Oberon Tarana Heritage Railway

Engineering Standard

Structures

OTCS 301

LOAD RATING OF UNDERBRIDGES

Version 1.0

Issued August, 2018

Approved by:

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Document control

Revision	Date of Approval	Summary of change
1.0	August, 2018	First Issue. Includes content from the following former RIC standard: RC 4100 and CRN CS 301 Ver 1.0

Summary of changes from previous version

Section	Summary of change

Contents

1 Purpose, Scope and Application

This document sets out the criteria for the load rating of the superstructures of steel and wrought iron underbridges

The aim is to supplement AS 5100 “Bridge design” in providing consistent and comprehensive rules and procedures for the rating of superstructures of steel and wrought iron underbridges in both "as new" and "as is" conditions.

2 References

2.1 Australian and international standards

AS 1170: 2002 “Structural design actions”

AS ISO 13822 - 2005 “Basis for Design of Structures – Assessment of Existing Structures

AS 1391: 2007 “Metallic materials - Tensile testing at ambient temperature”

AS 4100: 1998 “Steel structures”

AS 5100: 2004 “Bridge design”

2.2 CRN documents

OTCS 300 - Structures System

2.3 Other references

ANZRC Manual 1974

3 Engineering authority

Load rating of structures may only be undertaken by persons who have been granted appropriate Engineering Authority by the Engineering Manager.

4 General

All existing underbridges shall be assigned "as new" and “as is” load ratings.

Load rating shall be carried out in accordance with AS 5100 “Bridge design” and other relevant Codes and Standards including AS 1170 “Structural design actions” and AS 4100 “Steel structures”.

For the superstructures of steel and wrought iron underbridges, the load rating shall also be carried out in accordance with the requirements in this document.

Unless otherwise specified, all components and connections (including splices) shall be analysed.

Bridge component naming shall be in accordance with Engineering Standard OTCS 300 “Structures System”.

Notations shall be in accordance with AS 5100.

As is" ratings shall be based on site measurements including losses of structural cross section due to corrosion or other causes.

Calculations and summaries shall be annotated in sufficient detail to clearly distinguish between the "as is" and the "as new" rating of individual components.

The Standards and other reference documents used for the particular rating shall be stated. The values adopted in the calculations including material properties and load factors shall also be clearly stated and justified.

5 Load Capacity

5.1 Loss of section

The losses adopted in calculations shall be clearly stated and justified.

Where "as is" ratings are based on qualitative defect descriptions from inspection reports, use the losses detailed in Table 1.

Loss Level	Losses as a percentage of thickness
Minor	10%
Moderate	20%
Heavy	40%

Table 1 – Loss levels for "as-is" ratings

An appropriate level of judgement shall be used in adopting a loss level. As an example, minor corrosion in the horizontal leg of an angle would imply a 10% loss in thickness of that leg.

5.2 Material factors

In the absence of test data or designated steel type (on drawings or in specifications) the following values shall be used:

Material	Yield (MPa)	Ultimate (MPa)	Elongation (%)	Capacity factor, ϕ
Plates and sections				
Wrought iron [(1)(2)]	190 longitudinal 150 transverse	300	10	0.85
Steel<1910 [(2)]	210	400	20	0.90
1910-1940 [(2)]	230		20	
1941 – 1969 [(2)]	240		20	
After 1970	250		20	
Rivets [(3)]				
Wrought iron	Use same properties as for plate			0.8
Steel	Use same properties as for plate of relevant period			0.8

Table 2 – Material factors

Notes 1. Plastic properties not to be used if elongation <5%

2. Reduce yield by 5% where sections >20mm thickness are used
3. Field/hand driven rivets are assumed to be equivalent to shop rivets. All rivets, irrespective of installation method, have demonstrated satisfactory performance over the years.

Where testing to determine material tensile properties is undertaken, the requirements of AS 1391 “Metallic materials - Tensile testing at ambient temperature” shall be met. In the case of wrought iron, the additional requirements set out in Section 10.2 shall be satisfied.

5.3 Inadequate load capacity under existing conditions

Load carrying capacity of existing steel bridges can be derived using AS ISO 13822 provided the original physical and structural integrity of the member under consideration have not been significantly altered and similar traffic conditions prevail.

Traffic Conditions for main lines

- Train configurations documented in Section 6.2 apply;
- Performance shall be based on at least the past 20 years.

Member Conditions

- The original physical characteristics and structural integrity of the member have not been altered by either strengthening or replacing it;
- The member has not suffered more than 10% loss in capacity when load rated using dynamic load allowance factor (impact) from Manual 1974.

Where the above traffic and member conditions for the application of AS ISO 13822 cannot be attained then the load carrying capacity of that element shall be carried out using the dynamic load allowance from AS 5100.

6 Loads and Loading Factors

The loads and factors shall be in accordance with AS 5100 except as detailed below.

6.1 Dead loads

The combined unfactored dead load of rails, guard rails and transoms of the track together with steel walkway(s) shall be taken as 5kN/metre.

6.2 Live loads

The rating shall be derived from calculations based on the 300LA design loading in AS 5100, including 360kN front axle of simulated locomotive. The worst load effect shall be considered.

Ratings shall be specified in terms of current trains operating on the network. The following are recognised main line train consists and are shown diagrammatically in Appendix 2.

- Main Line freight (MF) - based on main line (82 class) locomotives plus 100 tonne NHGF coal wagons
- Branch line freight (BF) - branch line (422) locomotives plus 81 tonne NGTY wheat wagons
- Light Branch line freight (LB) - branch line (48) locomotives plus 76 tonne NGTY wheat wagons

- XPT/eXplorer (XP)
- Short bogie (SB92) - string of 11 metre bogie wagons such as RCGF steel coil wagons and a number of open wagons used in ore transport.

In addition to 300LA the following loads shall be used in rating:

- Class 1 & 2 lines – MF
- Class 3 lines - BF
- Class 5 – LB

6.3 Load factors

Load factors for dead loads and railway traffic shall be in accordance with AS 5100 Part 7 (Table 7.3).

Where the load carrying capacity rating of a component or connection is less than unity (1.0), the load factor for Live Load (LL) shall be calculated based on rating being equal to unity (1.0).

For example, if rating = 0.8 with LL load factor = 1.4, then LL load factor will be less than 1.4 for rating = 1.0.

The General Manager shall determine if a load factor lower than the AS 5100 value of 1.4 is acceptable.

6.4 Dynamic load allowance

The dynamic load allowance (DLA) specified in AS 5100 shall be used in the assessment of railway bridges.

For standard track, the dynamic load allowance is constant for speeds above 80km/hr, and varies linearly from zero for a speed of 0km/hr to the full value at 80km/hr. Thus in assessment of bridges for a speed greater than 80km/hr, the dynamic load allowance is the same as that for 80km/hr.

6.5 Nosing load

For nosing load other than for 300LA traffic loads, the load shall be taken as the proportion of the heaviest axle load to the 30 tonne axle design load (e.g., for 100t wagons with 25t axle loads, the nosing load would be 25/30 x 100 = 83.3 kN).

6.6 Wind load

A Serviceability Wind Speed of 20m/sec shall be used because of the short-term nature of the train loading on the structure.

7 Fatigue

Rating of bridges in terms of fatigue shall be undertaken in accordance with AS 5100.

8 Wind and Sway Bracing

The wind and sway bracing on old steel structures consists of flat bars and angles which generally are found to not have adequate theoretical capacity for current rail traffic. However, there is no evidence that the bracing is being overloaded. Loading effects

arising from dynamic load allowance are not applied to the bracing when calculating ratings.

The rating of these components will generally be less than one. The rating report shall include recommendations on the appropriate maintenance strategy i.e. inspection frequency, intervention levels and response times necessary to maintain safety.

9 Rating Results

Rating results shall be expressed as the ratio member capacity over applied load.

They shall be tabulated for “as new” and “as is”, and with and without full DLA.

Vehicle types and the effect of any speed restrictions in force or proposed shall be shown.

Where the rating is less than unity (1.0), the following shall also be included:

- Reduced speed necessary to raise the rating to unity (1.0), i.e. reducing DLA with respect to lower speed;
- Calculated load factor for live load with full DLA.

The results of the fatigue analysis shall also be provided.

A typical layout for the presentation of the rating results is shown in Appendix 1.

10 Reporting

10.1 General

A written report shall be prepared on the results of the load rating. The report is to include an executive summary at the front followed by:

- A statement regarding the particular Standards/ Codes and other reference documents used in the rating;
- A statement regarding the material properties and load factors used in the rating;
- Engineering details;
- Appendices.

The report shall include a general arrangement layout drawing of the bridge showing the arrangement of the main bridge components and the span layout.

10.2 Wrought iron test requirements

Deleted. Not Applicable

Appendix 1 Presentation of rating results

Executive summary

Bridge Superstructure Member Rating (Speed > 80km/Hr)			
Main Long. Girder	Primary X Girder	Secondary X Girder	Secondary Long. Stringer
3.13	1.10	1.14	1.01

Engineering details

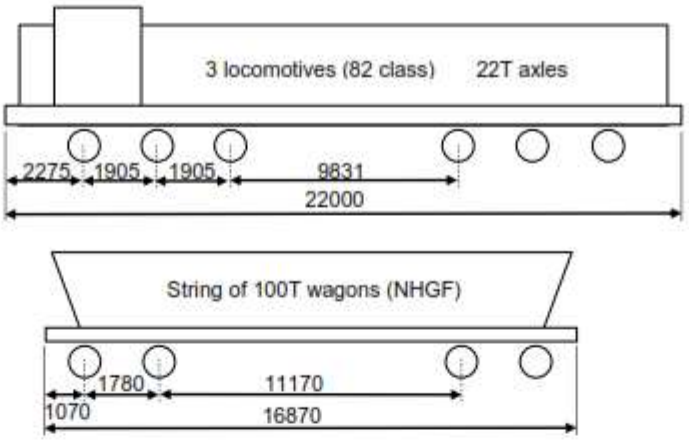
Superstructure Connection Rating (Speed > 80km/hr)					
Primary X Girder To Main Box Girder (Bolts)	Long. Stringer to Primary X Girder (Rivets)	Secondary X Girder to Main Box Girder			
		Complete Connection		One Failed Web Cleat	
		Rivets	Cleats	Rivets	Cleats
5.11	1.08	1.06	1.11	1.04	1.01

Appendix

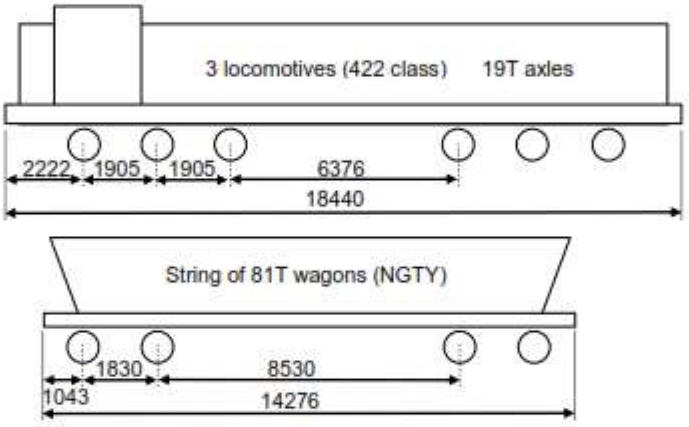
- Bridge photographs (along tracks & elevation)
- Bridge capacity
- Load effect summary
- Inspection summary
- Theoretical fatigue damage
- General Arrangement drawing

Appendix 2 Loading Diagrams

MF loading



BF loading



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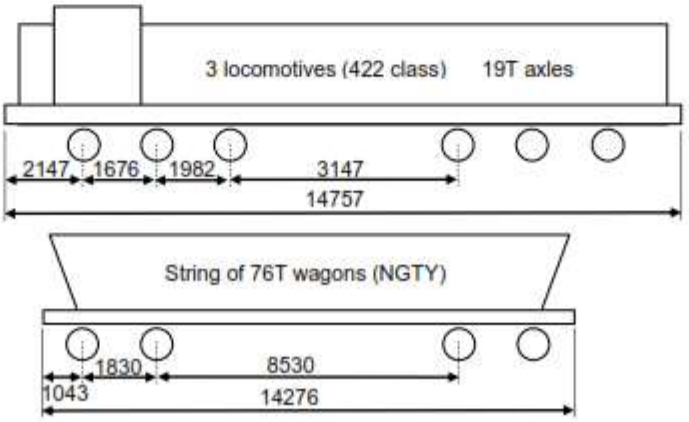
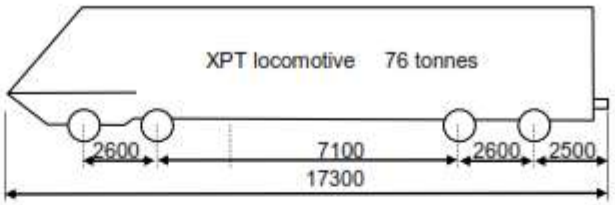


XP loading



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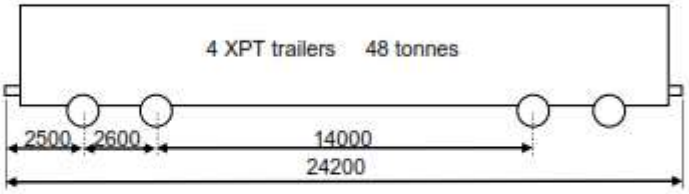

SB92 loading