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Bridge Transom

ETP-09-04

Applicability

ARTC Network Wide

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ARTC Section 9 Structures, ETS-09-00, EGH-09-01

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1.0	14 Feb 24	National Bridges & Structures Engineer	Stakeholders	Manager Track & Civil Standards	Head of Engineering Standards 11/04/2024

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Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	14 Feb 24		First Issue of document. Captures all transom contents from ETS-09-00 and Structures Repair Guideline.

Table of Contents

1 Introduction

1.1 Purpose

The purpose of this procedure is to provide requirements for bridge timber transoms and to provide approval conditions for the installation of FFU transoms.

Bridge transoms are primary load carrying elements of a railway bridge structure.

This document forms an integral part of Section 9 of the ARTC Track and Civil Code of Practice Section 9 ‘Structures’ ETS-09-00.

1.2 Scope

This procedure covers the timber transom properties and thicknesses for various train axle loads and the design requirements for FFU transoms, including fixing to the bridge spans.

1.3 Document Owner

The Head of Engineering Standards is the Document Owner. Queries should be directed to standards@artc.com.au in the first instance.

1.4 Reference Documents

The following documents support this procedure:

- ETS-09-00 ARTC CoP Section 9
- AS 1720.1 – “Timber structures – Design methods”.
- AS 2082 – “Timber Hardwood - Visually Stress - graded for structural purposes”.
- AS 2878 – “Timber classification into strength groups”.
- AS 3818.1 – “Timber – Heavy structural products – Visually graded, Part 1: General requirements”.
- AS 3818.2 - “Timber – Heavy structural products – Visually graded, Part 2: Railway track timbers”.
- JIS E 1203 (JRCEA/JSA) “Synthetic sleepers– Made from fibre reinforced foamed urethane”.

1.5 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
Transom	A rail bearer on a rail bridge supporting and locating the track, fastened to it and supported by steel or timber stringers or deck girders on open top spans.
FFU	Fibre-reinforced foamed urethane

2 Bridge Transom

2.1 Transom Material

Transoms are now available in a variety of materials. ARTC still uses hardwood timber transoms extensively but progressively installing FFU transoms.

Transoms manufactured from fibre composite materials, or any other materials shall only be utilised following “Type Approval” by ARTC.

2.2 Timber Transom

2.2.1 Timber Material

Specific requirements for timber transoms are as follows:

- Timber stress grade shall be F22 or higher.
- Structural grade and timber species shall comply with the requirements of
- Timber shall be free of loose knots, unsound knots and knot holes.
- Want, wane and sapwood, individually or in aggregate, shall not exceed one seventh of the cross-section nor two fifths of the wide face on which it occurs.

All other requirements for transom timber shall comply with the following standards:

- AS 1720.1 – “Timber structures – Design methods”.
- AS 2082 – “Timber Hardwood - Visually Stress - graded for structural purposes”.
- AS 2878 – “Timber classification into strength groups”.
- AS 3818.1 – “Timber – Heavy structural products – Visually graded, Part 1: General requirements”.
- AS 3818.2 - “Timber – Heavy structural products – Visually graded, Part 2: Railway track timbers”.

Table 1 Transom Timber

Groups	Common Name	Visual Stress-grade		Botanical Name(s)
		Structural Grade No 1	Structural Grade No 2	
Group 1	Grey Ironbark	F27	F22	E. siderophloia E. drepanophylla E. paniculata
	Red Ironbark	F22	N/A	E. fibrosa E. crebra E. sideroxylon
	Grey Gum	F27	F22	E. punctata E. propinqua
	Tallowwood	F22	N/A	E. microcorys
	White Mahogany	F22	N/A	E. acmenoides
Group 2	Spotted Gum	F22	N/A	C. maculate C. citriodora C. henryi

2.2.2 Timber transom Size

Open deck rail bridges with steel span lengths greater than 20m have built in camber. The thickness of transoms shall not be increased at ends of span to remove camber.

Transom dimensions and tolerances shall be as stated in below.

Table 2 Transom Dimensions and Tolerances

	DIMENSIONS (mm)	TOLERANCE (mm)
Length	2600 nominal	+50, -0
Width	250 nominal	+25, -0
Thickness	As per Tables 9.5 and 9.6 below	+6, -0

2.2.3 Transom Thickness and Holding Down Bolt

Some of the transom top steel span rail bridges in Victoria have 4 girders, compared to 2 girders in NSW. It is also relevant to note that some transom top bridges in Victoria were originally designed for Broad Gauge track whereas they are now standardised to Standard Gauge track.

2.2.3.1 Transoms for spans with 2 steel girders/stringers or with 3 timber girders

For transom top steel and timber rail bridges with span main girders at 2m centres maximum, the transom thickness shall be provided in accordance with below:

Table 3 Minimum Timber Transom Thickness and Holding Down Bolt for 2 girder/stringer steel spans and 3 girder timber spans

AXLE LOAD & SPACING	TRANSOM SPACING (mm)	MAX SPEED (km/h)	JOINT STRENGTH GROUP[3]	HD BOLT SIZE[4] (min)	TRACK HORIZ. ALIGNMENT	MIN. TRANSOM THICKNESS[5] (mm)
30t axles as per AS5100.2 - 300LA design rail traffic loading	600	115	J1	M30	Straight	190
					Curved	210[2]
		80	J1	M30	Straight	185
					Curved	205[2]
	500 - 550	115	J1	M30	Straight	170
					Curved	185[1]/200[2]
		80	J1	M30	Straight	165
					Curved	180[1]/190[2]
30t axles at ≥1500 centres (120t coal wagons)	500 - 600	115	J1	M24	Straight	150
					Curved	165[1]/170[2]
		80	J1	M24	Straight	150
					Curved	160[1]/165[2]
25t axles at ≥1500 centres (100t general freight wagons)	500 - 600	115	J2	M22	Straight	150
					Curved	150[1]/160[2]
		80	J2	M22	Straight	150
					Curved	150[2]

2.2.3.2 Transoms for spans with 4 steel girders

For transom top steel rail bridges with span main girders at 610, 910 and 610mm centres maximum, the transom thickness shall be provided in accordance with below:

Table 4 - Minimum Timber Transom thickness and Holding down Bolt for 4 steel girder spans

AXLE LOAD & SPACING	TRANSOM SPACING (mm)	MAX SPEED (km/h)	JOINT STRENGTH GROUP[3]	HD BOLT SIZE[4] (min)	TRACK HORIZ. ALIGNMENT	MIN. TRANSOM THICKNESS[5] (mm)
25t axles at ≥1500 centres	400 - 600	115	J1 or JD2	M22	Straight	110
					Curved	120[2]
		80	J1 or or JD2	M22	Straight	110
					Curved	120[2]

Notes on Tables 3 and 4:

(a) Bolt thread not to protrude into holding down bolt hole more than 10% of transom thickness.

(b) Maximum superelevation on curved track = 125 mm

1. *Max. track offset in relation to span centreline = 30 mm*
2. *Max. track offset in relation to span centreline = 70mm*
3. *J groups as specified in Table C1 of AS 3818.1*
4. *Swage Bolts shall be grade 8.8S bolts with reduced tension to suit timber application. All other bolts shall be commercial Grade 4.6.*
5. *Any localised reduction in thickness of a transom shall be achieved by a maximum 1 in 8 bevelling and rounded change of direction away from the reduced section.*

2.3 FFU transom

Fibre-reinforced foamed urethane (FFU) transoms are intended for use as bridge transoms only. FFU transoms shall not be used for spot re-transoming as they may lead to potential track problems associated with the effects of differences in elastic modulus between timber and FFU.

Structures representative shall verify design input data provided on FFU TRANSOM DESIGN CONDITION form and also, design data used by manufacturer to derive transom depth prior to proceeding with procurement. If necessary, seek engineering advice.

2.3.1 FFU Material

The FFU components provide an alternative material to hardwood timber for transoms for steel bridges on the ARTC network. They have equivalent material characteristics to that of timber and they are specifically designed for individual axle loads and bridge configurations with up to 50year design life.

2.3.2 FFU Transom Size

The minimum length of transom shall be the length between holding down bolt holes plus 400mm and the width shall be 250mm nominal unless otherwise approved by the corridor manager. The 200mm length beyond HD bolt at each end of transom is for a worker to put a foot there whilst installing transom HD bolts, sleeper plates and/or rails.

2.3.3 FFU Transom Thickness

FFU transoms are designed and manufactured by Sekisui Chemical Co. Ltd of Japan. FFU transoms shall be designed and supplied in accordance with 'JIS E 1203 (JRCEA/JSA) Synthetic sleepers– Made from fibre reinforced foamed urethane' and the manufacturer's requirements. FFU transoms are designed to mimic the physical and material characteristics of hardwood timber transoms.

Open deck rail bridges with steel span lengths greater than 20m have built in camber. The thickness of transoms shall not be increased at ends of span to remove camber.

Project Manager shall provide supplier with fully completed FFU TRANSOM DESIGN CONDITION form available from supplier. Details required on the form are axle load, train speed, rail offsets, track alignment, transom length and width, girder spacing, girder flange width, packer sizes and non-slip surface coating if required and holding down bolt size and locations if they are required to be pre-drilled by manufacturer.

FFU products are designed to achieve a high level of manufacturing precision that can eliminate the need for onsite modifications. They can be cut to specified precision, predrilled, pre-cut and prepacked. To facilitate this, Project Manager shall provide supplier with accurate survey and rail alignment data.

Where the gaskets (packers) are necessary, they can be ordered from Sekisui. The order shall include the correct dimensions (shall be greater than 3mm thick), shape and quantity of gaskets. Where the gaskets are to be positioned over rivets, the supplier shall be provided with rivet positions on drawing and required hole or groove sizes over rivets.

Axle load for specific track classification shall comply with the requirements of below.

Table 5 – Axle Loads for FFU transoms

TRACK CLASSIFICATION	AXLE LOAD (t)	SPEED (kph)
Hunter heavy haulage lines (New bridges)	35	>80
Hunter heavy haulage lines (Existing bridges)	30	>80
All other lines	25	>80
Lines requiring specific approval of Corridor Manager	23	>80

2.3.4 Traceability of FFU Transoms

FFU products are manufactured from non-naturally occurring materials. The manufacturing process and conformance testing records for each batch of FFU transoms shall be supplied by the manufacturer and retained by the corridor manager. The corridor manager shall maintain traceability records of all FFU transoms used in the corridor.

2.4 Holding Down Bolt

2.4.1 Bolt Size

The holding down bolt sizes shall be as specified in Table 3.

2.4.2 Swage Bolt

Swage bolts, tension reduced down to 40kN to suit timber application, are considered to be permanently locked and maintenance free. Refer to Figure 1.

2.4.3 Galvanised Bolt/Conical Spring/Nylon Lock Nut Assembly

This system is considered to be permanently locked and almost maintenance free. All bolts and washers are galvanized. Refer to Figure 1.

2.4.4 Location of bolts

1. **Drilled flanges**
    - Many transoms are attached to girders/stringers by a bolt on the outside of one girder flange and on the inside of the other. The latter bolt (inside location), that is, under the track plate is to be relocated during the re-transoming where practical, to the outer flange.
2. **Undrilled flanges, that is, clipped transom conversion**
    - Holes to be drilled in outer flange. Burning is not permitted.
    - Holes to be free of rag and perpendicular to top flange.
    - Drilling to be carried out by competent persons.
3. **Lateral positioning of holes**
    - Not less than 40mm from edge to centre of hole.

- Sufficient distance from the web so that the head of the bolt clears the fillet of the girder.
- Preferred distance from centre line of girder is 60mm (if bolts are kept as close as convenient to the web less damage is caused by transom flexing under load).

4. **Longitudinal positioning of holes**
   - At abutments, first holes as near as practical to girder ends but with transom wholly supported by girder flanges.
   - Holes positioned as close as practical to transom centrelines and holes to be spaced as uniformly as practical along the span.
   - Ensure that no hole is located such that the bolt head will foul the edge of a stiffener or other attachment.
   - No hole to be located within 50mm of any other holes.
5. **Bolt hole size**
   - Hole diameter is 2mm greater than bolt diameter.
   - If existing (undersize) holes are to be reused they must be enlarged by drilling or reaming.

2.4.5 Removal of Transom Bolts

- Burning off of transom bolts adjacent to the top flange surface is not permitted, as burning damage cannot be tolerated on any structural members of a railway bridge.
- Where possible transom bolts are to be removed with a spanner.
- When transom bolts need to be removed by oxy cutting the burning off is to occur only at the top surface of the transom and the bolt driven out through the transom.

2.5 Rail Plate Screw Spike

The holding down recommended screw spike and hole dimensions for rail plate installation are given in below:

Table 6 – Recommended screw spike and hole dimensions for rail plate installation

SCREW SPIKE DIMENSION	HOLE DIMENSION	NOTE
22 dia x 150mm long	17 dia x 140mm deep	Standard screw spikes with Fe6 washer
24 dia x 150mm long	19 dia x 140mm deep	Standard screw spikes with Fe6 washer
24 dia x 165mm long	19 dia x 150mm deep	Standard screw spikes with Fe6 washer

2.6 Transom Holding Down Assembly

All transoms on steel girder spans shall be seated on rubber pads to reduce impact loading on steel superstructure and if required packers shall be used to achieve required rail level.

Specific requirements for rubber pads under transoms are as follows:

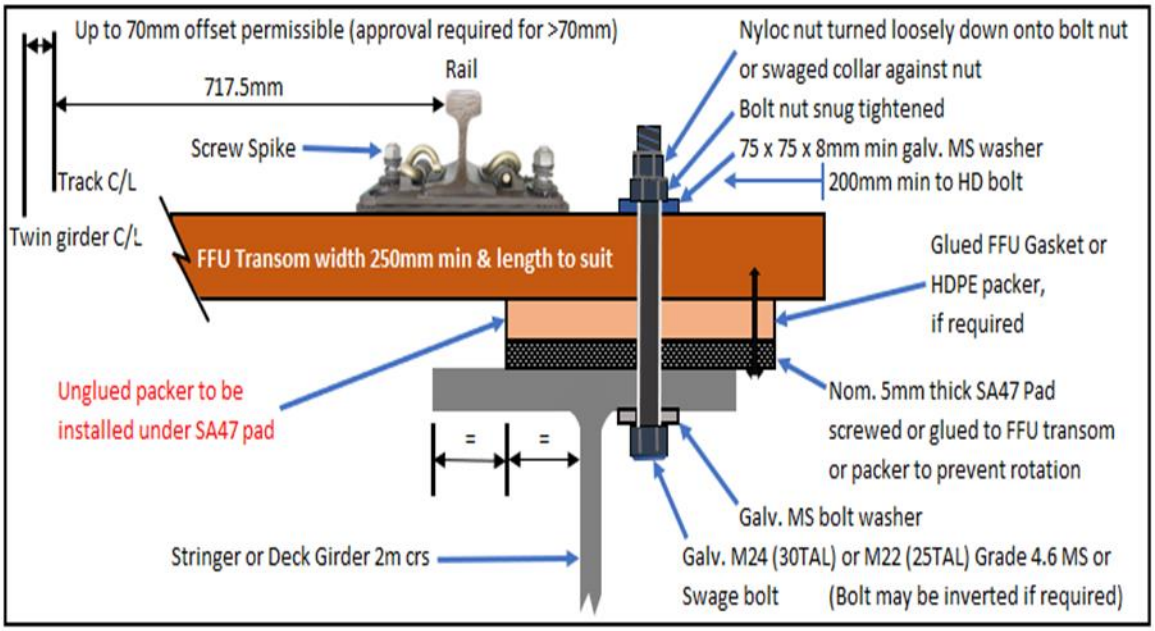
- Pad shall be SA47 rubber pad or equivalent.
- Nominal pad thickness 5mm.
- Total thickness of pad(s) shall not be greater than 32mm.

- No steel plate or any other packer type to be inserted between layers of rubber pads.

Specific requirements for packers under transoms are as follows:

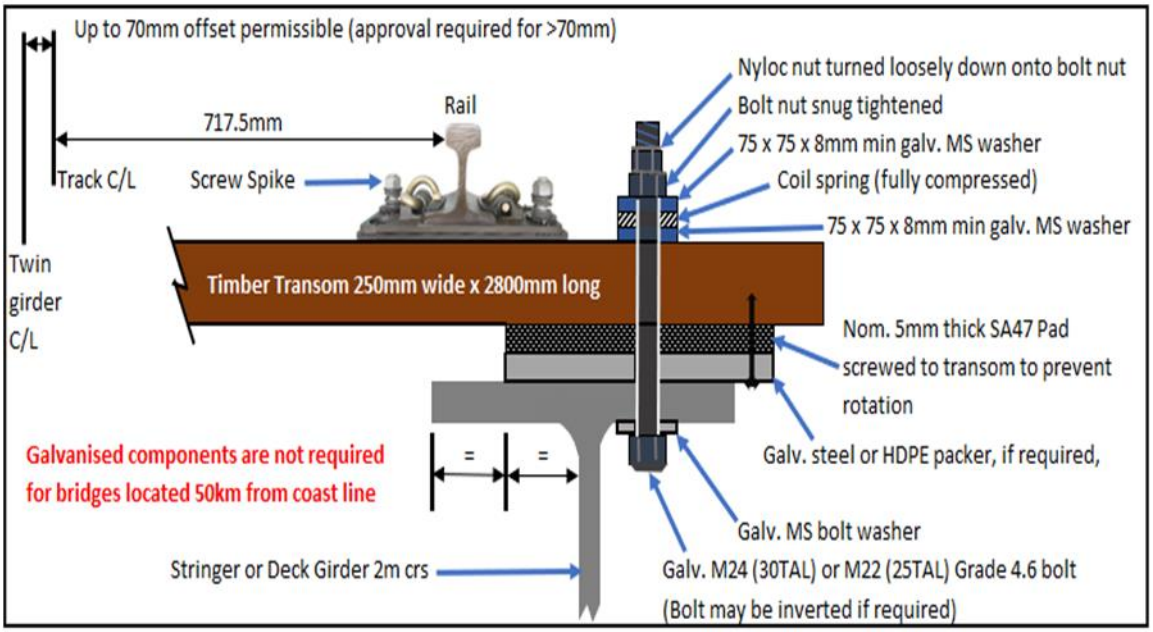
- Open deck rail bridges with steel span lengths greater than 20m have built in camber. The thickness of packers shall not be increased at ends of span to remove camber.
- Packer(s) shall be installed below rubber pad unless packer, especially FFU gasket, is glued to transom.
- Packers to be steel plates, High Density Polyethylene (HDPE) sheets, FFU gaskets or equivalent to suit required thicknesses.
- Packer thickness shall not be greater than 50mm in total unless otherwise approved by ARTC.
- Steel and HDPE packers shall not be less than 3mm thick.
- Conical spring is not required for non-shrinking FFU transom.
- Conical spring with flat washers can be installed either under bolt nut or head (spring expands as timber shrinks).
- No more than 2 flat washers shall be used under bolt head and 1 either side of conical spring

Typical transom holding down assembly is shown in Figure 1 below.



FFU Transom Assembly (Bolted)

Note: For FFU transoms, swage bolt with threaded nut and swage collar is an alternative option to mild steel bolt provided tension in swage bolt is less than 40kN



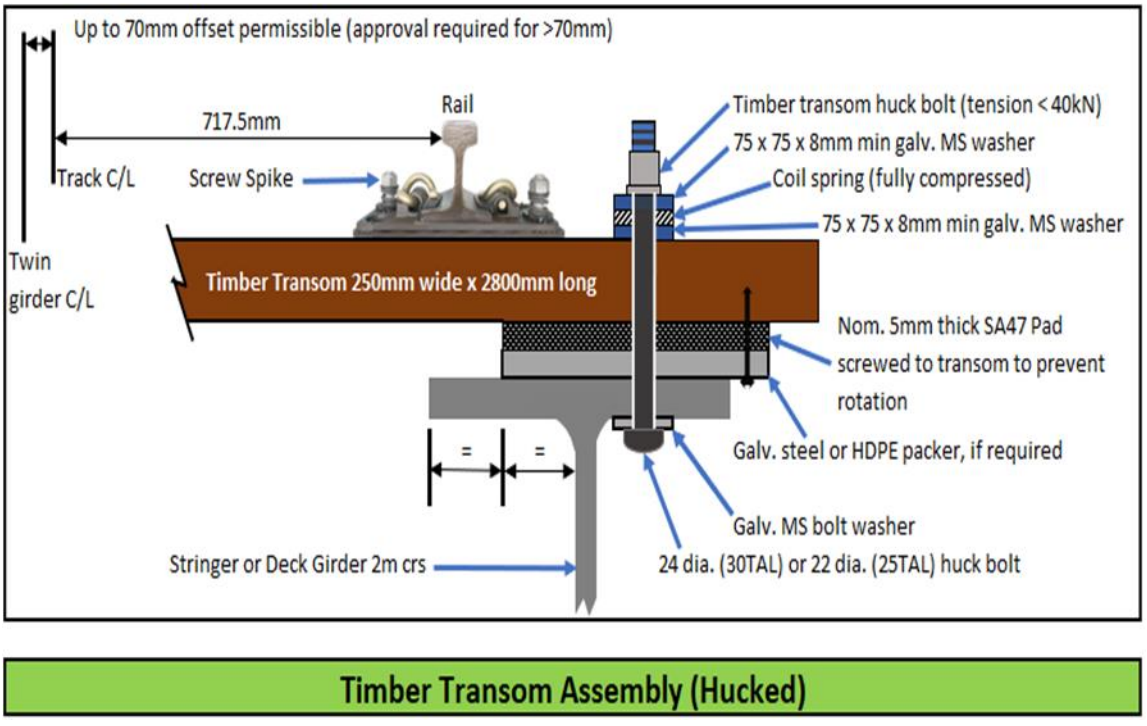


Figure 1 Transom holding down assembly details (typical)