NOTE: JULY 2018

The Timber Bridge Manual is a **reference document only**. Some of the contents are out-of-date.

It is recommended to seek advice from RMS Bridge and Structural Engineering (Rehabilitation Design) prior to use.

TIMBER BRIDGE MANUAL

Edition 1 Revision 0 – June 2008

SECTION SEVEN

TIMBER CONCRETE COMPOSITE BRIDGES

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SECTION SEVEN

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7. TIMBER-CONCRETE COMPOSITE BRIDGES

7. 1 GENERAL

7. 1.1 Scope

Section 7 covers the design, construction and maintenance of timber-concrete composite (TCC) bridge systems and specified components as outlined in Subsection 7.2. While it may be used for all types of timber-concrete composite systems, it is directed towards the more recently developed composite modular decks. Its use applies only to *approved* composite designs which use Australian hardwood species.

This section is to be read in conjunction with *Section 1- General* and other sections as may be specified. Section 1 provides the basic requirements and procedures for timber bridges and their components. This section provides specific additional requirements relating to timber- concrete composite bridge systems.

7. 1.2 Objectives

The objectives of this sections are to outline the requirements of, and to provide guidance in relation to, the design, construction and maintenance of timber-concrete composite bridge systems with specific emphasis on:

- inspection procedures
- preventative and routine maintenance
- rehabilitation and repairs
- engineering design and evaluation
- specifications
- material supply

7. 1.3 Definitions

Section 1 contains an extensive list of definitions pertaining to common terminologies, phrases and components related to timber bridges. This current subsection provides additional definitions related specifically to timber-concrete composite bridges.

Cast-In:

A term referring to items installed prior to a concrete pour and forming part of the finished module

Concrete Deck:
The top concrete slab of the module

Diaphragms:
The Concrete end support sections of the module

TCC Deck:
A term referring to the specific timber-concrete bridge module developed by the RTA at Grafton.

Drip Edge:
A V groove on the underside of the concrete adjacent to the edges provided to prevent water running under the deck to the timber girders

Long Term Deflection:
The accumulated vertical deflection of the module over time caused by repeated loading and drying of the timber

Module:
A completed timber-concrete bridge deck unit

Precamber:
A term referring to the intentional introduction of upwards vertical curvature to offset the effects of the mass of the module and long term deflection

Shear Connectors:
The steel plates and end channels embedded into the top surface of the timber girders

Principal's Representative:
The nominated representative of the Principal

Timber Girder Fabrication:
The trimming, sizing and grooving of the timber girders including installation of shear connectors and coach screws

Timber-Concrete Composite Connection:
The combined assembly of steel plate, channel and coach screw at the timber-concrete interface

7. 1.4 Limits of Application

The use of timber-concrete composite bridge systems is not a new concept and there are varied designs that have been used around the world, particularly in North America. However, nearly all of the North American systems use softwood timbers in conjunction with composite concrete slabs.

While the following information may apply to all types of TCC systems, RTA use relates only to *approved* composite designs which use Australian hardwood species.

7. 2 STRUCTURE TYPES AND COMPONENTS

This section deals specifically with the modular TCC deck shown in Figure 7.2-1. This design typically uses two timber girders made composite with a concrete deck to form an individual bridge deck module.

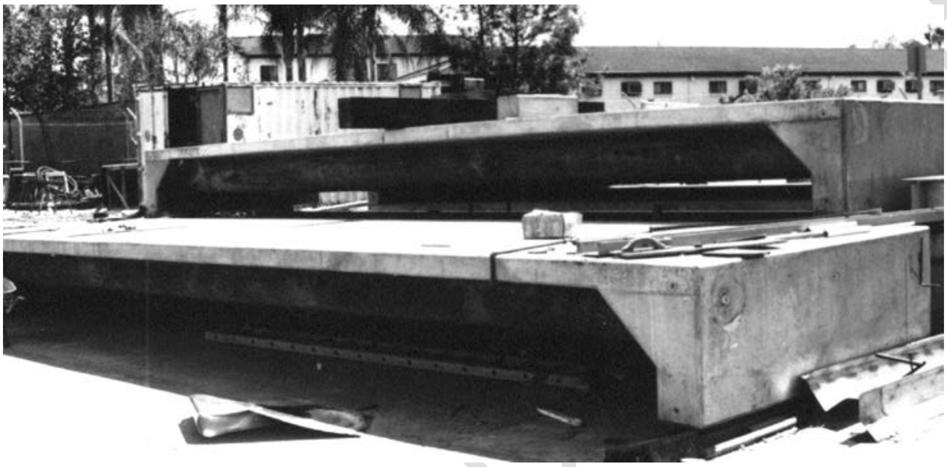

Figure 7.2-1 Deck Modules at RTA Fabrication Yard (Grafton)

These modules are prefabricated to sizes which can easily be transported to site and installed by crane or mobile gantry.

7. 2.1 Design Features

While specific engineering design and standard details will be outlined in Subsections 7.6 and 7.7, the following provides a brief resume of the basic components and materials.

Detailing of the TCC deck has been developed to counter the effects of timber shrinkage which can usually cause separation at the interface of composite systems. This new design features support of the timber girder through its composite connection to the concrete deck as shown in Figure 7.2.1-1. In this regard, the girder has no specific support or attachment at the traditional end bearing areas as shown in the figure. Therefore, as the girder dries, the shrinkage (dimensional change) in the girder occurs towards the concrete minimising the effects at the interface.

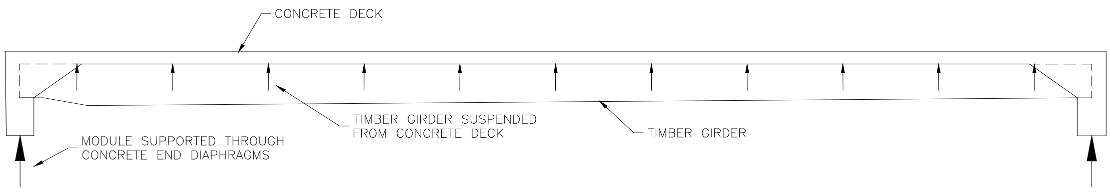

Figure 7.2.1-1 Elevation of Deck Module

7. 2.2 Timber Girders

Timber girders are selected from quality grade Australian hardwood species with a minimum stress grade of F27 and Durability Class 1. The member sizes are based on specific design requirements, but generally will not be less than 350 mm diameter at the smallest end section.

They are provided with flat surfaces on the top and fitted with steel plate shear connectors as shown in Figure 7.2.2-1 and the girders are trimmed and shaped at the ends to specific dimensions to suit their integration into the casting formwork as shown Figure 7. 2.2-2.

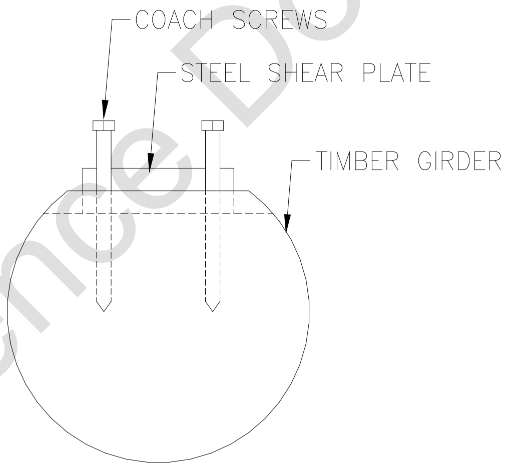

Figure 7.2.2-1 Section through Timber Girder

Figure 7. 2.2-2 Typical Sizing at End of Timber Girder

7. 2.3 Concrete Deck and Diaphragms

The concrete deck is cast integrally with the end diaphragms which provide the end support bearing for the modules. The design detailing of the concrete and reinforcement, as specified in Subsection 7.7, is critical to the performance of these modules. The concrete is designed to carry all the vertical shear forces.

7. 2.4 Timber-Concrete Interface Connection

In order to provide composite action between the concrete and timber, as well as support to the girder, a series of shear plates and coach screws are used as shown in Figures 7.2.4-1 and 7.2.4-2. The coach screws provide the support attachment for the girder to ensure it remains close to the concrete. The shear plates provide the horizontal shear strength between the two materials.

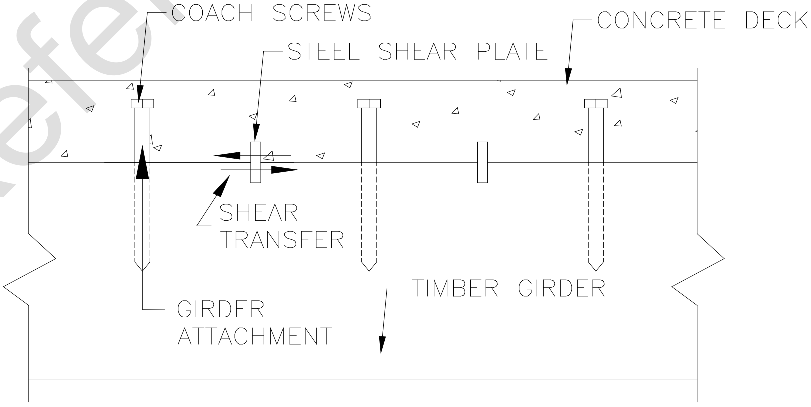

Figure 7.2.4-1 Shear Plates and Coach Screw Connectors

Figure 7. 2.4-2 Typical Shear Plates and Coach Screws

7. 3 INSPECTION PROCEDURES

Section 1 outlines the basic detailed inspection procedures for all timber bridge types and these procedures also apply to timber-concrete composite bridges. This subsection highlights specific additional considerations for timber-concrete composite bridges.

7. 3.1 Objectives and General Requirements

The basic objectives and requirements outlined in Section 1 must be considered during the inspection of TCC bridges. Specific attention must be given to both the concrete and timber elements, particularly the interface shear connections for any signs of distress or deterioration.

7. 3.2 Inspection Records

Detailed inspection records as outlined in Section 1 must be maintained for all inspections.

7. 3.3 Annual Visual Inspection

Annual visual inspections should be carried out on all TCC bridges and should be done together with the annual maintenance as outlined in Section 1.

The visual inspection shall include:

- all exposed components of the TCC module
- observation of the bridge under transient loading

- identification of any obvious structural defects and damage with specific emphasis on concrete cracking and timber/concrete failure at the shear connectors
- identification of any obvious deterioration
- specific attention to previously reported problem areas in past inspection records

Due to the unique nature of the TCC bridge system, as compared to the traditional timber bridges, some additional information is presented in the following sections.

7. 3.4 Observation under Transient Loading

The bridge should be observed under transient loading as outlined in Section 1. Specific attention should be given to:

- overall vertical displacement of the bridge
- relative movement between different modules
- relative slip of the timber and concrete components
- movement of the shear plate connectors
- separation of the timber and concrete components

Any suspected excessive movements should be followed up by a detailed inspection of the interface connection.

7. 3.5 Concrete Cracking and Crushing

All areas of the concrete should be inspected for cracking or crushing.

These modules are usually cast upside down and when they are placed in the upright position the concrete deck sustains some compression which offsets the potential shrinkage effects in the slab. Any cracks in the slab, particularly longitudinal cracks, should be recorded and reported immediately.

The end diaphragms should be inspected for structural cracking. Laboratory testing has identified several potential failure mechanisms at the end diaphragms which could cause cracking. The most prominent areas are shown in Figure 7.3.5-1. The cracks initiating at the corners of the haunch would be typically caused by flexural loading of the module. However, the cracking initiating at the top and end surfaces would be caused by bearing restraint or lack of gap behind the end of the module as outlined in Subsection 7.3.6.

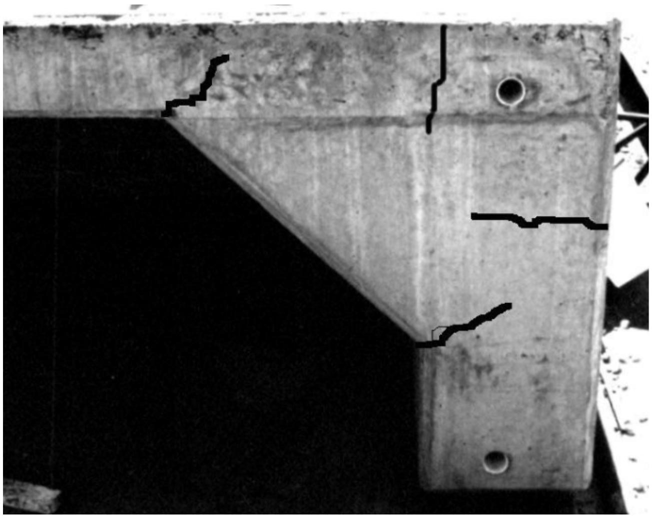

Figure 7.3.5-1 Potential Cracking in Modules

Particular attention should also be given to the concrete at the shear connectors. Overstressing of the concrete at the shear plates will result in crushing and spalling of the concrete in front of the plates as shown in the Figure 7.3.5-2.

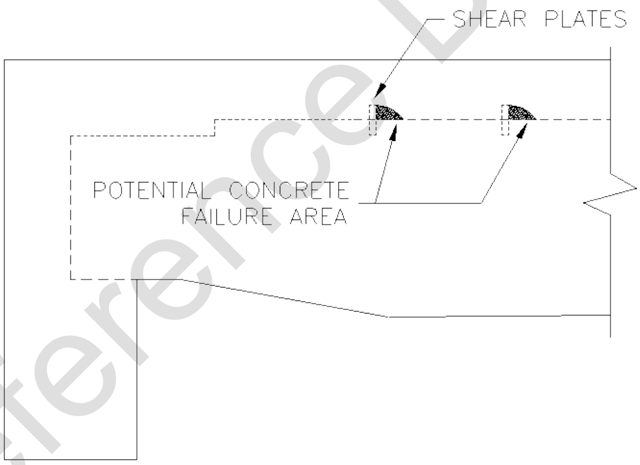

Figure 7.3.5-2 Potential Crushing of Concrete

7. 3.6 Bearing Restraint and Joint Gap

Cracking of the concrete can occur as a result of gradual build-up of debris behind the ends of the modules which prevents the normal rotation of the diaphragms under heavy loads as shown in Figure 7.3.6-1. It can also be caused by no gap being provided between modules during construction. This is accentuated for modules with very deep haunches. In addition, if no gap is provided, temperature can also play a significant role in producing internal forces. These areas between modules must be kept clear.

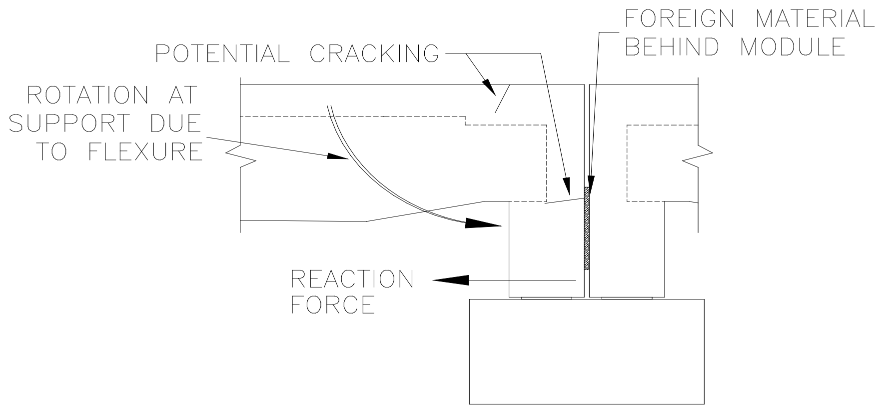

Figure 7.3.6-1 Bearing Restraint and Joint Blockage

7. 3.7 Timber Girders - Structural Failure and Damage

The potential failure and damage zones for the timber girder are

- flexural failure at mid-span
- horizontal splitting of the girder (see Figure 7.3.7-1)
- localised shear failure in the timber at the shear plate (see Figure 7.3.7-1)
- withdrawal of coach screws (separation of components)

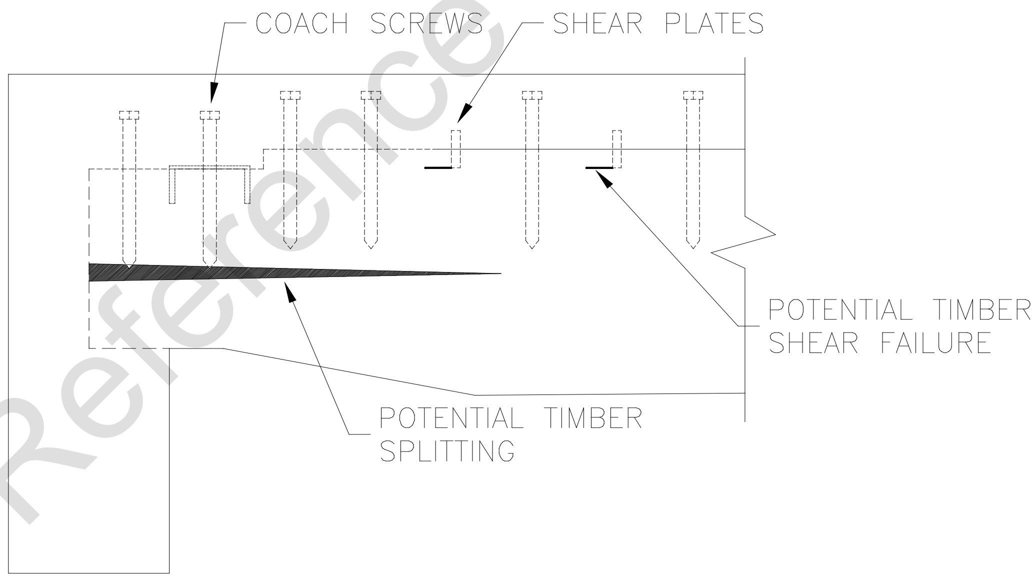

Figure 7.3.7-1 Potential Timber Failure Areas

7. 3.8 Timber Girders - Deterioration

Potential deterioration of the timber (ie: decay or insect attack) is highest at the timber-concrete interface, particularly at the ends of the girders (see Figure 7.3.8-1). If moisture accesses these areas, it is likely that the deterioration would be concentrated at the connectors which penetrate the timber. Typically, only a detailed boring of the girder would expose these problems as is outlined in Subsection 7.3.11.

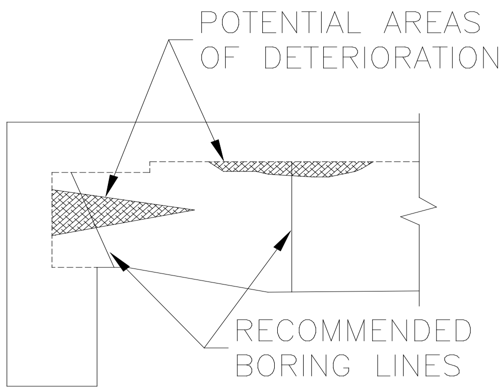

Figure 7.3.8-1 Potential Timber Deterioration Areas

7. 3.9 Additional Items for Annual Visual Inspection

The annual visual inspection should include the following additional items:

- visual signs of timber deterioration
- concrete cracking in slab and haunches
- concrete crushing and spalling at shear plates
- localised timber shear failure at shear plates
- girder splitting at ends
- separation of the timber and concrete components

7. 3.10 Detailed Inspection

A more detailed inspection should be carried out on timber bridges every three years. In the case of the composite bridge modules, this would consist of timber boring to evaluate the internal condition of the girders as outlined in Subsection 7.3.11.

If structural problems have been discovered, then the detailed inspection should include:

- mapping and marking concrete cracks
- monitoring crack propagation
- measuring interface slip
- measuring component separation
- possible load testing

Some additional details on monitoring and testing are outlined in Subsection 7.3.12.

7. 3.11 Timber Boring

The standard methods and identification for timber test boring are outlined in Section 1 and shall be applied to TCC bridges. However, with composite modules, there are several additional points to consider:

- the ends of the girders and other contact areas with the concrete are the most susceptible to deterioration
- the ends of the timber girders are embedded in the concrete and so it is necessary to drill in on an angle in order to properly check their ends (see Figure 7.3.8-1)
- cracked slabs will allow moisture to reach the tops of the girders

The boring lines to be adopted are shown in Figure 7.3.8-1. Vertical bores should extend up to the vicinity of the concrete slab (within 50 mm) but not completely through the girder.

7. 3.12 Monitoring and Testing

In cases where structural damage is observed, it is important to evaluate the extent of the damage, particularly its effect on the performance of the composite module. Problems should be reported to Bridge Engineering so that monitoring and evaluation can be arranged.

In addition to mapping cracks and monitoring of crack propagation, movements in the shear connectors should also be measured. Typically, a load test may be arranged with special measuring devices as shown in Figure 7.3.12-1. These gauges should measure relative horizontal movement between the concrete and timber as well as vertical separation of the components.

Figure 7.3.12-1 Instrumentation to Measure Slip and Separation

The work should be carried out though Bridge Engineering.

7. 4 PREVENTATIVE AND ROUTINE MAINTENANCE

Section 1 outlines the basic maintenance procedures for all timber bridge types and these also apply to timber-concrete composite bridges. This subsection outlines some additional maintenance activities specific to TCC bridges and their components.

7. 4.1 Objectives and General Requirements

The primary objectives of, and general requirements for, maintenance activities are outlined in Section 1.

7. 4.2 Preventative Maintenance

As outlined in Section 1, maintenance should begin with preventative measures to enhance durability through proper materials selection as well as design and construction detailing. In addition to the basic engineering and construction detailing outlined in Section 1, Subsection 7.7 reviews a number of design details specifically applicable to TCC bridges.

7. 4.3 Annual Maintenance

In general, the TCC bridge system requires very little maintenance compared to the traditional form of timber bridge. Each TCC module is an integral structural system which should not exhibit any loosening of its components, if properly constructed.

The following identifies some of the areas which require special attention in TCC bridges:

- removal of debris from between the modules and joints
- maintenance of the integrity of the sealants between the modules
- surface cracks in the concrete slab should be sealed
- retighten all bolted support connections

7. 4.4 Three Year Maintenance

There are no specific three year maintenance requirements for TCC deck modules as no access to the interface between the timber and concrete to retreat the high risk areas with preservative or retighten any connectors, is available.

7. 5 REHABILITATION AND REPAIRS

Section 1 outlines the general aspects of rehabilitation and repairs to timber bridges. This subsection describes repairs and rehabilitation related specifically to timber-concrete composite bridges.

These TCC modules should, in effect, be treated as disposable units as there is little that can be done to repair them once they *lose strength* through damage or deterioration. The timber girders cannot be replaced nor can the shear connection between the components be properly reinstated. Except for sealing of minor cracks, any major repairs to a module should be considered temporary and the module should be scheduled for replacement.

The following sections outline some of the typical repairs that may be applied to a TCC module while identifying when the module may need replacement.

7. 5.1 Cracking in Concrete Slab

Typically, minor cracking of the slab surface may be treated by using standard pavement sealants. However, severely cracked slabs may be overlayed with a rubberised flush seal to protect against moisture penetration. A detailed investigation should be conducted to determine the cause of this cracking and whether the module needs replacement.

7. 5.2 Cracking in Haunches

Generally, cracking in haunches will not occur as it requires very heavy loading, restrained bearings or poor quality construction. The causes should be investigated.

Very little can be done to rectify cracks at these locations although accessible areas may be sealed. If the cause of the cracking is established and can be rectified (such as restrained bearings), it will not be necessary to replace the module. However, all cracks should be sealed even it requires temporary removal of the module. If the cause cannot be established, the damage should be monitored and the module scheduled for replacement.

7. 5.3 Failed Shear Connectors

Modules which display failure of the shear connectors, in either the concrete or the timber, should be scheduled for replacement. Testing and monitoring as outlined in Subsection 7.3.12 may be required to determine the seriousness of the problem

Temporary repairs may be carried out to severely damaged modules using external strengthening as shown in Figure 7.5.3-1. This is only a remedial strengthening and should not be considered a permanent solution.

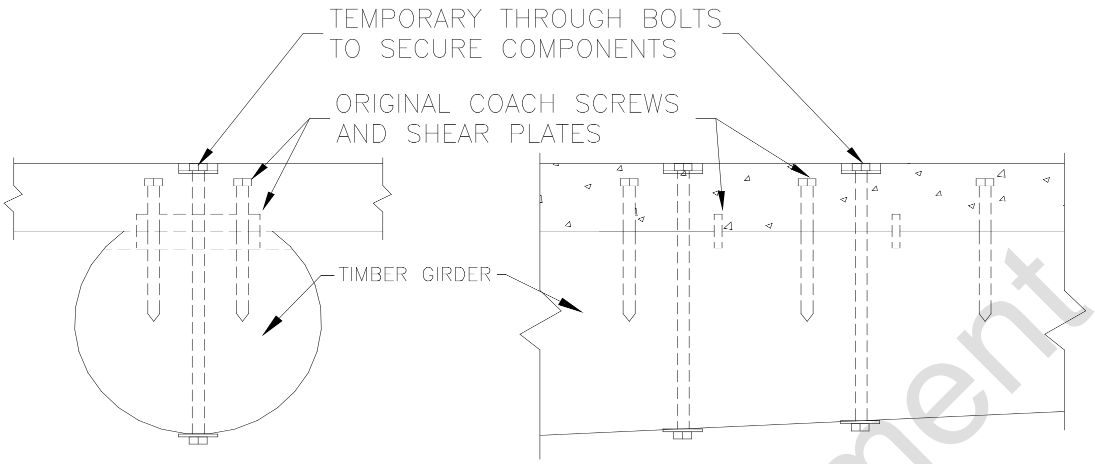

Figure 7.5.3-1 Temporary Repairs to Shear Connectors

7. 5.4 Timber Deterioration

If deterioration is discovered in the timber girders, detailed boring should be carried out, as outlined in Subsection 7.3.11, to clearly determine the extent of the damage. This information should be used to assess the structural capacity of the module.

If the strength is still adequate, then the girder should be properly treated to prevent further deterioration. This treatment should be followed up by an additional inspection within 6 months to ensure that the deterioration has been stopped. This girder should then be closely inspected during each annual inspection and the treatment reapplied.

If the deterioration has reduced the strength of the module to an unacceptable level, the module should be scheduled for replacement and load restrictions applied if necessary.

7. 6 ENGINEERING EVALUATION

Section 1 outlines the basic requirements for engineering design and evaluation of timber bridges. It lists the specifications applicable to the design of all timber bridges in NSW.

7. 7 DETAILING AND DURABILITY

This subsection outlines the standard details for timber-concrete composite bridges. These details must be adjusted to suit varied span lengths depending on the site conditions.

7. 7.1 Recommended Details

Development of the composite module was based on a standard set of details as shown in Figure 7.7.1-1. These details, coupled with the requirements of Subsection 7.8, have been proven through both full scale laboratory and field testing. They allow little variation for the designer and contractor.

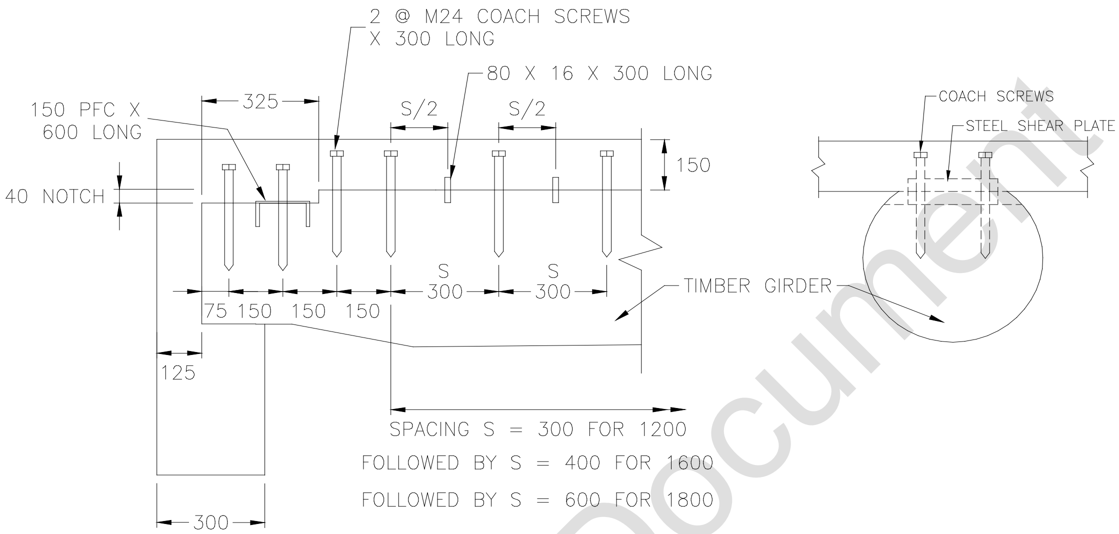

Figure 7.7.1-1 Typical Detailing - Macleay River Bridge

The end details shown in Figure 7.7.1-1 are critical to the proper performance of the modules. The details shown, including the 300 mm spacing (S) over 1200 mm, must be applied regardless of the length of the module. Subsequently, the spacing can be increased to 400 mm (as shown) for the next 1800 mm of length. Only the central portion of the girder/module will alter for different module lengths. This central portion will use 600 mm spacing (or less) to suit the remaining length.

7. 7.2 Construction and Durability

Durability of the TCC system relies primarily on proper construction/fabrication procedures and these are outlined in the next section. The critical features which must be properly carried out include:

- sizing of the timber girders
- preservative treatment of the timber girders
- installation of coach screws
- installation of shear plates and channels
- formwork, reinforcement and concrete pour

The following section outlines the procedures which must followed in order to ensure adequate durability of the modules in the long term.

7. 8 CONSTRUCTION SPECIFICATIONS

This section outlines the fabrication and construction specifications for the TCC bridge modules.

7. 8.1 Timber Girder Fabrication

7. 8.1.1 General

Except as may be noted in this specification, timber girder works shall be in accordance with RTA Form 2-500 *Specification for the Construction of Timber Beam Bridges.*

Unless otherwise specified on the drawings, timber girders shall be fabricated in accordance with the dimensional limits outlined below.

7. 8.1.2 Timber Girder Sizing

The top of the timber girders shall be sawn to provide a flat horizontal surface along the full length of the member as shown in Figure 7. 8.1.2-1. Unless otherwise specified on the drawings, the *nominal* width of this surface shall be 240 mm. To allow for the variability in girder diameter the actual width of this surface may vary along the length of the girder from a minimum of 180 mm to a maximum of 300 mm.

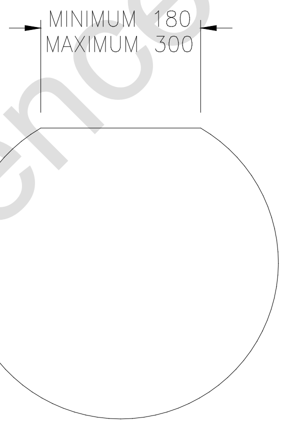

Figure 7. 8.1.2-1 Typical Girder Section

Where the girder diameter exceeds 400 mm, the sides and bottom shall be trimmed at the ends to provide an end section in accordance with the dimensional limits shown in Figure 7.8.1.2-2 (see also Figure 7. 2.2-2). The trimming shall extend beyond the limit of the concrete end diaphragms and then be tapered at 1:5 as shown in the figure.

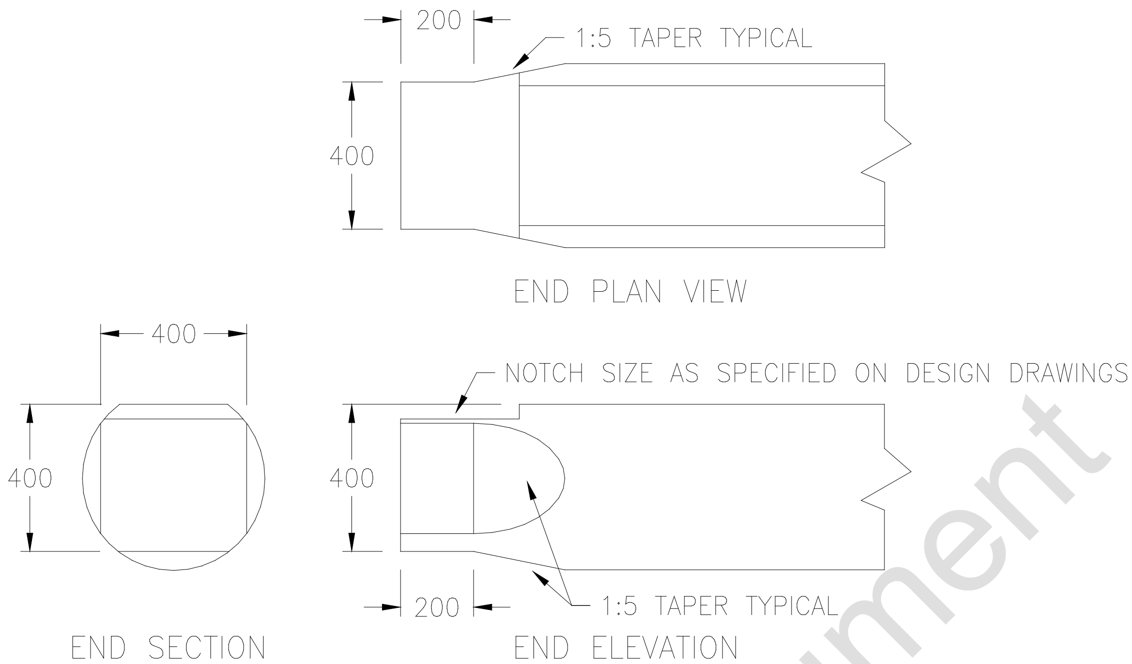

Figure 7.8.1.2-2 Typical Girder End Section

All areas that have been cut, particularly those which will be inside or in contact with the concrete, should be liberally coated with CN Emulsion or equivalent.

7. 8.2 Timber-Concrete Composite Connection

Except as specified in this section, shear connectors and coach screws shall be located as specified on the design drawings within a tolerance of +/- 2 mm. Unless otherwise specified on the drawings, shear connectors shall be installed in accordance with the following procedures and tolerances.

7. 8.2.1 Positioning of Coach Screws

The *nominal* transverse spacing between coach screws shall be 120 mm as shown in Figure 7.8.2.1-1. To allow for the variability in the actual width of the top surface of the girder, the positioning may be varied within the limits shown in the figure. These limits shall be applied in accordance with the following priorities:

- where the width of the top surface of the timber girder is between 240 mm and 320 mm, the edge distance to each coach screw shall be maintained at 60 mm.
- where the width of the top surface of the timber girder exceeds 320 mm, the centre distance between coach screws shall be maintained at 200 mm.
- where the width of the top surface of the timber girder is between 200 mm and 240 mm, the centre distance between coach screws shall be maintained at 120 mm.

- where the width of the top surface of the timber girder is less than 200 mm, the edge distance to each coach screw shall be maintained at 40 mm.

In no case shall the following limits be exceeded:

- the edge distance shall not be less than 40 mm or more than 70 mm
- the centre spacing between coach screws shall not be less than 100 mm or more than 200 mm.

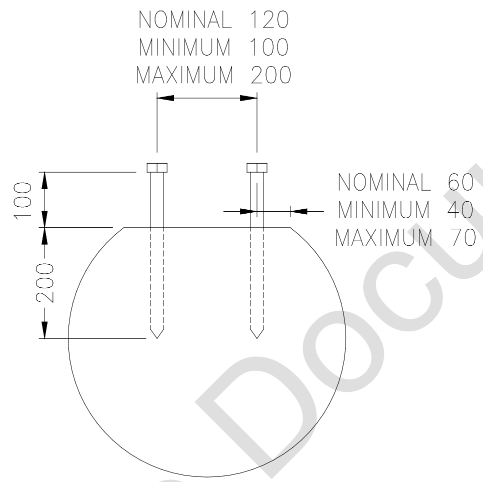

Figure 7.8.2.1-1 Positioning of Coach Screws

7. 8.2.2 Installation of Coach Screws

Unless otherwise specified on the drawings, coach screws shall be 300 mm long and shall be installed in the timber to a depth of 200 mm +/- 5 mm. Coach screws shall be installed into pre-drilled holes of diameter equal to the root diameter of the threaded portion of the coach screw. Additional countersink shall be provided for the shank portion of the coach screw, if required. Coach screws shall be installed by turning only and shall not be driven into the timber.

7. 8.2.3 Installation of Shear Plate Connectors

The shear plate connectors shall be installed into the timber to a depth equal to one half the width of the plate +/- 1 mm as shown in Figure 7.8.2.3-1. The plates shall be installed into pre-cut grooves equal to the thickness of the plate with a tolerance of + 0, - 0.1 mm. The plates shall not be loose and may be driven into the groove using a maximum 6 kg hammer. Care shall be taken to prevent splitting of the timber.

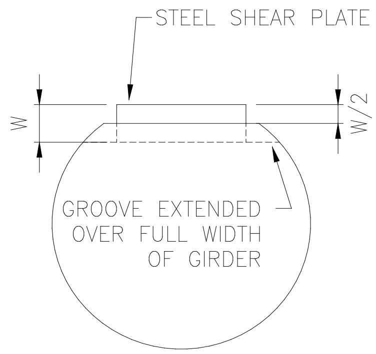

Figure 7.8.2.3-1 Installation of Shear Plates

The grooves shall be cut through the full width of the timber girder to provide for drainage, regardless of the length required for the shear plate.

7. 8.2.4 Installation of End Channel Shear Connector

Steel channel shear connectors at the ends of the girder (see Figure 7. 2.2-2) shall be installed into the timber to the full depth of the flanges, so that the inside face of the channel web bears evenly on the timber surface. The flanges shall be installed into pre-cut grooves in the timber, where the width of the grooves is equal to the thickness of the channel flanges with a tolerance of +/- 0.1 mm. The spacing between the two grooves shall be within +/- 1 mm. The channels shall not be loose and may be driven into the grooves using a maximum 6 kg hammer. Care shall be taken to prevent splitting of the timber and the ends of the girders shall be thoroughly inspected for end splits prior to installation in the casting bed.

Installation of the coach screws for the end shear connector shall be as specified in Subsection 7.8.2.2.

7. 8.3 Formwork and Casting Bed

Except as may be noted under, the casting bed and formwork shall be in accordance with AS 3610 *Formwork for Concrete.*

7. 8.3.1 General

Except as may be specified on the drawings or under, the minimum standards of construction for workmanship and the maximum construction tolerances shall be in accordance with AS 3600 *Concrete Structures Code*.

Fabrication and casting of the TCC deck modules shall only be carried out at approved fabrication facilities. Unless otherwise approved, casting shall be carried out upside down.

7. 8.3.2 Casting Bed

The casting bed shall be constructed of a rigid material supported on a solid foundation which will not deform or settle under the mass of the wet concrete as well as the supported girder and reinforcing components. The casting bed shall be shaped to provide a precamber along the length of the module equivalent to 1/300 of its length.

The casting surface shall be intentionally roughened to provide an equivalent grooved or broomed finish on the surface of the concrete deck. These grooves shall be oriented perpendicular to the span of the module. Only concrete reinforcing chairs shall be used if they are to be supported directly on the casting bed surface. Only approved releasing agents shall be used on the casting bed to avoid a slippery finished deck surface.

7. 8.3.3 Formwork Geometry

Except as noted in this section, formwork shall satisfy the dimensional requirements specified in the design drawings.

7. 8.3.3.1 Concrete Deck Thickness

The *nominal* deck thickness shall be as specified on the drawings but not less than 150 mm. To allow for variability in girder geometry and the precamber specified in Subsection 7.8.3.2, the deck thickness may be varied up to 190 mm along the length of the module as required.

7. 8.3.3.2 Precamber

Unless otherwise specified on the drawings, the casting bed shall be shaped to provide and maintain a precamber along the span, as specified in Subsection 7.8.3.2, during curing of the concrete.

7. 8.3.3.3 End Concrete Diaphragms

Unless otherwise specified on the drawings, formwork for the end diaphragms shall satisfy the following requirements. These requirements assume that, except for the precamber, the casting bed is oriented horizontally.

The outside end face of the diaphragm shall be sloped inwards, as shown in Figure 7. 8.3.3.3-1. This slope is to allow for end rotation, such that the end face will attain a vertical alignment when the module is righted and supporting the full mass. Unless specified otherwise on the drawings, this slope shall not be less than .012 from vertical or 12 mm for every 1000 mm of height.

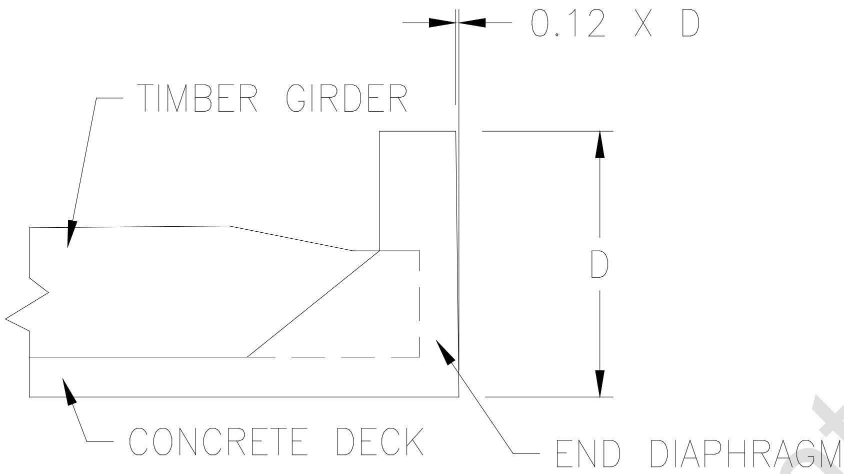

Figure 7. 8.3.3.3-1 Taper of End Face of Concrete Diaphragms

The sides of the end diaphragms in adjacent (matching) modules shall be tapered to accommodate for any prescribed crossfall, or change in transverse alignment, as shown in Figure 7.8.3.3.3-2. This taper shall be such that the sides of adjacent (matching) modules remain parallel.

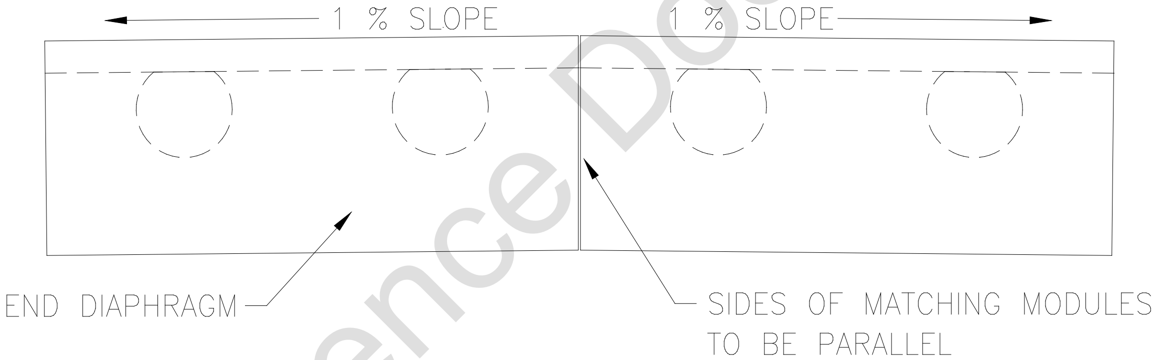

Figure 7.8.3.3.3-2 Taper of Sides of Concrete Diaphragms

7. 8.3.4 Positioning and Support of Timber Girders

Unless approved otherwise, timber girders shall be supported at their ends by connection to the formwork. The girder shall not be used to support any formwork or reinforcement during concrete pouring and curing, except as may be specified on the design drawings.

Unless specified otherwise on the drawings, the concrete cover to the ends of the timber girders shall not be less than 150 mm. Where the cover is less than 150 mm, care shall be taken to ensure that proper compaction of the concrete is achieved.

7. 8.4 Concrete and Reinforcement

7. 8.4.1 General

Except as may be noted under, concrete works shall be in accordance with RTA Form 20-80 *Concrete Work for Bridges,* and concrete and reinforcement placement shall satisfy the dimensional requirements specified in the design drawings.

7. 8.4.2 Reinforcement Placement

Reinforcement shall be placed in accordance with the design drawings and shall be properly secured to allow for vibration of the concrete during placement. Only concrete reinforcing chairs shall be used for support directly on the casting bed surface.

Unless otherwise specified in the drawings, minimum clear cover to the reinforcement shall be 30 mm.

7. 8.4.3 Concrete Placement

In order to avoid honeycombing of the finished surface, concrete should be placed as outlined below. If the bottom face of the casting bed is constructed of concrete, then only a rubber tipped vibrator shall be used to avoid damaging the casting surface and deck finish.

Concrete shall first be placed in the end diaphragms from the top and shall be vibrated until it fully extrudes into the adjacent deck area, as shown in Figure 7.8.4.3-1, over the full width of the module.

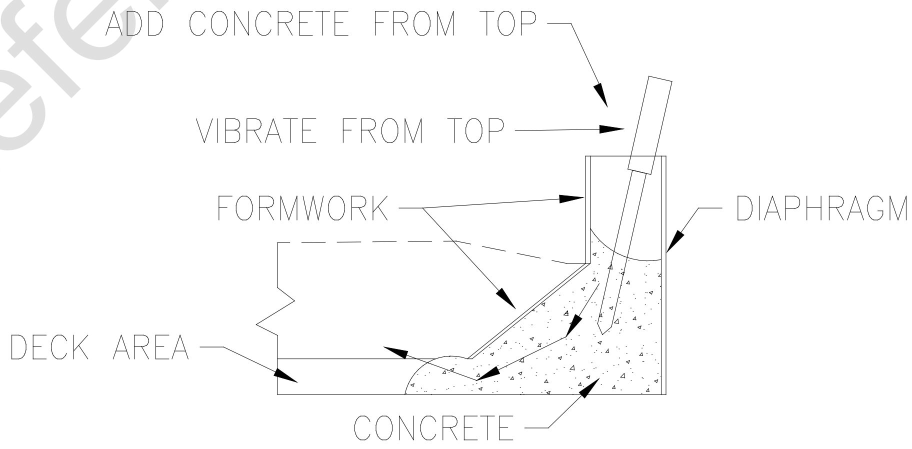

Figure 7.8.4.3-1 Placement of Concrete in End Diaphragms

Working from the ends of the module, concrete shall then be placed on one side of a timber girder only and vibrated until it fully extrudes under the girder to the other side.

The concrete deck and diaphragms of all modules shall be integrally formed during one concrete pouring operation.

7. 8.4.4 Concrete Finish

The deck surface shall have a finish as specified in Subsection 7.8.3.2 and modules requiring repairs to the deck surface after curing shall not be used unless approved.

The concrete level adjacent to the timber girders shall be extended between 10 mm to 15 mm below the top of the timber girder and a 20 mm V-groove drip edge shall be provided along the outside edge of each module as shown in Figure 7.8.4.4-1.

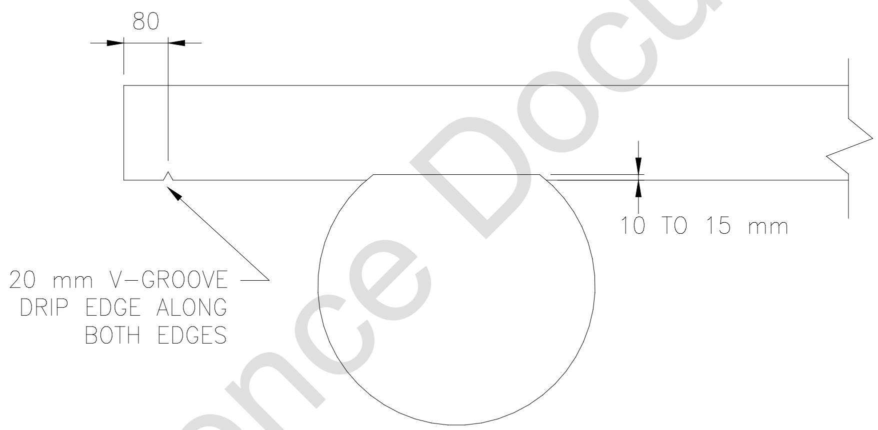

Figure 7.8.4.4-1 Drip Edge and Concrete Level

Unless specified otherwise on the design drawings, all edges shall be chamfered 20 mm x 20 mm and re-entrant angles filleted 20 mm x 20 mm.

7. 8.4.5 Curing

Concrete shall be allowed to cure for a minimum of 48 hours before the module is removed from the casting bed. Extreme care shall be taken while handling modules which have cured for less than 5 days. Modules shall be allowed to cure for at least 10 days before they are transported to the site.

7. 8.5 Handling and Transportation of Modules

7. 8.5.1 General

Modules shall not be moved or transported prior to the curing periods specified in Subsection 7.8.4.5. Care shall be taken to avoid damaging the edges of the concrete and modules requiring repairs shall not be used unless approved.

7. 8.5.2 Lifting of Modules

Where the design drawings specify lifting attachments or provide for specific cast-in lifting lugs, these shall *always* be used for lifting the modules. All other lifting methods shall be approved prior to use.

Unless otherwise specified or approved, modules shall not be lifted using temporary devices inserted in conduits in the concrete deck which were not specifically designed for that purpose. Modules shall not be lifted using temporary devices attached to the timber girders.

Slings may be used to lift and/or turn the modules, provided they comprise materials which will not damage the concrete edges or timber girders.

Lifting points shall always be positioned within L/6 from the ends of the module where L is equal its length. Under no circumstances shall a module be lifted from, or temporarily supported at, a point within the central two thirds of the span.

7. 8.5.3 Transportation of Modules

During transportation, modules shall always be supported at the end diaphragms at the permanent support points. Each end of a module shall be supported on at least two rubber bearing strips not less than 200 mm x 200 mm x 50 mm thick. These shall be located at W/4 from each side of the module where W is equal to the module width.

Modules shall not be stacked more than three high and the end support points for each module shall be coincident with the other modules in the stack. No support points or other loads shall be situated within the length of any module.

Modules shall be secured to the transport vehicle using approved straps or other materials which will not damage the concrete edges. At least one tie down shall be located within 2 m from each end of the modules.

7. 9 Material Supply

Unless otherwise specified on the design drawings, material supply for the timber-concrete composite system shall be as outlined in this section.

7. 9.1 Timber Girders

Except as may be noted in this section, the supply and handling of the timber girders shall be in accordance with RTA Form 2380 *Timber for Bridges*. Unless otherwise specified on the drawings, the timber girders shall be grade F27 Hardwood, Group S2, Durability Class 1 to AS 1720.

7. 9.2 Concrete

Concrete shall have a minimum 28 day compressive strength of 40 MPa, a maximum slump of 75 mm and a concrete exposure classification of B1. Testing of the concrete shall be carried out in accordance with AS 1012 *Methods of Testing Concrete*. Concrete additives shall not be used unless approved.

7. 9.3 Reinforcement

All steel reinforcing for the concrete shall be deformed bars to Grade 400 Y with a minimum yield strength of 400 MPa in accordance with AS 1302 *Steel Reinforcing Bars for Concrete.*

7. 9.4 Coach Screws

The coach screws for the timber-concrete interface connection shall be M24 x 300 mm for Grade 4.6 to AS 1393.

7. 9.5 Steel Shear Connectors

Shear connectors for the timber-concrete interface include both shear plates and the end steel channel reinforcement, as shown in Figures 7.8.2.1-1 and 7.8.2.3-1. These components shall satisfy the following minimum requirements:

- shear plates shall be minimum 250 mm x 75 mm x 16 mm for Grade 250 to AS 3678.
- end channels shall be 150 PFC x 600 mm long for Grade 300 to AS 3679

7. 9.6 Other Steel Hardware

In some cases modules may incorporate attachments such as kerbs and traffic barrier support brackets. Unless otherwise specified on the drawings, all other steel plates, sections and hardware that may be in the design shall satisfy the following minimum requirements:

- Steel plate shall be Grade 250 to AS 3678
- Steel sections shall be Grade 300 to AS 3679
- Bolts, coach screws, nuts and washers shall be supplied to RTA Form 2240
- Bolts shall be Grade 4.6 to AS 1111

7. 9.7 Protective Treatment

Unless specified otherwise on the drawings, all steel plates and sections shall be galvanised to AS /NZ 4680 and bolts, coach screws, and associated nuts and washers shall be galvanised to AS 1214.

In the majority of situations, it is not necessary to galvanise the reinforcement in the concrete. However, for severe exposure conditions, such as coastal regions and in flood prone areas, the reinforcement shall be galvanised.