridges

RDA - P / Form / TS / 1 (b) - 2008

Bridge Inspection Form (Concrete and Other Type Bridges)

Province: Western

Bridge No.	……... *in km*	……..*in Miles*	Route No:	Name of Road:
GPS COORD	X:	Y:	No of spans:	Crossing/Bridge Name :

	Component	Type	Condition	Rating
Bridge Surface	Pavement	A/C, DBST, SBST, Tar, Gravel, other	Good, Waving, Rutting, Crack, Pot hole, Others	
	Curb		Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others	
	Railing	Concrete, Steel, Other	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Wear of surfaces, Others	
Super-Structure	Deck slab	RCS/Arch(Concrete/Brick/ Dressed stone), Stone slabs, Timber	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, Rust, corrosion, Deformation of plates, Free lime water leakage, Others	
	Main beam/ Main structure	RCB/PSC-PRE/PSC/POS,Other	Good, scaling, Cracking, Spalling, Exposure and Corrosion of reinforcement,Excessive deflection of members, Others	
	Diaphragm	RCB/PSC-PRE/PSC/POS,Other	Good, scaling, Cracking, Spalling, Exposure and corrosion of reinforcement,Excessive deflection of members, Others	
	Painting			
Accessory	Expansion Joint		Invisible, Existed, Good, Abnormal sound, Clogged, Deformation, Gap, Others	
	Bearing		Sliding, Invisible, Existed, Good, broken, Anchor bolt, Abnormal displacement	
	Drainage		Clogged, Broken, Water leakage, Support Broken, Pipe broken Others	
Sub-Structure	Abutment1	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken (Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	Good
	Abutment2	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	Good
	Pier/s	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Leaning, Settlement, Sliding, Body broken(Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces), Others	Good
	Foundation	Pile/Cylinder/Spread(D/W stone, RRM, Concrete)	Settlement, Leaning, Moving, Crack, Scouring, Others	
	Wing wall	Concrete/RRM/ Dressed or Wedge stone/ Bricks	Good, Scaling, Cracking, Spalling, Exposure and corrosion of reinforcement, wear of surfaces	
	Embankment	River bank(Upstream & downStream) :		
		Side bank(Left & right)		
Others	1st approach	Exist but not good		
	2nd Approach			
Others (eg: Traffic signs)	(Specify)			

Rating	1. Component is in good condition with little or no deterioration.
	2. Component shows deterioration of a minor nature with primary structural material which is first signs of being affected.
	3. There is significant damage and a detailed survey needs to be carried out to establish whether repairwork is to be carried out
	4. There is a substantial damage and urgent repair is required or the bridge has to be closed to traffic or restriction on vehicle weight to be imposed.

Name of the Inspector :	Designation :	Date

Appendix ii

Questionnaire, which is used to get feedback from RDA bridge inspectors about the current inspection forms of RDA

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection** & **Condition Inspection** as per the specified frequency in RDA manual ?

[ ] Yes [ ] No

1.b If **Not**, what are the reasons ?

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[ ] Yes [ ] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

3 Under what situations you carry out a **special inspection** on a bridge ?

[ ] Vehicle impact on an element of a bridge
[ ] After a flood
[ ] After a fire nearby a bridge
[ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

5 What are the tools & instruments used for inspection ?

6 What are the special vehicles or machineries used for inspection ?

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Questionnaire to bridge Inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
☐	☑

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
☑	☐

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

—

3 Under what situations you carry out a **special inspection** on a bridge ?

- ☑ Vehicle impact on an element of a bridge
- ☐ After a flood
- ☑ After a fire nearby a bridge
- ☐ Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

If required, can be done

5 What are the tools & instruments used for inspection ?

No

6 What are the special vehicles or machineries used for inspection ?

No

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

—

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

[✓] Yes [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[ ] Yes [✓] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

—

3 Under what situations you carry out a **special inspection** on a bridge ?

[✓] Vehicle impact on an element of a bridge
[ ] After a flood
[✓] After a fire nearby a bridge
[ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Conduct when necessary.

5 What are the tools & instruments used for inspection ?

Camera
Ruler

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

System is user friendly need more tools & staff

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

[✓] Yes [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[✓] Yes [ ] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

—

3 Under what situations you carry out a **special inspection** on a bridge ?

[✓] Vehicle impact on an element of a bridge
[✓] After a flood
[✓] After a fire nearby a bridge
[ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Conduct

5 What are the tools & instruments used for inspection ?

—

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

System is ok

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
✓	

1.b **If Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
	✓

2.b **If Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

~~If Prof~~ If proper tools available, can inspect.

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Not Specify in form.

5 What are the tools & instruments used for inspection ?

Camara.

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

Need anew inspection form. ~~Our form is not~~.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
	✓

1.b If **Not**, what are the reasons ?

insufficient staff ~~& co~~
more other commitments

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
	✓

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

- Soffit of deck & abutment walls in waterways
- Difficulties with access

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Can be done if necessary resources provided

5 What are the tools & instruments used for inspection ?

Camara

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

not enough funds for repair works

8 Is there anything you can propose to improve the current system of inspection ?

Current forms are very basic
need more detailed form (can add testing etc)

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [x] Yes
- [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Inspect reachable items due to safety concerns

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

NO guideline in form

5 What are the tools & instruments used for inspection ?

Manual inspection

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Inspection method should be upgraded

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [ ] Yes
- [x] No

1.b If **Not**, what are the reasons ?

Staff work load

2.a Do you inspect all the **elements** of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Safety

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [x] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Not in form

5 What are the tools & instruments used for inspection ?

—

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

Form not match with [illegible] bridge

8 Is there anything you can propose to improve the current system of inspection ?

Bridge inspection is very important hence, the inspection method should be advanced.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
☐	☑

1.b If **Not**, what are the reasons ?

Time & staff

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
☐	☑

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Danger
Tools

3 Under what situations you carry out a **special inspection** on a bridge ?

☑	Vehicle impact on an element of a bridge
☐	After a flood
☑	After a fire nearby a bridge
☐	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Not given

5 What are the tools & instruments used for inspection ?

Camara

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

~~Re~~ Training is needed

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

[✓] Yes	[ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[ ] Yes	[✓] Not always

2.b **If Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

- Deck below face (takes photos only)
- Safety issues

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
✓	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

No provision

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Proper System (including inspection forms, equipment) is necessary.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [ ] Yes
- [x] No

1.b **If Not**, what are the reasons ?

Inadequate insectors

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

- Deck
- Danger

3 Under what situations you carry out a **special Inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Based on the form we can observe the surface

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

our system is fine. we are pleased to add more information

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

[✓] Yes	[ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[ ] Yes	[✓] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Inspect top elements Only in river bridges
It is dangerous

3 Under what situations you carry out a **special inspection** on a bridge ?

- [✓] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Can be done if proper guidline available.

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

Difficult to inspect all bridges in the division with current staff

8 Is there anything you can propose to improve the current system of inspection ?

New tools, Safe equipment.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection** & **Condition Inspection** as per the specified frequency in RDA manual ?

- [x] Yes
- [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Beam sofits & slab sofits.

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Not conduct, can be done

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

Top management not take actions for repair.

8 Is there anything you can propose to improve the current system of inspection ?

Non destructive testing is must. The RDA system needs an upgrade.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [x] Yes
- [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Deck, Asntmeats , specially river bridges

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Can be done. need info

5 What are the tools & instruments used for inspection ?

Manually inspect
Camera is use to take importait

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Need an advanced System

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [x] Yes
- [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b **If Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

—

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Lack of information

5 What are the tools & instruments used for inspection ?

—

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

~~Staff~~ More Engineers to EE division and [illegible] letter work.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

- [x] Yes
- [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

- [ ] Yes
- [x] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

underneath surface of deck is ignored in most cases.

3 Under what situations you carry out a **special inspection** on a bridge ?

- [x] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Not in inspection form. But can conduct

5 What are the tools & instruments used for inspection ?

Camara

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

Very hard to comply frequency with current work load.

8 Is there anything you can propose to improve the current system of inspection ?

Non-destructive test can be used.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
	✓

1.b **If Not,** what are the reasons ?

Lack of Engineers to run inspections

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
	✓

2.b If **Not,** what are the elements you generally miss & reasons for not being able to inspect those ?

- Underneath face of beams and slabs

Reasons : Safety issues

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Possible if details are provided

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Proper inspection sheet

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection** & **Condition Inspection** as per the specified frequency in RDA manual ?

[✓] Yes   [ ] No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

[ ] Yes   [✓] Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Soffit of deck is difficult to inspect due to absence of proper vehicles.

3 Under what situations you carry out a **special Inspection** on a bridge ?

- [✓] Vehicle impact on an element of a bridge
- [ ] After a flood
- [ ] After a fire nearby a bridge
- [ ] Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

form X

5 What are the tools & instruments used for inspection ?

Ruler
Camera
Hammer

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

The current method is outdated. There are new systems.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection** & **Condition Inspection** as per the specified frequency in RDA manual ?

Yes	No
[ ]	[✓]

1.b If **Not**, what are the reasons ?

Difficulties with workload

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

Yes	Not always
[ ]	[✓]

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

- Sofit of deck
- Not having proper equipment to maintain Safety

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Need more specfications to conduct

5 What are the tools & instruments used for inspection ?

Camera
Tap hammer

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

8 Is there anything you can propose to improve the current system of inspection ?

Form should be modified
- Remove unnecessary
- should be standard

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

✓	
Yes	No

1.b **If Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

	✓
Yes	Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

—

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

No clear details in form. ~~No proper~~

5 What are the tools & instruments used for inspection ?

Camera

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

No provision for some details

8 Is there anything you can propose to improve the current system of inspection ?

our system is outdated please ~~took ut~~ look into good systems.

Questionnaire to bridge inspectors of RDA on the current system of inspection

1.a Do you conduct **Routine Inspection & Condition Inspection** as per the specified frequency in RDA manual ?

✓	
Yes	No

1.b If **Not**, what are the reasons ?

—

2.a Do you inspect all the elements of a bridge during **Routine Inspection & Condition Inspection** ?

	✓
Yes	Not always

2.b If **Not**, what are the elements you generally miss & reasons for not being able to inspect those ?

Try always to inspect as much as possible.
But not comfortable in most cases.

3 Under what situations you carry out a **special inspection** on a bridge ?

✓	Vehicle impact on an element of a bridge
	After a flood
	After a fire nearby a bridge
	Do not run special inspections

4 How is your experience in **underwater inspection** with the current system ?

Inadequate guidline. yet we are able to do.

5 What are the tools & instruments used for inspection ?

Camara.

6 What are the special vehicles or machineries used for inspection ?

—

7 What are the issues you face with the current system ?

—

8 Is there anything you can propose to improve the current system of inspection ?

There are good bridge management systems. ~~[illegible]~~
Need to consider testing etc.

Appendix iii

Proposed new bridge inspection form with the present study

Deck slab

Deck slab	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Cracks at mid-span (moment cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage cracks)	Maximum crack width (mm)	
		Good condition		
	Vegitation on surface	Several spots	Neglegible impact	
			Considerable impact	
		Significant area covered	Neglegible impact	
			Considerable impact	
		No vegitation		

Girders

Beams/Girders	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	% Area		
		Stain marks of rust - potential to corrosion	% Area		
		Good condition			
	Cracking	Closely spaced cracks at mid-span (moment cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Torsional cracks	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Diaphragm malfunction	Relative displacement between girders	Hardly visible	Clearly visible	Severe
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Wearing surface and other accessories of the bridge deck

Wearing surface	Cracking at expansion joint	Cracking	Maximum crack width (mm)		
		Good condition			
	Pot holes, crocodile cracks and other damages	Cracking and damages	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Good condition			
	Flushing	Flushing	Mild discomfort to users	Moderate discomfort to	Severe discomfort to
		Good condition			
	Leakage	No leakage	Leakages, marks of leakages visible		

Expansion joint	Malfunction	Broken	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Aged	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Choked with debris	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Good condition			
		Not visible due to asphalt cover			

Side walk	Damages such as broken, dislocations, misplacements of elements etc	Damaged elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Dislocation of elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Misplacement of elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Good condition			

Railing	Damages such as broken, dislocations, misplacements of elements etc	Damaged elements	No danger to users	Significant danger to users	Extreme danger to users
		Dislocation of elements	No danger to users	Significant danger to users	Extreme danger to users
		Misplacement of elements	No danger to users	Significant danger to users	Extreme danger to users
		Good condition			

Drainage	Malfunction	Malfunction	Minor disturbance to drain	drain	drain
		Good condition			

Pier column - Reinforced concrete

Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	% Area		
		Stain marks of rust - potential to corrosion	% Area		
		Good condition			
	Cracking	Horizontal cracks at pier bottom (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Horizontal cracks at mid height of pier (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (settlement)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (thermal - shrinkage cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)		
		Good condition			
	Weathering	Weathering	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Reinforcement exposed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Pier column - Random rubble masonry

Rubble Pier Column/wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	% Area		
		Minor mortar dislocations, but soil passing through is not possible	% Area		
		Good condition			
	Movements and deformations	Lateral movement of pier	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition			
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Pier capping beam and bridge bearing at pier capping beam

Pier capping beam	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Flexural cracks at midspan/ cantilever	Maximum crack width (mm)	
			Length of the crack (mm)	
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Torsional cracks	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)	
		Good condition		
	Vegetation on surface	Several spots	Negligible impact	
			Considerable impact	
		Significant area covered	Negligible impact	
			Considerable impact	
		No vegetation		

Elastomeric bearing at pier	Washed out	Yes/No
	Excessive distortion of neoprene layer	Yes/No
	Corrosion of the metallic accessories	Yes/No
	Deterioration of the Teflon layer	Yes/No
	Excessive movement	Yes/No
Concrete hinge bearing at pier	Crushing of concrete	Yes/No
	Corrosion of reinforcement	Yes/No

Abutment wall - Reinforced concrete

Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	% Area		
		Stain marks of rust - potential to corrosion	% Area		
		Good condition			
	Cracking	Horizontal cracks at abutment bottom (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Horizontal cracks at mid height of abutment (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (thermal - shrinkage cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (settlement)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Map cracking (thermal - shrinkage - DEF- ASR)	Maximum crack width (mm)		
		Good condition			
	Weathering	Weathering	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Reinforcement exposed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Abutment wall - Mass concrete

Mass Concrete Abutment wall	Cracking	Horizontal cracks at abutment bottom (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Horizontal cracks at mid height of abutment (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (settlement)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (thermal - shrinkage cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)		
		Good condition			
	Weathering	Weathering	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Reinforcement exposed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Abutment wall - Random rubble masonry

Rubble Abutment wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	% Area		
		Minor mortar dislocations, but soil passing through is not possible	% Area		
		Good condition			
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Movements and deformations	Lateral movement of abutment wall	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Wingwall - reinforced concrete

Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	% Area		
		Stain marks of rust - potential to corrosion	% Area		
		Good condition			
	Cracking	Horizontal cracks at wall bottom (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Horizontal cracks at mid height of wall (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (thermal - shrinkage cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (settlement)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Map cracking (thermal - shrinkage - DEF- ASR)	Maximum crack width (mm)		
		Good condition			
	Weathering	Weathering	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Reinforcement exposed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Wingwall - mass concrete

Mass concrete wingwall	Cracking	Horizontal cracks at wall bottom (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Horizontal cracks at mid height of wall (flexural cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (settlement)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks (thermal - shrinkage cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)		
		Good condition			
	Weathering	Weathering	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Reinforcement exposed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Wingwall - Random rubble masonry

Rubble Wing wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	% Area		
		Minor mortar dislocations, but soil passing through is not possible	% Area		
		Good condition			
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Movements and deformations	Lateral movement of abutment wall	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Abutment capping beam

Abutment capping beam	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Flexural cracks aat midspan/ cantilever	Maximum crack width (mm)	
			Length of the crack (mm)	
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Torsional cracks	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)	
		Good condition		
	Vegetation on surface	Several spots	Negligible impact	
			Considerable impact	
		Significant area covered	Negligible impact	
			Considerable impact	
		No vegetation		

Bridge bearing at abutment

Elastomeric bearing at abutment	Washed out	Yes/No
	Excessive distortion of neoprene layer	Yes/No
	Corrosion of the metallic accessories	Yes/No
	teflon layer	Yes/No
	Excessive movement	Yes/No
Concrete hinge bearing at abutment	Crushing of concrete	Yes/No
	Corrosion of reinforcement	Yes/No

Foundation

Foundation	Scour	Scour affected the foundation	Negligible	Moderate	Sever
		Area under the footing subjected to scour	%		
	Deterioration of foundation elements	Degree of deterioration	Negligible	Moderate	Sever
		Area of deterioration	%		

Appendix iv

Inspection done on bridge 8-4 on road B225 with new inspection form

Bridge Inspection Form

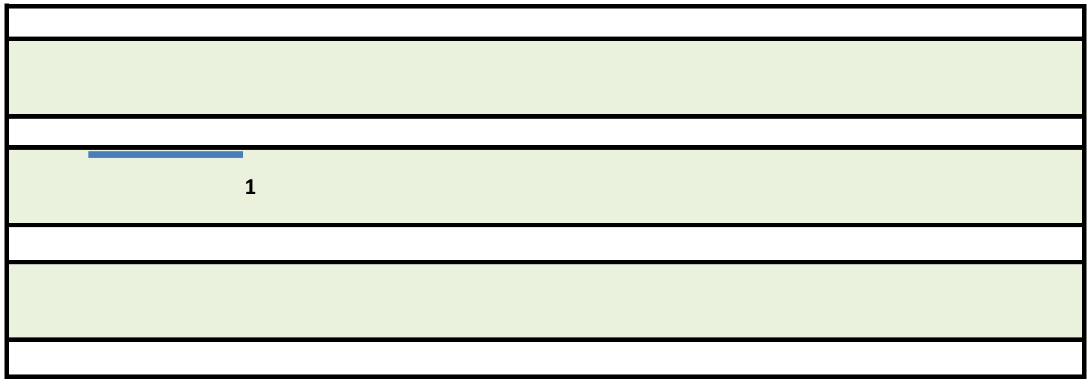
Road	B225
Bridge	.8/4
Date	10/9/2017
Inspector	W.P.R Indrajith

This is a self evaluation done on the proposed inspection form. Bridge 8/4 on road B22 (Kirindiwita - Aswannawatta) was selected, and actual inspection session was conducted.

Bridge information

No. of spans	2	
Span arrangement	12m + 12m	
Deck material	Prestress girder	√
	reinforced concrete deck slab	√
Abutment material	Reinforced concrete	
	Mass concrete	
	Rubble masonry	√
Pier material	Reinforced concrete	
	Mass concrete	
	Rubble masonry	√
Date of construction	No record	
Date of rehabilitation	No record	

Deck slab - span 1 - crack mapping

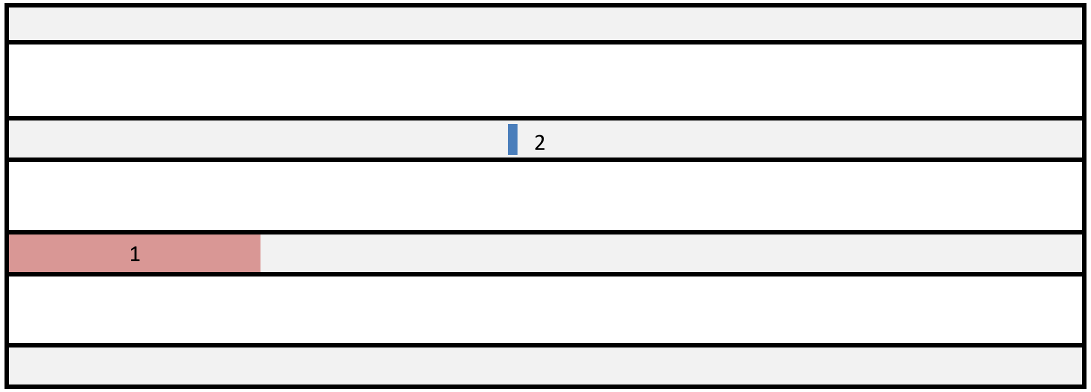


1 - Shear crack

Deck slab - span 1

Deck slab	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	0% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	28
			Carbonation depth -Drill and phenolphthalein (mm)	21
		Delamination - hammer tap	50% Area	
		Stain marks of rust - potential to corrosion	5% Area	
		Good condition		
	Cracking	Cracks at mid-span (moment cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	0.2
			Length of the crack (mm)	2000
		Map cracking (thermal - shrinkage cracks)	Maximum crack width (mm)	
		Good condition		
	Vegitation on surface	Several spots	Neglegible impact	
			Considerable impact	
		Significant area covered	Neglegible impact	
			Considerable impact	
		No vegitation		

Girder - span 1 - crack mapping



1- spalling - 5000 mmx200 mm

2- flexural crack

Girders - span 1

Girders	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)		
			Spalling of concrete		10 % Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)		
			Concrete cover to reinforcement - cover meter (mm)		
			Carbonation depth -Drill and phenolphthalein (mm)		
		Delamination - hammer tap	30% Area		
		Stain marks of rust - potential to corrosion	40% Area		
		Good condition			
	Cracking	Closely spaced cracks at mid-span (moment cracks)	Maximum crack width (mm)		0.2
			Length of the crack (mm)		1000
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)		
			Length of the crack (mm)		
		Torsional cracks	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition			
	Diaphragm malfunction	Relative displacement between girders	Hardly visible	Clearly visible	Severe
		Good condition	√		
	Vegetation on surface	Several spots	Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact √		
			Considerable impact		
		No vegetation			

Wearing surface

Wearing surface and other accessories of the bridge deck

Wearing surface	Cracking at expansion joint	Cracking	Maximum crack width (mm)		2
		Good condition			
	Pot holes, crocodile cracks and other damages	Cracking and damages	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Good condition		√	
	Flushing	Flushing	Mild discomfort to users	Moderate discomfort to	Severe discomfort to
		Good condition		√	
	Leakage	No leakage	√ Leakages, marks of leakages visible		

Expansion joint	Malfunction	Broken	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Aged	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Choked with debris	Mild discomfort to users	Moderate discomfort to users	Severe discomfort to users
		Good condition			
		Not visible due to asphalt cover		√	

Side walk	Damages such as broken, dislocations, misplacements of elements etc	Damaged elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Dislocation of elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Misplacement of elements	No discomfort	Discomfort, but no danger to users	Discomfort and danger to users
		Good condition		√	

Railing	Damages such as broken, dislocations, misplacements of elements etc	Damaged elements	No danger to users	Significant danger to users	Extreme danger to users
		Dislocation of elements	No danger to users	Significant danger to users	Extreme danger to users
		Misplacement of elements	No danger to users	Significant danger to users	Extreme danger to users
		Good condition		√	

Drainage	Malfunction	Malfunction	Minor disturbance to drain	Significant disturbance to drain	Extreme disturbance
		Good condition		√	

Pier column - crack mapping

Mortar dislocation due to water pressure at upstream

Pier column - Rubble masonry

Rubble Pier Column/wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	2% Area		
		Minor mortar dislocation, soil passing through not possible	3% Area		
		Good condition			
	Movements and deformations	Lateral movement of pier	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition	√		
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition	√		
	Vegetation on surface	Several spots	√ Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Pier capping beam and bridge bearing at pier - Crack mapping

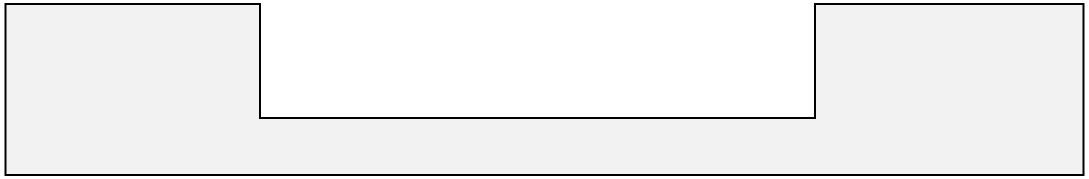
No distinct capping beam

Pier capping beam and bridge bearing at pier capping beam √ No capping beam

Pier capping beam	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Flexural cracks at midspan/ cantilever	Maximum crack width (mm)	
			Length of the crack (mm)	
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Torsional cracks	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)	
		Good condition		
	Vegetation on surface	Several spots	Negligible impact	
			Considerable impact	
		Significant area covered	Negligible impact	
			Considerable impact	
		No vegetation		

Elastomeric bearing at pier	Washed out	Yes/No
	Excessive distortion of neoprene layer	Yes/No
	Corrosion of the metallic accessories	Yes/No
	Deterioration of the Teflon layer	Yes/No
	Excessive movement	Yes/No
Concrete hinge bearing at pier	Crushing of concrete	Yes/No
	Corrosion of reinforcement	Yes/No

Abutment 1 - Abutment wall - Rubble masonry - crack mapping



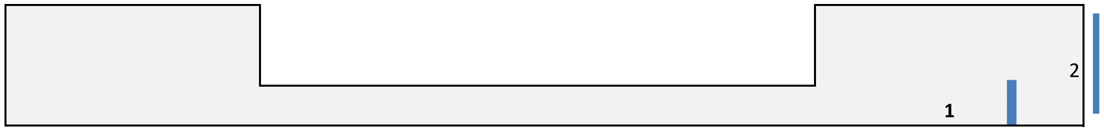
plan view

No cracks

Abutment wall - Rubble masonry

Rubble Abutment wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	0% Area		
		Minor mortar dislocations, but soil passing through is not possible	2% Area		
		Good condition			
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		
			Length of the crack (mm)		
		Good condition	√		
	Movements and deformations	Lateral movement of abutment wall	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition	√		
	Vegetation on surface	Several spots	√ Negligible impact		
			Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Abutment 1 - Wingwall - Rubble masonry - crack mapping



plan view

2 - Mortar dislocation due to upstream water pressure

1 - Crack due to lateral earth pressure

Wingwall - Random rubble masonry

Rubble Wing wall	Mortar dislocation	Mortar dislocation allowing soil to pass through	10% Area		
		Minor mortar dislocations, but soil passing through is not possible	% Area		
		Good condition			
	Cracking	Horizontal cracks indicating development of tensile stress	Maximum crack width (mm)		
			Length of the crack (mm)		
		Vertical cracks indicating settlement	Maximum crack width (mm)		4
			Length of the crack (mm)		750
		Good condition			
	Movements and deformations	Lateral movement of abutment wall	Mild (Hardly visible)	√ Moderate (Clearly visible)	Severe (Dangerously deformed)
		Vertical deformations	Mild (Hardly visible)	Moderate (Clearly visible)	Severe (Dangerously deformed)
		Good condition			
	Vegetation on surface	Several spots	Negligible impact		
			√ Considerable impact		
		Significant area covered	Negligible impact		
			Considerable impact		
		No vegetation			

Abutment 1 - abutment capping beam and bridge bearing at pier - Crack mapping

No distinct capping beam

Abutment capping beam

√ No capping beam

Abutment capping beam	Corrosion of reinforcement due to depassivation	Spalling and reinforcement exposed	Rate of corrosion -Polarization resistance (kOhm-cm)	
			Spalling of concrete	% Area
		No spalling of concrete	Risk of corrosion- Half cell potential (mV)	
			Concrete cover to reinforcement - cover meter (mm)	
			Carbonation depth -Drill and phenolphthalein (mm)	
		Delamination - hammer tap	% Area	
		Stain marks of rust - potential to corrosion	% Area	
		Good condition		
	Cracking	Closely spaced cracks at mid-span (moment cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Single cracks at mid-span (shrinkage)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Cracks closer to supports (shear cracks)	Maximum crack width (mm)	
			Length of the crack (mm)	
		Torsional cracks	Maximum crack width (mm)	
			Length of the crack (mm)	
		Map cracking (thermal - shrinkage - DEF - ASR)	Maximum crack width (mm)	
		Good condition		
	Vegetation on surface	Several spots	Negligible impact	
			Considerable impact	
		Significant area covered	Negligible impact	
			Considerable impact	
		No vegetation		

Bridge bearing at abutment

Elastomeric bearing at abutment	Washed out	Yes/No
	Excessive distortion of neoprene layer	Yes/No
	Corrosion of the metallic accessories	Yes/No
	Deterioration of the Teflon layer	Yes/No
	Excessive movement	Yes/No
Concrete hinge bearing at abutment	Crushing of concrete	Yes/No
	Corrosion of reinforcement	Yes/No

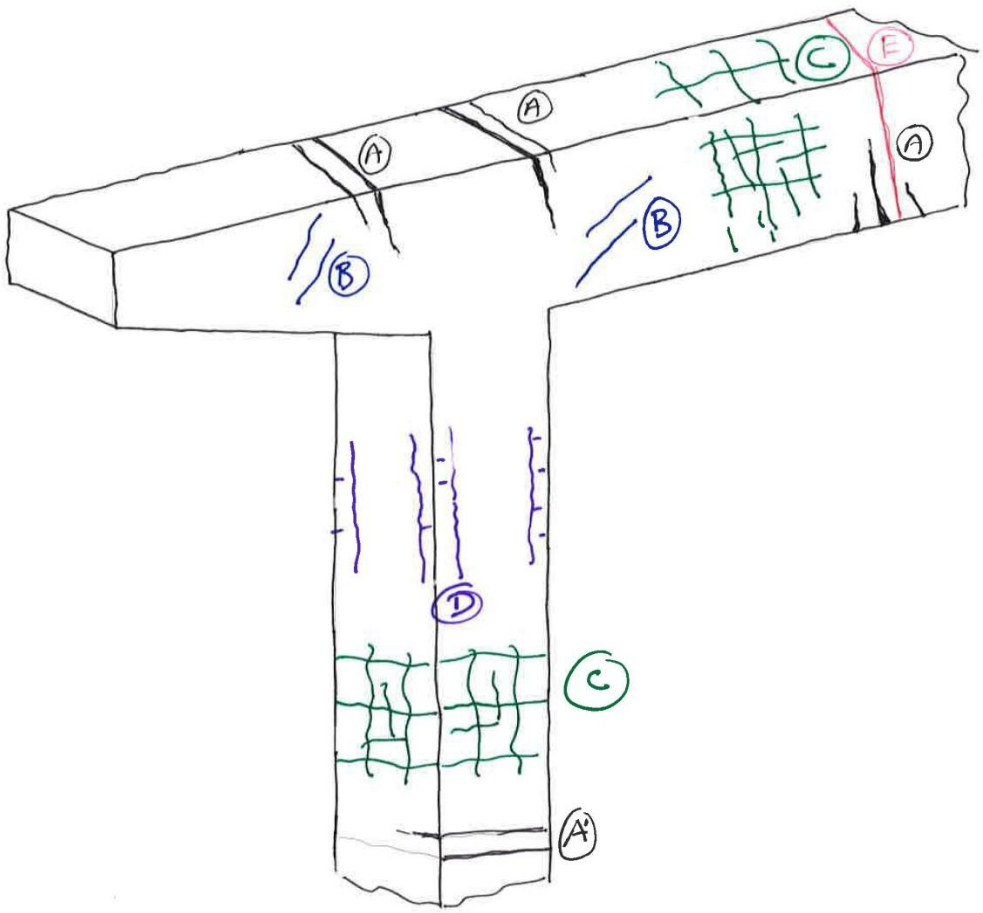
Foundation

Foundation	Scour	Scour affected the foundation	Negligible	Moderate	Sever
	Deterioration of foundation elements	Degree of deterioration	Negligible	Moderate	Sever

Appendix v

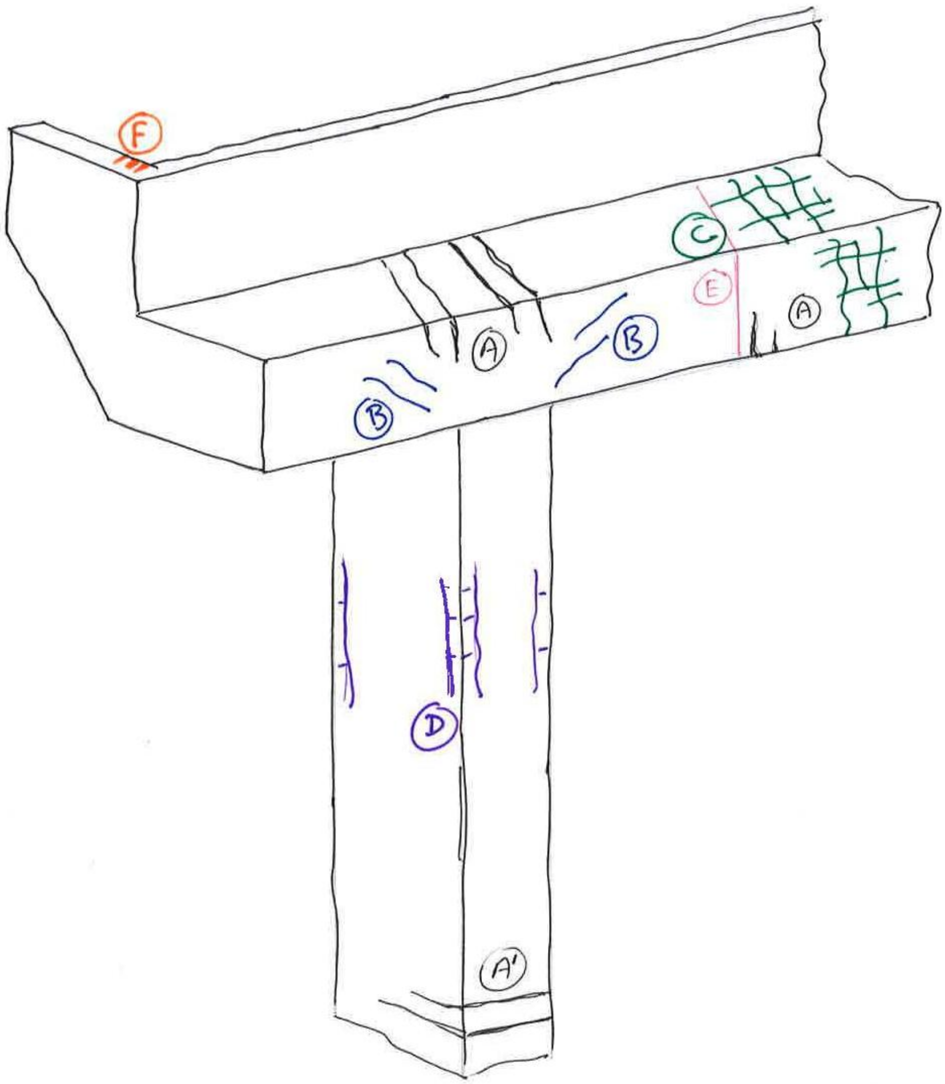
Graphical view of basic crack types and their possible locations; based on the finding from field investigations

Basic crack patterns of a general pier and a capping beam



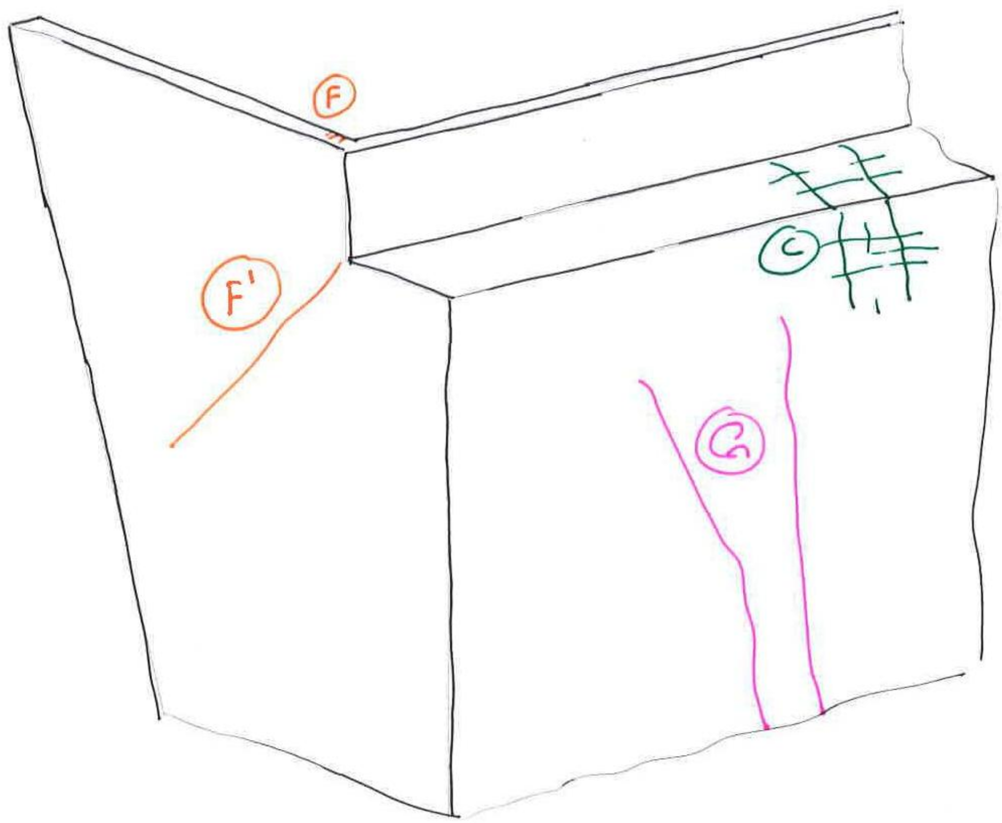
Type	Description
A	Cracks due to bending stresses induced mainly by vertical loads. Mainly possible at bottom face of spans and top face near supports. Could appear as a group of cracks in most cases. Crack width is maximum at faces.
A'	Cracks due to bending stresses induced mainly by lateral loads.
B	Shear cracks. Mainly possible near supports and around concentrated loads. Most likely 45 degrees to vertical plane.
C	Map cracking. There could be two possibilities. i) DEF, ii) Alkali Silica reaction. White colour deposits around cracks indicates the possibility of ASR.
D	Cracks parallel to edges. This is the early sign of spaling. At this stage, reinforcement must have started corrosion.
E	A single crack most likely at mid span of a beam indicates a possible cracking due to drying shrinkage. Most likely in thicker elements.

Basic crack patterns of a spill-through type abutment



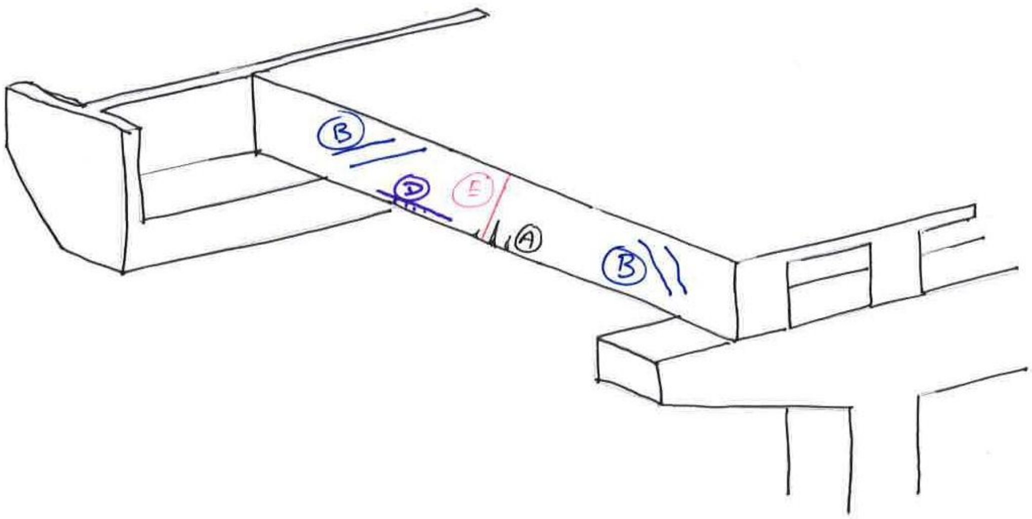
Type	Description
A	Cracks due to bending stresses induced mainly by vertical loads. Mainly possible at bottom face of spans and top face near supports. Could appear as a group of cracks in most cases. Crack width is maximum at faces.
A'	Cracks due to bending stresses induced mainly by lateral loads.
B	Shear cracks. Mainly possible near supports and around concentrated loads. Most likely 45 degrees to vertical plane.
C	Map cracking. There could be two possibilities. i) DEF, ii) Alkali Silica reaction. White colour deposits around cracks indicates the possibility of ASR.
D	Cracks parallel to edges. This is the early sign of spaling. At this stage, reinforcement must have started corrosion.
E	A single crack most likely at mid span of a beam indicates a possible cracking due to drying shrinkage. Most likely in thicker elements.
F	Cracks due to bending stresses induced due to lateral earth pressure. These cracks develop mainly at soil side and hence leave unnoticed.

Basic crack patterns of general type of an abutment



Type	Description
C	Map cracking. There could be two possibilities. i) DEF, ii) Alkali Silica reaction. White colour deposits around cracks indicates the possibility of ASR.
F	Cracks due to bending stresses induced due to lateral earth pressure. These cracks develop mainly at soil side and hence leave unnoticed.
F'	Cracks due to bending stresses induced due to lateral earth pressure. Difference from type F is that these cracks mainly happens in mass concrete abutments and masonry abutments.
G	Vertical cracks due to differential settlements. These cracks mainly develop in mass concrete abutments and masonry abutments.

Basic crack patterns of a bridge beam



Type	Description
A	Cracks due to bending stresses induced mainly by vertical loads. Mainly possible at bottom face of spans and top face near supports. Could appear as a group of cracks in most cases. Crack width is maximum at faces.
B	Shear cracks. Mainly possible near supports and around concentrated loads. Most likely 45 degrees to vertical plane.
D	Cracks parallel to edges. This is the early sign of spaling. At this stage, reinforcement must have started corrosion.
E	A single crack most likely at mid span of a beam indicates a possible cracking due to drying shrinkage. Most likely in thicker elements.

Appendix vi

Questionnaire to RDA experts to determine DIV

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Deck slab	Corrosion of reinforcement due to depassivation																
	Cracks at mid-span (moment cracks)																
	Cracks closer to supports (shear cracks)																
	Torsional cracks																
	Map cracking (thermal - shrinkage cracks)																
	Vegitation on surface																
Girders	Corrosion of reinforcement due to depassivation																
	Flexural crack at mid-span																
	Single shrinkage crack at mid-span																
	Cracks closer to supports (shear cracks)																
	Torsional cracks																
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc																
	Vegetation on surface																
Wearing surface	Cracking at expansion joint																
	Pot holes, crocodile cracks and other damages																
	Flushing																
	Leakage through wearing surface																
Expansion joint	Broken																
	Aged																
	Choked with debris																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact
Side walk	Damaged elements																
	Dislocation of elements																
	Misplacement of elements																
Railing	Damaged elements																
	Dislocation of elements																
	Misplacement of elements																
Drainage	Malfunction																
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation																
	Horizontal cracks at pier bottom (flexural cracks)																
	Horizontal cracks at mid height of pier (flexural cracks)																
	Vertical cracks (settlement)																
	Vertical cracks (thermal - shrinkage cracks)																
	Map cracking (thermal - shrinkage - DEF - ASR)																
	Weathering																
	Vegetation on surface																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Random Rubble Pier Column/wall	Mortar dislocation																
	Lateral movement of pier																
	Vertical deformations of pier																
	Horizontal cracks indicating development of tensile stress																
	Vertical cracks indicating settlement																
	Vegetation on surface																
Pier capping beam	Corrosion of reinforcement due to depassivation																
	Flexural cracks at mid-span																
	Single cracks at mid-span (shrinkage)																
	Cracks closer to supports (shear cracks)																
	Torsional cracks																
	Map cracking (thermal - shrinkage - DEF - ASR)																
	Vegetation on surface																
Elastomeric bearing at pier	Washed out																
	Excessive distortion of neoprene layer																
	Corrosion of the metallic accessories																
	Deterioration of the Teflon layer																
	Excessive movement																
Concrete hinge bearing at pier	Crushing of concrete																
	Corrosion of reinforcement																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation																
	Horizontal cracks at abutment bottom (flexural cracks)																
	Horizontal cracks at mid height of abutment (flexural cracks)																
	Vertical cracks (thermal - shrinkage cracks)																
	Vertical cracks (settlement)																
	Map cracking (thermal - shrinkage - DEF- ASR)																
	Weathering																
	Vegetation on surface																
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)																
	Horizontal cracks at mid height of abutment (flexural cracks)																
	Vertical cracks (settlement)																
	Vertical cracks (thermal - shrinkage cracks)																
	Map cracking (thermal - shrinkage - DEF - ASR)																
	Weathering																
	Vegetation on surface																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Rubble Abutment wall	Mortar dislocation leading to soil passing through																
	Horizontal cracks indicating development of tensile stress																
	Vertical cracks indicating settlement																
	Lateral movement of abutment wall																
	Vertical deformations of abutment wall																
	Vegetation on surface																
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation																
	Horizontal cracks at abutment bottom (flexural cracks)																
	Horizontal cracks at mid height of abutment (flexural cracks)																
	Vertical cracks (thermal - shrinkage cracks)																
	Vertical cracks (settlement)																
	Map cracking (thermal - shrinkage - DEF- ASR)																
	Weathering																
	Vegetation on surface																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)																
	Horizontal cracks at mid height of abutment (flexural cracks)																
	Vertical cracks (settlement)																
	Vertical cracks (thermal - shrinkage cracks)																
	Map cracking (thermal - shrinkage - DEF - ASR)																
	Weathering																
	Vegetation on surface																
Rubble Wing wall	Mortar dislocation leading to soil passing through																
	Horizontal cracks indicating development of tensile stress																
	Vertical cracks indicating settlement																
	Lateral movement of abutment wall																
	Vertical deformations of abutment wall																
	Vegetation on surface																
Abutment capping beam	Corrosion of reinforcement due to depassivation																
	Flexural crack at mid-span																
	Single cracks at mid-span (shrinkage)																
	Cracks closer to supports (shear cracks)																
	Torsional cracks																
	Map cracking (thermal - shrinkage - DEF - ASR)																
	Vegetation on surface																

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance			
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact
Elastomeric bearing at abutment	Washed out																
	Excessive distortion of neoprene layer																
	Corrosion of the metallic accessories																
	Deterioration of the teflon layer																
	Excessive movement																
Concrete hinge bearing at abutment	Crushing of concrete																
	Corrosion of reinforcement																
Foundation	Scour at foundation																
	Deterioration of foundation elements																

Appendix vii

Filled questionnaire forms by RDA experts to determine DIVs

Inspector- No 1		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Cracks at mid-span (moment cracks)		1			1					1					1		0.37
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks		1			1					1				1			0.375
	Map cracking (thermal - shrinkage cracks)			1		1					1			1				0.2625
	Vegitation on surface			1			1					1		1				0.1625
Girders	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Flexural crack at mid-span		1			1					1					1		0.37
	Single shrinkage crack at mid-span		1			1					1				1			0.375
	Cracks closer to supports (shear cracks)		1			1				1				1				0.42
	Torsional cracks			1		1					1				1			0.255
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1					1			1				1				0.525
	Vegetation on surface			1			1					1		1				0.1625
Wearing surface	Cracking at expansion joint				1		1			1				1				0.165
	Pot holes, crocodile cracks and other damages				1		1			1				1				0.165
	Flushing				1		1			1				1				0.165
	Leakage through wearing surface				1		1			1				1				0.165
Expansion joint	Broken				1			1		1				1				0.115
	Aged				1			1		1				1				0.115
	Choked with debris				1			1			1			1				0.0775

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1		1			1				1				0.165
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1		1			1				0.0525
	Dislocation of elements				1				1		1			1				0.0525
	Misplacement of elements				1				1		1			1				0.0525
Drainage	Malfunction				1			1			1			1				0.0775
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Horizontal cracks at pier bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of pier (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (settlement)		1				1				1					1		0.295
	Vertical cracks (thermal - shrinkage cracks)			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1				1		0.15
	Weathering		1				1					1			1			0.275
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation			1		1						1			1			0.23
	Lateral movement of pier	1					1					1				1		0.45
	Vertical deformations of pier		1				1					1				1		0.27
	Horizontal cracks indicating development of tensile stress	1					1					1				1		0.45
	Vertical cracks indicating settlement			1				1			1					1		0.125
	Vegetation on surface			1				1			1				1			0.13
Pier capping beam	Corrosion of reinforcement due to depassivation		1					1				1				1		0.22
	Flexural cracks at mid-span	1						1				1				1		0.4
	Single cracks at mid-span (shrinkage)		1					1				1				1		0.22
	Cracks closer to supports (shear cracks)	1						1				1				1		0.4
	Torsional cracks		1					1				1				1		0.22
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Elastomeric bearing at pier	Washed out			1				1			1				1			0.13
	Excessive distortion of neoprene layer			1			1			1						1		0.2125
	Corrosion of the metallic accessories			1				1			1					1		0.125
	Deterioration of the Teflon layer			1				1			1					1		0.125
	Excessive movement			1				1			1					1		0.125
Concrete hinge bearing at pier	Crushing of concrete	1				1				1					1			0.5925
	Corrosion of reinforcement			1		1						1			1			0.23

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1					1					1		0.25
	Vegetation on surface			1		1					1				1			0.255
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1						1				1		0.225
	Vegetation on surface			1		1					1				1			0.255

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Rubble Wing wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Abutment capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural crack at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1			1				1					1		0.175
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1			1					1				1		0.15
	Deterioration of the teflon layer			1				1				1				1		0.1
	Excessive movement			1			1				1					1		0.175
Concrete hinge bearing at abutment	Crushing of concrete			1			1				1				1			0.18
	Corrosion of reinforcement			1			1				1					1		0.175
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements	1					1					1			1			0.455

Inspector- No 2

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1						1			1			0.23
	Cracks at mid-span (moment cracks)			1		1						1			1			0.23
	Cracks closer to supports (shear cracks)		1			1						1			1			0.35
	Torsional cracks			1			1					1			1			0.155
	Map cracking (thermal - shrinkage cracks)				1	1						1			1			0.17
	Vegitation on surface				1	1						1		1				0.1775
Girders	Corrosion of reinforcement due to depassivation		1			1						1				1		0.345
	Flexural crack at mid-span		1			1						1				1		0.345
	Single shrinkage crack at mid-span				1		1					1				1		0.09
	Cracks closer to supports (shear cracks)	1				1						1			1			0.53
	Torsional cracks			1		1						1				1		0.225
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc		1						1			1				1		0.195
	Vegetation on surface				1	1						1			1			0.17
Wearing surface	Cracking at expansion joint				1	1					1				1			0.195
	Pot holes, crocodile cracks and other damages				1			1		1				1				0.115
	Flushing				1				1	1						1		0.0775
	Leakage through wearing surface				1			1			1			1				0.0775
Expansion joint	Broken				1		1			1				1				0.165
	Aged				1		1				1				1			0.12
	Choked with debris				1	1					1			1				0.2025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1			1			1			1				0.0775
	Dislocation of elements				1			1			1			1				0.0775
	Misplacement of elements				1		1			1				1				0.165
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1	1				1				0.09
	Misplacement of elements				1				1	1				1				0.09
Drainage	Malfunction				1	1				1					1			0.2325
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Horizontal cracks at pier bottom (flexural cracks)			1		1						1			1			0.23
	Horizontal cracks at mid height of pier (flexural cracks)			1		1						1			1			0.23
	Vertical cracks (settlement)			1		1						1			1			0.23
	Vertical cracks (thermal - shrinkage cracks)				1		1					1			1			0.095
	Map cracking (thermal - shrinkage - DEF - ASR)				1		1					1			1			0.095
	Weathering			1			1					1				1		0.15
	Vegetation on surface				1	1						1		1				0.1775

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1						1		1				0.5375
	Lateral movement of pier		1					1			1				1			0.25
	Vertical deformations of pier			1				1			1				1			0.13
	Horizontal cracks indicating development of tensile stress			1		1					1				1			0.255
	Vertical cracks indicating settlement			1				1				1			1			0.105
	Vegetation on surface				1	1						1		1				0.1775
Pier capping beam	Corrosion of reinforcement due to depassivation			1		1						1				1		0.225
	Flexural cracks at mid-span		1			1					1				1			0.375
	Single cracks at mid-span (shrinkage)				1		1						1		1			0.0825
	Cracks closer to supports (shear cracks)		1			1						1			1			0.35
	Torsional cracks				1	1						1			1			0.17
	Map cracking (thermal - shrinkage - DEF - ASR)				1	1						1			1			0.17
	Vegetation on surface				1	1						1		1				0.1775
Elastomeric bearing at pier	Washed out			1				1					1				1	0.085
	Excessive distortion of neoprene layer			1				1					1				1	0.085
	Corrosion of the metallic accessories			1				1					1				1	0.085
	Deterioration of the Teflon layer			1				1					1				1	0.085
	Excessive movement			1				1			1				1			0.13
Concrete hinge bearing at pier	Crushing of concrete		1					1				1				1		0.22
	Corrosion of reinforcement			1		1						1				1		0.225

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Horizontal cracks at abutment bottom (flexural cracks)			1		1						1				1		0.225
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1						1			1			0.23
	Vertical cracks (thermal - shrinkage cracks)				1	1						1			1			0.17
	Vertical cracks (settlement)				1	1						1			1			0.17
	Map cracking (thermal - shrinkage - DEF- ASR)				1	1						1			1			0.17
	Weathering			1			1					1			1			0.155
	Vegetation on surface				1	1					1			1				0.2025
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1		1						1				1		0.225
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1						1			1			0.23
	Vertical cracks (settlement)				1	1						1			1			0.17
	Vertical cracks (thermal - shrinkage cracks)				1	1						1			1			0.17
	Map cracking (thermal - shrinkage - DEF - ASR)				1	1						1			1			0.17
	Weathering			1		1						1			1			0.23
	Vegetation on surface				1	1						1			1			0.17

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1					1			1				0.3825
	Horizontal cracks indicating development of tensile stress			1				1				1				1		0.1
	Vertical cracks indicating settlement			1				1					1				1	0.085
	Lateral movement of abutment wall				1				1			1				1		0.015
	Vertical deformations of abutment wall			1					1			1				1		0.075
	Vegetation on surface		1			1					1			1				0.3825
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1				1		0.15
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1				1		0.15
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Vertical cracks (settlement)			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF- ASR)				1		1					1				1		0.09
	Weathering			1			1					1			1			0.155
	Vegetation on surface				1	1					1			1				0.2025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1		1			0.0925
	Vertical cracks (settlement)			1				1					1		1			0.0925
	Vertical cracks (thermal - shrinkage cracks)				1			1					1			1		0.0275
	Map cracking (thermal - shrinkage - DEF - ASR)				1			1					1			1		0.0275
	Weathering			1			1					1			1			0.155
	Vegetation on surface				1	1					1			1				0.2025
Rubble Wing wall	Mortar dislocation leading to soil passing through			1		1					1			1				0.2625
	Horizontal cracks indicating development of tensile stress			1				1				1			1			0.105
	Vertical cracks indicating settlement			1				1				1			1			0.105
	Lateral movement of abutment wall				1				1			1					1	0.0125
	Vertical deformations of abutment wall			1					1			1				1		0.075
	Vegetation on surface			1		1					1			1				0.2625
Abutment capping beam	Corrosion of reinforcement due to depassivation			1		1						1				1		0.225
	Flexural crack at mid-span			1			1					1					1	0.1475
	Single cracks at mid-span (shrinkage)				1		1						1				1	0.075
	Cracks closer to supports (shear cracks)		1				1					1					1	0.2675
	Torsional cracks			1			1					1					1	0.1475
	Map cracking (thermal - shrinkage - DEF - ASR)		1			1						1			1			0.35
	Vegetation on surface				1	1					1			1				0.2025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1				1				1				1		0.1
	Excessive distortion of neoprene layer			1			1					1				1		0.15
	Corrosion of the metallic accessories			1				1				1				1		0.1
	Deterioration of the teflon layer			1				1				1				1		0.1
	Excessive movement			1				1			1				1			0.13
Concrete hinge bearing at abutment	Crushing of concrete			1			1					1				1		0.15
	Corrosion of reinforcement			1			1						1			1		0.1375
Foundation	Scour at foundation	1					1				1				1			0.48
	Deterioration of foundation elements	1				1						1				1		0.525

Inspector- No 3		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1							1			1		0.2125
	Cracks at mid-span (moment cracks)	1				1							1		1			0.5175
	Cracks closer to supports (shear cracks)	1				1							1		1			0.5175
	Torsional cracks			1				1					1			1		0.0875
	Map cracking (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Vegitation on surface			1		1							1		1			0.2175
Girders	Corrosion of reinforcement due to depassivation			1		1							1			1		0.2125
	Flexural crack at mid-span	1				1							1			1		0.5125
	Single shrinkage crack at mid-span			1			1						1			1		0.1375
	Cracks closer to supports (shear cracks)	1				1							1			1		0.5125
	Torsional cracks		1			1							1			1		0.3325
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc		1				1				1				1			0.3
	Vegetation on surface			1				1					1		1			0.0925
Wearing surface	Cracking at expansion joint				1		1				1				1			0.12
	Pot holes, crocodile cracks and other damages				1		1			1					1			0.1575
	Flushing				1		1			1					1			0.1575
	Leakage through wearing surface				1		1					1				1		0.09
Expansion joint	Broken				1		1			1					1			0.1575
	Aged				1		1			1					1			0.1575
	Choked with debris				1		1					1			1			0.095

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1	1				1				0.09
	Misplacement of elements				1				1	1				1				0.09
Railing	Damaged elements				1				1				1	1				0.015
	Dislocation of elements				1				1				1	1				0.015
	Misplacement of elements				1				1				1	1				0.015
Drainage	Malfunction				1	1				1				1				0.24
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1		1							1			1		0.2125
	Horizontal cracks at pier bottom (flexural cracks)			1		1							1		1			0.2175
	Horizontal cracks at mid height of pier (flexural cracks)			1		1							1			1		0.2125
	Vertical cracks (settlement)			1		1							1			1		0.2125
	Vertical cracks (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Weathering		1			1							1		1			0.3375
	Vegetation on surface				1		1						1		1			0.0825

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation			1		1							1			1		0.2125
	Lateral movement of pier		1					1					1			1		0.2075
	Vertical deformations of pier		1					1					1			1		0.2075
	Horizontal cracks indicating development of tensile stress			1				1					1			1		0.0875
	Vertical cracks indicating settlement			1				1					1			1		0.0875
	Vegetation on surface				1	1							1		1			0.1575
Pier capping beam	Corrosion of reinforcement due to depassivation			1		1							1				1	0.21
	Flexural cracks at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)			1		1							1				1	0.21
	Torsional cracks			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface				1	1							1		1			0.1575
Elastomeric bearing at pier	Washed out			1			1						1				1	0.135
	Excessive distortion of neoprene layer			1			1						1				1	0.135
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the Teflon layer			1			1						1				1	0.135
	Excessive movement			1			1						1				1	0.135
Concrete hinge bearing at pier	Crushing of concrete			1		1							1				1	0.21
	Corrosion of reinforcement			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1		1							1			1		0.2125
	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1			1		0.2125
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1			1		0.2125
	Vertical cracks (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Vertical cracks (settlement)			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage - DEF- ASR)			1		1							1			1		0.2125
	Weathering			1		1							1			1		0.2125
	Vegetation on surface			1		1							1		1			0.2175
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1			1		0.2125
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1			1		0.2125
	Vertical cracks (settlement)			1		1							1			1		0.2125
	Vertical cracks (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Weathering			1		1							1			1		0.2125
	Vegetation on surface			1		1							1		1			0.2175

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through			1		1							1		1			0.2175
	Horizontal cracks indicating development of tensile stress			1		1							1		1			0.2175
	Vertical cracks indicating settlement			1		1							1		1			0.2175
	Lateral movement of abutment wall			1		1							1		1			0.2175
	Vertical deformations of abutment wall			1		1							1		1			0.2175
	Vegetation on surface			1		1							1		1			0.2175
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1		1							1		1			0.2175
	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1		1			0.2175
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1		1			0.2175
	Vertical cracks (thermal - shrinkage cracks)			1		1							1		1			0.2175
	Vertical cracks (settlement)			1		1							1		1			0.2175
	Map cracking (thermal - shrinkage - DEF- ASR)			1		1							1		1			0.2175
	Weathering			1		1							1		1			0.2175
	Vegetation on surface			1		1							1		1			0.2175

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1			1		0.2125
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1			1		0.2125
	Vertical cracks (settlement)			1		1							1			1		0.2125
	Vertical cracks (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Weathering			1		1							1			1		0.2125
	Vegetation on surface			1		1							1		1			0.2175
Rubble Wing wall	Mortar dislocation leading to soil passing through			1		1							1		1			0.2175
	Horizontal cracks indicating development of tensile stress			1		1							1		1			0.2175
	Vertical cracks indicating settlement			1		1							1		1			0.2175
	Lateral movement of abutment wall			1		1							1		1			0.2175
	Vertical deformations of abutment wall			1		1							1		1			0.2175
	Vegetation on surface			1		1							1		1			0.2175
Abutment capping beam	Corrosion of reinforcement due to depassivation			1		1							1				1	0.21
	Flexural crack at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)			1		1							1				1	0.21
	Torsional cracks			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface				1	1							1		1			0.1575

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1			1						1				1	0.135
	Excessive distortion of neoprene layer			1			1						1				1	0.135
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the teflon layer			1			1						1				1	0.135
	Excessive movement			1			1						1				1	0.135
Concrete hinge bearing at abutment	Crushing of concrete		1			1						1					1	0.3425
	Corrosion of reinforcement		1			1						1					1	0.3425
Foundation	Scour at foundation		1			1							1			1		0.3325
	Deterioration of foundation elements		1			1							1			1		0.3325

Inspector- No 4		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Cracks at mid-span (moment cracks)	1				1							1				1	0.51
	Cracks closer to supports (shear cracks)	1				1							1			1		0.5125
	Torsional cracks		1			1							1			1		0.3325
	Map cracking (thermal - shrinkage cracks)			1			1						1				1	0.135
	Vegitation on surface			1			1						1	1				0.15
Girders	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Flexural crack at mid-span	1				1							1			1		0.5125
	Single shrinkage crack at mid-span		1				1						1				1	0.255
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks	1				1							1				1	0.51
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1						1					1	0.5225
	Vegetation on surface			1			1						1	1				0.15
Wearing surface	Cracking at expansion joint			1		1					1				1			0.255
	Pot holes, crocodile cracks and other damages			1			1			1				1				0.225
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface			1		1							1				1	0.21
Expansion joint	Broken			1		1				1				1				0.3
	Aged			1			1					1				1		0.15
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements			1			1			1				1				0.225
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1			1		1				0.0275
	Misplacement of elements				1				1			1		1				0.0275
Drainage	Malfunction			1				1		1				1				0.175
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1				1						1				1	0.255
	Horizontal cracks at pier bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of pier (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1				1						1				1	0.255
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1			1						1				1	0.135

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1			1							1				1	0.33
	Lateral movement of pier	1				1							1				1	0.51
	Vertical deformations of pier	1				1							1				1	0.51
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1				1						1				1	0.255
	Vegetation on surface			1			1						1				1	0.135
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1							1				1	0.51
	Flexural cracks at mid-span		1			1							1				1	0.33
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface			1			1						1				1	0.135
Elastomeric bearing at pier	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer		1			1						1				1		0.345
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the Teflon layer			1			1						1				1	0.135
	Excessive movement		1				1						1				1	0.255
Concrete hinge bearing at pier	Crushing of concrete	1				1					1					1		0.55
	Corrosion of reinforcement		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)		1			1							1			1		0.3325
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1		1							1				1	0.21
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1			1						1				1	0.135

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1		1							1				1	0.21
Rubble Wing wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Abutment capping beam	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Flexural crack at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1			1						1				1	0.135
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Vegetation on surface		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer			1			1						1				1	0.135
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the teflon layer		1			1							1				1	0.33
	Excessive movement			1				1				1					1	0.0975
Concrete hinge bearing at abutment	Crushing of concrete	1				1						1				1		0.525
	Corrosion of reinforcement		1			1							1				1	0.33
Foundation	Scour at foundation	1				1							1				1	0.51
	Deterioration of foundation elements		1			1							1				1	0.33

Inspector- No 5		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation	1				1						1			1			0.53
	Cracks at mid-span (moment cracks)		1			1						1			1			0.35
	Cracks closer to supports (shear cracks)		1			1						1				1		0.345
	Torsional cracks		1			1						1				1		0.345
	Map cracking (thermal - shrinkage cracks)		1			1						1			1			0.35
	Vegitation on surface			1			1					1		1				0.1625
Girders	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Flexural crack at mid-span		1				1					1				1		0.27
	Single shrinkage crack at mid-span			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)		1				1					1				1		0.27
	Torsional cracks		1				1					1				1		0.27
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1				1				1			1			0.105
	Vegetation on surface			1				1				1				1		0.1
Wearing surface	Cracking at expansion joint			1				1		1				1				0.175
	Pot holes, crocodile cracks and other damages			1				1			1			1				0.1375
	Flushing			1				1				1				1		0.1
	Leakage through wearing surface		1				1					1				1		0.27
Expansion joint	Broken			1			1			1				1				0.225
	Aged			1				1			1			1				0.1375
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1			1			1			1				0.0775
	Dislocation of elements				1			1			1			1				0.0775
	Misplacement of elements				1				1		1				1			0.045
Railing	Damaged elements				1				1		1				1			0.045
	Dislocation of elements				1				1		1				1			0.045
	Misplacement of elements				1				1		1				1			0.045
Drainage	Malfunction		1				1				1				1			0.3
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1					1				1			0.555
	Horizontal cracks at pier bottom (flexural cracks)	1				1						1				1		0.525
	Horizontal cracks at mid height of pier (flexural cracks)	1				1						1				1		0.525
	Vertical cracks (settlement)	1				1						1				1		0.525
	Vertical cracks (thermal - shrinkage cracks)		1				1						1				1	0.255
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1				1		0.27
	Weathering		1				1					1					1	0.2675
	Vegetation on surface			1				1					1				1	0.085

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1							1		1			0.5175
	Lateral movement of pier	1				1							1		1			0.5175
	Vertical deformations of pier	1				1					1				1			0.555
	Horizontal cracks indicating development of tensile stress		1				1				1				1			0.3
	Vertical cracks indicating settlement	1				1						1		1				0.5375
	Vegetation on surface		1				1					1				1		0.27
Pier capping beam	Corrosion of reinforcement due to depassivation			1			1				1					1		0.175
	Flexural cracks at mid-span		1				1					1				1		0.27
	Single cracks at mid-span (shrinkage)		1				1				1					1		0.295
	Cracks closer to supports (shear cracks)			1			1					1				1		0.15
	Torsional cracks			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1				1		0.15
	Vegetation on surface			1				1				1				1		0.1
Elastomeric bearing at pier	Washed out			1					1	1					1			0.1425
	Excessive distortion of neoprene layer				1				1		1					1		0.04
	Corrosion of the metallic accessories			1					1			1				1		0.075
	Deterioration of the Teflon layer			1				1				1				1		0.1
	Excessive movement		1					1			1				1			0.25
Concrete hinge bearing at pier	Crushing of concrete		1				1			1					1			0.3375
	Corrosion of reinforcement		1				1				1				1			0.3

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1				1				1				1			0.3
	Horizontal cracks at abutment bottom (flexural cracks)	1				1						1				1		0.525
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1						1				1		0.525
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Vertical cracks (settlement)	1				1					1					1		0.55
	Map cracking (thermal - shrinkage - DEF- ASR)	1				1					1					1		0.55
	Weathering		1				1					1				1		0.27
	Vegetation on surface			1				1				1					1	0.0975
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)		1				1				1				1			0.3
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1				1			0.3
	Vertical cracks (settlement)	1					1				1					1		0.475
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1				1		0.27
	Weathering		1				1					1				1		0.27
	Vegetation on surface			1				1				1				1		0.1

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1				1						1				1		0.525
	Horizontal cracks indicating development of tensile stress	1				1						1				1		0.525
	Vertical cracks indicating settlement	1				1					1					1		0.55
	Lateral movement of abutment wall	1				1					1				1			0.555
	Vertical deformations of abutment wall	1				1					1				1			0.555
	Vegetation on surface			1				1				1				1		0.1
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Horizontal cracks at abutment bottom (flexural cracks)	1				1					1					1		0.55
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1					1				1			0.555
	Vertical cracks (thermal - shrinkage cracks)		1				1				1				1			0.3
	Vertical cracks (settlement)	1				1					1					1		0.55
	Map cracking (thermal - shrinkage - DEF- ASR)	1				1					1				1			0.555
	Weathering		1				1					1				1		0.27
	Vegetation on surface			1				1				1				1		0.1

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)		1				1					1				1		0.27
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (settlement)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1				1				1				1		0.1
Rubble Wing wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress	1					1					1				1		0.45
	Vertical cracks indicating settlement	1					1					1				1		0.45
	Lateral movement of abutment wall		1				1					1				1		0.27
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1				1				1				1		0.1
Abutment capping beam	Corrosion of reinforcement due to depassivation	1					1				1				1			0.48
	Flexural crack at mid-span	1					1				1					1		0.475
	Single cracks at mid-span (shrinkage)		1				1					1				1		0.27
	Cracks closer to supports (shear cracks)		1				1				1					1		0.295
	Torsional cracks		1					1				1				1		0.22
	Map cracking (thermal - shrinkage - DEF - ASR)		1					1				1				1		0.22
	Vegetation on surface			1				1					1				1	0.085

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1			1					1				1		0.15
	Excessive distortion of neoprene layer			1				1			1				1			0.13
	Corrosion of the metallic accessories			1			1				1				1			0.18
	Deterioration of the teflon layer			1				1			1				1			0.13
	Excessive movement		1					1		1					1			0.2875
Concrete hinge bearing at abutment	Crushing of concrete		1				1				1				1			0.3
	Corrosion of reinforcement	1					1				1				1			0.48
Foundation	Scour at foundation	1				1				1				1				0.6
	Deterioration of foundation elements	1				1				1				1				0.6

Inspector- No 6

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1			1						1				1	0.135
	Cracks at mid-span (moment cracks)		1				1					1			1			0.275
	Cracks closer to supports (shear cracks)		1				1						1		1			0.2625
	Torsional cracks		1				1					1			1			0.275
	Map cracking (thermal - shrinkage cracks)			1				1					1				1	0.085
	Vegitation on surface			1				1				1		1				0.1125
Girders	Corrosion of reinforcement due to depassivation			1				1					1				1	0.085
	Flexural crack at mid-span		1				1					1			1			0.275
	Single shrinkage crack at mid-span			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)		1				1					1			1			0.275
	Torsional cracks		1				1					1				1		0.27
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc		1				1				1				1			0.3
	Vegetation on surface			1				1					1		1			0.0925
Wearing surface	Cracking at expansion joint			1				1			1				1			0.13
	Pot holes, crocodile cracks and other damages			1				1		1				1				0.175
	Flushing			1				1			1			1				0.1375
	Leakage through wearing surface			1				1				1				1		0.1
Expansion joint	Broken			1				1		1				1				0.175
	Aged			1				1			1				1			0.13
	Choked with debris			1				1			1				1			0.13

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements			1				1			1				1			0.13
	Dislocation of elements			1				1			1				1			0.13
	Misplacement of elements		1				1				1				1			0.3
Railing	Damaged elements			1				1			1				1			0.13
	Dislocation of elements			1				1			1				1			0.13
	Misplacement of elements			1				1			1				1			0.13
Drainage	Malfunction				1				1		1				1			0.045
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1				1						1		1			0.2625
	Horizontal cracks at pier bottom (flexural cracks)		1				1						1				1	0.255
	Horizontal cracks at mid height of pier (flexural cracks)		1				1						1			1		0.2575
	Vertical cracks (settlement)			1				1			1				1			0.13
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1					1			1		0.0875
	Weathering			1				1				1			1			0.105
	Vegetation on surface			1				1				1			1			0.105

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1				1					1			1			0.275
	Lateral movement of pier		1				1				1				1			0.3
	Vertical deformations of pier		1				1				1				1			0.3
	Horizontal cracks indicating development of tensile stress			1				1				1			1			0.105
	Vertical cracks indicating settlement			1				1			1				1			0.13
	Vegetation on surface			1				1				1			1			0.105
Pier capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural cracks at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1				1					1		1			0.0925
Elastomeric bearing at pier	Washed out			1				1			1					1		0.125
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1				1			1					1		0.125
	Deterioration of the Teflon layer			1				1			1					1		0.125
	Excessive movement			1				1			1					1		0.125
Concrete hinge bearing at pier	Crushing of concrete			1				1			1					1		0.125
	Corrosion of reinforcement			1				1			1					1		0.125

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1				1					1					1	0.2675
	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1			1			0.105
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1			1		0.0875
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Vertical cracks (settlement)			1				1			1				1			0.13
	Map cracking (thermal - shrinkage - DEF- ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1				1					1			1		0.0875
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1			1		0.0875
	Vertical cracks (settlement)		1				1						1			1		0.2575
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1					1			1		0.0875
	Weathering			1				1					1		1			0.0925
	Vegetation on surface			1				1					1		1			0.0925

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1				1					1			1			0.275
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1				1				1			0.3
	Lateral movement of abutment wall		1				1				1				1			0.3
	Vertical deformations of abutment wall		1				1				1				1			0.3
	Vegetation on surface			1				1					1		1			0.0925
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1				1					1			1		0.0875
	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1			1		0.0875
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Vertical cracks (settlement)			1				1					1		1			0.0925
	Map cracking (thermal - shrinkage - DEF- ASR)			1				1					1		1			0.0925
	Weathering			1				1					1		1			0.0925
	Vegetation on surface			1				1					1		1			0.0925

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1			1		0.0875
	Vertical cracks (settlement)			1				1					1			1		0.0875
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1					1			1		0.0875
	Weathering			1				1					1			1		0.0875
	Vegetation on surface			1				1					1			1		0.0875
Rubble Wing wall	Mortar dislocation leading to soil passing through			1				1					1		1			0.0925
	Horizontal cracks indicating development of tensile stress			1				1					1		1			0.0925
	Vertical cracks indicating settlement			1				1					1		1			0.0925
	Lateral movement of abutment wall			1				1					1		1			0.0925
	Vertical deformations of abutment wall			1				1					1		1			0.0925
	Vegetation on surface			1				1					1		1			0.0925
Abutment capping beam	Corrosion of reinforcement due to depassivation		1				1					1				1		0.27
	Flexural crack at mid-span		1				1					1				1		0.27
	Single cracks at mid-span (shrinkage)		1				1					1				1		0.27
	Cracks closer to supports (shear cracks)		1				1					1				1		0.27
	Torsional cracks		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1				1					1			1		0.0875

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1				1				1					1	0.0975
	Excessive distortion of neoprene layer		1				1					1					1	0.2675
	Corrosion of the metallic accessories			1				1				1					1	0.0975
	Deterioration of the teflon layer			1				1				1					1	0.0975
	Excessive movement		1				1					1					1	0.2675
Concrete hinge bearing at abutment	Crushing of concrete			1				1					1				1	0.085
	Corrosion of reinforcement			1				1					1				1	0.085
Foundation	Scour at foundation			1				1					1				1	0.085
	Deterioration of foundation elements			1				1					1				1	0.085

Inspector- No 7		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1							1			1		0.2125
	Cracks at mid-span (moment cracks)		1			1							1				1	0.33
	Cracks closer to supports (shear cracks)	1				1							1			1		0.5125
	Torsional cracks		1			1							1			1		0.3325
	Map cracking (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vegitation on surface			1		1							1	1				0.225
Girders	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Flexural crack at mid-span	1				1							1			1		0.5125
	Single shrinkage crack at mid-span		1			1							1				1	0.33
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks	1				1							1				1	0.51
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1						1					1	0.5225
	Vegetation on surface			1			1						1	1				0.15
Wearing surface	Cracking at expansion joint			1		1					1				1			0.255
	Pot holes, crocodile cracks and other damages			1			1			1				1				0.225
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface			1		1							1				1	0.21
Expansion joint	Broken			1		1				1				1				0.3
	Aged			1			1					1				1		0.15
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements			1				1		1				1				0.175
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1			1		1				0.0275
	Misplacement of elements				1				1			1		1				0.0275
Drainage	Malfunction			1				1		1				1				0.175
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1				1						1				1	0.255
	Horizontal cracks at pier bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of pier (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1			1						1				1	0.135

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1			1							1				1	0.33
	Lateral movement of pier	1				1							1				1	0.51
	Vertical deformations of pier	1				1							1				1	0.51
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1				1						1				1	0.255
	Vegetation on surface			1			1						1				1	0.135
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1							1				1	0.51
	Flexural cracks at mid-span		1			1							1				1	0.33
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface			1			1						1				1	0.135
Elastomeric bearing at pier	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer		1			1						1				1		0.345
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the Teflon layer			1			1						1				1	0.135
	Excessive movement		1				1						1				1	0.255
Concrete hinge bearing at pier	Crushing of concrete	1				1					1					1		0.55
	Corrosion of reinforcement		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)		1			1							1			1		0.3325
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1		1							1				1	0.21
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1			1						1				1	0.135

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1		1							1				1	0.21
Rubble Wing wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Abutment capping beam	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Flexural crack at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1			1						1				1	0.135
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Vegetation on surface		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer			1			1						1				1	0.135
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the teflon layer		1			1							1				1	0.33
	Excessive movement			1				1				1					1	0.0975
Concrete hinge bearing at abutment	Crushing of concrete	1				1						1				1		0.525
	Corrosion of reinforcement		1			1							1				1	0.33
Foundation	Scour at foundation	1				1							1				1	0.51
	Deterioration of foundation elements		1			1							1				1	0.33

Inspector- No 8		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1							1	1				0.225
	Cracks at mid-span (moment cracks)			1		1					1			1				0.2625
	Cracks closer to supports (shear cracks)		1			1							1	1				0.345
	Torsional cracks			1		1							1	1				0.225
	Map cracking (thermal - shrinkage cracks)			1		1							1	1				0.225
	Vegitation on surface				1		1						1	1				0.09
Girders	Corrosion of reinforcement due to depassivation			1		1							1	1				0.225
	Flexural crack at mid-span			1		1						1		1				0.2375
	Single shrinkage crack at mid-span			1		1							1	1				0.225
	Cracks closer to supports (shear cracks)		1			1							1	1				0.345
	Torsional cracks			1		1							1	1				0.225
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1			1					1				1		0.15
	Vegetation on surface				1			1					1	1				0.04
Wearing surface	Cracking at expansion joint				1	1				1					1			0.2325
	Pot holes, crocodile cracks and other damages				1			1		1				1				0.115
	Flushing				1			1			1				1			0.07
	Leakage through wearing surface			1			1				1				1			0.18
Expansion joint	Broken				1	1				1					1			0.2325
	Aged				1		1						1				1	0.075
	Choked with debris				1		1						1				1	0.075

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1				1		1				1			0.045
	Dislocation of elements				1				1		1				1			0.045
	Misplacement of elements				1				1		1				1			0.045
Railing	Damaged elements				1				1			1		1				0.0275
	Dislocation of elements				1				1				1	1				0.015
	Misplacement of elements				1				1				1	1				0.015
Drainage	Malfunction				1			1			1				1			0.07
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1		1							1		1			0.2175
	Horizontal cracks at pier bottom (flexural cracks)		1			1							1		1			0.3375
	Horizontal cracks at mid height of pier (flexural cracks)		1			1							1		1			0.3375
	Vertical cracks (settlement)		1			1							1		1			0.3375
	Vertical cracks (thermal - shrinkage cracks)		1			1							1		1			0.3375
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1	1				0.225
	Weathering			1				1					1		1			0.0925
	Vegetation on surface				1			1					1		1			0.0325

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1			1							1		1			0.3375
	Lateral movement of pier	1					1					1		1				0.4625
	Vertical deformations of pier	1					1						1		1			0.4425
	Horizontal cracks indicating development of tensile stress		1				1						1		1			0.2625
	Vertical cracks indicating settlement	1					1						1		1			0.4425
	Vegetation on surface				1	1							1	1				0.165
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1							1		1			0.5175
	Flexural cracks at mid-span		1			1							1		1			0.3375
	Single cracks at mid-span (shrinkage)			1		1							1		1			0.2175
	Cracks closer to supports (shear cracks)		1			1							1		1			0.3375
	Torsional cracks		1			1							1		1			0.3375
	Map cracking (thermal - shrinkage - DEF - ASR)	1				1							1		1			0.5175
	Vegetation on surface				1			1					1		1			0.0325
Elastomeric bearing at pier	Washed out		1			1							1				1	0.33
	Excessive distortion of neoprene layer			1		1							1				1	0.21
	Corrosion of the metallic accessories			1		1							1				1	0.21
	Deterioration of the Teflon layer			1		1							1				1	0.21
	Excessive movement			1		1							1				1	0.21
Concrete hinge bearing at pier	Crushing of concrete			1		1							1				1	0.21
	Corrosion of reinforcement			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1			1						1		1			0.1425
	Horizontal cracks at abutment bottom (flexural cracks)			1			1						1		1			0.1425
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1						1		1			0.1425
	Vertical cracks (thermal - shrinkage cracks)				1		1						1		1			0.0825
	Vertical cracks (settlement)	1					1						1	1				0.45
	Map cracking (thermal - shrinkage - DEF- ASR)	1					1						1	1				0.45
	Weathering			1				1					1		1			0.0925
	Vegetation on surface				1			1					1		1			0.0325
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1		1			0.0925
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1		1			0.0925
	Vertical cracks (settlement)			1			1						1			1		0.1375
	Vertical cracks (thermal - shrinkage cracks)			1			1						1			1		0.1375
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1			1		0.1375
	Weathering			1				1					1			1		0.0875
	Vegetation on surface				1			1					1			1		0.0275

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through			1			1					1				1		0.15
	Horizontal cracks indicating development of tensile stress			1				1				1				1		0.1
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall			1				1				1				1		0.1
	Vertical deformations of abutment wall		1					1					1			1		0.2075
	Vegetation on surface		1				1						1		1			0.2625
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1			1							1	1				0.345
	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1			1		0.2125
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1			1		0.2125
	Vertical cracks (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Vertical cracks (settlement)			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1							1		1			0.3375
	Weathering				1			1					1			1		0.0275
	Vegetation on surface				1				1				1			1		0.0025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1					1			1		0.0875
	Vertical cracks (settlement)			1				1					1			1		0.0875
	Vertical cracks (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1		1			0.1425
	Weathering				1				1				1					0
	Vegetation on surface				1				1				1				1	0
Rubble Wing wall	Mortar dislocation leading to soil passing through			1			1					1				1		0.15
	Horizontal cracks indicating development of tensile stress			1			1						1			1		0.1375
	Vertical cracks indicating settlement		1			1							1			1		0.3325
	Lateral movement of abutment wall			1			1						1			1		0.1375
	Vertical deformations of abutment wall		1				1						1			1		0.2575
	Vegetation on surface		1					1					1			1		0.2075
Abutment capping beam	Corrosion of reinforcement due to depassivation			1			1						1			1		0.1375
	Flexural crack at mid-span			1			1						1			1		0.1375
	Single cracks at mid-span (shrinkage)			1			1						1			1		0.1375
	Cracks closer to supports (shear cracks)		1				1						1			1		0.2575
	Torsional cracks		1				1						1			1		0.2575
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1						1			1		0.2575
	Vegetation on surface			1				1					1			1		0.0875

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out		1			1					1						1	0.3675
	Excessive distortion of neoprene layer		1			1							1				1	0.33
	Corrosion of the metallic accessories		1			1							1				1	0.33
	Deterioration of the teflon layer		1			1							1				1	0.33
	Excessive movement		1			1							1				1	0.33
Concrete hinge bearing at abutment	Crushing of concrete		1			1							1				1	0.33
	Corrosion of reinforcement		1			1							1				1	0.33
Foundation	Scour at foundation	1				1							1	1				0.525
	Deterioration of foundation elements	1				1							1	1				0.525

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		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1				1					1			1			0.275
	Cracks at mid-span (moment cracks)		1				1					1			1			0.275
	Cracks closer to supports (shear cracks)		1				1					1			1			0.275
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vegitation on surface				1				1			1				1		0.015
Girders	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Flexural crack at mid-span			1				1				1					1	0.0975
	Single shrinkage crack at mid-span			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1			1				1					1		0.175
	Vegetation on surface				1			1					1		1			0.0325
Wearing surface	Cracking at expansion joint			1				1			1					1		0.125
	Pot holes, crocodile cracks and other damages			1				1			1				1			0.13
	Flushing			1				1			1				1			0.13
	Leakage through wearing surface			1				1				1				1		0.1
Expansion joint	Broken		1				1				1				1			0.3
	Aged		1				1				1				1			0.3
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Side walk	Damaged elements				1				1			1				1		0.015
	Dislocation of elements				1				1			1				1		0.015
	Misplacement of elements				1				1			1				1		0.015
Railing	Damaged elements				1				1			1			1			0.02
	Dislocation of elements				1				1			1			1			0.02
	Misplacement of elements				1				1			1			1			0.02
Drainage	Malfunction			1				1					1			1		0.0875
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1				1					1			1		0.0875
	Horizontal cracks at pier bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of pier (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1				1					1				1		0.27
	Lateral movement of pier	1				1					1					1		0.55
	Vertical deformations of pier	1				1					1					1		0.55
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1				1					1		0.295
	Vegetation on surface				1			1					1		1			0.0325
Pier capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural cracks at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface				1				1				1			1		0.0025
Elastomeric bearing at pier	Washed out			1				1				1				1		0.1
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1				1				1				1		0.1
	Deterioration of the Teflon layer			1				1				1				1		0.1
	Excessive movement		1				1				1					1		0.295
Concrete hinge bearing at pier	Crushing of concrete			1				1				1					1	0.0975
	Corrosion of reinforcement			1				1				1					1	0.0975

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1				1					1			1		0.0875
	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)		1				1				1					1		0.295
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1				1					1		0.175
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1			1					1			1		0.0275
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1					1		0.295
	Vertical cracks (settlement)		1				1				1					1		0.295
	Vertical cracks (thermal - shrinkage cracks)		1				1				1					1		0.295
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1				1					1				1		0.27
	Horizontal cracks indicating development of tensile stress		1				1				1					1		0.295
	Vertical cracks indicating settlement	1					1				1					1		0.475
	Lateral movement of abutment wall	1					1				1					1		0.475
	Vertical deformations of abutment wall	1					1					1				1		0.45
	Vegetation on surface				1				1				1			1		0.0025
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF- ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)		1				1					1			1			0.275
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1				1		0.27
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015
Rubble Wing wall	Mortar dislocation leading to soil passing through		1					1				1				1		0.22
	Horizontal cracks indicating development of tensile stress		1					1				1				1		0.22
	Vertical cracks indicating settlement		1					1				1				1		0.22
	Lateral movement of abutment wall		1					1				1				1		0.22
	Vertical deformations of abutment wall		1					1				1				1		0.22
	Vegetation on surface				1				1			1			1			0.02
Abutment capping beam	Corrosion of reinforcement due to depassivation		1					1				1				1		0.22
	Flexural crack at mid-span		1					1				1				1		0.22
	Single cracks at mid-span (shrinkage)			1				1			1					1		0.125
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface				1				1			1			1			0.02

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1				1				1					1	0.0975
	Excessive distortion of neoprene layer			1				1				1					1	0.0975
	Corrosion of the metallic accessories			1				1				1					1	0.0975
	Deterioration of the teflon layer			1				1				1					1	0.0975
	Excessive movement		1				1					1					1	0.2675
Concrete hinge bearing at abutment	Crushing of concrete		1				1					1				1		0.27
	Corrosion of reinforcement		1				1					1				1		0.27
Foundation	Scour at foundation		1				1					1				1		0.27
	Deterioration of foundation elements		1				1					1				1		0.27

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		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation	1				1					1			1				0.5625
	Cracks at mid-span (moment cracks)			1		1				1				1				0.3
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks			1				1				1			1			0.105
	Map cracking (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Vegitation on surface			1		1				1				1				0.3
Girders	Corrosion of reinforcement due to depassivation	1				1				1					1			0.5925
	Flexural crack at mid-span	1				1				1					1			0.5925
	Single shrinkage crack at mid-span				1			1				1					1	0.0375
	Cracks closer to supports (shear cracks)	1				1					1			1				0.5625
	Torsional cracks		1			1					1			1				0.3825
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1				1				1				0.6
	Vegetation on surface		1			1						1		1				0.3575
Wearing surface	Cracking at expansion joint			1		1				1				1				0.3
	Pot holes, crocodile cracks and other damages			1		1				1				1				0.3
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface				1			1					1				1	0.025
Expansion joint	Broken	1				1				1				1				0.6
	Aged		1			1					1				1			0.375
	Choked with debris	1				1				1				1				0.6

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements			1			1			1				1				0.225
	Dislocation of elements			1			1			1				1				0.225
	Misplacement of elements		1			1				1				1				0.42
Railing	Damaged elements			1		1				1				1				0.3
	Dislocation of elements			1		1				1				1				0.3
	Misplacement of elements		1			1				1				1				0.42
Drainage	Malfunction				1		1			1				1				0.165
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1						1			1			0.53
	Horizontal cracks at pier bottom (flexural cracks)	1				1					1					1		0.55
	Horizontal cracks at mid height of pier (flexural cracks)				1		1						1			1		0.0775
	Vertical cracks (settlement)		1				1						1		1			0.2625
	Vertical cracks (thermal - shrinkage cracks)		1				1						1		1			0.2625
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1		1			0.1425
	Weathering		1				1						1		1			0.2625
	Vegetation on surface			1		1					1					1		0.25

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1					1			1				0.5625
	Lateral movement of pier	1				1					1			1				0.5625
	Vertical deformations of pier		1				1			1					1			0.3375
	Horizontal cracks indicating development of tensile stress			1			1					1			1			0.155
	Vertical cracks indicating settlement	1				1				1				1				0.6
	Vegetation on surface			1			1				1			1				0.1875
Pier capping beam	Corrosion of reinforcement due to depassivation			1		1							1		1			0.2175
	Flexural cracks at mid-span		1			1							1			1		0.3325
	Single cracks at mid-span (shrinkage)				1			1					1				1	0.025
	Cracks closer to supports (shear cracks)		1			1							1				1	0.33
	Torsional cracks				1	1							1			1		0.1525
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1						1		1				0.2375
	Vegetation on surface		1			1				1				1				0.42
Elastomeric bearing at pier	Washed out			1		1				1					1			0.2925
	Excessive distortion of neoprene layer				1	1				1					1			0.2325
	Corrosion of the metallic accessories				1	1				1				1				0.24
	Deterioration of the Teflon layer				1	1				1				1				0.24
	Excessive movement	1				1				1				1				0.6
Concrete hinge bearing at pier	Crushing of concrete		1				1			1						1		0.3325
	Corrosion of reinforcement	1					1			1						1		0.5125

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1						1			1			0.35
	Horizontal cracks at abutment bottom (flexural cracks)	1				1						1		1				0.5375
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1						1		1				0.5375
	Vertical cracks (thermal - shrinkage cracks)				1			1					1	1				0.04
	Vertical cracks (settlement)	1						1		1				1				0.475
	Map cracking (thermal - shrinkage - DEF- ASR)				1	1							1	1				0.165
	Weathering			1		1				1				1				0.3
	Vegetation on surface			1		1				1				1				0.3
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1				1				1				1				0.6
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1						1			1			0.53
	Vertical cracks (settlement)	1				1						1			1			0.53
	Vertical cracks (thermal - shrinkage cracks)				1			1					1		1			0.0325
	Map cracking (thermal - shrinkage - DEF - ASR)				1			1					1		1			0.0325
	Weathering	1				1					1			1				0.5625
	Vegetation on surface	1				1							1	1				0.525

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1				1						1				1		0.525
	Horizontal cracks indicating development of tensile stress	1				1						1				1		0.525
	Vertical cracks indicating settlement	1				1						1				1		0.525
	Lateral movement of abutment wall	1				1				1				1				0.6
	Vertical deformations of abutment wall	1				1				1				1				0.6
	Vegetation on surface		1				1			1				1				0.345
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1				1						1		1			0.2625
	Horizontal cracks at abutment bottom (flexural cracks)		1				1					1			1			0.275
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1						1			1			0.53
	Vertical cracks (thermal - shrinkage cracks)		1					1					1		1			0.2125
	Vertical cracks (settlement)		1					1					1		1			0.2125
	Map cracking (thermal - shrinkage - DEF- ASR)			1				1					1		1			0.0925
	Weathering		1				1					1			1			0.275
	Vegetation on surface			1			1					1			1			0.155

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1			1				1			0.13
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1			1			0.105
	Vertical cracks (settlement)				1				1		1					1		0.04
	Vertical cracks (thermal - shrinkage cracks)			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)				1				1				1		1			0.0075
	Weathering				1			1					1			1		0.0275
	Vegetation on surface		1			1				1				1				0.42
Rubble Wing wall	Mortar dislocation leading to soil passing through	1				1						1		1				0.5375
	Horizontal cracks indicating development of tensile stress			1				1					1			1		0.0875
	Vertical cracks indicating settlement		1			1				1					1			0.4125
	Lateral movement of abutment wall		1			1				1				1				0.42
	Vertical deformations of abutment wall	1				1				1				1				0.6
	Vegetation on surface				1		1			1				1				0.165
Abutment capping beam	Corrosion of reinforcement due to depassivation	1				1						1					1	0.5225
	Flexural crack at mid-span	1				1						1					1	0.5225
	Single cracks at mid-span (shrinkage)				1			1					1				1	0.025
	Cracks closer to supports (shear cracks)			1				1					1				1	0.085
	Torsional cracks			1				1					1				1	0.085
	Map cracking (thermal - shrinkage - DEF - ASR)			1					1				1				1	0.06
	Vegetation on surface		1					1		1				1				0.295

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out	1				1				1							1	0.585
	Excessive distortion of neoprene layer	1				1				1						1		0.5875
	Corrosion of the metallic accessories		1				1					1				1		0.27
	Deterioration of the teflon layer		1				1					1				1		0.27
	Excessive movement			1			1			1							1	0.21
Concrete hinge bearing at abutment	Crushing of concrete	1				1				1							1	0.585
	Corrosion of reinforcement	1				1				1							1	0.585
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements			1					1			1			1			0.08

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		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Cracks at mid-span (moment cracks)		1			1							1			1		0.3325
	Cracks closer to supports (shear cracks)		1			1							1			1		0.3325
	Torsional cracks			1		1							1			1		0.2125
	Map cracking (thermal - shrinkage cracks)			1		1							1			1		0.2125
	Vegitation on surface				1		1			1				1				0.165
Girders	Corrosion of reinforcement due to depassivation	1				1							1				1	0.51
	Flexural crack at mid-span			1		1							1				1	0.21
	Single shrinkage crack at mid-span			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)			1		1							1				1	0.21
	Torsional cracks			1		1							1				1	0.21
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc		1				1				1						1	0.2925
	Vegetation on surface				1	1							1				1	0.15
Wearing surface	Cracking at expansion joint				1				1	1				1				0.09
	Pot holes, crocodile cracks and other damages				1		1			1				1				0.165
	Flushing				1		1			1				1				0.165
	Leakage through wearing surface			1			1						1	1				0.15
Expansion joint	Broken				1			1		1					1			0.1075
	Aged				1			1		1					1			0.1075
	Choked with debris				1			1		1					1			0.1075

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1				1				1	1				0.015
	Dislocation of elements				1				1				1	1				0.015
	Misplacement of elements				1				1				1	1				0.015
Railing	Damaged elements				1				1				1				1	0
	Dislocation of elements				1				1				1				1	0
	Misplacement of elements				1				1				1				1	0
Drainage	Malfunction		1				1			1							1	0.33
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at pier bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of pier (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)		1			1							1				1	0.33
	Weathering		1			1							1				1	0.33
	Vegetation on surface		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1						1				1		0.525
	Lateral movement of pier	1				1						1				1		0.525
	Vertical deformations of pier	1				1						1				1		0.525
	Horizontal cracks indicating development of tensile stress	1				1						1				1		0.525
	Vertical cracks indicating settlement	1				1						1				1		0.525
	Vegetation on surface				1	1						1				1		0.165
Pier capping beam	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Flexural cracks at mid-span		1			1							1				1	0.33
	Single cracks at mid-span (shrinkage)		1			1							1				1	0.33
	Cracks closer to supports (shear cracks)		1			1							1				1	0.33
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)		1			1							1				1	0.33
	Vegetation on surface		1			1							1				1	0.33
Elastomeric bearing at pier	Washed out			1			1					1					1	0.1475
	Excessive distortion of neoprene layer			1			1					1				1		0.15
	Corrosion of the metallic accessories			1			1					1				1		0.15
	Deterioration of the Teflon layer		1				1					1				1		0.27
	Excessive movement			1			1					1				1		0.15
Concrete hinge bearing at pier	Crushing of concrete			1			1					1				1		0.15
	Corrosion of reinforcement			1			1					1				1		0.15

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1							1				1	0.33
	Weathering		1			1							1				1	0.33
	Vegetation on surface				1	1							1				1	0.15
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)			1				1					1				1	0.085
	Vertical cracks (thermal - shrinkage cracks)			1				1					1				1	0.085
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1					1				1	0.085
	Weathering		1			1							1				1	0.33
	Vegetation on surface			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1							1				1	0.33
	Horizontal cracks indicating development of tensile stress		1			1							1				1	0.33
	Vertical cracks indicating settlement		1				1						1				1	0.255
	Lateral movement of abutment wall	1					1						1				1	0.435
	Vertical deformations of abutment wall		1						1				1				1	0.18
	Vegetation on surface				1	1							1				1	0.15
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1							1				1	0.33
	Weathering		1			1							1				1	0.33
	Vegetation on surface		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1		1							1				1	0.21
	Horizontal cracks at mid height of abutment (flexural cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)			1		1							1				1	0.21
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Weathering		1			1							1				1	0.33
	Vegetation on surface			1		1							1				1	0.21
Rubble Wing wall	Mortar dislocation leading to soil passing through			1		1							1				1	0.21
	Horizontal cracks indicating development of tensile stress			1		1							1				1	0.21
	Vertical cracks indicating settlement			1		1							1				1	0.21
	Lateral movement of abutment wall			1		1							1				1	0.21
	Vertical deformations of abutment wall			1		1							1				1	0.21
	Vegetation on surface			1		1							1				1	0.21
Abutment capping beam	Corrosion of reinforcement due to depassivation	1				1							1				1	0.51
	Flexural crack at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)			1		1							1				1	0.21
	Torsional cracks			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1		1						1				1		0.225
	Excessive distortion of neoprene layer			1		1						1				1		0.225
	Corrosion of the metallic accessories			1		1						1				1		0.225
	Deterioration of the teflon layer		1			1						1				1		0.345
	Excessive movement			1		1						1				1		0.225
Concrete hinge bearing at abutment	Crushing of concrete			1			1					1				1		0.15
	Corrosion of reinforcement			1			1					1				1		0.15
Foundation	Scour at foundation	1							1	1				1				0.45
	Deterioration of foundation elements		1						1	1				1				0.27

Inspector- No 12		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1			1					1			1			0.155
	Cracks at mid-span (moment cracks)		1			1				1				1				0.42
	Cracks closer to supports (shear cracks)		1			1					1				1			0.375
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage cracks)			1				1					1			1		0.0875
	Vegitation on surface		1			1				1				1				0.42
Girders	Corrosion of reinforcement due to depassivation			1				1				1			1			0.105
	Flexural crack at mid-span		1				1					1			1			0.275
	Single shrinkage crack at mid-span				1			1				1				1		0.04
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1				1		1				1				0.175
	Vegetation on surface		1			1				1				1				0.42
Wearing surface	Cracking at expansion joint		1				1				1			1				0.3075
	Pot holes, crocodile cracks and other damages			1		1				1				1				0.3
	Flushing			1		1				1				1				0.3
	Leakage through wearing surface		1			1						1				1		0.345
Expansion joint	Broken		1			1				1				1				0.42
	Aged			1				1				1				1		0.1
	Choked with debris		1				1				1				1			0.3

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements		1			1				1				1				0.42
	Dislocation of elements		1				1			1				1				0.345
	Misplacement of elements		1				1			1				1				0.345
Railing	Damaged elements		1				1			1				1				0.345
	Dislocation of elements		1				1			1				1				0.345
	Misplacement of elements		1				1			1				1				0.345
Drainage	Malfunction	1				1				1				1				0.6
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1				1					1			1			0.275
	Horizontal cracks at pier bottom (flexural cracks)	1				1						1		1				0.5375
	Horizontal cracks at mid height of pier (flexural cracks)	1				1						1		1				0.5375
	Vertical cracks (settlement)	1				1						1		1				0.5375
	Vertical cracks (thermal - shrinkage cracks)			1			1					1		1				0.1625
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1		1				0.1625
	Weathering		1				1					1		1				0.2825
	Vegetation on surface			1			1				1			1				0.1875

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1				1				1			1				0.3075
	Lateral movement of pier	1				1				1				1				0.6
	Vertical deformations of pier		1			1					1			1				0.3825
	Horizontal cracks indicating development of tensile stress		1			1					1			1				0.3825
	Vertical cracks indicating settlement		1			1					1			1				0.3825
	Vegetation on surface		1			1					1			1				0.3825
Pier capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural cracks at mid-span		1			1					1			1				0.3825
	Single cracks at mid-span (shrinkage)		1			1						1				1		0.345
	Cracks closer to supports (shear cracks)		1			1						1				1		0.345
	Torsional cracks			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1			1			0.105
	Vegetation on surface		1				1				1			1				0.3075
Elastomeric bearing at pier	Washed out		1				1				1			1				0.3075
	Excessive distortion of neoprene layer		1				1				1			1				0.3075
	Corrosion of the metallic accessories		1				1				1			1				0.3075
	Deterioration of the Teflon layer		1				1				1			1				0.3075
	Excessive movement	1					1				1			1				0.4875
Concrete hinge bearing at pier	Crushing of concrete		1				1				1			1				0.3075
	Corrosion of reinforcement			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1			1					1			1			0.155
	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1			1			0.155
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1			1			0.155
	Vertical cracks (thermal - shrinkage cracks)			1			1					1			1			0.155
	Vertical cracks (settlement)		1			1						1			1			0.35
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1						1		1				0.3575
	Weathering			1			1				1			1				0.1875
	Vegetation on surface		1			1						1		1				0.3575
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)		1			1						1		1				0.3575
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1						1		1				0.3575
	Vertical cracks (settlement)		1			1						1		1				0.3575
	Vertical cracks (thermal - shrinkage cracks)		1			1						1		1				0.3575
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1		1				0.1625
	Weathering		1			1						1		1				0.3575
	Vegetation on surface		1				1					1		1				0.2825

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1				1				1			1				0.3075
	Horizontal cracks indicating development of tensile stress		1			1					1			1				0.3825
	Vertical cracks indicating settlement		1			1					1			1				0.3825
	Lateral movement of abutment wall		1			1					1			1				0.3825
	Vertical deformations of abutment wall			1				1			1			1				0.1375
	Vegetation on surface			1			1				1			1				0.1875
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1			1					1			1			0.155
	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1			1			0.155
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1			1			0.155
	Vertical cracks (thermal - shrinkage cracks)			1			1					1			1			0.155
	Vertical cracks (settlement)			1			1					1			1			0.155
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1			1			0.155
	Weathering			1			1				1			1				0.1875
	Vegetation on surface			1			1				1			1				0.1875

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)		1				1				1			1				0.3075
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1			1				0.3075
	Vertical cracks (settlement)		1				1				1			1				0.3075
	Vertical cracks (thermal - shrinkage cracks)		1				1					1		1				0.2825
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1		1				0.2825
	Weathering		1				1					1		1				0.2825
	Vegetation on surface		1				1				1			1				0.3075
Rubble Wing wall	Mortar dislocation leading to soil passing through			1				1			1				1			0.13
	Horizontal cracks indicating development of tensile stress			1				1			1				1			0.13
	Vertical cracks indicating settlement			1				1			1				1			0.13
	Lateral movement of abutment wall		1				1				1			1				0.3075
	Vertical deformations of abutment wall			1				1			1			1				0.1375
	Vegetation on surface			1				1			1			1				0.1375
Abutment capping beam	Corrosion of reinforcement due to depassivation			1			1				1				1			0.18
	Flexural crack at mid-span		1			1					1			1				0.3825
	Single cracks at mid-span (shrinkage)			1			1				1			1				0.1875
	Cracks closer to supports (shear cracks)			1			1				1			1				0.1875
	Torsional cracks			1				1			1			1				0.1375
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1			1			1				0.1375
	Vegetation on surface			1			1			1				1				0.225

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out		1				1				1			1				0.3075
	Excessive distortion of neoprene layer		1				1				1			1				0.3075
	Corrosion of the metallic accessories		1				1				1			1				0.3075
	Deterioration of the teflon layer		1				1				1			1				0.3075
	Excessive movement		1			1					1			1				0.3825
Concrete hinge bearing at abutment	Crushing of concrete		1				1				1				1			0.3
	Corrosion of reinforcement		1				1				1				1			0.3
Foundation	Scour at foundation	1				1				1				1				0.6
	Deterioration of foundation elements	1				1				1				1				0.6

Inspector- No 13		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1					1			1				0.2625
	Cracks at mid-span (moment cracks)		1					1		1					1			0.2875
	Cracks closer to supports (shear cracks)	1					1				1				1			0.48
	Torsional cracks		1					1				1			1			0.225
	Map cracking (thermal - shrinkage cracks)			1		1						1		1				0.2375
	Vegitation on surface			1		1						1		1				0.2375
Girders	Corrosion of reinforcement due to depassivation	1						1				1			1			0.405
	Flexural crack at mid-span		1				1					1			1			0.275
	Single shrinkage crack at mid-span				1			1				1				1		0.04
	Cracks closer to supports (shear cracks)			1				1			1					1		0.125
	Torsional cracks			1				1			1					1		0.125
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1				1			1			1				0.1375
	Vegetation on surface			1			1					1			1			0.155
Wearing surface	Cracking at expansion joint				1			1			1				1			0.07
	Pot holes, crocodile cracks and other damages			1		1				1				1				0.3
	Flushing			1		1				1				1				0.3
	Leakage through wearing surface			1		1						1			1			0.23
Expansion joint	Broken			1				1		1				1				0.175
	Aged		1			1				1				1				0.42
	Choked with debris			1				1			1			1				0.1375

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Side walk	Damaged elements			1			1			1				1				0.225
	Dislocation of elements			1			1			1				1				0.225
	Misplacement of elements			1				1		1				1				0.175
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1	1				1				0.09
	Misplacement of elements				1			1			1			1				0.0775
Drainage	Malfunction			1			1				1			1				0.1875
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1						1			1			0.53
	Horizontal cracks at pier bottom (flexural cracks)	1				1						1			1			0.53
	Horizontal cracks at mid height of pier (flexural cracks)	1				1						1			1			0.53
	Vertical cracks (settlement)	1				1					1			1				0.5625
	Vertical cracks (thermal - shrinkage cracks)			1		1					1			1				0.2625
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1						1				1		0.225
	Weathering			1		1						1				1		0.225
	Vegetation on surface				1		1						1	1				0.09

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1				1				1				0.6
	Lateral movement of pier	1				1				1				1				0.6
	Vertical deformations of pier	1					1			1				1				0.525
	Horizontal cracks indicating development of tensile stress	1					1			1				1				0.525
	Vertical cracks indicating settlement	1					1			1				1				0.525
	Vegetation on surface			1			1						1	1				0.15
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1					1				1			0.555
	Flexural cracks at mid-span	1					1					1				1		0.45
	Single cracks at mid-span (shrinkage)	1				1							1				1	0.51
	Cracks closer to supports (shear cracks)	1					1					1				1		0.45
	Torsional cracks			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Vegetation on surface				1		1						1				1	0.075
Elastomeric bearing at pier	Washed out		1				1				1						1	0.2925
	Excessive distortion of neoprene layer		1				1				1						1	0.2925
	Corrosion of the metallic accessories			1			1				1					1		0.175
	Deterioration of the Teflon layer			1			1				1					1		0.175
	Excessive movement		1				1				1					1		0.295
Concrete hinge bearing at pier	Crushing of concrete			1				1			1					1		0.125
	Corrosion of reinforcement			1				1			1					1		0.125

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Horizontal cracks at abutment bottom (flexural cracks)	1				1						1				1		0.525
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1						1				1		0.525
	Vertical cracks (thermal - shrinkage cracks)	1				1						1				1		0.525
	Vertical cracks (settlement)		1				1					1			1			0.275
	Map cracking (thermal - shrinkage - DEF- ASR)			1		1						1				1		0.225
	Weathering				1		1						1				1	0.075
	Vegetation on surface				1		1						1				1	0.075
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)				1		1					1					1	0.0875
	Horizontal cracks at mid height of abutment (flexural cracks)				1		1					1					1	0.0875
	Vertical cracks (settlement)		1				1					1			1			0.275
	Vertical cracks (thermal - shrinkage cracks)		1				1					1			1			0.275
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1						1				1		0.225
	Weathering				1		1						1				1	0.075
	Vegetation on surface				1		1						1				1	0.075

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1						1				1		0.345
	Horizontal cracks indicating development of tensile stress	1				1					1				1			0.555
	Vertical cracks indicating settlement	1				1						1					1	0.5225
	Lateral movement of abutment wall	1					1				1						1	0.4725
	Vertical deformations of abutment wall		1				1						1				1	0.255
	Vegetation on surface			1					1				1				1	0.06
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1				1				1				1			0.3
	Horizontal cracks at abutment bottom (flexural cracks)		1				1				1				1			0.3
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1				1			0.3
	Vertical cracks (thermal - shrinkage cracks)		1				1				1				1			0.3
	Vertical cracks (settlement)			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF- ASR)	1					1					1					1	0.4475
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1				1		1			0.0075

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1					1				1			1		0.0625
	Horizontal cracks at mid height of abutment (flexural cracks)			1					1				1			1		0.0625
	Vertical cracks (settlement)			1					1				1			1		0.0625
	Vertical cracks (thermal - shrinkage cracks)			1					1				1			1		0.0625
	Map cracking (thermal - shrinkage - DEF - ASR)			1					1				1			1		0.0625
	Weathering				1				1				1			1		0.0025
	Vegetation on surface				1				1				1			1		0.0025
Rubble Wing wall	Mortar dislocation leading to soil passing through		1					1				1			1			0.225
	Horizontal cracks indicating development of tensile stress			1			1					1				1		0.15
	Vertical cracks indicating settlement			1			1						1			1		0.1375
	Lateral movement of abutment wall		1					1			1					1		0.245
	Vertical deformations of abutment wall		1					1			1					1		0.245
	Vegetation on surface			1				1					1				1	0.085
Abutment capping beam	Corrosion of reinforcement due to depassivation		1			1						1				1		0.345
	Flexural crack at mid-span		1			1						1				1		0.345
	Single cracks at mid-span (shrinkage)		1			1						1				1		0.345
	Cracks closer to supports (shear cracks)		1				1					1				1		0.27
	Torsional cracks			1				1					1				1	0.085
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1					1						1	0.2475
	Vegetation on surface				1			1					1				1	0.025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out		1			1						1					1	0.3425
	Excessive distortion of neoprene layer		1					1				1					1	0.2175
	Corrosion of the metallic accessories		1					1				1					1	0.2175
	Deterioration of the teflon layer			1				1				1					1	0.0975
	Excessive movement			1				1				1					1	0.0975
Concrete hinge bearing at abutment	Crushing of concrete		1					1			1						1	0.2425
	Corrosion of reinforcement		1				1				1						1	0.2925
Foundation	Scour at foundation			1			1					1				1		0.15
	Deterioration of foundation elements			1			1					1			1			0.155

Inspector- No 14		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Cracks at mid-span (moment cracks)	1					1						1				1	0.435
	Cracks closer to supports (shear cracks)	1					1						1			1		0.4375
	Torsional cracks		1				1						1			1		0.2575
	Map cracking (thermal - shrinkage cracks)			1			1						1				1	0.135
	Vegitation on surface			1			1						1	1				0.15
Girders	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Flexural crack at mid-span	1				1							1			1		0.5125
	Single shrinkage crack at mid-span		1				1						1				1	0.255
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks	1				1							1				1	0.51
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1						1					1	0.5225
	Vegetation on surface				1			1					1	1				0.04
Wearing surface	Cracking at expansion joint			1		1					1				1			0.255
	Pot holes, crocodile cracks and other damages			1			1			1				1				0.225
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface			1		1							1				1	0.21
Expansion joint	Broken			1		1				1				1				0.3
	Aged			1			1					1				1		0.15
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements			1			1			1				1				0.225
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1			1		1				0.0275
	Misplacement of elements				1				1			1		1				0.0275
Drainage	Malfunction			1				1		1				1				0.175
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1				1						1				1	0.255
	Horizontal cracks at pier bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of pier (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (settlement)		1				1						1				1	0.255
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface				1		1						1				1	0.075

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1			1							1				1	0.33
	Lateral movement of pier	1				1							1				1	0.51
	Vertical deformations of pier	1				1							1				1	0.51
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1				1						1				1	0.255
	Vegetation on surface				1			1					1				1	0.025
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1							1				1	0.51
	Flexural cracks at mid-span		1			1							1				1	0.33
	Single cracks at mid-span (shrinkage)			1		1							1				1	0.21
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1				1	0.21
	Vegetation on surface				1			1					1				1	0.025
Elastomeric bearing at pier	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer		1			1						1				1		0.345
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the Teflon layer			1			1						1				1	0.135
	Excessive movement			1				1					1				1	0.085
Concrete hinge bearing at pier	Crushing of concrete	1				1					1					1		0.55
	Corrosion of reinforcement		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)	1					1						1				1	0.435
	Horizontal cracks at mid height of abutment (flexural cracks)	1					1						1				1	0.435
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Vertical cracks (settlement)		1				1						1			1		0.2575
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1				1					1				1	0.085
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1		1							1				1	0.21

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Horizontal cracks at abutment bottom (flexural cracks)		1			1							1				1	0.33
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1		1							1				1	0.21
	Vertical cracks (settlement)			1		1							1				1	0.21
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1						1				1	0.135
	Weathering			1			1						1				1	0.135
	Vegetation on surface			1			1						1				1	0.135

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1				1							1				1	0.51
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1							1				1	0.51
	Vertical cracks (settlement)		1			1							1				1	0.33
	Vertical cracks (thermal - shrinkage cracks)			1			1						1				1	0.135
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1						1				1	0.135
	Weathering			1				1					1				1	0.085
	Vegetation on surface			1		1							1				1	0.21
Rubble Wing wall	Mortar dislocation leading to soil passing through		1			1							1		1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1							1				1	0.51
	Vertical cracks indicating settlement		1			1							1				1	0.33
	Lateral movement of abutment wall	1				1							1				1	0.51
	Vertical deformations of abutment wall	1				1							1				1	0.51
	Vegetation on surface			1		1							1				1	0.21
Abutment capping beam	Corrosion of reinforcement due to depassivation		1			1							1				1	0.33
	Flexural crack at mid-span			1		1							1				1	0.21
	Single cracks at mid-span (shrinkage)			1			1						1				1	0.135
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1			1							1				1	0.33
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Vegetation on surface		1			1							1				1	0.33

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out	1				1					1				1			0.555
	Excessive distortion of neoprene layer			1			1						1				1	0.135
	Corrosion of the metallic accessories			1			1						1				1	0.135
	Deterioration of the teflon layer		1			1							1				1	0.33
	Excessive movement			1				1				1					1	0.0975
Concrete hinge bearing at abutment	Crushing of concrete	1				1						1				1		0.525
	Corrosion of reinforcement		1			1							1				1	0.33
Foundation	Scour at foundation	1				1							1				1	0.51
	Deterioration of foundation elements		1			1							1				1	0.33

Inspector- No 15

Component	Defect	Possibility leading to short term collapse: High	Possibility leading to short term collapse: Moderate	Possibility leading to short term collapse: Low	Possibility leading to short term collapse: No impact	Leading to durability issues: High	Leading to durability issues: Moderate	Leading to durability issues: Low	Leading to durability issues: No impact	Physical discomfort to road users: High	Physical discomfort to road users: Moderate	Physical discomfort to road users: Low	Physical discomfort to road users: No impact	Disturbing appearance: High	Disturbing appearance: Moderate	Disturbing appearance: Low	Disturbing appearance: No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1			1					1			1				0.3825
	Cracks at mid-span (moment cracks)			1		1				1				1				0.3
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks			1				1			1				1			0.13
	Map cracking (thermal - shrinkage cracks)			1			1			1					1			0.2175
	Vegitation on surface			1				1			1				1			0.13
Girders	Corrosion of reinforcement due to depassivation	1				1					1			1				0.5625
	Flexural crack at mid-span	1				1				1				1				0.6
	Single shrinkage crack at mid-span			1			1			1				1				0.225
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks		1			1				1				1				0.42
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1				1				1				0.6
	Vegetation on surface			1				1			1				1			0.13
Wearing surface	Cracking at expansion joint			1			1			1				1				0.225
	Pot holes, crocodile cracks and other damages			1			1			1				1				0.225
	Flushing			1			1			1				1				0.225
	Leakage through wearing surface			1		1					1			1				0.2625
Expansion joint	Broken			1			1				1				1			0.18
	Aged			1			1				1				1			0.18
	Choked with debris			1				1			1				1			0.13

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements		1				1			1				1				0.345
	Dislocation of elements		1				1			1				1				0.345
	Misplacement of elements	1				1				1				1				0.6
Railing	Damaged elements	1					1			1				1				0.525
	Dislocation of elements	1					1			1				1				0.525
	Misplacement of elements	1					1			1				1				0.525
Drainage	Malfunction		1			1					1				1			0.375
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1				1				1				0.6
	Horizontal cracks at pier bottom (flexural cracks)	1				1				1				1				0.6
	Horizontal cracks at mid height of pier (flexural cracks)			1		1				1				1				0.3
	Vertical cracks (settlement)		1			1				1				1				0.42
	Vertical cracks (thermal - shrinkage cracks)		1			1				1				1				0.42
	Map cracking (thermal - shrinkage - DEF - ASR)		1			1				1				1				0.42
	Weathering		1			1						1			1			0.35
	Vegetation on surface			1				1				1			1			0.105

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation	1				1				1				1				0.6
	Lateral movement of pier	1				1				1				1				0.6
	Vertical deformations of pier	1				1				1				1				0.6
	Horizontal cracks indicating development of tensile stress		1			1				1				1				0.42
	Vertical cracks indicating settlement		1			1				1				1				0.42
	Vegetation on surface		1					1				1			1			0.225
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1				1				1				0.6
	Flexural cracks at mid-span	1				1				1				1				0.6
	Single cracks at mid-span (shrinkage)	1				1				1				1				0.6
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks	1				1				1				1				0.6
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1				1				1				0.3
	Vegetation on surface			1				1			1				1			0.13
Elastomeric bearing at pier	Washed out		1			1				1				1				0.42
	Excessive distortion of neoprene layer		1			1				1				1				0.42
	Corrosion of the metallic accessories		1			1				1				1				0.42
	Deterioration of the Teflon layer		1			1				1				1				0.42
	Excessive movement	1				1				1				1				0.6
Concrete hinge bearing at pier	Crushing of concrete		1				1			1					1			0.3375
	Corrosion of reinforcement	1					1			1					1			0.5175

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation		1			1				1				1				0.42
	Horizontal cracks at abutment bottom (flexural cracks)	1				1				1				1				0.6
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1				1				1				0.6
	Vertical cracks (thermal - shrinkage cracks)			1		1				1				1				0.3
	Vertical cracks (settlement)			1		1				1				1				0.3
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1				1				1				0.42
	Weathering			1			1				1			1				0.1875
	Vegetation on surface			1			1				1				1			0.18
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1				1					1				1			0.555
	Horizontal cracks at mid height of abutment (flexural cracks)	1				1				1				1				0.6
	Vertical cracks (settlement)	1						1		1				1				0.475
	Vertical cracks (thermal - shrinkage cracks)	1						1		1				1				0.475
	Map cracking (thermal - shrinkage - DEF - ASR)	1						1		1				1				0.475
	Weathering			1				1		1				1				0.175
	Vegetation on surface			1				1		1				1				0.175

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1				1						1			1			0.53
	Horizontal cracks indicating development of tensile stress	1				1					1			1				0.5625
	Vertical cracks indicating settlement	1				1						1		1				0.5375
	Lateral movement of abutment wall	1				1				1				1				0.6
	Vertical deformations of abutment wall		1			1				1				1				0.42
	Vegetation on surface		1				1				1				1			0.3
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	1				1				1				1				0.6
	Horizontal cracks at abutment bottom (flexural cracks)		1			1				1				1				0.42
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1				1				1				0.42
	Vertical cracks (thermal - shrinkage cracks)	1				1				1				1				0.6
	Vertical cracks (settlement)	1				1				1				1				0.6
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1					1			1				0.3825
	Weathering			1			1				1				1			0.18
	Vegetation on surface			1				1				1			1			0.105

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1			1			1				1				0.225
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1			1				1				0.225
	Vertical cracks (settlement)				1			1		1				1				0.115
	Vertical cracks (thermal - shrinkage cracks)			1			1			1				1				0.225
	Map cracking (thermal - shrinkage - DEF - ASR)				1		1			1				1				0.165
	Weathering				1			1			1				1			0.07
	Vegetation on surface			1				1				1				1		0.1
Rubble Wing wall	Mortar dislocation leading to soil passing through	1				1				1				1				0.6
	Horizontal cracks indicating development of tensile stress	1				1				1				1				0.6
	Vertical cracks indicating settlement	1				1				1				1				0.6
	Lateral movement of abutment wall	1				1				1				1				0.6
	Vertical deformations of abutment wall	1				1				1				1				0.6
	Vegetation on surface			1				1			1				1			0.13
Abutment capping beam	Corrosion of reinforcement due to depassivation	1				1				1				1				0.6
	Flexural crack at mid-span	1				1				1				1				0.6
	Single cracks at mid-span (shrinkage)		1			1				1				1				0.42
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks		1			1				1				1				0.42
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1			1				1				0.345
	Vegetation on surface			1			1					1				1		0.15

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out	1				1				1							1	0.585
	Excessive distortion of neoprene layer	1				1				1						1		0.5875
	Corrosion of the metallic accessories		1				1					1			1			0.275
	Deterioration of the teflon layer		1				1					1			1			0.275
	Excessive movement			1			1			1							1	0.21
Concrete hinge bearing at abutment	Crushing of concrete	1				1				1							1	0.585
	Corrosion of reinforcement	1				1				1							1	0.585
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements		1						1			1			1			0.2

Inspector- No 16		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1			1			1				1				0.225
	Cracks at mid-span (moment cracks)	1				1						1			1			0.53
	Cracks closer to supports (shear cracks)	1				1						1			1			0.53
	Torsional cracks		1			1						1			1			0.35
	Map cracking (thermal - shrinkage cracks)			1			1					1			1			0.155
	Vegitation on surface				1				1				1	1				0.015
Girders	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Flexural crack at mid-span	1				1						1				1		0.525
	Single shrinkage crack at mid-span		1				1					1				1		0.27
	Cracks closer to supports (shear cracks)	1				1							1				1	0.51
	Torsional cracks		1				1						1				1	0.255
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc		1			1				1					1			0.4125
	Vegetation on surface			1				1			1			1				0.1375
Wearing surface	Cracking at expansion joint			1				1		1					1			0.1675
	Pot holes, crocodile cracks and other damages			1				1		1					1			0.1675
	Flushing				1				1				1				1	0
	Leakage through wearing surface			1		1							1				1	0.21
Expansion joint	Broken			1			1				1					1		0.175
	Aged			1			1				1					1		0.175
	Choked with debris			1			1					1				1		0.15

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1			1			1			1				0.0775
	Dislocation of elements			1				1			1			1				0.1375
	Misplacement of elements				1			1			1			1				0.0775
Railing	Damaged elements				1				1	1				1				0.09
	Dislocation of elements				1				1	1				1				0.09
	Misplacement of elements				1				1	1				1				0.09
Drainage	Malfunction				1		1				1			1				0.1275
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation		1			1							1			1		0.3325
	Horizontal cracks at pier bottom (flexural cracks)	1				1						1				1		0.525
	Horizontal cracks at mid height of pier (flexural cracks)	1				1						1				1		0.525
	Vertical cracks (settlement)	1				1						1				1		0.525
	Vertical cracks (thermal - shrinkage cracks)		1				1						1				1	0.255
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1						1				1	0.255
	Weathering			1			1						1				1	0.135
	Vegetation on surface		1				1						1		1			0.2625

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1				1						1				1	0.255
	Lateral movement of pier	1				1					1					1		0.55
	Vertical deformations of pier		1				1			1					1			0.3375
	Horizontal cracks indicating development of tensile stress	1				1						1			1			0.53
	Vertical cracks indicating settlement	1				1					1				1			0.555
	Vegetation on surface			1			1						1			1		0.1375
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1						1				1		0.525
	Flexural cracks at mid-span		1				1					1				1		0.27
	Single cracks at mid-span (shrinkage)			1				1					1				1	0.085
	Cracks closer to supports (shear cracks)		1				1						1				1	0.255
	Torsional cracks	1					1						1				1	0.435
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1						1				1	0.255
	Vegetation on surface			1				1					1			1		0.0875
Elastomeric bearing at pier	Washed out			1			1					1					1	0.1475
	Excessive distortion of neoprene layer			1			1					1					1	0.1475
	Corrosion of the metallic accessories			1			1					1					1	0.1475
	Deterioration of the Teflon layer				1			1					1				1	0.025
	Excessive movement			1				1			1				1			0.13
Concrete hinge bearing at pier	Crushing of concrete		1				1				1						1	0.2925
	Corrosion of reinforcement		1				1				1						1	0.2925

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation				1		1				1			1				0.1275
	Horizontal cracks at abutment bottom (flexural cracks)		1				1					1					1	0.2675
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)		1			1					1				1			0.375
	Vertical cracks (settlement)		1			1					1				1			0.375
	Map cracking (thermal - shrinkage - DEF- ASR)		1			1						1		1				0.3575
	Weathering			1				1				1				1		0.1
	Vegetation on surface		1				1				1			1				0.3075
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1				1		0.15
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1				1		0.15
	Vertical cracks (settlement)	1				1					1				1			0.555
	Vertical cracks (thermal - shrinkage cracks)	1				1					1				1			0.555
	Map cracking (thermal - shrinkage - DEF - ASR)		1			1						1		1				0.3575
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1			1				0.1875

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1				1					1			1			0.275
	Horizontal cracks indicating development of tensile stress			1			1					1			1			0.155
	Vertical cracks indicating settlement			1			1				1				1			0.18
	Lateral movement of abutment wall			1				1			1				1			0.13
	Vertical deformations of abutment wall			1			1			1					1			0.2175
	Vegetation on surface				1			1				1			1			0.045
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1			1					1			1			0.155
	Horizontal cracks at abutment bottom (flexural cracks)		1				1			1						1		0.3325
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1				1			0.3
	Vertical cracks (thermal - shrinkage cracks)			1			1			1					1			0.2175
	Vertical cracks (settlement)			1			1			1				1				0.225
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1				1			1				0.1875
	Weathering			1			1				1				1			0.18
	Vegetation on surface				1		1					1			1			0.095

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1			1			0.155
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1				1		0.15
	Vertical cracks (settlement)		1			1						1			1			0.35
	Vertical cracks (thermal - shrinkage cracks)			1				1				1		1				0.1125
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1		1				0.1125
	Weathering		1				1					1			1			0.275
	Vegetation on surface			1			1				1			1				0.1875
Rubble Wing wall	Mortar dislocation leading to soil passing through		1				1					1			1			0.275
	Horizontal cracks indicating development of tensile stress		1				1					1			1			0.275
	Vertical cracks indicating settlement		1				1					1			1			0.275
	Lateral movement of abutment wall	1					1					1		1				0.4625
	Vertical deformations of abutment wall		1				1					1			1			0.275
	Vegetation on surface			1				1			1			1				0.1375
Abutment capping beam	Corrosion of reinforcement due to depassivation	1				1					1				1			0.555
	Flexural crack at mid-span		1				1					1				1		0.27
	Single cracks at mid-span (shrinkage)		1				1					1				1		0.27
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1			1			0.275
	Vegetation on surface			1				1			1			1				0.1375

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out		1				1					1			1			0.275
	Excessive distortion of neoprene layer			1				1				1			1			0.105
	Corrosion of the metallic accessories		1				1					1		1				0.2825
	Deterioration of the teflon layer		1				1					1			1			0.275
	Excessive movement		1				1					1			1			0.275
Concrete hinge bearing at abutment	Crushing of concrete		1				1					1				1		0.27
	Corrosion of reinforcement		1				1					1				1		0.27
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements	1				1						1			1			0.53

Inspector- No 17		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Cracks at mid-span (moment cracks)		1			1					1					1		0.37
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks		1			1					1				1			0.375
	Map cracking (thermal - shrinkage cracks)			1		1					1			1				0.2625
	Vegitation on surface			1			1					1		1				0.1625
Girders	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Flexural crack at mid-span		1			1					1					1		0.37
	Single shrinkage crack at mid-span		1			1					1				1			0.375
	Cracks closer to supports (shear cracks)		1			1				1				1				0.42
	Torsional cracks			1		1					1				1			0.255
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1					1			1				1				0.525
	Vegetation on surface			1			1					1		1				0.1625
Wearing surface	Cracking at expansion joint				1		1			1				1				0.165
	Pot holes, crocodile cracks and other damages				1		1			1				1				0.165
	Flushing				1		1			1				1				0.165
	Leakage through wearing surface				1		1			1				1				0.165
Expansion joint	Broken				1			1		1				1				0.115
	Aged				1			1		1				1				0.115
	Choked with debris				1			1			1			1				0.0775

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1		1			1				1				0.165
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1		1			1				0.0525
	Dislocation of elements				1				1		1			1				0.0525
	Misplacement of elements				1				1		1			1				0.0525
Drainage	Malfunction				1			1			1			1				0.0775
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Horizontal cracks at pier bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of pier (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (settlement)		1				1				1					1		0.295
	Vertical cracks (thermal - shrinkage cracks)			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1				1		0.15
	Weathering		1				1					1			1			0.275
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation			1		1						1			1			0.23
	Lateral movement of pier	1					1					1				1		0.45
	Vertical deformations of pier		1				1					1				1		0.27
	Horizontal cracks indicating development of tensile stress	1					1					1				1		0.45
	Vertical cracks indicating settlement			1				1			1					1		0.125
	Vegetation on surface			1				1			1				1			0.13
Pier capping beam	Corrosion of reinforcement due to depassivation		1					1				1				1		0.22
	Flexural cracks at mid-span	1						1				1				1		0.4
	Single cracks at mid-span (shrinkage)		1					1				1				1		0.22
	Cracks closer to supports (shear cracks)	1						1				1				1		0.4
	Torsional cracks		1					1				1				1		0.22
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Elastomeric bearing at pier	Washed out			1				1			1				1			0.13
	Excessive distortion of neoprene layer			1			1			1						1		0.2125
	Corrosion of the metallic accessories			1				1			1					1		0.125
	Deterioration of the Teflon layer			1				1			1					1		0.125
	Excessive movement			1				1			1					1		0.125
Concrete hinge bearing at pier	Crushing of concrete	1				1				1					1			0.5925
	Corrosion of reinforcement			1		1						1			1			0.23

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1					1					1		0.25
	Vegetation on surface			1		1							1		1			0.2175
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1						1				1		0.225
	Vegetation on surface			1		1					1				1			0.255

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Rubble Wing wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Abutment capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural crack at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1			1				1					1		0.175
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1			1					1				1		0.15
	Deterioration of the teflon layer			1				1				1				1		0.1
	Excessive movement			1			1				1					1		0.175
Concrete hinge bearing at abutment	Crushing of concrete		1				1				1				1			0.3
	Corrosion of reinforcement			1			1				1					1		0.175
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements	1					1					1			1			0.455

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		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1			1					1			1				0.3825
	Cracks at mid-span (moment cracks)	1				1					1				1			0.555
	Cracks closer to supports (shear cracks)	1				1				1					1			0.5925
	Torsional cracks		1			1					1				1			0.375
	Map cracking (thermal - shrinkage cracks)			1		1					1				1			0.255
	Vegitation on surface				1			1				1		1				0.0525
Girders	Corrosion of reinforcement due to depassivation		1			1						1			1			0.35
	Flexural crack at mid-span	1				1						1			1			0.53
	Single shrinkage crack at mid-span		1				1					1			1			0.275
	Cracks closer to supports (shear cracks)	1				1						1				1		0.525
	Torsional cracks		1			1						1			1			0.35
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1				1					1				1			0.555
	Vegetation on surface				1			1				1		1				0.0525
Wearing surface	Cracking at expansion joint				1		1				1			1				0.1275
	Pot holes, crocodile cracks and other damages				1			1		1				1				0.115
	Flushing				1			1			1				1			0.07
	Leakage through wearing surface			1			1					1				1		0.15
Expansion joint	Broken				1	1				1				1				0.24
	Aged				1		1					1				1		0.09
	Choked with debris				1		1				1				1			0.12

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1	1				1					1			0.2325
	Dislocation of elements				1		1			1					1			0.1575
	Misplacement of elements				1	1				1				1				0.24
Railing	Damaged elements				1				1		1			1				0.0525
	Dislocation of elements				1				1	1				1				0.09
	Misplacement of elements				1				1	1				1				0.09
Drainage	Malfunction				1		1			1				1				0.165
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	1				1						1			1			0.53
	Horizontal cracks at pier bottom (flexural cracks)	1				1							1			1		0.5125
	Horizontal cracks at mid height of pier (flexural cracks)	1				1							1			1		0.5125
	Vertical cracks (settlement)			1		1					1				1			0.255
	Vertical cracks (thermal - shrinkage cracks)				1		1						1			1		0.0775
	Map cracking (thermal - shrinkage - DEF - ASR)				1		1						1			1		0.0775
	Weathering			1			1						1			1		0.1375
	Vegetation on surface				1		1						1	1				0.09

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation				1		1				1			1				0.1275
	Lateral movement of pier		1					1				1			1			0.225
	Vertical deformations of pier			1				1			1				1			0.13
	Horizontal cracks indicating development of tensile stress	1					1					1			1			0.455
	Vertical cracks indicating settlement		1				1					1			1			0.275
	Vegetation on surface				1		1				1			1				0.1275
Pier capping beam	Corrosion of reinforcement due to depassivation	1				1					1			1				0.5625
	Flexural cracks at mid-span	1				1					1				1			0.555
	Single cracks at mid-span (shrinkage)			1			1						1			1		0.1375
	Cracks closer to supports (shear cracks)	1				1						1			1			0.53
	Torsional cracks		1			1					1			1				0.3825
	Map cracking (thermal - shrinkage - DEF - ASR)			1		1							1			1		0.2125
	Vegetation on surface				1		1					1		1				0.1025
Elastomeric bearing at pier	Washed out		1			1				1					1			0.4125
	Excessive distortion of neoprene layer		1			1				1					1			0.4125
	Corrosion of the metallic accessories			1		1						1			1			0.23
	Deterioration of the Teflon layer		1			1						1			1			0.35
	Excessive movement		1			1				1				1				0.42
Concrete hinge bearing at pier	Crushing of concrete	1				1					1			1				0.5625
	Corrosion of reinforcement		1			1							1		1			0.3375

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	1				1						1		1				0.5375
	Horizontal cracks at abutment bottom (flexural cracks)	1				1						1			1			0.53
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1						1			1			0.35
	Vertical cracks (thermal - shrinkage cracks)				1		1				1				1			0.12
	Vertical cracks (settlement)			1			1					1			1			0.155
	Map cracking (thermal - shrinkage - DEF- ASR)				1		1					1			1			0.095
	Weathering				1		1					1			1			0.095
	Vegetation on surface				1		1					1		1				0.1025
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1			1					1			1			0.155
	Horizontal cracks at mid height of abutment (flexural cracks)			1			1					1			1			0.155
	Vertical cracks (settlement)			1			1				1				1			0.18
	Vertical cracks (thermal - shrinkage cracks)				1			1				1			1			0.045
	Map cracking (thermal - shrinkage - DEF - ASR)				1			1				1			1			0.045
	Weathering			1			1					1			1			0.155
	Vegetation on surface			1			1					1		1				0.1625

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1			1					1			1				0.3825
	Horizontal cracks indicating development of tensile stress			1				1				1				1		0.1
	Vertical cracks indicating settlement		1				1			1					1			0.3375
	Lateral movement of abutment wall		1				1				1				1			0.3
	Vertical deformations of abutment wall			1			1				1				1			0.18
	Vegetation on surface				1	1							1	1				0.165
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	1				1						1		1				0.5375
	Horizontal cracks at abutment bottom (flexural cracks)	1				1					1					1		0.55
	Horizontal cracks at mid height of abutment (flexural cracks)		1			1					1					1		0.37
	Vertical cracks (thermal - shrinkage cracks)				1			1					1			1		0.0275
	Vertical cracks (settlement)			1			1				1				1			0.18
	Map cracking (thermal - shrinkage - DEF- ASR)				1			1					1		1			0.0325
	Weathering			1			1						1		1			0.1425
	Vegetation on surface				1			1					1	1				0.04

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)		1				1					1			1			0.275
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1			1			0.275
	Vertical cracks (settlement)		1				1					1			1			0.275
	Vertical cracks (thermal - shrinkage cracks)			1				1				1			1			0.105
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1					1		1			0.0925
	Weathering		1				1						1		1			0.2625
	Vegetation on surface		1				1					1		1				0.2825
Rubble Wing wall	Mortar dislocation leading to soil passing through		1			1						1			1			0.35
	Horizontal cracks indicating development of tensile stress			1			1					1			1			0.155
	Vertical cracks indicating settlement		1				1					1			1			0.275
	Lateral movement of abutment wall		1					1				1			1			0.225
	Vertical deformations of abutment wall			1				1					1		1			0.0925
	Vegetation on surface				1		1						1		1			0.0825
Abutment capping beam	Corrosion of reinforcement due to depassivation			1		1						1		1				0.2375
	Flexural crack at mid-span		1			1							1		1			0.3375
	Single cracks at mid-span (shrinkage)				1	1							1			1		0.1525
	Cracks closer to supports (shear cracks)	1				1						1			1			0.53
	Torsional cracks			1		1					1				1			0.255
	Map cracking (thermal - shrinkage - DEF - ASR)				1			1					1			1		0.0275
	Vegetation on surface				1		1					1		1				0.1025

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1		1				1					1			0.2925
	Excessive distortion of neoprene layer		1			1				1					1			0.4125
	Corrosion of the metallic accessories			1		1						1				1		0.225
	Deterioration of the teflon layer			1		1						1				1		0.225
	Excessive movement		1			1				1				1				0.42
Concrete hinge bearing at abutment	Crushing of concrete	1				1							1			1		0.5125
	Corrosion of reinforcement		1			1							1			1		0.3325
Foundation	Scour at foundation	1				1					1			1				0.5625
	Deterioration of foundation elements		1			1						1			1			0.35

Inspector- No 19		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation		1				1					1			1			0.275
	Cracks at mid-span (moment cracks)		1				1					1			1			0.275
	Cracks closer to supports (shear cracks)		1				1					1			1			0.275
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vegitation on surface				1				1			1				1		0.015
Girders	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Flexural crack at mid-span			1				1				1					1	0.0975
	Single shrinkage crack at mid-span			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc			1			1				1					1		0.175
	Vegetation on surface				1		1						1		1			0.0325
Wearing surface	Cracking at expansion joint			1				1			1					1		0.125
	Pot holes, crocodile cracks and other damages			1				1			1				1			0.13
	Flushing			1				1			1				1			0.13
	Leakage through wearing surface			1				1				1				1		0.1
Expansion joint	Broken		1				1				1				1			0.3
	Aged		1				1				1				1			0.3
	Choked with debris			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1				1			1				1		0.015
	Dislocation of elements				1				1			1				1		0.015
	Misplacement of elements				1				1			1				1		0.015
Railing	Damaged elements				1				1			1			1			0.02
	Dislocation of elements				1				1			1			1			0.02
	Misplacement of elements				1				1			1			1			0.02
Drainage	Malfunction			1				1					1			1		0.0875
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1				1					1			1		0.0875
	Horizontal cracks at pier bottom (flexural cracks)			1				1					1			1		0.0875
	Horizontal cracks at mid height of pier (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation		1				1					1				1		0.27
	Lateral movement of pier	1				1					1					1		0.55
	Vertical deformations of pier	1				1					1					1		0.55
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1				1					1		0.295
	Vegetation on surface				1			1					1		1			0.0325
Pier capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural cracks at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface				1				1				1			1		0.0025
Elastomeric bearing at pier	Washed out			1				1				1				1		0.1
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1				1				1				1		0.1
	Deterioration of the Teflon layer			1				1				1				1		0.1
	Excessive movement		1				1				1					1		0.295
Concrete hinge bearing at pier	Crushing of concrete			1				1				1					1	0.0975
	Corrosion of reinforcement			1				1				1					1	0.0975

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1				1					1			1		0.0875
	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)		1				1				1					1		0.295
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1				1					1		0.175
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1			1					1			1		0.0275
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1				1					1		0.295
	Vertical cracks (settlement)		1				1				1					1		0.295
	Vertical cracks (thermal - shrinkage cracks)		1				1				1					1		0.295
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through		1				1					1				1		0.27
	Horizontal cracks indicating development of tensile stress		1				1				1					1		0.295
	Vertical cracks indicating settlement	1					1				1					1		0.475
	Lateral movement of abutment wall	1					1				1					1		0.475
	Vertical deformations of abutment wall	1					1					1				1		0.45
	Vegetation on surface				1				1				1			1		0.0025
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (thermal - shrinkage cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF- ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	High	Modera te	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of abutment (flexural cracks)			1				1				1				1		0.1
	Vertical cracks (settlement)		1				1					1			1			0.275
	Vertical cracks (thermal - shrinkage cracks)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF - ASR)		1				1					1				1		0.27
	Weathering			1				1				1				1		0.1
	Vegetation on surface				1				1			1				1		0.015
Rubble Wing wall	Mortar dislocation leading to soil passing through		1					1				1				1		0.22
	Horizontal cracks indicating development of tensile stress		1					1				1				1		0.22
	Vertical cracks indicating settlement		1					1				1				1		0.22
	Lateral movement of abutment wall		1					1				1				1		0.22
	Vertical deformations of abutment wall		1					1				1				1		0.22
	Vegetation on surface				1				1			1			1			0.02
Abutment capping beam	Corrosion of reinforcement due to depassivation		1					1				1				1		0.22
	Flexural crack at mid-span		1					1				1				1		0.22
	Single cracks at mid-span (shrinkage)			1				1			1					1		0.125
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface				1				1			1			1			0.02

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1				1				1					1	0.0975
	Excessive distortion of neoprene layer			1				1				1					1	0.0975
	Corrosion of the metallic accessories			1				1				1					1	0.0975
	Deterioration of the teflon layer			1				1				1					1	0.0975
	Excessive movement		1				1					1					1	0.2675
Concrete hinge bearing at abutment	Crushing of concrete		1				1					1				1		0.27
	Corrosion of reinforcement		1				1					1				1		0.27
Foundation	Scour at foundation		1				1					1				1		0.27
	Deterioration of foundation elements		1				1					1				1		0.27

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		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Deck slab	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Cracks at mid-span (moment cracks)		1			1					1					1		0.37
	Cracks closer to supports (shear cracks)	1				1				1				1				0.6
	Torsional cracks		1			1					1				1			0.375
	Map cracking (thermal - shrinkage cracks)			1		1					1			1				0.2625
	Vegitation on surface			1			1					1		1				0.1625
Girders	Corrosion of reinforcement due to depassivation			1		1					1					1		0.25
	Flexural crack at mid-span		1			1					1					1		0.37
	Single shrinkage crack at mid-span		1			1					1				1			0.375
	Cracks closer to supports (shear cracks)		1			1				1				1				0.42
	Torsional cracks			1		1					1				1			0.255
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	1					1			1				1				0.525
	Vegetation on surface			1			1					1		1				0.1625
Wearing surface	Cracking at expansion joint				1		1			1				1				0.165
	Pot holes, crocodile cracks and other damages				1		1			1				1				0.165
	Flushing				1		1			1				1				0.165
	Leakage through wearing surface				1		1			1				1				0.165
Expansion joint	Broken				1			1		1				1				0.115
	Aged				1			1		1				1				0.115
	Choked with debris				1			1			1			1				0.0775

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Side walk	Damaged elements				1		1			1				1				0.165
	Dislocation of elements				1			1		1				1				0.115
	Misplacement of elements				1			1		1				1				0.115
Railing	Damaged elements				1				1		1			1				0.0525
	Dislocation of elements				1				1		1			1				0.0525
	Misplacement of elements				1				1		1			1				0.0525
Drainage	Malfunction				1			1			1			1				0.0775
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Horizontal cracks at pier bottom (flexural cracks)			1				1				1				1		0.1
	Horizontal cracks at mid height of pier (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (settlement)		1				1				1					1		0.295
	Vertical cracks (thermal - shrinkage cracks)			1			1					1				1		0.15
	Map cracking (thermal - shrinkage - DEF - ASR)			1			1					1				1		0.15
	Weathering		1				1					1			1			0.275
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Random Rubble Pier Column/wall	Mortar dislocation			1		1						1			1			0.23
	Lateral movement of pier	1					1					1				1		0.45
	Vertical deformations of pier		1				1					1				1		0.27
	Horizontal cracks indicating development of tensile stress	1					1					1				1		0.45
	Vertical cracks indicating settlement			1				1			1					1		0.125
	Vegetation on surface			1				1			1				1			0.13
Pier capping beam	Corrosion of reinforcement due to depassivation		1					1				1				1		0.22
	Flexural cracks at mid-span	1						1				1				1		0.4
	Single cracks at mid-span (shrinkage)		1					1				1				1		0.22
	Cracks closer to supports (shear cracks)	1						1				1				1		0.4
	Torsional cracks		1					1				1				1		0.22
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Elastomeric bearing at pier	Washed out			1				1			1				1			0.13
	Excessive distortion of neoprene layer			1			1			1						1		0.2125
	Corrosion of the metallic accessories			1				1			1					1		0.125
	Deterioration of the Teflon layer			1				1			1					1		0.125
	Excessive movement			1				1			1					1		0.125
Concrete hinge bearing at pier	Crushing of concrete	1				1				1					1			0.5925
	Corrosion of reinforcement			1		1						1			1			0.23

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1					1					1		0.25
	Vegetation on surface			1		1					1				1			0.255
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Rubble Abutment wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation			1			1					1				1		0.15
	Horizontal cracks at abutment bottom (flexural cracks)	1					1					1				1		0.45
	Horizontal cracks at mid height of abutment (flexural cracks)		1				1					1				1		0.27
	Vertical cracks (thermal - shrinkage cracks)				1		1					1				1		0.09
	Vertical cracks (settlement)		1				1					1				1		0.27
	Map cracking (thermal - shrinkage - DEF- ASR)			1			1					1				1		0.15
	Weathering			1		1						1				1		0.225
	Vegetation on surface			1		1					1				1			0.255

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Mass concrete wingwall	Horizontal cracks at abutment bottom (flexural cracks)	1						1				1				1		0.4
	Horizontal cracks at mid height of abutment (flexural cracks)		1					1				1				1		0.22
	Vertical cracks (settlement)		1					1				1				1		0.22
	Vertical cracks (thermal - shrinkage cracks)				1			1				1				1		0.04
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Weathering			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18
Rubble Wing wall	Mortar dislocation leading to soil passing through	1					1					1				1		0.45
	Horizontal cracks indicating development of tensile stress		1				1					1				1		0.27
	Vertical cracks indicating settlement		1				1					1				1		0.27
	Lateral movement of abutment wall	1					1					1				1		0.45
	Vertical deformations of abutment wall		1				1					1				1		0.27
	Vegetation on surface			1		1					1				1			0.255
Abutment capping beam	Corrosion of reinforcement due to depassivation			1				1				1				1		0.1
	Flexural crack at mid-span			1				1				1				1		0.1
	Single cracks at mid-span (shrinkage)			1				1				1				1		0.1
	Cracks closer to supports (shear cracks)			1				1				1				1		0.1
	Torsional cracks			1				1				1				1		0.1
	Map cracking (thermal - shrinkage - DEF - ASR)			1				1				1				1		0.1
	Vegetation on surface			1			1				1				1			0.18

		Possibility leading to short term collapse				Leading to durability issues				Physical discomfort to road users				Disturbing appearance				
		High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	High	Moderate	Low	No impact	Rating
Elastomeric bearing at abutment	Washed out			1			1				1					1		0.175
	Excessive distortion of neoprene layer			1				1			1					1		0.125
	Corrosion of the metallic accessories			1			1					1				1		0.15
	Deterioration of the teflon layer			1				1				1				1		0.1
	Excessive movement			1			1				1					1		0.175
Concrete hinge bearing at abutment	Crushing of concrete			1			1				1				1			0.18
	Corrosion of reinforcement			1			1				1					1		0.175
Foundation	Scour at foundation	1				1						1			1			0.53
	Deterioration of foundation elements	1					1					1			1			0.455

Appendix viii

Summary of the DIV for all considered distresses, from questionnaire survey with RDA experts

Member	Distress	Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean (DIV)	STDV
Deck slab	Corrosion of reinforcement due to depassivation	0.25	0.23	0.21	0.33	0.53	0.14	0.21	0.23	0.28	0.56	0.53	0.16	0.26	0.33	0.38	0.23	0.25	0.38	0.28	0.25	**0.30**	**0.12**
	Cracks at mid-span (moment cracks)	0.37	0.23	0.52	0.51	0.35	0.28	0.33	0.26	0.28	0.3	0.33	0.42	0.29	0.44	0.3	0.53	0.37	0.56	0.28	0.37	**0.36**	**0.10**
	Cracks closer to supports (shear cracks)	0.6	0.35	0.52	0.51	0.35	0.26	0.51	0.35	0.28	0.6	0.33	0.38	0.48	0.44	0.6	0.53	0.6	0.59	0.28	0.6	**0.46**	**0.13**
	Map cracking (thermal - shrinkage cracks)	0.26	0.17	0.21	0.14	0.35	0.09	0.21	0.23	0.1	0.21	0.21	0.09	0.24	0.14	0.22	0.16	0.26	0.26	0.1	0.26	**0.19**	**0.07**
	Vegitation on surface	0.16	0.18	0.22	0.15	0.16	0.11	0.23	0.09	0.02	0.3	0.17	0.42	0.24	0.15	0.13	0.02	0.16	0.05	0.02	0.16	**0.16**	**0.10**
Girders	Corrosion of reinforcement due to depassivation	0.25	0.35	0.21	0.33	0.53	0.09	0.33	0.23	0.15	0.59	0.51	0.11	0.41	0.33	0.56	0.15	0.25	0.35	0.15	0.25	**0.31**	**0.15**
	Flexural crack at mid-span	0.37	0.35	0.51	0.51	0.27	0.28	0.51	0.24	0.1	0.59	0.21	0.28	0.28	0.51	0.6	0.53	0.37	0.53	0.1	0.37	**0.37**	**0.16**
	Single shrinkage crack at mid-span	0.38	0.09	0.14	0.26	0.1	0.1	0.33	0.23	0.1	0.04	0.21	0.04	0.04	0.26	0.23	0.27	0.38	0.28	0.1	0.38	**0.20**	**0.12**
	Cracks closer to supports (shear cracks)	0.42	0.53	0.51	0.51	0.27	0.28	0.51	0.35	0.1	0.56	0.21	0.1	0.13	0.51	0.6	0.51	0.42	0.53	0.1	0.42	**0.38**	**0.17**
	Torsional cracks	0.26	0.23	0.33	0.51	0.27	0.27	0.51	0.23	0.1	0.38	0.21	0.1	0.13	0.51	0.42	0.26	0.26	0.35	0.1	0.26	**0.28**	**0.13**
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	0.53	0.2	0.3	0.52	0.11	0.3	0.52	0.15	0.18	0.6	0.29	0.18	0.14	0.52	0.6	0.41	0.53	0.56	0.18	0.53	**0.37**	**0.18**
	Vegetation on surface	0.16	0.17	0.09	0.15	0.1	0.09	0.15	0.04	0.03	0.36	0.15	0.42	0.16	0.04	0.13	0.14	0.16	0.05	0.03	0.16	**0.14**	**0.10**
Wearing surface	Cracking at expansion joint	0.17	0.2	0.12	0.26	0.18	0.13	0.26	0.23	0.13	0.3	0.09	0.31	0.07	0.26	0.23	0.17	0.17	0.13	0.13	0.17	**0.18**	**0.07**
	Pot holes, crocodile cracks and other damages	0.17	0.12	0.16	0.23	0.14	0.18	0.23	0.12	0.13	0.3	0.17	0.3	0.3	0.23	0.23	0.17	0.17	0.12	0.13	0.17	**0.19**	**0.06**
	Flushing	0.17	0.08	0.16	0.23	0.1	0.14	0.23	0.07	0.13	0.23	0.17	0.3	0.3	0.23	0.23	0	0.17	0.07	0.13	0.17	**0.16**	**0.08**
	Leakage through wearing surface	0.17	0.08	0.09	0.21	0.27	0.1	0.21	0.18	0.1	0.03	0.15	0.35	0.23	0.21	0.26	0.21	0.17	0.15	0.1	0.17	**0.17**	**0.08**
Expansion joint	Broken	0.12	0.17	0.16	0.3	0.23	0.18	0.3	0.23	0.3	0.6	0.11	0.42	0.18	0.3	0.18	0.18	0.12	0.24	0.3	0.12	**0.23**	**0.12**
	Aged	0.12	0.12	0.16	0.15	0.14	0.13	0.15	0.08	0.3	0.38	0.11	0.1	0.42	0.15	0.18	0.18	0.12	0.09	0.3	0.12	**0.17**	**0.10**
	Choked with debris	0.08	0.2	0.1	0.18	0.18	0.13	0.18	0.08	0.18	0.6	0.11	0.3	0.14	0.18	0.13	0.15	0.08	0.12	0.18	0.08	**0.17**	**0.12**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Side walk	Damaged elements	0.17	0.08	0.09	0.23	0.08	0.13	0.18	0.05	0.02	0.23	0.02	0.42	0.23	0.23	0.35	0.08	0.17	0.23	0.02	0.17	**0.16**	**0.11**
	Dislocation of elements	0.12	0.08	0.09	0.12	0.08	0.13	0.12	0.05	0.02	0.23	0.02	0.35	0.23	0.12	0.35	0.14	0.12	0.16	0.02	0.12	**0.13**	**0.09**
	Misplacement of elements	0.12	0.17	0.09	0.12	0.05	0.3	0.12	0.05	0.02	0.42	0.02	0.35	0.18	0.12	0.6	0.08	0.12	0.24	0.02	0.12	**0.16**	**0.15**
Railing	Damaged elements	0.05	0.09	0.02	0.09	0.05	0.13	0.09	0.03	0.02	0.3	0	0.35	0.09	0.09	0.53	0.09	0.05	0.05	0.02	0.05	**0.11**	**0.13**
	Dislocation of elements	0.05	0.09	0.02	0.03	0.05	0.13	0.03	0.02	0.02	0.3	0	0.35	0.09	0.03	0.53	0.09	0.05	0.09	0.02	0.05	**0.10**	**0.13**
	Misplacement of elements	0.05	0.09	0.02	0.03	0.05	0.13	0.03	0.02	0.02	0.42	0	0.35	0.08	0.03	0.53	0.09	0.05	0.09	0.02	0.05	**0.11**	**0.15**
Drainage	Malfunction	0.08	0.23	0.24	0.18	0.3	0.05	0.18	0.07	0.09	0.17	0.33	0.6	0.19	0.18	0.38	0.13	0.08	0.17	0.09	0.08	**0.19**	**0.13**
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	0.1	0.53	0.21	0.26	0.56	0.26	0.26	0.22	0.09	0.53	0.33	0.28	0.53	0.26	0.6	0.33	0.1	0.53	0.09	0.1	**0.31**	**0.18**
	Horizontal cracks at pier bottom (flexural cracks)	0.1	0.23	0.22	0.51	0.53	0.26	0.51	0.34	0.09	0.55	0.33	0.54	0.53	0.51	0.6	0.53	0.1	0.51	0.09	0.1	**0.36**	**0.19**
	Horizontal cracks at mid height of pier (flexural cracks)	0.27	0.23	0.21	0.33	0.53	0.26	0.33	0.34	0.22	0.08	0.33	0.54	0.53	0.33	0.3	0.53	0.27	0.51	0.22	0.27	**0.33**	**0.13**
	Vertical cracks (settlement)	0.3	0.23	0.21	0.26	0.53	0.13	0.33	0.34	0.22	0.26	0.33	0.54	0.56	0.26	0.42	0.53	0.3	0.26	0.22	0.3	**0.32**	**0.12**
	Vertical cracks (thermal - shrinkage cracks)	0.15	0.1	0.21	0.14	0.26	0.09	0.21	0.34	0.27	0.26	0.21	0.16	0.26	0.14	0.42	0.26	0.15	0.08	0.27	0.15	**0.21**	**0.09**
	Map cracking (thermal - shrinkage - DEF - ASR)	0.15	0.1	0.21	0.14	0.27	0.09	0.21	0.23	0.1	0.14	0.33	0.16	0.23	0.14	0.42	0.26	0.15	0.08	0.1	0.15	**0.18**	**0.09**
	Weathering	0.28	0.15	0.34	0.09	0.27	0.11	0.09	0.09	0.1	0.26	0.33	0.28	0.23	0.09	0.35	0.14	0.28	0.14	0.1	0.28	**0.20**	**0.10**
	Vegetation on surface	0.18	0.18	0.08	0.14	0.09	0.11	0.14	0.03	0.02	0.25	0.33	0.19	0.09	0.08	0.11	0.26	0.18	0.09	0.02	0.18	**0.14**	**0.08**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Random Rubble Pier Column/wall	Mortar dislocation	0.23	0.54	0.21	0.33	0.52	0.28	0.33	0.34	0.27	0.56	0.53	0.31	0.6	0.33	0.6	0.26	0.23	0.13	0.27	0.23	**0.35**	**0.15**
	Lateral movement of pier	0.45	0.25	0.21	0.51	0.52	0.3	0.51	0.46	0.55	0.56	0.53	0.6	0.6	0.51	0.6	0.55	0.45	0.23	0.55	0.45	**0.47**	**0.12**
	Vertical deformations of pier	0.27	0.13	0.21	0.51	0.56	0.3	0.51	0.44	0.55	0.34	0.53	0.38	0.53	0.51	0.6	0.34	0.27	0.13	0.55	0.27	**0.40**	**0.15**
	Horizontal cracks indicating development of tensile stress	0.45	0.26	0.09	0.51	0.3	0.11	0.51	0.26	0.27	0.16	0.53	0.38	0.53	0.51	0.42	0.53	0.45	0.46	0.27	0.45	**0.37**	**0.15**
	Vertical cracks indicating settlement	0.13	0.11	0.09	0.26	0.54	0.13	0.26	0.44	0.3	0.6	0.53	0.38	0.53	0.26	0.42	0.56	0.13	0.28	0.3	0.13	**0.32**	**0.17**
	Vegetation on surface	0.13	0.18	0.16	0.14	0.27	0.11	0.14	0.17	0.03	0.19	0.17	0.38	0.15	0.03	0.23	0.14	0.13	0.13	0.03	0.13	**0.15**	**0.08**
Pier capping beam	Corrosion of reinforcement due to depassivation	0.22	0.23	0.21	0.51	0.18	0.1	0.51	0.52	0.1	0.22	0.33	0.1	0.56	0.51	0.6	0.53	0.22	0.56	0.1	0.22	**0.33**	**0.19**
	Flexural cracks at mid-span/cantilever	0.4	0.38	0.21	0.33	0.27	0.1	0.33	0.34	0.1	0.33	0.33	0.38	0.45	0.33	0.6	0.27	0.4	0.56	0.1	0.4	**0.33**	**0.13**
	Single cracks at mid-span (shrinkage)	0.22	0.08	0.21	0.21	0.3	0.1	0.21	0.22	0.1	0.03	0.33	0.35	0.51	0.21	0.6	0.09	0.22	0.14	0.1	0.22	**0.22**	**0.14**
	Cracks closer to supports (shear cracks)	0.4	0.35	0.21	0.51	0.15	0.1	0.51	0.34	0.1	0.33	0.33	0.35	0.45	0.51	0.6	0.26	0.4	0.53	0.1	0.4	**0.35**	**0.15**
	Torsional cracks	0.22	0.17	0.21	0.33	0.15	0.1	0.33	0.34	0.1	0.15	0.33	0.15	0.14	0.33	0.6	0.44	0.22	0.38	0.1	0.22	**0.25**	**0.13**
	Map cracking (thermal - shrinkage - DEF - ASR)	0.1	0.17	0.21	0.21	0.15	0.1	0.21	0.52	0.1	0.24	0.33	0.11	0.14	0.21	0.3	0.26	0.1	0.21	0.1	0.1	**0.19**	**0.10**
	Vegetation on surface	0.18	0.18	0.16	0.14	0.1	0.09	0.14	0.03	0	0.42	0.33	0.31	0.08	0.03	0.13	0.09	0.18	0.1	0	0.18	**0.14**	**0.11**
Elastomeric bearing at pier	Washed out	0.13	0.09	0.14	0.56	0.14	0.13	0.56	0.33	0.1	0.29	0.15	0.31	0.29	0.56	0.42	0.15	0.13	0.41	0.1	0.13	**0.25**	**0.17**
	Excessive distortion of neoprene layer	0.21	0.09	0.14	0.35	0.04	0.13	0.35	0.21	0.13	0.23	0.15	0.31	0.29	0.35	0.42	0.15	0.21	0.41	0.13	0.21	**0.22**	**0.11**
	Corrosion of the metallic accessories	0.13	0.09	0.14	0.14	0.08	0.13	0.14	0.21	0.1	0.24	0.15	0.31	0.18	0.14	0.42	0.15	0.13	0.23	0.1	0.13	**0.16**	**0.08**
	Deterioration of the Teflon layer	0.13	0.09	0.14	0.14	0.1	0.13	0.14	0.21	0.1	0.24	0.27	0.31	0.18	0.14	0.42	0.03	0.13	0.35	0.1	0.13	**0.17**	**0.10**
	Excessive movement	0.13	0.13	0.14	0.26	0.25	0.13	0.26	0.21	0.3	0.6	0.15	0.49	0.3	0.09	0.6	0.13	0.13	0.42	0.3	0.13	**0.25**	**0.16**
Concrete hinge bearing at pier	Crushing of concrete	0.59	0.22	0.21	0.55	0.34	0.13	0.55	0.21	0.1	0.33	0.15	0.31	0.13	0.55	0.34	0.29	0.59	0.56	0.1	0.59	**0.34**	**0.19**
	Corrosion of reinforcement	0.23	0.23	0.21	0.33	0.3	0.13	0.33	0.21	0.1	0.51	0.15	0.18	0.13	0.33	0.52	0.29	0.23	0.34	0.1	0.23	**0.25**	**0.12**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	0.15	0.53	0.21	0.33	0.3	0.27	0.33	0.14	0.09	0.35	0.33	0.16	0.53	0.33	0.42	0.13	0.15	0.54	0.09	0.15	**0.28**	**0.15**
	Horizontal cracks at abutment bottom (flexural cracks)	0.45	0.23	0.21	0.51	0.53	0.11	0.51	0.14	0.1	0.54	0.33	0.16	0.53	0.44	0.6	0.27	0.45	0.53	0.1	0.45	**0.36**	**0.18**
	Horizontal cracks at mid height of abutment (flexural cracks)	0.27	0.23	0.21	0.51	0.53	0.09	0.51	0.14	0.1	0.54	0.33	0.16	0.53	0.44	0.6	0.27	0.27	0.35	0.1	0.27	**0.32**	**0.17**
	Vertical cracks (thermal - shrinkage cracks)	0.09	0.17	0.21	0.21	0.27	0.09	0.21	0.08	0.1	0.04	0.33	0.16	0.53	0.14	0.3	0.38	0.09	0.12	0.1	0.09	**0.18**	**0.12**
	Vertical cracks (settlement)	0.27	0.17	0.21	0.33	0.55	0.13	0.33	0.45	0.3	0.48	0.33	0.35	0.28	0.26	0.3	0.38	0.27	0.16	0.3	0.27	**0.30**	**0.10**
	Map cracking (thermal - shrinkage - DEF- ASR)	0.15	0.17	0.21	0.14	0.55	0.1	0.14	0.45	0.18	0.17	0.33	0.36	0.23	0.14	0.42	0.36	0.15	0.1	0.18	0.15	**0.23**	**0.13**
	Weathering	0.25	0.16	0.21	0.09	0.27	0.1	0.09	0.09	0.1	0.3	0.33	0.19	0.08	0.09	0.19	0.1	0.25	0.1	0.1	0.25	**0.17**	**0.08**
	Vegetation on surface	0.26	0.2	0.22	0.21	0.1	0.09	0.21	0.03	0.03	0.3	0.15	0.36	0.08	0.09	0.18	0.31	0.22	0.1	0.03	0.26	**0.17**	**0.10**
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	0.4	0.23	0.21	0.51	0.3	0.09	0.51	0.09	0.1	0.6	0.33	0.36	0.09	0.51	0.56	0.15	0.4	0.16	0.1	0.4	**0.30**	**0.18**
	Horizontal cracks at mid height of abutment (flexural cracks)	0.22	0.23	0.21	0.51	0.3	0.09	0.51	0.09	0.3	0.53	0.33	0.36	0.09	0.51	0.6	0.15	0.22	0.16	0.3	0.22	**0.30**	**0.16**
	Vertical cracks (settlement)	0.22	0.17	0.21	0.33	0.48	0.26	0.33	0.14	0.3	0.53	0.09	0.36	0.28	0.33	0.48	0.56	0.22	0.18	0.3	0.22	**0.30**	**0.13**
	Vertical cracks (thermal - shrinkage cracks)	0.04	0.17	0.21	0.14	0.27	0.09	0.14	0.14	0.3	0.03	0.09	0.36	0.28	0.14	0.48	0.56	0.04	0.05	0.3	0.04	**0.19**	**0.15**
	Map cracking (thermal - shrinkage - DEF - ASR)	0.1	0.17	0.21	0.14	0.27	0.09	0.14	0.14	0.1	0.03	0.09	0.16	0.23	0.14	0.48	0.36	0.1	0.05	0.1	0.1	**0.16**	**0.11**
	Weathering	0.1	0.23	0.21	0.14	0.27	0.09	0.14	0.09	0.1	0.56	0.33	0.36	0.08	0.14	0.18	0.1	0.1	0.16	0.1	0.1	**0.18**	**0.12**
	Vegetation on surface	0.18	0.17	0.22	0.21	0.1	0.09	0.21	0.03	0.02	0.53	0.21	0.28	0.08	0.21	0.18	0.19	0.18	0.16	0.02	0.18	**0.17**	**0.11**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Rubble Abutment wall	Mortar dislocation leading to soil passing through	0.45	0.38	0.22	0.34	0.53	0.28	0.34	0.15	0.27	0.53	0.33	0.31	0.35	0.34	0.53	0.28	0.45	0.38	0.27	0.45	**0.36**	**0.10**
	Horizontal cracks indicating development of tensile stress	0.27	0.1	0.22	0.51	0.53	0.27	0.51	0.1	0.3	0.53	0.33	0.38	0.56	0.51	0.56	0.16	0.27	0.1	0.3	0.27	**0.34**	**0.16**
	Vertical cracks indicating settlement	0.27	0.09	0.22	0.33	0.55	0.3	0.33	0.27	0.48	0.53	0.26	0.38	0.52	0.33	0.54	0.18	0.27	0.34	0.48	0.27	**0.35**	**0.13**
	Lateral movement of abutment wall	0.45	0.02	0.22	0.51	0.56	0.3	0.51	0.1	0.48	0.6	0.44	0.38	0.47	0.51	0.6	0.13	0.45	0.3	0.48	0.45	**0.40**	**0.17**
	Vertical deformations of abutment wall	0.27	0.08	0.22	0.51	0.56	0.3	0.51	0.21	0.45	0.6	0.18	0.14	0.26	0.51	0.42	0.22	0.27	0.18	0.45	0.27	**0.33**	**0.16**
	Vegetation on surface	0.26	0.38	0.22	0.21	0.1	0.09	0.21	0.26	0	0.35	0.15	0.19	0.06	0.21	0.3	0.05	0.26	0.17	0	0.26	**0.19**	**0.11**
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	0.15	0.53	0.22	0.33	0.53	0.09	0.33	0.35	0.1	0.26	0.33	0.16	0.3	0.33	0.6	0.16	0.15	0.54	0.1	0.15	**0.28**	**0.16**
	Horizontal cracks at wall bottom (flexural cracks)	0.45	0.15	0.22	0.33	0.55	0.09	0.33	0.21	0.1	0.28	0.33	0.16	0.3	0.33	0.42	0.33	0.45	0.55	0.1	0.45	**0.31**	**0.14**
	Horizontal cracks at mid height of wall (flexural cracks)	0.27	0.15	0.22	0.33	0.56	0.09	0.33	0.21	0.1	0.53	0.33	0.16	0.3	0.33	0.42	0.3	0.27	0.37	0.1	0.27	**0.28**	**0.13**
	Vertical cracks (thermal - shrinkage cracks)	0.09	0.04	0.22	0.21	0.3	0.09	0.21	0.21	0.1	0.21	0.33	0.16	0.3	0.21	0.6	0.22	0.09	0.03	0.1	0.09	**0.19**	**0.13**
	Vertical cracks (settlement)	0.27	0.15	0.22	0.21	0.55	0.09	0.21	0.21	0.1	0.21	0.33	0.16	0.1	0.21	0.6	0.23	0.27	0.18	0.1	0.27	**0.23**	**0.13**
	Map cracking (thermal - shrinkage - DEF- ASR)	0.15	0.09	0.22	0.14	0.56	0.09	0.14	0.34	0.1	0.09	0.33	0.16	0.45	0.14	0.38	0.19	0.15	0.03	0.1	0.15	**0.20**	**0.14**
	Weathering	0.23	0.16	0.22	0.14	0.27	0.09	0.14	0.03	0.1	0.28	0.33	0.19	0.1	0.14	0.18	0.18	0.23	0.14	0.1	0.23	**0.17**	**0.07**
	Vegetation on surface	0.26	0.2	0.22	0.14	0.1	0.09	0.14	0	0.02	0.16	0.33	0.19	0.01	0.14	0.11	0.1	0.26	0.04	0.02	0.26	**0.14**	**0.10**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Mass concrete wingwall	Horizontal cracks at wall bottom (flexural cracks)	0.4	0.09	0.21	0.51	0.27	0.09	0.51	0.09	0.1	0.13	0.21	0.31	0.06	0.51	0.23	0.16	0.4	0.28	0.1	0.4	**0.25**	**0.16**
	Horizontal cracks at mid height of wall (flexural cracks)	0.22	0.09	0.21	0.51	0.27	0.09	0.51	0.09	0.1	0.11	0.21	0.31	0.06	0.51	0.23	0.15	0.22	0.28	0.1	0.22	**0.22**	**0.14**
	Vertical cracks (settlement)	0.22	0.09	0.21	0.33	0.27	0.09	0.33	0.09	0.28	0.04	0.21	0.31	0.06	0.33	0.12	0.35	0.22	0.28	0.28	0.22	**0.22**	**0.10**
	Vertical cracks (thermal - shrinkage cracks)	0.04	0.03	0.21	0.14	0.27	0.09	0.14	0.09	0.27	0.1	0.21	0.28	0.06	0.14	0.23	0.11	0.04	0.11	0.27	0.04	**0.14**	**0.09**
	Map cracking (thermal - shrinkage - DEF - ASR)	0.1	0.03	0.21	0.14	0.1	0.09	0.14	0.14	0.27	0.01	0.21	0.28	0.06	0.14	0.17	0.11	0.1	0.09	0.27	0.1	**0.14**	**0.08**
	Weathering	0.1	0.16	0.21	0.09	0.1	0.09	0.09	0	0.1	0.03	0.33	0.28	0	0.09	0.07	0.28	0.1	0.26	0.1	0.1	**0.13**	**0.09**
	Vegetation on surface	0.18	0.2	0.22	0.21	0.1	0.09	0.21	0	0.02	0.42	0.21	0.31	0	0.21	0.1	0.19	0.18	0.28	0.02	0.18	**0.17**	**0.11**
Rubble Wing wall	Mortar dislocation leading to soil passing through	0.45	0.26	0.22	0.34	0.45	0.09	0.34	0.15	0.22	0.54	0.21	0.13	0.23	0.34	0.6	0.28	0.45	0.35	0.22	0.45	**0.32**	**0.14**
	Horizontal cracks indicating development of tensile stress	0.27	0.11	0.22	0.51	0.45	0.09	0.51	0.14	0.22	0.09	0.21	0.13	0.15	0.51	0.6	0.28	0.27	0.16	0.22	0.27	**0.27**	**0.16**
	Vertical cracks indicating settlement	0.27	0.11	0.22	0.33	0.45	0.09	0.33	0.33	0.22	0.41	0.21	0.13	0.14	0.33	0.6	0.28	0.27	0.28	0.22	0.27	**0.27**	**0.12**
	Lateral movement of abutment wall	0.45	0.01	0.22	0.51	0.27	0.09	0.51	0.14	0.22	0.42	0.21	0.31	0.25	0.51	0.6	0.46	0.45	0.23	0.22	0.45	**0.33**	**0.16**
	Vertical deformations of abutment wall	0.27	0.08	0.22	0.51	0.27	0.09	0.51	0.26	0.22	0.6	0.21	0.14	0.25	0.51	0.6	0.28	0.27	0.09	0.22	0.27	**0.29**	**0.16**
	Vegetation on surface	0.26	0.26	0.22	0.21	0.1	0.09	0.21	0.21	0.02	0.17	0.21	0.14	0.09	0.21	0.13	0.14	0.26	0.08	0.02	0.26	**0.16**	**0.08**
Abutment capping beam	Corrosion of reinforcement due to depassivation	0.1	0.23	0.21	0.33	0.48	0.27	0.33	0.14	0.22	0.52	0.51	0.18	0.35	0.33	0.6	0.56	0.1	0.24	0.22	0.1	**0.30**	**0.16**
	Flexural crack at mid-span/cantilever	0.1	0.15	0.21	0.21	0.48	0.27	0.21	0.14	0.22	0.52	0.21	0.38	0.35	0.21	0.6	0.27	0.1	0.34	0.22	0.1	**0.26**	**0.14**
	Single cracks at mid-span (shrinkage)	0.1	0.08	0.21	0.14	0.27	0.27	0.14	0.14	0.13	0.03	0.21	0.19	0.35	0.14	0.42	0.27	0.1	0.15	0.13	0.1	**0.18**	**0.10**
	Cracks closer to supports (shear cracks)	0.1	0.27	0.21	0.51	0.3	0.27	0.51	0.26	0.1	0.09	0.21	0.19	0.27	0.51	0.6	0.1	0.1	0.53	0.1	0.1	**0.27**	**0.17**
	Torsional cracks	0.1	0.15	0.21	0.33	0.22	0.27	0.33	0.26	0.1	0.09	0.21	0.14	0.09	0.33	0.42	0.1	0.1	0.26	0.1	0.1	**0.19**	**0.10**
	Map cracking (thermal - shrinkage - DEF - ASR)	0.1	0.35	0.21	0.21	0.22	0.1	0.21	0.26	0.1	0.06	0.21	0.14	0.25	0.21	0.35	0.28	0.1	0.03	0.1	0.1	**0.18**	**0.09**
	Vegetation on surface	0.18	0.2	0.16	0.33	0.09	0.09	0.33	0.09	0.02	0.3	0.21	0.23	0.03	0.33	0.15	0.14	0.18	0.1	0.02	0.18	**0.17**	**0.10**

		Individual DIV of inspectors in the sample																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Mean**	**STDV**
Elastomeric bearing at abutment	Washed out	0.18	0.1	0.14	0.56	0.15	0.1	0.56	0.37	0.1	0.59	0.23	0.31	0.34	0.56	0.59	0.28	0.18	0.29	0.1	0.18	**0.29**	**0.18**
	Excessive distortion of neoprene layer	0.13	0.15	0.14	0.14	0.13	0.27	0.14	0.33	0.1	0.59	0.23	0.31	0.22	0.14	0.59	0.11	0.13	0.41	0.1	0.13	**0.22**	**0.15**
	Corrosion of the metallic accessories	0.15	0.1	0.14	0.14	0.18	0.1	0.14	0.33	0.1	0.27	0.23	0.31	0.22	0.14	0.28	0.28	0.15	0.23	0.1	0.15	**0.18**	**0.08**
	Deterioration of the teflon layer	0.1	0.1	0.14	0.33	0.13	0.1	0.33	0.33	0.1	0.27	0.35	0.31	0.1	0.33	0.28	0.28	0.1	0.23	0.1	0.1	**0.20**	**0.10**
	Excessive movement	0.18	0.13	0.14	0.1	0.29	0.27	0.1	0.33	0.27	0.21	0.23	0.38	0.1	0.1	0.21	0.28	0.18	0.42	0.27	0.18	**0.22**	**0.10**
Concrete hinge bearing at abutment	Crushing of concrete	0.18	0.15	0.34	0.53	0.3	0.09	0.53	0.33	0.27	0.59	0.15	0.3	0.24	0.53	0.59	0.27	0.3	0.51	0.27	0.18	**0.33**	**0.16**
	Corrosion of reinforcement	0.18	0.14	0.34	0.33	0.48	0.09	0.33	0.33	0.27	0.59	0.15	0.3	0.29	0.33	0.59	0.27	0.18	0.33	0.27	0.18	**0.30**	**0.13**
Foundation	Scour at foundation	0.53	0.48	0.33	0.51	0.6	0.09	0.51	0.53	0.27	0.53	0.45	0.6	0.15	0.51	0.53	0.53	0.53	0.56	0.27	0.53	**0.45**	**0.15**
	Deterioration of foundation elements	0.46	0.53	0.33	0.33	0.6	0.09	0.33	0.53	0.27	0.08	0.27	0.6	0.16	0.33	0.2	0.53	0.46	0.35	0.27	0.46	**0.36**	**0.16**

Appendix ix

Condition states of distresses

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Deck slab	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Cracks at mid-span (moment cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Cracks closer to supports (shear cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vegitation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Girders	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Flexural crack at mid-span	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Single shrinkage crack at mid-span	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Cracks closer to supports (shear cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Torsional cracks	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Relative displacement between girders due to malfunction of diaphragms, tie rods etc	Sever	Clearly visible	Hardly visible	No displacement	Displacement noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Wearing surface	Cracking at expansion joint	Crack width>19mm	19mm<Crack width<6mm	6mm<Crack width<0mm	No crack	Cracking noticed	N/A	N/A	Good condition
	Pot holes, crocodile cracks and other damages	Severe discomfort & danger to user	Severe discomfort to user	Mild discomfort to user	Good condition	Cracking and damages noticed	N/A	N/A	Good condition
	Flushing	Severe discomfort & danger to user	Severe discomfort to user	Mild discomfort to user	Good condition	Flushing noticed	N/A	N/A	Good condition
	Leakage through wearing surface	Severe leakages noticed & significant durability issues	Significant leakages noticed	Minor leakages noticed	No evidence of leakages	Leakages / marks noticed	N/A	N/A	Good condition
Expansion joint	Broken	discomfort to user	discomfort to user	Mild discomfort to user	Good condition	damages noticed	N/A	N/A	Good condition
	Aged								
	Choked with debris	discomfort to user	discomfort to user	Mild discomfort to user	Good condition	Choked with debris	N/A	N/A	Good condition
Side walk	Damaged elements	Severe discomfort & danger to user	Severe discomfort to user	Mild discomfort to user	Good condition	Damages noticed	N/A	N/A	Good condition
	Dislocation of elements	Severe discomfort & danger to user	Severe discomfort to user	Mild discomfort to user	Good condition	Dislocations noticed	N/A	N/A	Good condition
	Misplacement of elements	Severe discomfort & danger to user	Severe discomfort to user	Mild discomfort to user	Good condition	Misplacements notices	N/A	N/A	Good condition
Railing	Damaged elements	Extreme danger to user	Significant danger to users	Damages notice, but no danger to users	Good condition	Damages noticed	N/A	N/A	Good condition
	Dislocation of elements	Extreme danger to user	Significant danger to users	Dislocations notice, but no danger to users	Good condition	Dislocations noticed	N/A	N/A	Good condition
	Misplacement of elements	Extreme danger to user	Significant danger to users	Misplacements notice, but no danger to users	Good condition	Misplacements notices	N/A	N/A	Good condition
Drainage	Malfunction	Extreme disturbance to drainage system	Significant disturbance to the drainage	Minor disturbance to drainage	Good condition	Malfunction	N/A	N/A	Good condition

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Reinforced Concrete Pier Column/wall	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Horizontal cracks at pier bottom (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Horizontal cracks at mid height of pier (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (settlement)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (thermal - shrinkage cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage - DEF - ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Weathering	Severe (R/F exposed)	Moderate (clearly visible)	Mild (Hardly visible)	Good condition	Weathering noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Random Rubble Pier Column/wall	Mortar dislocation	Soil passing through	Possible for soil to pass through	Not possible for soil to pass through	Good condition	Area >75%	Area >50%	Area> 25%	Good condition
	Lateral movement of pier	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vertical deformations of pier	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Horizontal cracks indicating development of tensile stress	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks indicating settlement	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Pier capping beam	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Flexural cracks at mid-span/cantilever	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Single cracks at mid-span (shrinkage)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Cracks closer to supports (shear cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Torsional cracks	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage - DEF - ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Elastomeric bearing at pier	Washed out	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Excessive distortion of neoprene layer	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Corrosion of the metallic accessories	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Deterioration of the Teflon layer	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Excessive movement	Yes	N/A	N/A	No	Yes	N/A	N/A	No
Concrete hinge bearing at pier	Crushing of concrete	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Corrosion of reinforcement	Yes	N/A	N/A	No	Yes	N/A	N/A	No

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Reinforced Concrete Abutment wall	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Horizontal cracks at abutment bottom (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Horizontal cracks at mid height of abutment (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (thermal - shrinkage cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (settlement)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage - DEF- ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Weathering	Severe (R/F exposed)	Moderate (clearly visible)	Mild (Hardly visible)	Good condition	Weathering noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Mass Concrete Abutment wall	Horizontal cracks at abutment bottom (flexural cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Horizontal cracks at mid height of abutment (flexural cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks (settlement)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks (thermal - shrinkage cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Map cracking (thermal - shrinkage - DEF - ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Weathering	Severe (R/F exposed)	Moderate (clearly visible)	Mild (Hardly visible)	Good condition	Weathering noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Rubble Abutment wall	Mortar dislocation leading to soil passing through	Soil passing through	Possible for soil to pass through	Not possible for soil to pass through	Good condition	Area >75%	Area >50%	Area> 25%	Good condition
	Horizontal cracks indicating development of tensile stress	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks indicating settlement	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Lateral movement of abutment wall	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vertical deformations of abutment wall	Severe (Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Reinforced Concrete Wing wall	Corrosion of reinforcement due to depassivation	Spalling + (Polarization resistance or Half cell potential reading exceed the limit)	Spalling + (both Polarization resistance and Half cell potential readings within the limit)	No spalling + (carbonation depth/cover)>90 %	No spalling + (carbonation depth/cover)<90 %	Spalling area>5%	Spalling noticed but spalling area<5%	Area of stain marks or delaminated area >10%	Both Area of stain marks and delaminated area <10%
	Horizontal cracks at wall bottom (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Horizontal cracks at mid height of wall (flexural cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (thermal - shrinkage cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vertical cracks (settlement)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage - DEF- ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Weathering	Severe (R/F exposed)	Moderate (clearly visible)	Mild (Hardly visible)	Good condition	Weathering noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Mass concrete wingwall	Horizontal cracks at wall bottom (flexural cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Horizontal cracks at mid height of wall (flexural cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks (settlement)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks (thermal - shrinkage cracks)	Crack width>0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	Good condition	Cracks noticed	N/A	N/A	Good condition
	Map cracking (thermal - shrinkage - DEF - ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Weathering	Severe (R/F exposed)	Moderate (clearly visible)	Mild (Hardly visible)	Good condition	Weathering noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Rubble Wing wall	Mortar dislocation leading to soil passing through	Soil passing through	Possible for soil to pass through	Not possible for soil to pass through	Good condition	Area >75%	Area >50%	Area> 25%	Good condition
	Horizontal cracks indicating development of tensile stress	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Vertical cracks indicating settlement	Crack width>5mm	Crack width>2mm	2mm>Crack width	Good condition	Cracks noticed	N/A	N/A	Good condition
	Lateral movement of abutment wall	(Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vertical deformations of wall	(Dangerously deformed)	Moderate(Clearly visible)	Mild(Hardly visible)	Good condition	Movement noticed	N/A	N/A	Good condition
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots
Abutment capping beam	Corrosion of reinforcement due to depassivation	(Polarization resistance or Half	Polarization resistance and	(carbonation depth/cover)>90	(carbonation depth/cover)<90	Spalling area>5%	but spalling area<5%	marks or delaminated area	marks and delaminated area
	Flexural crack at mid-span/cantilever	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Single cracks at mid-span (shrinkage)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Cracks closer to supports (shear cracks)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Torsional cracks	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Map cracking (thermal - shrinkage - DEF - ASR)	Crack width >0.3mm	0.3mm>crack width>0.2mm	0.2mm>crack width>0mm	No crack	There are cracks	N/A	N/A	No Cracks
	Vegetation on surface	Considerable impact noticed	N/A	N/A	Neglegible impact only	Significant area covered	N/A	N/A	Several spots

		Severity level				Extent level			
		Very High	High	Medium	Low/Negative	Very High	High	Medium	Low/Negative
Elastomeric bearing at abutment	Washed out	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Excessive distortion of neoprene layer	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Corrosion of the metallic accessories	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Deterioration of the teflon layer	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Excessive movement	Yes	N/A	N/A	No	Yes	N/A	N/A	No
Concrete hinge bearing at abutment	Crushing of concrete	Yes	N/A	N/A	No	Yes	N/A	N/A	No
	Corrosion of reinforcement	Yes	N/A	N/A	No	Yes	N/A	N/A	No
Foundation	Scour at foundation	Scour level is sever	Scour level is moderate	Scour level is neglegible	Good condition	Scour area>75%	Scour area>50%	Scour area>25%	Good condition
	Deterioration of foundation elements	Severe deterioration	Moderate deterioration	Negligible Deterioration	Good condition	Affected area>75%	Affected area>50%	Affected area>25%	Good condition

Appendix x

Calculation of BCV for comparison

Summary of calculation BCV - Bridge (4/1) Road B435

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure	Bridge deck 0.85	Deck slab	1	0.782	0.3656
		Girders	-	-	-
	Accessories	Wearing surface	0.43	0.142	0.0050
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
0.55	0.15	Railing	0.21	0	0.0000
		Drainage	0.14	0.16	0.0018
Substructure	Pier	Pier column or wall	-	-	-
	-	Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment	Abutment wall or column	0.47	0	0.0000
		Wing wall	0.47	0	0.0000
		Capping beam	-	0	-
0.45	0.27	Bearing pad	0.07	0.62	0.0053
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0.11	0.0361
				∑SIV.CIV.MIV.CMCV	0.4139

BCV	58.612145	%

Summary of calculation BCV - Bridge (6/1) Road B435

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.55	Bridge deck 0.85	Deck slab	1	0.824	0.3852
		Girders	-	-	-
	Accessories 0.15	Wearing surface	0.43	0.456	0.0162
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
		Railing	0.21	0	0.0000
		Drainage	0.14	0.19	0.0022
Substructure 0.45	Pier -	Pier column or wall	-	-	-
		Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment 0.27	Abutment wall or column	0.47	0.22	0.0126
		Wing wall	0.47	0	0.0000
		Capping beam	-	0	-
		Bearing pad	0.07	0.57	0.0048
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0.168	0.0552
				∑SIV.CIV.MIV.CMCV	0.4762

BCV	52.380995	%

Summary of calculation BCV - Bridge (6/2) Road B425

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.55	Bridge deck 0.85	Deck slab	-	0	-
		Girders	1	0	0.0000
	Accessories 0.15	Wearing surface	0.43	0.12	0.0043
		Expansion joint	-	-	-
		Side walk	0.21	0.1	0.0017
		Railing	0.21	0	0.0000
		Drainage	0.14	0.36	0.0042
Substructure 0.45	Pier 0.45	Pier column or wall	0.45	0.62	0.0565
		Pier capping beam	0.45	0.24	0.0219
		Bearing pad	0.1	0.22	0.0045
	Abutment 0.15	Abutment wall or column	0.47	0.24	0.0076
		Wing wall	0.47	0.11	0.0035
		Capping beam	-	-	-
		Bearing pad	0.07	0.22	0.0010
	Foundation 0.4	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.1051

BCV	89.488675	%

Summary of calculation BCV - Bridge (16/3) Road B208

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure	Bridge deck 0.85	Deck slab	-	0	-
		Girders	1	0	0.0000
	Accessories	Wearing surface	0.43	0.11	0.0039
		Expansion joint	-	-	-
0.55		Side walk	0.21	0.21	0.0036
	0.15	Railing	0.21	0	0.0000
		Drainage	0.14	0.12	0.0014
Substructure	Pier	Pier column or wall	0.45	0	0.0000
	0.45	Pier capping beam	0.45	0	0.0000
		Bearing pad	0.1	0.44	0.0089
	Abutment	Abutment wall or column	0.47	0	0.0000
		Wing wall	0.47	0	0.0000
	0.15	Capping beam	-	0	-
0.45		Bearing pad	0.07	0.44	0.0021
	Foundation 0.4	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.0199

BCV	98.00845	%

Summary of calculation BCV - Bridge (8/4) Road B225

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure	Bridge deck 0.85	Deck slab	0.4	0	0.0000
		Girders	0.6	0.82	0.2300
	Accessories	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
0.55		Side walk	0.21	0	0.0000
	0.15	Railing	0.21	0	0.0000
		Drainage	0.14	0.58	0.0067
Substructure	Pier	Pier column or wall	0.82	0.42	0.0697
		Pier capping beam	-	0	-
	0.45	Bearing pad	0.18	0.8	0.0292
	Abutment	Abutment wall or column	0.47	0.55	0.0174
		Wing wall	0.47	0.38	0.0121
		Capping beam	-	0	-
0.45	0.15	Bearing pad	0.07	0.8	0.0038
	Foundation 0.4	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.3689

BCV	63.110575	%

Summary of calculation BCV - Bridge (11/3) Road B225

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.55	Bridge deck 0.85	Deck slab	0.4	0.08	0.0150
		Girders	0.6	0.89	0.2496
	Accessories 0.15	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
		Railing	0.21	0	0.0000
		Drainage	0.14	0.24	0.0028
Substructure 0.45	Pier -	Pier column or wall	-	-	-
		Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment 0.27	Abutment wall or column	0.47	0.35	0.0200
		Wing wall	0.47	0.34	0.0194
		Capping beam	-	0	-
		Bearing pad	0.07	0.7	0.0060
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.3127

BCV	68.726705	%

Summary of calculation BCV - Bridge (6/3) Road B444

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure	Bridge deck 0.85	Deck slab	1	0	0.0000
		Girders	-	-	-
	Accessories	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
0.55	0.15	Railing	0.21	0	0.0000
		Drainage	0.14	0.19	0.0022
Substructure	Pier -	Pier column or wall	-	-	-
		Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment	Abutment wall or column	0.47	0	0.0000
		Wing wall	0.47	0.21	0.0120
		Capping beam	-	0	-
0.45	0.27	Bearing pad	0.07	0.21	0.0018
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.0160

BCV	98.40274	%

Summary of calculation BCV - Bridge (11/2) Road B472

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.55	Bridge deck 0.85	Deck slab	1	0.11	0.0514
		Girders	-	-	-
	Accessories 0.15	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
		Railing	0.21	0	0.0000
		Drainage	0.14	0.11	0.0013
Substructure 0.45	Pier -	Pier column or wall	-	-	-
		Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment 0.27	Abutment wall or column	0.47	0.12	0.0069
		Wing wall	0.47	0.1	0.0057
		Capping beam	-	0	-
		Bearing pad	0.07	0.12	0.0010
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.0663

BCV	93.37208	%

Summary of calculation BCV - Bridge (4/1) Road B063

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure 0.55	Bridge deck 0.85	Deck slab	0.4	0.1	0.0187
		Girders	0.6	0.1	0.0281
	Accessories 0.15	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
		Railing	0.21	0	0.0000
		Drainage	0.14	0.36	0.0042
Substructure 0.45	Pier -	Pier column or wall	-	-	-
		Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment 0.27	Abutment wall or column	0.47	0.81	0.0463
		Wing wall	0.47	0.92	0.0525
		Capping beam	-	0	-
		Bearing pad	0.07	0.54	0.0046
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.1543

BCV	84.570765	%

Summary of calculation BCV - Bridge (38/1) Road A003

Structure (SIV)	Component (CIV)	Members	(MIV)	(CMCV)	SIV.CIV.MIV.CMCV
Superstructure	Bridge deck 0.85	Deck slab	0.4	0.18	0.0337
		Girders	0.6	0.27	0.0757
	Accessories	Wearing surface	0.43	0	0.0000
		Expansion joint	-	-	-
		Side walk	0.21	0	0.0000
0.55	0.15	Railing	0.21	0.33	0.0057
		Drainage	0.14	0.24	0.0028
Substructure	Pier	Pier column or wall	-	-	-
	-	Pier capping beam	-	-	-
		Bearing pad	-	-	-
	Abutment	Abutment wall or column	0.47	0.12	0.0069
		Wing wall	0.47	0.13	0.0074
	0.27	Capping beam	-	0	-
0.45		Bearing pad	0.07	0.31	0.0026
	Foundation 0.73	Pile cap, Pile, Spread footing	1	0	0.0000
				∑SIV.CIV.MIV.CMCV	0.1348

BCV	86.520295	%