A BOOST FOR BRIDGE ASSET MANAGEMENT
Anthony Rooke, Principal Engineer Asset Management, ARRB Group Ltd., QLD
Andrew Volpato, Senior Engineer Asset Management, Toowoomba Regional Council, QLD
Justin Welligamage, Principal Engineer Asset Management, Toowoomba Regional Council, QLD

Abstract

Toowoomba Regional Council (TRC) is responsible for management of Council’s network of bridges and major culverts. Providing acceptable levels of service relies on effective asset management based on a clear understanding of risk. Pressure to reduce funding for bridge maintenance each year coupled with government initiatives to increase national productivity through increased heavy vehicle weights limits, requires asset owners to adopt risk-based decision-making principles which must be supported by accurate and meaningful asset information, captured in a systematic and consistent manner. ARRB Group Ltd assisted TRC with implementation of a corporate methodology for managing these assets and delivering their strategic asset management objectives. This paper describes how effective risk-based bridge asset management need not be complicated or sophisticated. It describes key elements in ensuring consistency in data capture, management systems and the use of information to effectively manage bridge and other structures assets. Council’s goals were achieved through a collaborative approach in implementation of the ARRB Structures Information System (ASIS), supported by programmed inspections and professional engineering advice.

Key Words:
- Risk-based bridge asset management
- Collaborative approach to achieve strategic asset management objectives
- Data consistency and quality

Introduction

Like other infrastructure asset classes, the Toowoomba Regional Council (TRC) has responsibility for management of the council’s network of bridges and major culverts. The ability to provide safe acceptable levels of service relies on effective asset management based on a clear understanding of risk. TRC like other similar asset owners and managers are responsible to maintain road assets in a manner which will provide an appropriate level of service, taking into consideration aspects such as structural safety and value-for-money investment. The reality is that maintenance funding is increasingly being placed under pressure at a time where there is also increased pressure from the freight industry and Government to operate existing networks under heavier vehicles to increase national productivity. The problem is specifically related to existing bridges and culverts which were not designed to current standards yet are expected to still carry increased loads safely. The challenge is to determine how existing and aging infrastructure can be managed to provide the required higher service levels at the lowest cost. Local government and other asset owners increasingly have to adopt risk-based decision-making principles which have to be supported by accurate and meaningful asset information, captured in a systematic and consistent manner.

In the local government area, insufficient specialised technical expertise and gaps in relation to asset information are key issues preventing informed decisions to be made on aspects related to asset performance and safety. A simple question related to allowing heavier vehicles on a particular route or bridge, becomes very difficult to answer. Local Government assets in many instances are the ‘last mile’ in trying to realise increased productivity through the introduction of heavier vehicles. Effective asset management requires asset owners and
managers to fully understand the risks associated with their assets and networks. Adopting a structured risk-based approach will support asset managers in decision-making around investment of limited funds, service levels and safety.

TRC has recognised the need to adopt a strategic and methodical approach to implementing best-practice principles in managing the structural assets on their network. This paper discusses the process that TRC is going through in establishing a fit-for-purpose asset management system through a collaborative approach with ARRB Group Ltd. (ARRB) making use of ARRB’s expert advice and specifically ARRB’s customised structures asset management system, ASIS.

The outcome of the combined effort of TRC and ARRB has been the implementation of sound asset management principles and implementation of a structures management system which is a boost for bridge asset management within TRC and forms the basis and framework for effective asset management in the future. This paper provides a brief overview of the basic asset management principles adopted, the ARRB structures information system and its implementation within TRC.

Asset Management Fundamentals
The objective of asset management can be defined in terms of meeting required current and future service levels in the most cost-effective manner. To be effective, asset management needs to be integrated into the asset lifecycle such that all practices and management strategies are aimed at achieving lowest long-term costs. There are many models and descriptions for asset management. For the purposes of this discussion, reference is made to the International Infrastructure Management Manual (IIMM 2009).

ARRB subscribes to these definitions and has developed asset management procedures and systems incorporating the principles of fit-for-purpose and keeping it simple. To a large degree, asset management and risk management cannot be separated and it is hence important to understand the interrelationships.

**Figure 1** defines the asset lifecycle activities as defined by IIMM and illustrates the fact that asset management, to be effective, needs to be integrated into a number of related activities.

![Figure 1: Key asset lifecycle activities (IIMM)](image)

One of the fundamental success factors is the quality of the data. No matter how sophisticated the systems and processes are, if the data is flawed then the final decisions will be flawed. Adaptability of any system is crucial in ensuring positive outcomes. Given that the cost of data capture is one of the most expensive items in setting up a system, it is critical to clearly define what information is required and for what purpose. The system must not dictate how business is done.

In order to develop management plans and strategies and provide robust arguments for funding, asset managers need to understand the risk on an individual and network level. The following section describes the key risk areas that should be taken into consideration.

**Risk Management**
Risk management is a complex topic and incorporates both business and asset risks. It is important to understand the key inputs to the risk management process. Factors such as knowledge of the asset, asset condition, future demand and levels of service are all required in order to make decisions. **Figure 2** outlines the risk management approach.
adopted by IIMM and highlights important fundamental principles of risk management:

- Identify critical asset and business risks.
- Understand overall risk exposure.
- Plan to manage risks to acceptable levels.

Only two of the above risks, condition and loading, are highlighted due to limitations on content of the paper.

**Condition Risk**

Structural condition is a key risk factor and a major driver in maintenance funding allocation. Condition assessment is predominantly reliant on the collection of subjective visual inspection data. Local government generally adopt SRA processes and procedures in collecting data used for defining local authority assets.

TRC has adopted the procedures outlined in the Queensland Department of Transport and Main Roads (TMR) Bridge Inspection Manual (BIM) which prescribes a hierarchical system of three levels of bridge inspections (common to most jurisdictions in Australia) as follows:

- **Level 1** routine maintenance inspection – a visual inspection to check the general serviceability and safety of the structure.
- **Level 2** bridge condition inspection – an inspection to visually assess and rate the condition of a structure including all components (as a basis for assessing the effectiveness of past maintenance treatments, identifying current maintenance needs, modelling and forecasting future changes in condition and estimating future budget requirements) and to identify any significant damage or defects requiring urgent repair or replacement.
- **Level 3** detailed engineering inspections and analysis – investigations intended to provide improved knowledge of the condition, load carrying capacity, in-service performance and other characteristics that are beyond the scope of Level 1 and level 2 inspections.

As part of a level 2 bridge inspection, structural elements are rated individually on a visual basis on a scale of 1 to 4. Table 1 summarises the general condition rating system used by TMR. A fifth condition state is used by TMR to describe the overall condition of a bridge that has reached the end of its service life.
Depending on the experience of the bridge inspector, it can be difficult to establish an overall condition rating for a structure as part of a level 2 inspection. ARRB’s policy is for all level 2 inspection reports to be reviewed by an experienced structural engineer and the overall condition rating is usually determined at this stage.

Over the course of 18 months and three separate commissions, ARRB has undertaken level 2 inspections of all 79 bridges and large culverts in the TRC network. This has provided TRC with a greater understanding and confidence in the condition of their network.

### Loading Risk

Another key risk to bridge and culvert assets is increased vehicle loading. The ability of the structures on a particular route to support heavier loads must be assessed in order for the asset owner to understand the overall risk exposure by allowing heavier vehicles to use local routes.

Local authorities are more likely to have older infrastructure, including timber bridges, which introduces added complexity in decision making. ARRB has developed analysis tools to enable the rapid assessment of timber bridges based on selected data captured as part of the standard level 2 inspections. Through use of these tools, six timber bridges requiring strengthening and/or replacement due to condition and/or assessed load capacity have been identified. TRC have been able to implement appropriate management strategies while long-term strengthening/replacement schemes are implemented.

A systematic approach is required to determine the critical capacity risks on a network. In a perfect world this includes:

- Identification of key routes, including affected assets
- Confirmation of specific vehicle loading to be used in assessment
- Sourcing of as-built drawings and data for both superstructures and substructures
- Undertaking structural assessment to confirm safety and service levels
- Preparation of route maps identifying levels of access.

Invariably, insufficient data prevents structural assessments to be undertaken or the analysis indicates a lack of capacity resulting in funding for strengthening and/or replacement of structures.

A network review is required to try and optimise and/or eliminate restrictions and then a re-assessment of the remaining restrictions needs to be undertaken. Where there is insufficient data available to undertake standard assessment techniques, the following options can be considered:

- Comparison with other similar bridge types designed in the same period for which data is available
- Review of research undertaken by state jurisdictions on structural capacity of older types of bridges which support increased capacity in many instances
- Evaluation of historical permitted loads as a benchmark for comparison with proposed increased loads
- Instrumentation and proof loading of structures to confirm load rating in collaboration with the freight industry.

At the end of the day, asset owners have the responsibility to ensure that assets are operating under acceptable safety margins. Regardless of the decision to either accept larger loads or to reject applications, the asset owner will have to be able to demonstrate that a robust process has been

### Table 1 Condition rating definitions

<table>
<thead>
<tr>
<th>Condition State</th>
<th>Condition State Meaning</th>
<th>Example</th>
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<tbody>
<tr>
<td>1</td>
<td>New or Good</td>
<td>Component is in good condition.</td>
</tr>
<tr>
<td>2</td>
<td>Minor Defects</td>
<td>Requires maintenance or monitoring to prevent further problems.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate Defects</td>
<td>Will require major maintenance or repairs to prevent further deterioration in condition state 4.</td>
</tr>
<tr>
<td>4</td>
<td>Severe Defects</td>
<td>Component is beyond repair and should be replaced.</td>
</tr>
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followed. Where funding is required to address restrictions, the more evidence available to support the risk profile, the more likely approval will be given. Asset owners need to understand that success is measured not only in protecting assets, but also in maximising the availability of the network to users.

**Risk Prioritisation**
One of the core objectives of a maintenance system for bridges and culverts is to ensure that the structures can retain their operational performance over their service life. A maintenance system must reduce risk and improve safety of structures. It must also ensure that long-term planning of maintenance strategies can be applied within budget constraints to ensure the effective use of limited resources.

With sufficient data and information about the different types of risks outlined above it is possible to use appropriate weighting factors to combine all relevant risks into one overall risk factor. There are many valid methods and models in use. ARRB has developed a package called *WhichBridge* which is a condition-based maintenance optimisation tool where the probability of failure algorithm is directly linked to the condition of the component being assessed. This risk assessment method generates a risk score for each component assessed as well as an overall numerical score for the structure, which can be used to rank the risk exposure of structures, isolated networks or the entire bridge stock.

**Maintenance and Forward Works Scheduling**
A principal objective of undertaking systematic asset management is to develop prioritised maintenance schedules based on risk.

Typically, maintenance recommendations are made as part of the inspection process and prioritised at a project level. ARRB’s approach differs slightly in that prioritised maintenance strategies are developed for each structure and can then be analysed at the network level in order to develop network wide maintenance projects.

**ARRB Structures Information System**
Having an integrated structures asset management system is crucial in ensuring accurate information is produced consistently, efficiently and effectively.

It needs to be acknowledged that there are key differences in managing road and structures assets. In most instances the level of detail required to effectively capture relevant structural data is greater than for typical road assets such as pavements and signs. The data set required to effectively describe the overall condition of any bridge or culvert structure needs to make provision for at least individual element condition rating, structural load carrying capacity and any risks that can impact on service level.

Within the context of an ‘integrated management system’, it makes sense to ensure that all aspects of structures management, from inspection, condition and load rating, valuation, risk assessment, overall weighted condition and development of prioritised maintenance work programs can be managed in a single system.

In order to add value, ARRB developed a functional, fully integrated and cost-effective Structures Management System to provide the necessary tools, data and advice to enable asset owners to effectively manage their structures. It is easy to modify the system to accommodate any organisational requirements.

ARRB’s approach acknowledges the need to keep things simple, flexible and focused on client outcomes and needs. The success of the development and implementation of the structures management system is based on the fact that the development has taken into account, not only the expertise and experience of ARRB but also that the system has been modified based on the real-life experience of the level 2 inspection programs which effectively provide information on a wide range of structures managed by local government and state jurisdictions. The key success factor is that the system is able to integrate with the client processes, policies and systems and not require changes in the way that clients conduct their business.
The following sections briefly describe the system before discussing how ASIS has been adopted and implemented by TRC to manage their assets.

Fundamentally, ASIS has been designed to answer the following key questions:

- What assets do I own?
- Where are they?
- What condition are they in?
- What maintenance do they require?
- How much will it cost?
- When should it be done?
- What maintenance has previously been done?
- What is the asset worth?
- What risks exist?

The system is simple to use with an intuitive user interface. It incorporates data integrity rules with automatic checking at all stages of the data entry process to ensure accuracy and consistency.

The fully integrated system makes provision for data capture and management of the following:

- structure inventory
- level 1 inspections
- level 2 inspections (individual component condition including timber drilling and scour surveys).
- maintenance strategies
- maintenance history
- risk assessment and prioritisation
- risk register
- valuation
- records capture (e.g. construction drawings, reports, multi-media files etc.)
- reporting (multiple automatic/standard reports at asset and network level).

TRC recognised the importance of a simple to use, fit-for-purpose structures management system and requested that ARRB supply a populated copy of ASIS for use in-house by asset managers and operational staff undertaking level 1 inspections.

As ARRB uses ASIS to deliver level 2 inspection projects, and having previously undertaken TRC’s level 2 inspection program over the previous 18 months, the system was able to be supplied with all basic inventory data and, more importantly, with a complete set of level 2 condition data and a forward works program of maintenance, refurbishment, replacement and further investigation. This means that TRC has the ability to consistently and effectively monitor the condition and performance of the network. Furthermore, by implementing ASIS, TRC now has a single source for all of their bridge and large culvert data. As more data is captured and construction records are incorporated into the system, TRC’s confidence and understanding of the bridge and large culvert network, its condition and the risks it presents will improve, as will their ability to manage risk effectively.

Implementation of the system within council involved a series of half-day workshops with key personnel in order to introduce them to the various modules of the system, their use and the benefits the collected data provides at both a project and network level.

**Conclusion**

Effective asset management relies on the establishment and application of consistent policies and procedures to ensure that asset management is undertaken in a systematic way. The importance of quality data and consistent condition assessment is paramount. To enable the asset owner to prioritise forward work and develop defendable budget and funding requests, a risk-based approach is required to establish a decision framework. The value of a simple, fit-for-purpose structures asset management system has been discussed. The system needs to be flexible and developed to suit the client’s business by providing a central point for all data storage, risk management, prioritisation of future maintenance work as well as any other specific requirements such as valuation and remaining service life and standardised technical and management
reporting. TRC recognises all of the above and are well on their way to implementing a corporate methodology and delivering their strategic asset management objectives. The collaborative approach developed through the level 2 bridge inspection program undertaken by ARRB Group is an excellent example of how effective systematic asset management can be realised. ARRB acknowledges the assistance and support of TRC in the implementation of the asset management system.

References
