

Bridge Asset Management in NSW

Michael B Bushby
General Manager Infrastructure Maintenance
Roads and Traffic Authority (NSW)

1 SYNOPSIS

Management of the arterial road infrastructure bridges in NSW is a component of the overall road network infrastructure management undertaken by the Roads and Traffic Authority (RTA). Asset management principles are applied in the context of the NSW Government Policy and Strategic context.

The RTA recognises the importance of managing bridges and their load carrying capacity, to ensure overall network connectivity and level of service to road users. A committed and competent bridge owner and manager, the RTA continues to proactively manage its bridge stock by:

- understanding issues related to the relevant design era,
- identifying and responding to changes in condition of bridge elements through a systematic and structured inspection regime,
- addressing emerging bridge issues, investing in new technologies and
- implementing innovative solutions in the management of its heritage bridge stock.

The RTA's bridge inventory has been constructed over more than 100 years and as such there are many emerging technological issues regarding bridge management. The RTA will continue to address these emerging issues in a professional manner.

Strategies have been developed and adopted based on material type, historical or geographical groupings. The RTA plans to continue to manage the NSW bridge inventory, balancing the often competing demands of capacity and required usage.

2 STRATEGIC CONTEXT

One of the Roads and Traffic Authority's (RTA) primary responsibilities is the management of public assets valued at nearly \$51 billion. Effective discharge of this responsibility, for the State Road Network and other State Assets, requires long term planning and analysis of the usage and performance of the network.

The NSW road network is estimated at over 182,000 km in length. The RTA is responsible for the maintenance and development of approximately 17,620 km of the major arterial road network in NSW, known as State Roads. The RTA also provides assistance to councils for managing their Regional Roads (approx. 18,500 km) and, to a limited extent, Local Roads, through funding and other support. The RTA also manages approximately 2,960 km of Regional and Local roads in the unincorporated area in the far west of NSW where there is no council. Included in this portfolio the RTA manages 4,701 bridges, 3,330 traffic signal sites

and 9 vehicular ferries. The bridges include major internationally recognised structures such as the Sydney Harbour Bridge and the Anzac Bridge.

The RTA periodically produces an Infrastructure Maintenance Plan that demonstrates how the RTA goes about the planning for its long-term asset management responsibilities, and the results of the planning work in terms of a five year plan. The RTA *Infrastructure Maintenance Plan* has been developed within the overall context of the NSW Government's Integrated Transport Plan *Action for Transport 2010* and the RTA's Strategic Plan *The Journey Ahead*.

2.1 Maintenance as the Government's Top Priority for Road Management

Action for Transport 2010 gives top priority to maintenance of the road network.¹ "The NSW road ...network is...a significant public asset which must be continually maintained as our first priority to ensure reliability, safety and retained value."

2.2 Road Maintenance adherence to Total Asset Management Policies

Action for Transport 2010 supports the RTA managing its road network as a long-term renewable asset² so the RTA definition of maintenance includes rebuilding the network to maintain its serviceability to road users over time.

The RTA Infrastructure Maintenance Plan has been developed in accordance with the principles of Total Asset Management (TAM). A description of TAM is provided below:

"Total Asset Management is the strategic management of physical assets to best support the delivery of agency services.

*With constant reference to whole-of-government planning, the agency's Corporate Plan, and its Service Delivery Strategy, the TAM approach requires asset managers to assess what assets are needed to support successful service delivery. It then calls for detailed plans for the management of those assets which are to be acquired, maintained or disposed of."*³

Total Asset Management promotes proactive planned maintenance, to manage the risk of asset deterioration rather than react to it, thus ensuring serviceability and reliability of the asset.

Asset management is also defined by Austroads⁴ as a comprehensive and structured approach to the long-term management of assets as tools for the efficient and effective delivery of community benefits. Total Asset Management plays a key role in the strategic planning of an asset over its life from capital procurement, maintenance and ultimate replacement or disposal.

2.3 The RTA Business Model

The RTA has adopted a client/purchaser/provider business model as the basis of its organisational structure and for managing the planning and delivery of its products and services to the NSW community. The business model was introduced to support a more commercial and customer focused method of operation and to assign specific roles and accountabilities to business units.

2.3.1 The clients:

The role of the three “Client” directorates is to:

- Develop program policy and strategy based on Government direction and community needs.
- Establish overall programs of works and project priorities, allocate funding and be responsible for the effectiveness of the RTA’s achievement of community outcomes.
- Develop delivery standards.
- Interface with the office of the Minister for Roads, and manage relations and agreements with national and other State Government agencies.

2.3.2 Service purchaser:

The purchaser provides the following services so that the clients can deliver programs and projects:

- Gives professional advice to the clients, in the development and delivery of integrated road transport solutions.
- Manages the provision of products and services specified by the clients, to ensure best value for money,
- Ensure consistency of practice across the State and the integration with local government and community needs.

2.3.3 Service Provider

Delivery of RTA programs by program but includes:

- RTA Operations is the RTA’s internal service provider which undertakes road, bridge, traffic works and driver and vehicle services across NSW. It operates commercially and has to be competitive with the private sector.
- Local Councils play an important role in maintaining roads and managing traffic on parts of the State Road network on behalf of the RTA, especially outside Sydney, as well as on the road network under their control.
- Civil and other contractors also provide products and services of road and bridge construction and maintenance.

3 BRIDGE ASSET MANAGEMENT IN RTA, NSW

3.1 Bridge Asset Portfolio

The 4701 bridge structures managed by the RTA include 2263 bridge size culverts. Any structure over six metres in length is considered as a bridge structure and recorded in the RTA Bridge Information system. 700 bridges on RTA roads were constructed before 1948 design standards and further 2100 are constructed for pre 1976 design standards.

Distribution of bridges by material type is given in table 1 (As at 30 June 2003)

Bridge Material	Total
Reinforced Concrete	499
Prestress Concrete	1391
Steel	429
Timber (22 TDOOL, 47 TTRUS, 28 TBEAM and 7 TMISC)	112
Masonry	7
Culvert	2263
Grand Total	4701

Table 1: Bridge Inventory by Construction Material

Valuation of the RTA's bridge inventory is \$6.64 billion in replacement value with a \$5.5 billion written down value. The RTA spends around \$85 million a year in maintaining and renewing the bridge asset portfolio.

The RTA exercises powers provided in the Roads Act (1993) to manage the RTA identified bridge assets. Other NSW Acts that influence the RTA management of its bridge assets include the NSW Heritage Act (1977) and Environmental Planning and Assessment (EP & A -Act (1979).

3.2 Bridge Information System

The RTA uses an in house developed Oracle based database named *Bridge Information System* (BIS) to store and manage information relating to its bridge assets. The BIS is used to keep an up to date record of the bridge inventory and the bridge condition data. The BIS provides a method for categorising bridges into good, fair and poor categories based on the bridge element condition data for each bridge. The BIS is also used for annual capitalisation to value replacement costs and depreciation of the bridge assets. This capitalisation information is published in the RTA annual report.

The RTA adopted a bridge condition rating system similar to the *Pontis System* from the Federal Highways Authority (FHWA) USA, to rate individual bridge elements on their condition. Generally each bridge has about 10 –12 elements. These elements are condition rated using the RTA Bridge Inspection Procedure and recorded in the BIS.

Bridge Inspection regimes have been determined based on material type, recurrence period, or by the condition of the bridge and the liability exposure associated with the rate of deterioration from that condition, or a combination of time and condition.

3.3 Bridge Inspection

Generally the RTA adopts the following inspection regime:

Level 1 – Safety inspection - This is a drive through inspection and is expected to collect information regarding the status and performance of ancillary elements such as barriers, deck scuppers, and waterways. These undertaken as part of the general road inspection.

Level 2 – Condition rating inspections (generally every 2 years for steel and concrete bridges and annually for timber) – These inspections are done in accordance with the RTA bridge

inspection procedures. A detailed visual assessment of element condition reported in accordance with parameters defined within the inspection manual guidelines. The inspection would be undertaken by an experienced Bridge Inspector to assess the specific material type, and may recommend the need for a higher-level inspection.

Level 3 – Engineering inspections (as required)- A detailed inspection based upon reported deterioration of individual elements within the bridge. The inspection would be carried out by a structural engineer and involve recording sufficient data to determine the capacity and possible maintenance actions for the continued functioning of those elements.

Underwater inspections (4 yearly) - Inspection are undertaken by experienced divers to assess the material condition specific material type and take under water photographs/videos as necessary.

Where prior experience has identified particular elements of particular bridge types as being at risk of distress or deterioration, the inspector shall be provided with the requirements for: a more detailed examination of such elements and guidance about the particular features of distress or deterioration to look for

3.4 Issues related to age of bridges

There are bridges in the RTA controlled network that were constructed as early as the late 19th century and early 20th century. These bridges are still in service and often carrying modern highway loadings. Design loading adopted for bridge designs have been categorised into three eras as given below:

ERA	LOAD DESCRIPTION	MASS
Pre 1948	A36	Rigid truck - gross mass 15 -17T - Plus an additional uniformly distributed load
1948 – 1976	MS18	Semi-trailer - gross mass 33T
1976 – Onwards	T44	Semi-trailer - gross mass 44T

Table 2: History of Bridge Design Loading

The RTA recently completed an assessment of all pre 1948 bridges to understand the load carrying capacity of these bridges and to identify any deficiencies. With that knowledge the RTA is now proceeding to develop forward strategies to address the issues identified.

Assessment of bridges designed between 1948 and 1976 is underway. It is not expected to result in the discovery of major load carrying deficiencies. Post 1976 designed bridges are generally accepted as having sufficient capacity to carry current legal loads.

3.5 Heritage issues

Having a bridge stock dating back to 19th century presents significant challenges in preserving the heritage bridges as well as keeping these heritage significant bridges in the RTA controlled road network as operating assets.

To manage the RTA's heritage responsibilities under the NSW Heritage Act, the RTA has conducted five separate studies to identify the heritage significance of bridges controlled by the RTA. Major studies completed include the following:

- *Study of relative heritage significance of all timber truss road bridges in NSW* (MBK, 1999)
- *Murray River Crossings Heritage Study* (HTR, 1998)
- *Study of relative heritage significance of RTA controlled timber beam road bridges in NSW* (Cardno MBK, 2000)
- *Study of heritage significance of pre 1930 RTA controlled metal road bridges in NSW* (Cardno MBK, 2001)
- *Heritage Significance of NSW Pre 1948 Concrete Slab, Beam and Arch Bridges* (Burns and Roe Worley, 2004)

These studies guide the identification and selection of potential treatments for the bridges.

3.6 Width deficiency issues

Road users perceive road width deficiencies as a major concern. Often bridges constructed for older design standards are width deficient compared to current standards. A program of work identifying the priority for widening is being developed to address the width deficiency issues.

3.7 Issues related to condition of bridges

General issues related to bridge maintenance are due to deterioration in condition of various bridge elements. Changes in the condition of bridge elements together with maintenance actions required are recorded in BIS when condition inspections are completed according to the identified cyclic basis. Minor maintenance actions identified during condition inspections are generally programmed for implementation during the year.

3.8 Repainting of steel bridges

Bridge steelwork is not designed to be sacrificial during the service life of the structure. It therefore needs to be protected with paint coatings to prevent corrosion and metal loss and deliver design service life. However, paint coatings on steel bridges deteriorate over time due to aging, environmental factors and general wear and tear, and need to be satisfactorily maintained to ensure their effectiveness.

The RTA controls about 415 steel and iron bridges. These steel and iron bridges were constructed from the early 1860's through to the present day. Most of these bridges are painted with lead paint primers and maintenance painting of these bridges involves stringent Occupational Health and Safety standards as well as Environmental protection standards.

The largest steel structure that the RTA maintains is the Sydney Harbour Bridge. Management activities related to the Sydney Harbour Bridge are separated from the general bridge inventory in consideration to its size and national icon status.

A separate program of work focused on steel bridge repainting is developed to protect the RTA controlled steel bridges.

4 OTHER EMERGING BRIDGE ISSUES

4.1 Alkali Aggregate Reaction (AAR) and Deferred Ettringite Formation (DEF)

Resulting from regular underwater inspections, the RTA has identified deterioration of precast prestressed concrete piles in a number of bridges. Further investigation of this deterioration has indicated the reason for deterioration being concrete distress mechanism called alkali aggregate reaction (AAR).

The cracking produced by AAR in the Tempe Bridge had led to “delayed ettringite formation” (DEF). In that case emergency works to install new piles was undertaken. The RTA has identified a further five bridges constructed in the same era with similar piles having less serious cracking, but again thought to be due to AAR and DEF.

Tempe Bridge has been strengthened with the installation of replacement bored piles to replace the original. Temporary repairs have been carried out on two other bridges. The balance are being monitored for further deterioration.

4.2 Emergency response

The RTA maintains an ‘emergency bridging’ stock for emergencies and use as supports for timber bridge repair. Having a large number of timber truss bridges requires a substantial stock of emergency bridging to ensure these bridges can be supported after damage and until each is strengthened for current legal loads.

4.3 Cross border issues

The Murray River forms the border between Victoria and NSW. There are 30 structures that provide vehicular and/or pedestrian access across the Murray River between NSW and Victoria. Two bridges are privately owned and maintained. One bridge is owned and maintained by the NSW Department of Natural Resources. Three bridges are on National Highways (NH). The Victorian and NSW State Governments jointly fund twenty-four structures under the provisions of an agreement between RTA and VicRoads renewed in 2001. Many of these bridges have high heritage value and include features reflecting the use of the Murray River by paddle steamers.

There are four bridges jointly funded by Queensland and NSW. Each state maintains two bridges.

5 MANAGEMENT STRATEGIES

5.1 Country Timber Bridge Program

In 1998 the NSW Government announced a five year strategy to upgrade 140 timber bridge crossings. This program is largely complete and has resulted in the replacement of 124 timber bridges and upgrading of a further 16 because of heritage considerations.

5.2 Timber Bridge Management

The RTA is constantly under pressure to replace or significantly upgrade many of the remaining timber bridges on NSW roads, because they do not meet current width and loading standards, because of local community pressure for improved access and because of the large recurrent maintenance burden the bridges impose.

Many of these bridges, especially those employing truss designs, are of heritage significance. The RTA has developed a management strategy, "*Timber bridge management*" which provides clear direction for the management of all of the RTA's timber bridges, taking into account the competing factors affecting their future, especially heritage, safety and access issues.

28 timber truss bridges for which the RTA is responsible, are listed on the State Heritage Register in NSW. The RTA is committed to retaining these in accordance with the requirements of the Heritage legislation. To ensure this is possible, under current loading requirements, Conservation Management Plans (CMP) are being prepared for each bridge. These will be progressively submitted to the Heritage Council for endorsement. Under the legislation the CMP allows the RTA to define ongoing management and maintenance proposals and to obtain Heritage Council approval to undertake those works.

5.3 Regional Road Timber Bridge Program

Local government councils are responsible for Regional Roads though they receive considerable State Government funding assistance through the RTA. Following the success of the Country Timber Bridge Program the Government announced in mid 2003 that it would assist local government with its management of timber bridges on Regional Roads.

The objective of the regional roads timber bridge program is to reduce the cost of maintaining timber bridges by enabling cost effective upgrading or replacement of existing timber bridges on regional roads, to a similar level of service to the existing crossings.

The State Government announcement in July 2003 stated that it will provide \$105 million over 7 years from the 2004/2005 financial year to assist councils to upgrade their timber bridges on regional roads in rural and regional areas. This follows strong concerns from councils in relation to asset management planning and in particular the growing maintenance liabilities associated with timber bridges and the critical nature of bridges to the functioning of the road network. The program is based on the Government providing a 50% funding contribution, making the total program worth an estimated \$210 million.

5.4 Murray River Crossings Strategy

The Murray River crossings between NSW and Victoria form critical lifelines for the movement of people and goods, not only between the local areas on each side of the river,

including the important tourist trade, but also between the main capital cities along the eastern and southern coasts of Australia.

The *Murray River Crossing Strategy* summarises the proposed management by the RTA and VicRoads for the future of these vital road crossings.

5.5 Program for strengthening of bridges

Assessment of pre 1948 bridges has identified bridges that do not have a sufficient factor of safety to carry live loads within the normal risk assessment. The RTA has prepared a forward program to address the strength issues on a priority basis.

5.6 New technology

The RTA continues to invest in new technology that could provide options for future bridge management. Some examples of use of new technology projects undertaken by the RTA include:

Reactive Powder Concrete bridge (Ductal) – Replacement of Shepherds Gully Bridge near Newcastle. Reactive powder concrete is being used to manufacture pre stressed bridge girders. The advantage of using Ductal is that its high strength reduces the size of the structural components required and hence reduces the weight of the bridge significantly.

Fibre Reinforced Polymer (FRP) deck – Coutts Crossing – The RTA replaced a timber beam approach span of the Coutts Crossing with a FRP module including reinforced concrete deck. Advantages in the use of FRP reinforced bridge deck compared to the conventional steel concrete bridge include low weight and high strength, greatly improved corrosion resistance and durability, and replacement of existing deck with lighter composite decks allow increased traffic loads without increasing loads on foundations.

The RTA formed a joint venture with, University of Southern Queensland and Composite Fibre Technologies for developing a suitable bridge design. In addition Cardno MBK and Connell Wagner consultants were engaged to design the substructure and the superstructure.

5.7 Innovative methods to address strengthening of Heritage Bridges

The RTA is under continuous pressure to balance its heritage responsibilities and the need for providing bridges that can carry current legal loads safely. These conflicting demands on heritage timber bridges have necessitated the RTA to seek innovative solutions for the strengthening of heritage significant bridges to keep them operational. Recently the RTA has received approval from the NSW Heritage Office to use the following treatments in strengthening heritage bridges.

- Stress Laminated Timber (SLT) decks on truss spans
- Timber Concrete Composite decks in place of timber beam approach spans
- Strengthening of bottom chords of timber trusses using steel laminates
- Flashing of timber members to protect timber from water.

6 CONCLUSION

The RTA recognises the importance of managing bridges and their load carrying capacity, to ensure overall network connectivity and level of service to road users. A committed and competent bridge owner and manager, the RTA, continues to proactively manage its bridge stock by:

- understanding issues related to the relevant design era,
- identifying and responding to changes in condition of bridge elements through a systematic and structured inspection regime,
- addressing emerging bridge issues, investing in new technologies and
- implementing innovative solutions in the management of its heritage bridge stock.

The RTA's bridge inventory has been constructed over more than 100 years and as such there are many emerging technological issues regarding bridge management. The RTA will continue to address these emerging issues in a professional manner.

Strategies have been developed and adopted based on material type, historical or geographical groupings. The RTA plans to continue to manage the NSW bridge inventory, balancing the often competing demands of capacity and required usage.

7 REFERENCES

-
- ¹ Government of NSW, *Action for Transport 2010*, page 23, 26
 - ² Government of NSW, *Action for Transport 2010*, page 23
 - ³ NSW Government Asset Management Committee (www.gamc.nsw.gov.au/tam): *TAM an Overview* (2003)
 - ⁴ *Strategy for Improving Asset Management Practice*, Austroads AP-53/97