



TIMBER BRIDGE MAINTENANCE AND REFURBISHMENT PREVENTIVE MAINTENANCE STANDARDS



STRUCTURES ENGINEERING

Document No: 6706-02-2226





Maintenance of jarrah stringers – drilling reservoir hole for borate treatment.

Cover - German tourists admire the tall substructure of Sues Bridge, over the Blackwood River

PREVENTIVE MAINTENANCE STANDARD FOR TIMBER BRIDGES

The Senior Engineer Bridge Maintenance (SEBM) is the delegated custodian. All comments and requests for changes should be submitted to the SEBM.

AUTHORISATION

The Senior Engineer Structures owns and controls this Document and authorises its issue and use.

R F SCANLON

SENIOR ENGINEER STRUCTURES

Date: 15/07/2010

Document No. 6706/02/2226

REVISION STATUS RECORD


Page No.	Revision No.	Revision Date	Revision Description/Reference	Approved By	Signature
1	1		Engineer Title Amended		
2	1		Revised 6/98		
	2		General Revision 9/00		
	3		General Revision 5/04		
	4		General Revision 8/09		
Various	5		Coloured plastic plug system added		
Various	6	Aug 2012	Introductory sections re-formatted, work items added. Activity code 012 renamed, Activity code 034 revised,		
1 & Appendix H	7	December 2021	Delegated custodian changed to SEBM Coloured plastic plug schedule modified to seven year colour cycle	A Lim	

TABLE OF CONTENTS

1.	INTRODUCTION.....	5
2.	PURPOSE.....	5
3.	OTHER REFERENCES.....	6
4.	MAINTENANCE DEFINITIONS.....	6
5.	GENERAL PRINCIPLES OF TIMBER DETERIORATION.....	7
5.1	Fungi.....	7
5.2	Termites.....	8
5.3	Marine Organisms.....	9
5.4	Corrosion of Fasteners.....	10
5.5	Shrinkage and Splitting.....	10
5.6	Fire.....	11
6.	TIMBER BRIDGE PREVENTIVE MAINTENANCE ACTIVITIES	
6.1	011 Timber End-grain Sealing.....	13
6.2	012 Fastener Maintenance.....	15
6.3	013 Groundline Treatment of Piles.....	17
6.4	013a Waterline Treatment of Piles In Permanent Water.....	19
6.5	014 Treatment of Decking Planks.....	21
6.6	015 Treatment of Timber Stringer.....	23
6.7	016 Routine Maintenance of Outside Timber Stringers.....	25
6.8	017 Treat Abutment End of Wandoo Stringers.....	27
6.9	018 Treat Abutment Bedlogs (ground contact).....	29
6.10	019 Treat Timber Bearers, Pier Bedlogs (off ground).....	31
6.11	021 Repair of Split Piles.....	33
6.12	022 Repair of Split Stringers.....	35
6.13	023 Treatment (fungicide) of Gravel Pavement.....	37
6.14	031 Timber Handrail Maintenance.....	39
6.15	032 Deck Drainage (Pre-Overlay Bridges).....	41
6.16	033 Removal of Deck Vegetation.....	43
6.17	034 Vegetation and Debris Clearing.....	45
6.18	035 Regulatory and Warning Signs.....	47
6.19	041 Marine Organism Protection.....	49
6.20	042 Termite Inspection and Treatment.....	51

APPENDICES

Appendix A.1	Boracol 400 RH pile groundline treatment.....	53
Appendix A.1a	Boracol 400 RH pile groundline treatment.....	54
Appendix A.2	Preschem (14mm) pile treatment.....	55
Appendix A.3	Preschem (17mm) pile treatment.....	56
Appendix A.4	Impel Rod (12mm) pile treatment.....	57
Appendix B.1	Boracol 200 deck treatment.....	58
Appendix B.2	Boracol 400 deck treatment.....	59
Appendix C.1	Solubor Slurry Treatment - Stringers.....	60
Appendix C.2	Solubor Slurry Treatment - Bedlogs.....	61
Appendix C.3	Boracol 400 Treatment – Stringers.....	62
Appendix C.4	Solubor Slurry Treatment - Bearers (off ground).....	63
Appendix C.5	Boracol 400 Treatment - Bearers (off ground).....	64
Appendix C.6	Timbor/Polybor Pavement Treatment.....	65
Appendix C.7	Use of Fungicide Reservoir Bags (“blood bags”).....	66
Appendix D.1	Pile Banding – Type 1.....	67

Appendix D.2	Pile Banding – Type 2.....	68
Appendix D.3	Pile Banding – Type 3.....	69
Appendix E	Use of Termidor Dust	70
Appendix F	Suppliers of Preventive Maintenance Materials.	71
Appendix G	Material Safety Data Sheets (MSDS) – hyperlinks.....	74
Appendix H	Plastic Plug Colours.....	75

1.0 INTRODUCTION

The past 20 years have seen significant and on-going advance in the technology of timber preservation. Possibly the most significant move has been the development of diffusible fungicides to enable effective treatment of timber structures in service.

This manual endeavours to present the best of these advances, together with a synthesis of the relevant traditional timber engineering practices (particularly related to waterproofing and marine borer prevention) which have contributed to the durability of so many existing structures.

Thorough cleaning of the relevant timber elements is a necessary pre-cursor to successful execution of most preventive maintenance work items on these bridges. It is therefore advisable (and most economical) that that bridge be systematically cleaned using a high-pressure water lance (with turbo head) prior to commencement of timber maintenance work.

The materials selected for use in these Activities have been chosen both for their effectiveness and also for their favourable characteristics impacting occupational health and the environment.

All such materials must be viewed with respect and used strictly in accordance with the manufacturers MSDS and labelling instructions – for convenience, hyperlinks for current MSDS have been included as Appendix G. It is recommended that PVC or Nitrile gloves at least be worn for protection at all times when handling timber preservative materials, waterproofing materials and related cleaning solvents. Spillages of these materials into waterways and stream catchments must be avoided, and all used containers are to be removed from the work site and disposed of according to manufacturers instructions.

Use of this manual by all relevant bridge workers is encouraged, and feedback is welcomed on all aspects of the manual - particularly on difficulties, details and suggested improvements of application processes.

2.0 PURPOSE

The purpose of these Standards is to assist bridge owners in maintaining their to bridge stock and to maximise their serviceable life by providing specific maintenance items and descriptions on how to carry out these items.

This Manual has been compiled for the use of bridge maintenance managers and workers. The activities described are a collection of maintenance actions that, when undertaken in a regular and systematic manner, will have a sustained beneficial effect on extending the life of the structures while reducing the necessity for extensive specific repairs and major maintenance - enabling considerable savings in infrastructure replacement cost while retaining high levels of bridge serviceability.

3.0 OTHER REFERENCES

Main Roads Specification 850 Timber Bridges provides the technical requirements for maintenance and refurbishment of bridge timber.

The Bridge Management System Programme Management Module User Handbook Document No. 6706-02-2243 Appendix A3 provides details of work item code category definitions

4.0 MAINTENANCE DEFINITIONS

Main Roads has the following definitions for maintenance, aligned with the Bridge Maintenance System/IRIS work item codes:

Routine Maintenance (R)

Small mainly reactive works which are normally anticipated within a budget timeframe, but their precise nature, location and timing are not known in advance. Routine maintenance mainly consists of minor work items planned on a short term basis, usually about two weeks or less.

Periodic Maintenance (P)

Maintenance treatments conducted at regular intervals of longer than one year. These Work Items are carried out before or at an early stage in the development of defects (e.g. timber rot) aimed at preventing occurrence or progression of the defect. It is undertaken on a proactive rather than reactive basis.

Specific Works (S) (either one-off or Capital works)

These include one-off repairs, refurbishment and upgrade works to retain the bridge as near as practicable to its “as constructed” condition or to improve the bridge characteristics such as strength, geometry and safety. Specific works also includes bridge replacement. Specific works are planned, proactive work items and normally are scheduled at least two years in advance of the delivery year.

Each activity to follow has both an activity code, and associated IRIS work item.

5.0 GENERAL PRINCIPLES OF TIMBER DETERIORATION

There are two types of deterioration in timber - biological and non-biological.

The main agents of biological attack are:

- fungi
- termites
- marine borers.

The main causes of non-biological attack are:

- corrosion of fasteners
- shrinkage and splitting
- fire.

5.1 Fungi

Severe internal decay of timbers used for bridge members is caused by 'white rot' or 'brown rot' fungi. External surface decay, especially in ground contact areas, is caused by 'soft rot' fungi. Other fungi such as mould and sapstain fungi may produce superficial discolouration on timber but are generally not of structural significance.

Fungal growths will not develop unless there is a source of infection from which the plants can grow. Fungi procreate by producing vast numbers of microscopic spores which may float in the air for long periods and be blown for considerable distances. Although it is fair to say that no timber in service will be free from decay because of an absence of infecting spores, these spores will not germinate and develop unless there is:

- * an adequate supply of food (wood cells)
- * an adequate supply of air or oxygen. (Note that prolonged immersion in water saturates timber and inhibits fungal growth)
- * a suitable range of temperatures. (Optimum temperatures are 20 deg C to 25 deg C for soft rots, while their rate of growth declines above or below the optimum - with a greater tolerance of lower temperatures apparent)
- * a continuing supply of moisture. (Wood with a moisture content below 20% is safe from decay, and many fungi require a moisture content above 30%).

Once established, the decay fungi continue to grow at an accelerating rate as long as favourable conditions prevail. Depriving the fungus of any one of these required conditions will effectively curtail the spread of decay. Wood that is kept either dry or saturated will not rot. Moisture change can affect decay indirectly because drying often leads to surface checks, which may expose untreated sections of timber or create water-trapping pockets. Proper preservative treatment effectively provides a toxic barrier to the decay fungi's food supply, thus preventing decay.

5.2 Termites

Western Australia has a large number of different species of termites which are widely distributed. Heavy termite attack is found in the North West regions of the State (particularly due to the feared species *Mastotermes Darwiniensis*), but the hazard is still sufficient in the southern regions to constitute a significant problem.

Practically all termite damage to timber bridges occurs through subterranean termites (especially *Coptotermes acinaciformis* and allied species) which require contact with the soil or some other constant source of moisture.

Termites live in colonies or nests which may be located below ground in the soil, or above ground in a tree stump, hollowed-out bridge member or an earth mound. Each colony contains a queen, workers, soldiers and reproductives (alates), along with eggs and developing castes. The workers, who usually constitute the highest proportion of the colony population, are white-bodied, blind insects some 3-6 mm in length - featuring well developed mandibles for eating timber. Attack by subterranean termites originates from the nest, but may spread well above ground level, either inside the wood or via mud-walled shelter tubes called galleries which are constructed on the outside of bridge timbers. These galleries are essential for termites - which require an absence of light, a humid atmosphere (around 96%) and a source of moisture to survive. At least once a year in each colony, the alates develop eyes and wings and leave the nest under favourable weather conditions to migrate up to 200 metres from the original nest. After migration, their wings fall off, pheromones are released, and a few of these may pair to start new colonies.

Termite attack, once established, usually degrades timber much more quickly than fungi, but it is rare for termite attack to occur in the durable hardwoods (such as Jarrah, Wandoo and Blackbutt) normally used in bridge construction without some pre-existing fungal decay. This decay accelerates as the termites extend their galleries through the structure - moving fungal spores and moisture about with their bodies. Hence, although most of the material removed by termites has already lost its structural strength because of decay, the control of termite infestations remains an important consideration.

Basically, there will be two different approaches to termite control for timber bridges. Both alternatives require regular termite inspection, accompanied by full eradication measures when activity is detected;

- 1) Traditional termite inspection, associated with direct application of termiticide to active termite populations. For best effect, the termiticide should be of the non-repellant type (such as fipronil or imadoclopid) to achieve maximum effect against nests and remote colonies. Correct application as per the chemical manufacturer's label will see fairly quick cessation of termite activity, typically within days. When applying termiticides into timber, use of either dusting or foaming equipment is recommended to maximise 'coverage' and to minimise the chance of spillage from splits and checks into waterways.
- 2) Monitoring and baiting systems (such as Sentricon and Exterra), whereby ground monitoring stations are regularly inspected and subsequently upgraded to baiting stations when activity is detected. The baits use sophisticated Insect Growth Regulator (also called Chitin Synthesis Inhibitor) chemicals such as triflumuron, hexaflumuron, chlorfluazuron, diflubenzuron and flufenoxuron. These are generally marketed as colony elimination systems, with contracts incorporating regular inspections and warranties for termite control. The mode of action means that the eradication process is slow, typically taking between 3 months and 2 years. Note that the placement of monitoring stations around bridges will not intercept all activity – traditional inspection is also advised, and much of the termite eradication in bridges results from the direct application of 'above ground' bait stations.

Clearly, modern termite control strategies promise good return for investment but also demand higher levels of technical input from both owners and pest control managers. The concept of trying to poison the bridge approaches with sprayed chemical has had its day, as has the concept of arranging the local pest control manager to do a 'one-shot' termite treatment' with either spray or arsenic dust.

5.3 Marine Organisms

Damage to underwater timber in the sea or tidal inlets is usually caused by marine borers, and is more severe in tropical and sub-tropical waters than in colder waters. The two main groups of animal involved are:

- * Molluscs (Teredinidae) - this group includes various species of *Teredo*, *Nausitora* and *Bankia*. They are commonly known in Australia as teredo or as 'shipworm'. They start life as minute, free-swimming organisms and after lodging on timber they quickly develop into a new form and commence tunnelling. A pair of boring shells on the head grow rapidly in size as the boring progresses, while the tail with its two water-circulating syphons remains at the original entrance. The teredine borers destroy timber at all levels from the mudline to high-water level, but the greatest intensity of attack seems to occur in the zone between 300 mm above and 600 mm below low tide level. A serious feature of their attack is that, while the interior of a pile may be practically eaten away, only a few small holes may be visible on the surface.
- * Crustaceans - this group includes species of *Sphaeroma* (pill bugs, similar to garden slaters), *Limnoria* (gribbles), and *Chelura*. They attack the wood on its surface, making many shorter and narrower tunnels than those made by the teredines. The timber so affected is steadily eroded from the outside by wave action and the piles assume a 'waisted' appearance or 'hourglass effect'. Attack by *Sphaeroma* is limited to the zone between tidal limits, with the greatest damage close to half-tide level. They cannot survive in water containing less than 1.0-1.5 per cent salinity, but can grow at lower temperatures than the teredines.

Many strategies have been developed for control of marine borers but, assuming that the piles have sufficient remaining strength, the most effective systems usually work by reducing the oxygen content of the water around the borers.

5.4 Corrosion Of Fasteners

Corrosion of steel fasteners can cause serious strength reductions for two related reasons. Firstly, the steel fastener reduces in size and weakens, and secondly a chemical reaction involving iron salts from the rusting process can cause de-fibration of the surrounding wood (Note: this is not a fungal decay, but the softening process normally increases moisture ingress and leads to decay).

5.5 Shrinkage And Splitting

Moisture can exist in wood as water or water vapour in the cell cavities, and as chemically-bound water within the cell walls. As green timber loses moisture to the surrounding atmosphere, a point is reached when the cell cavities no longer contain water, but the cell walls are still saturated with chemically-bound water. This point is called the 'fibre saturation point'. Wood is dimensionally stable while its moisture remains above the fibre saturation point (which is typically around 30% for most timbers). Bridges are normally constructed from green timber which gradually dries below its fibre saturation point until it reaches equilibrium with the surrounding atmosphere. As it does so, the wood shrinks but because it is anisotropic, it does not shrink equally in all directions. Maximum shrinkage occurs parallel to the annular rings - about half as much occurs perpendicular to the annual rings, and a small amount along the grain.

The relatively large cross-section timbers used in bridges lose moisture through their exterior surfaces so that the interior of the member remains above the fibre saturation point while the outer layers fall below and attempt to shrink. This sets up tensile stresses perpendicular to the grain and when these exceed the tensile strength of the wood, a split or check develops - which deepens as the moisture content continues to drop. As timber dries more rapidly through the ends of a member than through the sides, more serious splitting occurs at the ends. Deep checks provide an ideal environment for the introduction or acceleration of fungal decay.

Shrinkage also causes splitting where the timber is restrained by a bolted steel plate or other type of fastening. This splitting can be avoided by allowing the timber to shrink freely by using slotted holes. As timber shrinks, it tends to lose contact with steel washers or plates, so the connection is no longer tight. Checking the tightness of nuts in bolted connections is therefore a standard item of routine maintenance for timber bridges.

5.6 Fire

Wood itself does not burn. The effect of heat is firstly to decompose the wood (a process known as 'pyrolysis') and it is some of the products of this decomposition that burn if conditions are suitable. This concept is important in discussions on the action of fire retardants.

In theory, wood decomposes at temperatures as low as 20°C (at the rate of 1% per century). At 93°C the wood will become charred in about 5 years.

When wood is heated, several zones of pyrolysis occur which are well delineated due to the excellent insulating properties of wood (thermal conductivity roughly 1/300 that of steel). These zones can be described generally as follows:

* Zone A: 95°C - 200°C

water vapour is given off and wood eventually becomes charred.

* Zone B: 200° - 280°C

water vapour, formic and acetic acids and glyoxal are given off, ignition is possible but difficult.

* Zone C: 280 ° - 500°C

combustible gases (carbon monoxide, methane, formaldehyde, formic and acetic acids, methanol and hydrogen) diluted with carbon dioxide and water vapour are given off. Residue is black fibrous char. Normally vigorous flaming occurs. If, however, the temperature is held below 500°C, a thick layer of char builds up and because the thermal conductivity of char is only 1/4 that of wood, it retards the penetration of heat and thus reduces the flaming.

* Zone D: 500°C - 1 000°C

in this zone the char develops the crystalline structure of graphite, glowing occurs and the char is gradually consumed.

* Zone E: Above 1 000°C

at these temperatures the char is consumed as fast as it is formed.

As the temperature of the wood is lowered, the above-mentioned behaviour still holds - eg combustion normally ceases below 280°C.

The numerical values quoted are approximate, and in practical situations depend on many factors such as the duration of heating and the rate at which oxygen is fed to the combustible gases.

Geometrical configuration is also very important. For example, a vertical stick less than 20 mm thick may burn from the bottom up without an external source of heat, but will not burn from the top down. A stick appreciably thicker than 20 mm will not burn unaided by an external heat source. Large section round timbers, as used in bridge construction, have good resistance to fire and, except during a severe bush fire, usually survive quite successfully.

When a timber element is heated above 280°C, it chars at more or less a constant rate regardless of the value of temperature.

Typical charring rates are:

- * softwood 0.6 mm/minute.
- * hardwood 0.4 mm/minute.

These rates hold reasonably true provided that the minimum dimension of the structural member is not reduced to less than 50% of the original.

The strength of a timber structural member during a fire depends on the portion of wood that has been charred, the temperature distribution in the sound wood and the theoretical relationship between strength and temperature. To obtain the strength of structural members from these considerations is a complex analytical problem. However, research has shown that for most practical situations it is reasonably conservative to assume that the strength of charred sound timber is 80% of the value that it had before the burning commenced.

6.0. TIMBER BRIDGE PREVENTIVE MAINTENANCE ACTIVITIES

6.1 Activity Code No. 011 (Work Item P101)

Timber End – grain Sealing

General Description

Sealing of all exposed or susceptible timber endgrain against the ingress of damaging moisture.

Quality Standard

After maintenance, all visible or accessible timber endgrain will have been coated, with the UV-resistant topcoat extended for at least 50 mm back along the length of each member. Coating system to be re-applied at least every 5 years.

Unit of Measurement

Square Metres (of end-grain)

Steps

1. Endgrain cleaned as necessary, with high pressure water jet. Loose and rotten material to be removed.
2. Remove free water from surface using air compressor and blow pipe.
3. While endgrain is saturated but surface dry, brush liberally with approved diffusible fungicide (currently Boracol 200 RH).
4. When touch-dry, brush liberally with approved water repellent. (Currently Cellavit CE-102, Aussie Clear and Koppers Arch CN Timber Oil). Coating to extend back approx 50 mm longitudinal to the grain of each treated member.
5. (Need at least one day drying period before application of top coat, and up to 3 weeks recommended before coating over CN Oil).
6. Where exposed tops of piles are hollowed by rot or termites (and this condition has been treated as per relevant Activity Code), the top surface of the pile shall be filled and rendered smooth with cementitious grout filler.
7. Brush or spray application of approved UV-resistant topcoat (currently RPM Permaroof or Crommelin Chemicals 'Elastoseal HD'). Entire coating area of water repellent to be treated. Where coating needs to span narrow cracks or cover grout filler, Crommelin Reinforcing Fabric 15A02 (non woven polyester fabric) shall be fixed over the top surface and brushed with as much topcoat as necessary to create a durable waterproofing membrane. Fabric generally shaped over the top end, and fixed by nailing at the sides.

Suggested Personnel

Two Construction Workers, one with a "B" Class driver's licence. Additional assistance may be necessary when traffic control is required.

Suggested Plant

Utility or Light Truck

1 Water Tank (if stream water not available)

High-pressure water cleaning unit (500psi capacity or better, with turbo head)

Materials

Fungicide pre-coat Boracol 200RH, or approved equivalent.

Water repellent (Cellavit CE-102, or approved similar)

Topcoat (Crommelins 'Elastoseal HD', or approved similar)

Brushes and cleaning solvents.

Concrete grout as required.

Planning Notes

1. Pre-inspection of bridge to determine current availability of water.
2. Inspect bridge and list areas for high pressure cleaning.
3. Schedule second visit, as required, for topcoat treatment.
4. Note need, or otherwise, for filling pile tops with grout.

Average Daily Production

(To be determined)

Work Classification

Routine Maintenance

6.2 Activity Code No. 012 (Work Items P102, S315)

Fastener Maintenance

General Description

Checking condition of all structural fasteners, and tightening all loose bolts.

Quality Standard

All fastenings to be left tight and to the appropriate durability standard.

Unit Of Measurement

Item (note that scope will vary considerably)

Steps

1. If not already upgraded, all threaded fastenings within 1.5m of either groundline or waterline to be removed for hole inspection and fastener replacement. For bolt removal, generally use jaw on pulling bar with 50-T capacity hollow jack, (operated by Porta Power).
Where the bolt has severely corroded and cannot be easily pulled out or driven out, the two options for removal are:
 - a) weld a section of sound bolt to the embedded bolt, and use the enhanced 'purchase' to pull the bolt through as above.
 - b) use a hollow coring tool (32mm max diameter) to drill around the remains of the bolt.
2. Check condition of hole through timber member;
 - if hole enlargement and decay minimal, ream hole for PVC sleeve (26mm dia hole for 20mm dia thread, etc), sterilise inside hole by washing with Boracol 200 then insert heavy duty PVC electrical conduit sleeve.
 - if hole too large for simple sleeving, need to either re-locate connection or reinstate by sleeving and then filling the remaining void with grout or epoxy (Suitable epoxy will be one with high SG and low rate of cure with low exothermic heat output with good bond to saturated timber).
3. Coat shank and thread of fastening with approved petrolatum paste prior to replacement.
4. All fastening nuts to be tightened as tight as can be achieved with standard hand tools (i.e. snug tight).
For tightening of existing bolts, note that fused nuts can often be unfrozen with heat and good penetrating oil. Where the nut cannot be loosened, fastener replacement (as described above) will be necessary unless the designer or supervisor directs otherwise.
5. Tightened nuts and threads to be coated with approved petrolatum paste as a barrier to corrosion

Suggested Personnel

1 Supervisory staff

1 Construction worker

Suggested Plant

1 Utility or light truck.

50-T capacity Portapack jack.

Welder

Coring machine for bolt removal, hole reaming.

Materials

Diffusible fungicide (Boracol 200 or approved equivalent)

Spanners

Replacement bolts (or threaded rod), heavy washers and nuts

Heavy duty PVC electrical conduit for sleeving.

Denso Multi-Purpose Primer, PP Petrolatum Primer (paste) or Lanotec Type A grease.

Planning Notes

Work is best scheduled for summer, when water levels are lower (common for the critical waling zone to be under water in winter).

Where pier heights are less than 3.0m, bracing and walings may be removed at the discretion of the supervising (structural design) engineer. Note that the consequent holes need to be treated and filled as described above.

Average Daily Production

To be determined, but will vary considerably.

Work Classification

Bolt Tightening – Routine Maintenance

Bolt Replacement & Sleeving – Specific Maintenance

6.3 Activity Code No. 013 (Work Item P103)

Groundline Treatment of Piles

General Description

Application of a measured dose of diffusible fungicide to the ground zone of each timber pile.

Quality Standard

Assessed risk zone at the groundline of each pile to be treated with diffusible boron-based fungicide, to a Boric Acid Equivalent (BAE) of at least 4.5 kg/cubic metre. Re-treatment interval (full recommended treatment) 5 years.

Unit Of Measurement

Per treated pile.

Steps

1. If pile has not previously been treated with diffusible fungicide, it is necessary to first drill the specified volume of treatment reservoir for a pile of that diameter and height of risk zone.
 - see attached design charts (Appendix A) for each approved fungicide. Depending on pile diameter, a maximum of 12 holes should be drilled (at 2 levels, as described in Appendix A, with no more than 6 holes per level) and subject to re-treatment until the design loading has been attained. The number of holes specified in Appendix A.1 is a design loading figure only - to be achieved by repeated treatment of 12 holes or less, rather than by excessive drilling and weakening of the piles.
 - treatment reservoirs for liquid fungicide must be drilled through sound timber, away from checks and splits. For 20 mm dia standard reservoir drill bits, the treatment volume is 32 ml/100 mm of hole. Maximum practical length of each sloped treatment reservoir is 500 mm.
2. Each treatment hole to be filled with liquid fungicide. If fluid level drops quickly in a hole due to leakage, the treatment in that hole shall be supplemented with 4 no. 14 mm dia 'Polesaver' or Impel rods.
3. After treatment, each reservoir hole shall be capped with a plastic plug of the same colour as specified in Appendix H.
4. Where the required treatment volume cannot be fitted into the available drilled reservoirs during the initial visit, a subsequent 'top-up' visit must be scheduled for a time between one and three months hence.
5. The treatment (or re-treatment) date for the bridge shall be recorded, to enable scheduling of the next treatment. Fungicide usage and batch number of chemical applied to be recorded for each pile.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 Utility or light truck
Electric generator set.

Materials

Measuring tape, or calipers (for determining pile diameters)
Electric drills
Reservoir drill bits (500 mm x 20 mm dia)
Drilling guide (optional, but very useful)
Liquid fungicide (Boracol 400RH or approved equivalent)
14 mm dia 'Polesaver' rods or Impel rods.
Removable plastic caps for treatment reservoirs.

Planning Notes

Piles in permanent water are not intended for this treatment, as saturation of the timber at water level makes leaching too rapid – see Activity 13a for treatment of piles in water. Repaired (potted) timber piles should be scheduled for standard treatment in the zone above the level of the concrete collar, because of the high moisture contents which develop here. Finally, it is important to emphasise that treatment holes be drilled through sound timber, as leakage through splits or other defects will reduce the effectiveness of any dosed treatment.

Average Daily Production

(To be determined)

Work Classification

Routine Maintenance

6.4 Activity Code No. 013a (Work Item P103)

Waterline Treatment of Piles in Permanent Water

General Description

Application of a measured dose of diffusible fungicide to the waterline zone of each timber pile in permanent water.

Quality Standard

Risk zone just above the waterline of each pile to be treated with diffusible boron-based solid treatment rods, to a Boric Acid Equivalent (BAE) of at least 4.5 kg/cu.m. Re-treatment interval (full recommended treatment) 5 years.

Unit Of Measurement

Per treated pile

Steps

1. If pile has not previously been treated with diffusible fungicide, it is necessary to first drill the specified volume of treatment reservoir for a pile of that diameter. See the attached design charts (Appendix A) for each approved type of treatment rod.
2. Each treatment hole to be filled with solid treatment rods.
3. After treatment, each reservoir hole shall be capped with a plastic plug of the same colour as specified in Appendix H.

Suggested Personnel

1 Supervisory staff
2 Construction worker

Suggested Plant

1 utility or light truck
Boat or access platform suitable for working over water.
Drill (preferably pneumatic) and generator source.

Materials

Measuring tape, or callipers (for determining pile diameters).
Reservoir drill bits (500 mm x 22 mm dia.)
Treatment rods.
Removable plastic caps for treatment reservoirs.

Planning Notes

Work is best scheduled to coincide with significant maintenance work on the bridge, because of the access equipment requirements.
Need for this sub-Activity should be identified in the full condition inspection report.

Average Daily Production

To be determined, but will vary considerably.

Work Classification

Routine Maintenance

6.5 Activity Code No. 014 (Work Item P103, R207)

Treatment (Fungicide) of Decking Planks

General Description

Application of a measured dose of diffusible fungicide to the timber decking; usually prior to reinforced concrete overlay.

Quality Standard

All timber bridge decking to be treated with diffusible boron-based fungicide, to a Boric Acid Equivalent (BAE) of at least 3.0 kg/cubic metre. Retreatment not necessary (minimal leaching).

Unit Of Measurement

Square metres of deck area

Steps

1. Decking must be saturated with water on the day prior to fungicide treatment, to encourage 'take-up' of the hygroscopic Boracol.
2. Hessian is placed over decking, to minimise runoff losses of Boracol as well as its later role in slowing concrete leakage from gaps between planks.
3. Boracol 200RH application rate is selected from the attached chart (Appendix B.1) according to the thickness of the timber planks. Note
that application of Boracol 400 (at the rate defined in Appendix B.2) is permissible, although spray application of this formulation seems unlikely - brushing or spreading more practical.
4. Normal application is by spraying. Note that sound decking will be quite dense and will not absorb the full dose of fungicide in one application without excessive runoff. It is therefore usual for two or even three repeat applications to be necessary before the correct dosage is obtained, with an absorption interval of an hour or so in between applications.
5. Boracol 200 application is usually scheduled for a time at least one day prior to casting of the reinforced concrete overlay.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

Trailer-mounted water tank
Compressor and spray outfit (herbicide spray outfit adequate)

Materials

Water for pre-wetting
Boracol 200RH or approved equivalent
Rolls of hessian, and suitable nails for fastening.
Large paint brushes (if application under deck needed)

Planning Notes

1. Must ensure a source of clean water available for pre-wetting of the decking.
2. For bridges that have RCO, but no record of deck fungicide treatment - need to core representative samples of decking for Boric Acid assay.
If positive, no further action indicated.
If negative, need to treat from underneath (can use either brush with B-400 or spray mist - either will be time-consuming !)

Average Daily Production

(Needs to be determined)

Work Classification

Specific Maintenance

6.6 Activity Code No. 015 (Work Item P103)

Treatment (Fungicide) of Timber Stringers

General Description

Application of a measured dose of diffusible Borate fungicide to specific stringers as directed.

Quality Standard

The entire volume of each designated stringer is to be treated with diffusible boron-based fungicide to a Boric Acid Equivalent (BAE) of at least 3.0 kg/cubic metre. Re-treatment not necessary (minimal leaching)

Unit Of Measurement

Cubic metres treated.

Steps

1. Stringer diameter to be measured at midspan and both supports, and mean diameter estimated for dosage assessment purposes.
2. Borate application dose to be read from the appropriate design table (Appendix C.1 for Timbor slurry, Appendix C.3 for Boracol 400).
3. Holes equivalent to the design volume of the application dose of Borate slurry must be either found (ie pipes or hollows) or made (drilled reservoirs) in the subject stringer.
For materials such as wandoo (with characteristic central pipe), treatment holes at centre and near supports will usually suffice, but solid jarrah stringers will need much more drilling to create the necessary reservoir voids - reduced treatment reservoir volumes, with a programme of re-treatment with Boracol 400 will be acceptable for such stringers.
Note that the most efficient method of treating solid stringers is by using the reservoir bag ("blood bag") system as described in Appendix C.7
4. The prepared borate slurry or Boracol is pumped or poured into the stringers, the holes capped with plastic plugs of the same colour as specified in Appendix H and the treatment volumes & relevant fungicide batch numbers recorded.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 Utility or light truck
Electric generator set
Pumping equipment for borate slurry

Materials

Electric drills
Reservoir drill bits (20 mm dia)
Plastic caps for reservoir treatments
Borate (Timbor or Polybor) powder.
Boracol 400 or approved equivalent.

Planning Notes

This treatment is intended for application to all 'outside' timber stringers because of the effects of prolonged weathering. It should also be considered for extending the service life of marginal stringers - those with moderately poor (still OK) drilling indications or those showing marked spiral grain and a tendency to rapid deterioration.

Average Daily Production

(Variable; to be determined.)

Work Classification

Specific Maintenance

6.7 Activity Code No. 016 (Work Item P101, P103, R207,R208)

Routine Maintenance of Outside Timber Stringers

General Description

Thorough cleaning and general maintenance of exposed outer timber stringers.

Quality Standard

All dirt and loose decayed material to be removed. Consideration given to the need for split repairs, fungicide treatment and flashing as appropriate.

Unit Of Measurement

Item (per stringer)

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Note that for high bridges or those with piers in deep water, these tasks are best accomplished from a mobile work platform such as the 'Topper' underbridge inspection unit.
3. All loose material to be removed from the surface of outer stringers, using a high-pressure water jet.
4. Any necessary repairs (including scarf splits) to be performed at this stage.
5. If not already treated, each outer stringer should now receive a full fungicide treatment using either Borate slurry or Boracol 400 as specified (see Activity Code 015).
6. Where so specified by the design engineer, flashing shall be attached to prevent excessive wetting of all outer stringers at positions where scupper outflows or other drainage allow direct discharge onto the stringer (see Activity Code 032)
7. Record location (Bridge No.), times, plant and materials used.
8. Remove warning signs and other traffic control devices on completion of the work.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 utility or light truck
Trailer-mounted water tank
High-pressure water cleaning unit
Mobile work platform, for higher bridges

Materials

Water
Borate fungicide
Pre-cut flashing plates
Flat head nails.

Planning Notes

1. Prior structural inspection is advised, to enable proper planning of any associated stringer repairs.
2. Pre-inspection should also note availability of stream water for cleaning, and list the number and position of flashing plates to be installed.

Average Daily Production

(to be determined)

Work Classification

Routine Maintenance

6.8 Activity Code No. 017 (Work Item P103)

Treat Abutment End of Wandoo Stringers

General Description

Treat the abutment end half only of the wandoo endspan stringers, using Borate slurry.

Quality Standard

Assessed risk zone at the abutment end of each nominated stringers to be treated with diffusible borate slurry fungicide to a Boric Acid Equivalent (BAE) of at least 3.0 kg/cu.m. Re-treatment not necessary.

Unit Of Measurement

Cubic metres treated

Steps

1. Stringer diameter to be measured both midspan and abutment, and mean diameter estimated for dosage assessment purposes.
2. Borate slurry application dose to be derived from the attached design table at Appendix C.1 - use a minimum of half the material indicated for a 6.0m span.
eg. for 600mm ave, diameter, need 3.7 litres of slurry.
3. Treatment holes to be drilled to central pipe from upper section of stringer, at positions close to the sloven and again 2.0m to 2.5m from support.
4. The prepared slurry is pumped into the stringers, the holes capped with plastic plugs of the same colour as specified in Appendix H and the treatment volumes recorded.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 utility or light truck
Electric generator set
Pumping equipment for borate slurry

Materials

Electric drills
Reservoir drill bits (20mm dia)
Plastic caps for reservoir treatments
Borate (Timbor/Polybor/Solubor) powder

Planning Notes

This treatment is a specific maintenance procedure for minimising decay and the heavy termite risk at the abutment end of wandoo stringers. The decision to treat will be made by an experienced bridge engineer - most likely in conjunction with the need for other repair work at the bridge.

Average Daily Production

(To be determined)

Work Classification

Specific Maintenance

6.9. Activity Code No. 018 (Work Item P103)

Treat Abutment Bedlogs and Bearers (ground contact)

General Description

Application of a measured dose of diffusible fungicide to each of the timber bedlogs or bearers specified for this treatment.

Quality Standard

Full supporting length of each bedlog or bearer to be treated with diffusible boron-based fungicide, to a Boric Acid Equivalent (BAE) of at least 4.5kg/cu.m
Re-treatment interval (full recommended treatment) 5 years.

Unit Of Measurement

Cubic metres treated.

Steps

1. Average diameter of each bedlog or bearer estimated and recorded for dosage assessment purposes.
1. Borate slurry application dose for each bedlog or bearer to be derived from the attached design table at Appendix C.2. Note that the dosage quoted is per metre run of log.
The entire supporting length of each log must be treated.
2. Slurry dosage to be pumped into each bedlog via 20mm diameter reservoir holes, at 500mm or 1.0m spacings as splits, pipes, etc require (prefer that all such holes pass through centre of bedlog).
3. After treatment, the holes are to be capped with plastic plugs of the same colour as specified in Appendix H and the treatment volumes recorded.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 utility or light truck
Electric generator set
Pumping equipment for borate slurry

Materials

Electric drills
Reservoir drill bits (22mm dia)
Plastic caps for reservoir treatments
Borate (Timbor/Polybor/Solubor) powder

Planning Notes

Work is best scheduled for summer, when water levels are lower.

Average Daily Production

(To be determined)

Work Classification

Routine Maintenance

6.10 Activity Code No. 019 (Work Item P103)

Treat Timber Bearers, Pier Bedlogs (off ground)

General Description

Application of a measured dose of diffusible borate fungicide to each of the bearers or bedlogs identified for treatment.

Note that pier bedlogs in ground contact shall require full treatment as per Activity Code 018.

Quality Standard

All members specified for this Activity to be treated to a Boric Acid Equivalent (BAE) of at least 3.0 kg/cu.m.

Re-treatment not necessary (minimal leaching losses).

Unit Of Measurement

Cubic metres treated.

Steps

1. Equivalent diameter of the relevant bearer or bedlog estimated and recorded for dosage assessment purposes.
2. Borate slurry application dose to be derived from the attached design table at Appendix C.4.
If Boracol 400 specified by the design engineer, use the table at Appendix C.5.
3. Slurry dosage to be pumped into each bedlog via 20 or 22mm diameter reservoir holes, at 500mm or 1.0m spacings as splits, pipes, etc require (prefer that all such holes pass through centre of bedlog).
4. After treatment, the holes are to be capped with plastic plugs of the same colour as specified in Appendix H and the treatment volumes recorded.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 utility or light truck
Electric generator set
Pumping equipment for borate slurry

Materials

Electric drills
Reservoir drill bits (20 or 22mm dia)
Plastic caps for reservoir treatments
Borate (Timbor/Polybor/Solubor) powder
Boracol 400 or approved equivalent

Planning Notes

Work is best scheduled for summer, when water levels are low.

Designers will frequently specify that bearers be treated with Boracol 400, to ensure the earliest possible protection effect for 'marginal' support members.

Average Daily Production

(To be determined)

Work Classification

Specific Maintenance

6.11 Activity Code No. 021 (Work Items S561, S564, P101, P103)

Repair of Split Piles

General Description

Treatment of the decay in the vicinity of the split, sealing the split and banding as directed.

Quality Standard

All splits shall be sterilised and sealed, and repaired as required by banding at such positions directed by the engineer.

Unit Of Measurement

Per pile (but varies).

Steps

1. Loose material to be cleaned from splits, using a high-pressure water jet.
2. When surface water has cleared from split, sterilise the zone by brushing Boracol 200RH liberally onto all accessible timber inside the split.
3. Allow Boracol at least 3 hours to be absorbed into the surface of the split.
4. The split shall be filled to the outer surface by trowelling or pumping Koppers Arch CNB Timber Protective Paste (or approved alternative).
(This step to seal against future moisture ingress and weathering).
5. Where splitting is severe, standard pile bands (see Appendix D) will be attached and tensioned at positions directed by the Engineer.

Suggested Personnel

1 supervisory staff
1 construction worker.

Suggested Plant

1 utility or light truck
Trailer-mounted water tank
High-pressure water cleaning unit.
Trowels or pumping equipment (for CNB paste)

Materials

Boracol 200RH, or approved equivalent
Koppers Arch CNB Timber Protective Paste, or Cubor Paste

- a. Note that CNB materials currently unavailable from Australian suppliers. Need to either substitute CN emulsion, or preferably add polybor powder as thickening to a CN product.

Planning Notes

Prior structural inspection of bridge is a necessary pre-requisite for this task, to enable engineering assessment of banding needs at each pile.

Average Daily Production

(To be determined.)

Work Classification

Routine Maintenance

6.12. Activity Code No. 022 (Work Items S655, S661)

Repair of Split Stringers (Scarf Splits less than 800 long)

General Description

Bolting of stringers with short horizontal scarf splits.

Quality Standard

All split zones to be sterilised, sealed and then repaired by bolting as specified.

Unit Of Measurement

Item (per stringer)

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Note that for high bridges or those spans with deep water, these tasks are best accomplished from a mobile work platform such as the 'Topper' underbridge inspection unit.
3. Any loose material to be cleaned from splits, using a high-pressure water jet.
4. When surface water has cleared from the split, brush Boracol 200RH liberally onto all accessible timber inside the split.
5. Allow Boracol at least 3 hours to be absorbed into the surface of the split.
6. The face of the split shall be sealed by trowelling or pumping Koppers Arch CNB Timber Protective Paste.
7. 22 mm diameter holes drilled right through the split stringers, at 90 degrees to the split (+/- 15 degrees). First hole 100 mm from the open end of the split, then further holes each 600 mm as necessary.
8. The inside of each hole shall be sterilised with Boracol 200RH, then packed with Denso paste before insertion of 20 mm diameter galvanised threaded rod.
9. Washers and nuts fitted to the threaded rod, and tightened to close the split as much as possible with hand tools. (Curved washers where fitted to the stringer, and flat washers when contacting over decking or overlay concrete).
10. Record location (Bridge No.), times, plant, and materials used.
11. Remove warning signs and other traffic control devices on completion of the work.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 utility or light truck
Trailer-mounted water tank
High-pressure water cleaning unit
Mobile work platform, for higher bridges

Electric generator and drills.

Materials

Water

Liquid fungicide (Boracol 200RH or approved equivalent)

Protective paste (Koppers Arch CNB, or Cubor Paste

Note that CNB materials currently unavailable from Australian suppliers. Need to either substitute CN emulsion, or preferably add polybor powder as thickening to a CN product.

20 mm diameter galvanised steel threaded rod and matching nuts.

150x150x10 mm curved washers (350 mm diameter), with 22 mm dia holes.

'Denso' Multi-Purpose Primer (paste).

Planning Notes

1. Pre-inspection essential for this Activity. For scarf splits longer than 800 mm, this activity does not apply and the stringer condition needs to be referred to an experienced Bridge Engineer for consideration.
2. Pre-inspection will also enable availability of stream water to be determined, for planning stringer cleaning.
3. Plan work to allow for absorption of Boracol when sterilising splits.

Average Daily Production

(To be determined, but will vary considerably)

Work Classification

Specific Maintenance

6.13 Activity Code No. 023 (Work Item P103)

Treatment (fungicide) of Gravel Pavement

General Description

Application of a measured dose of borate fungicide to the gravel pavement on bridges which have no reinforced concrete overlay. Intended to greatly extend the service life of timber superstructures by neutralising the deleterious effects of the moist gravel without the expense of constructing a concrete overlay.

Quality Standard

All deck pavements specified for this Activity to be treated to a Boric Acid Equivalent of at least 8 kg/cu.m.

Re-treatment not necessary. Minimal leaching losses if treatment preserved by sealing road pavement in the vicinity of the bridge deck.

Unit Of Measurement

Square metres of deck area treated.

Steps

1. Bridge deck pavement dimensions measured, and total deck area calculated, allowing for 2 metres 'over-run' treatment beyond each abutment.
2. Borate powder application dose to be derived from the attached design table at Appendix C.6
3. Full depth of gravel pavement to be removed from the bridge deck and 2m approaches, and stockpiled for mixing with borate powder.
4. Borate treatment thoroughly mixed into the stockpiled gravel, taking care to avoid initial release of borate dust and loss of borate to the surrounding environment.
5. Gravel pavement returned to the bridge surface, and compacted wet in lifts suitable to achieve min. 90% compaction throughout.
6. Bridge deck sealed with full-width bituminous seal, including at least 10 metres approach length behind each abutment, to ensure that the treatment is not unduly disturbed by road maintenance activities.

Suggested Personnel

1 Supervisory staff
Plant operators to suit machinery on site.
1 Labourer to handle borate bags.
Traffic controllers as necessary.

Suggested Plant

Front end loader.
Pavement stabilising mixer.
Light drum roller
Water truck

Materials

Borate (Timbor/Polybor/Solubor) powder.

Planning Notes

Work is best scheduled for summer (dry) weather.

Other Activities which would be beneficial to schedule with this treatment include Timber Deck Treatment (Activity Code 014) and Stringer Treatment (Activity Code 015).

Average Daily Production

(needs to be determined)

Work Classification

Specific Maintenance

6.14 Activity Code No. 031 (Work Item P101)

Timber Handrail Maintenance

General Description

Painting, repair and replacement of posts, rails and hardware due to accidental damage, vandalism or normal deterioration.

Quality Standard

Original structural integrity and appearance of the railing to be restored.

Unit Of Measurement

Linear metre run of completed rail assembly.

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Remove damaged or unserviceable railings (timber and steel), spacer blocks and posts.
3. Install new posts where required and check general rail alignment.
4. Install new spacer blocks (for flexbeam only), posts and railing as required, including delineators where necessary.
5. Tighten structural fixings and anchorages (except at expansion joints on steel flexbeam railing).
6. Check and tighten anchorage assemblies.
7. Paint posts or panels as necessary.
8. Record location, times, plant and materials used.
9. Remove warning signs and other traffic control signs on completion of work on a section.

Suggested Personnel

- 1 Supervisory staff
- 1 Construction worker.

Suggested Plant

- 1 Light truck or utility
- 1 Electric drill/saw powered by either vehicle or separate generator
- 1 Rattle gun
- Torque wrench (if nut tightening tension specified)
- Miscellaneous tools and drills.

Materials

- Galvanised flexbeam, posts and separators.
- Assortment of nuts and bolts commonly used on task
- Paint and paint brushes
- Delineators

Planning Notes

1. Determine requirements for repair and order materials as necessary and allow sufficient time for delivery.
Note that damaged or unserviceable railing includes any timber broken by accident impact, and members significantly weakened by decay or termite attack.
2. If damage caused by vehicle accident, consider whether problems with road geometry or bridge width may have contributed to the accident.
3. If applicable, ensure tensions for tightening nuts are known.

Average Daily Production

50 metres.

Work Classification

Routine Maintenance

6.15 Activity Code No. 032 (Work Item R208)

Deck Drainage (Pre-overlay Bridges)

General Description

Clearing drainage scuppers or kerb holes, and fixing of flashing to stringers.

Quality Standard

Restoration of the full deck drainage capacity of the bridge, and fixing of flashing to stringers.

Unit Of Measurement

Item (service bridge drainage clearance).

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Clean all dirt, vegetation and road debris from all deck scuppers and drains.
3. If not already done, securely nail flashing (750 mm wide x 1 200 mm high, galvanised steel or aluminium), covering ends of decking and extending clear from outer stringer, at each scupper outflow position. Where bridge height is significant, installation of flashing is best done from a work platform such as the 'Topper' underbridge inspection unit.
4. Record location (Bridge No.), times, plant and materials used.
5. Remove warning signs and traffic control devices.

Suggested Personnel

1 Supervisory staff
1 Construction worker.

Suggested Plant

Generally, one single axle maintenance truck and road maintenance accessories. Mobile work platform, for higher bridges.

Materials

Pre-cut flashing plates.
Flat head nails.

Planning Notes

1. Pre-inspection should determine the number of scupper positions requiring flashing, and the need or otherwise for a safe working platform for attaching flashing.
2. For bridges programmed for construction of reinforced concrete overlay within 12 months, this activity may be reduced to simple cleaning of scuppers.

Average Daily Production

Dependent on the degree of activity being performed.

Work Classification

Routine Maintenance

6.16 Activity Code No. 033 (Work Item R207, R205)

Removal of Deck Vegetation

General Description

The removal of all vegetation and pockets of soil from the bridge deck and superstructure area.

Quality Standard

The bridge running surface and the upper protrusions of members such as halfcaps, bearers and kerbing shall be left free from vegetation and any pockets of soil likely to sustain vegetation. No removed vegetation shall be left within the road reserve.

Unit Of Measurement

Item (bridge vegetation clearance)

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Physically remove all larger plants, with roots intact if possible.
3. Smaller and grassy weeds are to be swept or shovelled, as appropriate, into piles for removal by truck. Loose soil shall also be removed from the road surface and kerbing at this time.
4. Where weed growth or soil is evident on the top of half caps, bearers or decking ends, removal by means of high-pressure water jet will generally be sufficient.
5. Where weed growth is sufficiently vigorous to warrant herbicide application, this task shall be referred to the relevant road maintenance team.
6. Record location (Bridge No.), times and plant utilisation.
7. Remove warning signs and other traffic control devices on completion of the work.

Suggested Personnel

1 Supervisory staff
1 Construction worker.

Suggested Plant

1 utility or light truck
Trailer-mounted water tank
High-pressure water cleaning unit.

Materials

Water
Brooms and shovels.

Planning Notes

1. Task is best planned for late winter or early summer.
2. Pre-inspection of the bridge is advised to determine current availability of water for cleaning purposes.

Average Daily Production

(To be determined, but varies.)

Work Classification

Routine Maintenance

6.17 Activity Code No. 034 (Work Item R205)

Vegetation and Debris Clearing

General Description

1. The area of land under the structure and for a distance of 10m beyond the kerb line on both sides of the structure or to the road reserve boundaries (whichever is less) and 10m beyond the abutment faces shall be designated the Control Area for the Structure. Refer Plan view Drawing 1230-1666
2. Within the control area a vertical clearance envelope shall also be provided for a height of 6m above the road deck for a distance of 5m beyond the kerb line, or to the road reserve boundaries (whichever is less), on both sides of the structure. Refer Elevation view Drawing 1230-166
3. All vegetation felled, cut, pruned or mowed shall be collected and removed from site and disposed of at a suitable waste facility. Flood debris shall also be removed from within the control area.
4. For vegetation within the Control Area where trunks are greater than 100mm in diameter, consideration shall be given for herbicide treatment to prevent regrowth.
5. Vegetation outside the Control Area that is identified as a hazard and has the potential to fall onto or damage the structure, or may affect the free flow of water under the structure should also be assessed on a case by case basis for removal.
6. Vegetation within the Control Area that does not pose a hazard and does not have the potential to fall onto or damage the structure, or effect the free flow of water under the structure, and is considered to be of special significance or of special aesthetic value, may be retained.

Quality Standard

All vegetation within the Control Area shall be felled, cut with a brush cutter, pruned or mowed to a height of not more than 100mm above ground surface. This shall include the removal of woody plant regrowth, such a suckers and seedlings.

No pruned material or flood debris shall be left within the road reserve.

Unit Of Measurement

Square metres

Steps

1. Larger shrubs and trees within the control area to be cut to a height of not more than 100mm above ground surface , the stumps poisoned and prunings stacked for removal.
2. All grassy weeds and smaller shrubs within the control area to be mowed with a brush cutter, and as much of the mowings/prunings as possible stacked for mulching or removal.
3. All flood debris to be removed from the control area.

Suggested Personnel

- 1 Supervisory staff
- 1 Construction worker.

Suggested Plant

1 light truck or utility with heavy trailer
Chain saws
Brush cutter.

Materials

Nil.

Planning Notes

1. Task is most usefully planned for late winter or early summer.
2. Check and list sites where a brush cutter is required to be used.
3. Pre-inspection advised, to enable specification of larger plant for removal of heavy flood debris where this problem exists. Removal of heavy tree debris adjacent to piers must be treated as a priority task.
4. In all circumstances appropriate approval/s shall be obtained prior to undertaking clearing. Note specific requirements to vegetation clearance within water catchments and areas of specific control ie Avon Valley, Swan River Trust, etc have specific regulations for vegetation clearance and their Acts prevail over both the Main Roads Act and the Local Government Act.
5. Removal of large trees is likely to be both expensive and a sensitive issue, but such trees close to the bridge probably pose the greatest dangers to outer stringers and piles (for both flood and fire risk), as well as the stability of wingwalls. Because of the sensitivity, this aspect should only be done with the endorsement of the relevant regional asset manager.
6. Need to consider stream bank stability when directing removal of large trees close to bridges. It is usually better to cut the tree off just above ground, leaving the roots intact to avoid soil disturbance.

Average Daily Production

(To be determined.)

Work Classification

Routine Maintenance.

6.18 Activity Code No. 035 (Work Item R215)

Regulatory and Warning Signs

General Description

The repair, replacement, straightening and cleaning of markings, signs and supports, so as to restore and maintain adequate regulation, warning and guidance to traffic.

Quality Standard

The treated sign should be legible by both day and night from greater than the stopping sight distance for the road speed environment. Less than 15% of the lettering, symbols or colour should be faded or damaged. The sign standard should be within 50 mm of vertical measured 1.5m above ground level. The sign face should be within 5 degrees of the specified angle to the road.

Unit Of Measurement

Item.

Steps

1. Place warning signs and other traffic control devices in accordance with AS 1742.3 and MRWA Traffic Management For Roadworks Code Of Practice.
2. Replace damaged posts and straighten posts when it is noticeable that they are not vertical.
3. Replace signs which are badly damaged or where reflectivity has been lost. Salvage re-useable signs, posts and fittings.
4. Straighten signs if bent (where possible).
5. Patch and/or refurbish signs where this is possible.
6. Wash down signs if dirty.
7. Where new sign posts are erected, ensure that they are erected vertical, at the correct height, at the correct angle to the road centreline, and are at the correct distance from the edge of the seal.
Installation in accordance with AS 1742.2-1994 Appendix C.
8. Compact backfill or concrete around off-bridge posts.
9. Attach sign to post ensuring it is at the correct height, the top and bottom edges are horizontal, and it is the correct distance from, and angle to, the edge of the seal.
10. Enter details on a Road Traffic Sign Inventory Sheet.
11. Record need for road marking, if bridgeworks or other activity has obscured pavement markings.
12. Record location (SLKM, Bridge No.), times, plant and materials used for MMS/BMS.
13. Remove warning signs and other traffic control signs on completion of work.

Suggested Personnel

1 Supervisory staff
1 Construction worker

Suggested Plant

1 Utility with suitable rack or trailer.
1 Truck with suitable tray mounted crane.
Post hole digger/auger
Hand tamper
Ladders
2 blocks and tackle.

Materials

Where new sign posts are erected, ensure that they are erected vertical, at the correct height, at the correct angle to the road centreline, and are at the correct distance from the edge of the seal.

Installation in accordance with AS 1742.2-1994 Appendix C.

Planning Notes

1. Determine requirements for signs and posts from sign inventory information, load posting advices and inspections and order well in advance if not covered by store stocks.
2. Enquire into location of other underground services and ensure that these are not damaged when digging holes for posts.
3. Specify the appropriate plant, materials (including quantities) and crew and organise these.
4. Check that no works are planned in the immediate future that could make the sign unnecessary in that location.
5. Signs should be checked at night-time at least twice per year to confirm adequacy.

Average Daily Production

Large signs: 1-3
Small signs: 10-15.

6.19 Activity Code No. 041(Work Item P101)

Marine Organism Protection

General Description

Encapsulation of all timber piles subject to marine borer attack.

Quality Standard

At the completion of this Activity, all piles will be effectively encapsulated between 300 mm above the highest static water level, and 500 mm below the lowest anticipated bed level.

Unit Of Measurement

Metre run of protected pile.

Steps

1. Protective systems must be approved for the particular structure by an experienced Bridge Engineer, with systems currently in use including sand encapsulation (fibreglass collars), full concrete encapsulation, and the Denso "Seashield Series 60" or MarineGard 60 systems.
2. Where the Denso system is selected, it shall be applied according to the manufacturers published specifications.
3. Where a bridge has an existing sand encapsulation system, it is essential that the sand level in the collar be maintained at or above the water level - using free-flowing coarse sand for the re-charging. When the sand level is repeatedly found to be low in a particular collar, it may be assumed that the reason is either physical damage to the collar or bed scour exposing the bottom of the collar. In either case, underwater inspection (requiring licensed divers) is necessary to enable correct diagnosis and reinstatement.
4. Record location (Bridge No.), times, plant and materials used.

Suggested Personnel

1 Supervisory staff
1 Construction worker
Certified divers, as required for specialised application.

Suggested Plant

1 Truck
Specialised access equipment, including barges, as required.

Materials

Free-flowing coarse sand
Replacement fibreglass collars as specified by Engineer
Proprietary system components.

Planning Notes

1. This work is specialised, and installation of new systems shall always be performed under Engineering direction.
2. Where bridges have existing sand encapsulation systems, sand levels must be checked at least annually and topped up as found necessary.
3. Where piles have been encapsulated by any system above the waterline there will be a significant risk of fungal decay, and these piles should be given a full fungicide treatment - preferably with the slower-release rods such as Impel or Polesaver. (See Activity 013a.)

Average Daily Production

Not applicable.

Work Classification

Specific Maintenance

6.20 Activity Code No. 042 (Work Item R204)

Termite Inspection and Treatment

General Description

Inspection of bridges to detect active termite infestation, and subsequent colony eradication measures where activity discovered.

Quality Standard

All timber bridges to be scheduled for annual termite inspection by licensed pest control operator or similar professional. Termite eradication measures to be applied by licensed pest control operators only, and pursued until eradication confirmed.

It is emphasised that treatment with organo-chlorine or arsenic trioxide materials will no longer be authorised on bridge sites, and the poor efficacy and high chemical use of conventional barrier systems makes them unsuited for bridges. The delayed action of most insect growth regulator treatments means that these cannot be accommodated within the traditional time frame for contracts, as eradication may well take 12 months or more to achieve.

Unit Of Measurement

Square metre of bridge deck area.

Steps

1. The initial visit by the Contractor will either certify the absence of termite activity, or herald the need for eradication treatment. Eradication method must either be according to Australian Standard AS 2178-1986, or alternative methodology as specifically agreed by the Structures Delivery And Standards Engineer.
2. Where termite activity is detected in individual bridges, the supervisor must be notified by the Contractor to enable the position and degree Of infestation to be recorded on the Bridge Management System.
3. When the Contractor is satisfied that termite eradication has been achieved at a bridge site, the supervisor must be notified to enable confirmation and recording of the eradication date.
4. Eradication must be followed by removal of the nest material, to ensure that any re-appearance of termite activity is not confused by old inactive nest material.

Suggested Personnel

1 Supervisory staff, experienced in termite detection and species identification (not full-time on site, but needed for quality assurance role)

1 Licensed pest control operator (Contractor).

Labourers, as required, to provide access for Contractor.

Suggested Plant

1 light vehicle for supervisor

Other plant, as needed, provided by Contractor.

Access scaffolding.

Minimum inspection aids (as detailed in AS4349.3 – 1998), provided by Contractor.

Materials

Termiticide, approved by SDSE

Provided by Contractor

Materials currently approved for termite eradication include Termidor (dust or liquid), Premise liquid and the use of insect growth regulators represented by the Exterra and Sentricon TM systems. See Appendix E for notes relating to the preferred treatment, Termidor dust.

Planning Notes

1. It is prudent for as many bridges as possible within reasonable distance from a major regional centre to be grouped under a common Termite Maintenance Agreement. Local Authorities should be encouraged to pool resources for such Agreements.
2. A trained supervisor should inspect a representative sample (including previously recognised 'problem' bridges) of the bridges in each particular Termite Maintenance Agreement, both before and after Contract inspection - making detailed notes of any infestation found.
3. 'Eradication' of termite activity (a formal end to treatment at a particular bridge for that year) must be mutually agreed between the Contractor and the supervisor.
4. The basis of termite control in timber bridges is regular, accurate inspection accompanied by complete colony eradication when activity is detected. It is important that Contractors being considered for termite control work in bridges be able to demonstrate high proficiency in both inspection and eradication skills relevant to bridges – a field demonstration of these skills, including use of the proposed eradication method, is a valid pre-qualification test for prospective Contractors.

Average Daily Production

Not applicable.

Work Classification

Routine Maintenance

APPENDIX A.1

BORACOL 400 RH PILE GROUNDLINE TREATMENT (20 dia. Holes)

Application Rate 5 kg/m³ (BAE)

Treatment holes 20 mm dia x 500 mm long = 160 ml/hole.

Number of Holes ** (see note below)	Max Treated Dia (mm)	Boracol Volume/pile (litres)
4	247	0.64
5	276	0.8
6	302	0.96
7	326	1.12
8	349	1.28
9	370	1.44
10	390	1.6
12	427	1.92
14	461	2.24
15	477	2.4
16	493	2.56
18	523	2.88
20	551	3.2
21	565	3.36
22	578	3.52
24	604	3.84
25	616	4.0
28	652	4.48
30	675	4.8

Normal pile treatment:

4 holes evenly spaced at ground level plus 4 holes 200-300 mm above GL, interspersed between lower holes. (Holes must be in sound timber - no splits.)
Re-treat at intervals after 4 weeks until required dosage rate is obtained.

** Note that use of more than 12 treatment holes at the groundline of any pile is not recommended. Where the required number of treatment holes exceeds 12, the treatment may be accomplished by re-treating the existing holes until the full amount of fungicide dose has been achieved.

APPENDIX A.1a

BORACOL 400 RH PILE GROUNDLINE TREATMENT (22 dia. Holes)

Application Rate 5 kg/cu.metre (BAE)

Treatment holes 22mm dia x 500mm long = 190 ml/hole.

Number of Holes **(see note below)	Max. Treated Diameter (mm)	Boracol Volume /pile (litres)
4	271	0.76
5	303	0.95
6	332	1.14
7	359	1.33
30	384	1.52
9	407	1.71
10	429	1.90
12	470	2.28
14	507	2.66
15	525	2.85
16	542	3.04
18	575	3.42
20	606	3.80
21	621	3.99
22	636	4.18
24	665	4.56
25	678	4.75
28	718	5.32
30	743	5.70

Normal pile treatment:

4 holes evenly spaced at ground level plus 4 holes 200-300 mm above GL, interspersed between lower holes. (Holes must be in sound timber – no splits). Re-treat at intervals after 4 weeks until required dosage rate is obtained.

** Note that the use of more than 12 treatment holes at the groundline of any pile is not recommended. Where the required number of treatment holes exceeds 12, the treatment may be accomplished by re-treating the existing holes (after allowing time for fungicide diffusion) until the full amount of borate dose has been achieved.

APPENDIX A.2

PR718ESCHEM 'POLESAVER' ROD - PILE GROUNDLINE TREATMENT

Application Rate 6 kg/m³
 (as per 9/91 Technical Data Sheet)
 Rods 125 mm long, 14 mm diameter

No of Rods	Max Treated Dia (mm)	Pile Dia (mm)	No of Rods Required
9	175	200	12
12	202	240	17
16	233	250	18
20	260	260	20
24	285	280	23
30	319	300	27
36	350	320	30
40	369	340	34
48	404	360	38
50	412	380	43
56	436	400	47
60	451	420	52
70	488	440	57
80	521	460	62
90	553	480	68
100	583	500	74
110	611	520	80
120	638	540	86
140	689	560	92
		580	99
		600	106
		620	113
		640	121

Treatment holes drilled evenly spaced, and in staggered layers 200-300mm separated as per Boracol 400 instructions. First row of holes 700mm min. above normal water level.

APPENDIX A.3

PRESCHEM 'RAIL RODS' - PILE GROUNDLINE TREATMENT

Application Rate 6 kg/m³
(as per 9/91 Technical Data Sheet)
Rods 70 mm long, 17 mm diameter

No of Rods	Max Treated Dia (mm)	Pile Dia (mm)	No of Rods Required
9	159	200	14
12	183	240	21
14	198	250	22
21	243	260	24
24	260	280	29
28	280	300	32
30	290	320	36
36	318	340	42
42	343	360	46
48	367	380	52
56	396	400	57
60	410	420	63
70	443	440	69
80	474	460	75
90	502	480	82
100	529	500	89
110	555	520	97
120	580	540	104
140	626	560	112
150	648	580	120
160	670	600	129
180	710	620	137
		640	146
		660	156
		680	165

Treatment holes drilled evenly spaced, and in staggered layers 200-300mm. separated as per Boracol 400 instructions. First row of holes 700mm min. above normal water level.

APPENDIX A.4

IMPEL RODS – PILE GROUNDLINE TREATMENT

Application Rate 4.5 kg/cubic metre
Rods 12mm diameter, 100mm long

No. of Rods	Max. Treated Dia (mm)	Pile Dia (mm)	No. of Rods Required
10	126	100	6
15	155	150	14
20	180	200	25
30	220	250	39
40	250	300	56
50	280	320	64
60	310	340	72
70	335	360	80
80	360	380	90
90	380	400	100
100	400	420	110
110	420	440	120
120	440	460	132
130	455	480	144
140	475	500	156
150	490	520	168
160	505	540	182
170	520	560	195
180	540	580	210
190	550	600	224
200	565	620	240
210	580	640	255
220	595	650	265
240	620	675	285
260	645	700	305
280	670	725	325

Treatment holes drilled evenly spaced, and in staggered layers 200-300mm separated as per Boracol 400 instructions. First row of holes 700mm min. above normal water level.

APPENDIX B.1

BORACOL 200 RH DECKING TREATMENT

Application Rate 3 kg/m³ (BAE)

Decking Thickness (mm)	Application Rate (litres/m ²)
20	0.21
25	0.26
40	0.42
50	0.53
75	0.79
100	1.05
125	1.32
150	1.58
175	1.84
200	2.10

Appendix B.2

BORACOL 400 RH DECK/SAWN TIMBER TREATMENT

Application Rate 3 kg/cubic m. (BAE)

Decking (or Section) Thickness (mm)	Application Rate (litres/sq. metre)
20	0.10
25	0.13
40	0.21
50	0.26
75	0.40
100	0.53
125	0.66
150	0.79
175	0.92
200	1.05

Note that this treatment only suitable for either brush application or spreading (with watering can or similar) on wetted timber. Material too thick for spraying.

APPENDIX C.1

TIMBOR/POLYBOR SLURRY TREATMENT OF STRINGERS

Application Rate $\approx 4.5 \text{ kg/m}^3$ (BAE)

Slurry proportion 5.0kg Solubor power, 2.90l water
(mixture strength 1.10 kg/l BAE)

6 m Spans		7.5 m Spans	
Stringer Diameter (mm)	Slurry Volume (litres)	Stringer Diameter (mm)	Slurry Volume (litres)
350	2.5	350	3.1
400	3.3	400	4.1
450	4.1	450	5.2
500	5.1	500	6.4
550	6.2	550	7.7
600	7.4	600	9.2
650	8.6	650	10.8
700	10.0	700	12.5
750	11.5	750	14.4
800	13.1	800	16.3
850	14.8	850	18.4
900	16.5	900	20.7
950	18.4	950	23.0
1000	20.4	1000	25.5

Notes:

1. Slurry to be pumped into stringer at 4 or 5 positions along length as splits, pipes etc. allow. (Minimum application - holes at supports, midspan).
2. 'Pot life' of slurry mixture approximately 20 minutes at 10°C extending to 40 minutes at 30°C.
3. 22mm diameter holes create 380 ml volume per metre length.

APPENDIX C.2

TIMBOR/POLYBOR SLURRY TREATMENT OF BEDLOGS

Application Rate $\approx 4.5 \text{ kg/m}^3$ (BAE)

Slurry proportion 5.0kg Solubor powder, 2.90 litres water
(mixture strength 1.10 kg/l BAE)

Treatment Dose Required per Metre Run of Bedlog

Bedlog Diameter (mm)	Slurry Volume (litres/m run)
250	0.21
300	0.31
350	0.42
400	0.54
450	0.69
500	0.85
550	1.03
600	1.23
650	1.44
700	1.67
750	1.91
800	2.18
900	2.76
1000	3.40
1100	4.12
1200	4.90

Notes:

1. Slurry to be pumped into bedlog via 22mm diameter holes, at 500mm or 1.0m spacings, as splits, pipes etc. require. (prefer that all holes pass through centre of bedlog).
2. 'Pot life' of slurry mixture approximately 20 minutes at 10°C, extending to 40 minutes at 30°C.
3. 22mm diameter holes create 380 ml volume per metre length.

APPENDIX C.3

BORACOL 400 RH TREATMENT OF STRINGERS

Application Rate = 3.0 kg/cu.metre (BAE)

6m Spans		7.5 m Spans	
Stringer Diameter (mm)	Boracol (litres)	Stringers Diameter (mm)	Boracol (litres)
350	3.0	350	3.8
400	3.9	400	5.0
450	5.0	450	6.3
500	6.1	500	7.8
550	7.4	550	9.5
600	8.8	600	11.3
650	10.3	650	13.2
700	12.0	700	15.4

Note: 22mm diameter holes create 380 ml volume per metre length.

50 mm diameter holes create 1.96 litres volume per metre length.

Note that re-treatment of reservoir holes (allowing 4 weeks minimum for previous fungicide dose to disperse) is much preferable to drilling excessive numbers of treatment holes in stringers. More than one reservoir hole per metre run of stringer is not advised. Note that trials are being established May 2004 to test the feasibility of applying large volumes of fungicide to treatment holes by means of attaching plastic reservoirs above the hole entrance to allow diffusion over a time period.

APPENDIX C.4

TIMBOR/POLYBOR SLURRY TREATMENT OF BEARERS and BEDLOGS

(not in ground contact)

Application Rate = 3.0 kg/cu. metre (BAE)

Slurry proportion 5.0 kg Solubor powder, 2.90 litres water
(mixture strength 1.10 kg/litre BAE)

Treatment Dose Required per Metre Run of Bedlog

Ave. Bedlog Diameter (mm)	Slurry Volume (Litres/m. run)
150	0.1
200	0.15
250	0.2
300	0.25
350	0.3
400	0.4
450	0.5
500	0.6
550	0.75
600	0.9
650	1.0
700	1.2
750	1.3
800	1.5
900	1.9
1000	2.3
1100	2.8
1200	3.3

Notes:

1. Slurry to be pumped into bedlog via 22mm diameter holes, at 500mm or 1.0m spacings as splits, pipes, etc require. Prefer that all holes pass through centre of bedlog
2. 'Pot life' of slurry mixture approximately 20 minutes at 10 deg C, extending to 40 minutes at 30 deg C
3. 22mm diameter holes create 380 ml volume per metre length.

APPENDIX C.5

BORACOL 400 RH TREATMENT OF BEDLOGS and BEARERS

(not in ground contact) 3.3

Application Rate = 3.0 kg/cu. metre (BAE)

Treatment Dose Required per Metre Run of Bedlog

Ave. Bedlog Diameter (mm)	Boracol Dose (Litres/m. run)
150	0.16
200	0.28
250	0.44
300	0.63
350	0.86
400	1.12
450	1.43
500	1.76
550	2.20
600	2.53
650	2.97
700	3.44
750	3.95
800	4.5
900	5.7
1000	7.00
1100	8.50
1200	10.1

Note: 22mm diameter holes create 380 ml volume per metre length.

APPENDIX C.6

TIMBOR/POLYBOR TREATMENT OF GRAVEL PAVEMENT

Application Rate = 8 kg/cu.metre (BAE), related to deck

= 1.2 kg/sq.metre (BAE), related to deck

= 1.0 kg of Polybor per sq.metre of deck

e.g. bridge deck 6.7m wide x 18m long, plus 2x2m approaches = 147.4 sq.metres area =>
say 150 kg Polybor, uniformly applied in water for pavement compaction

APPENDIX C.7

Use Of Fungicide Reservoir Bags (“Blood Bags”)

As shown in the stringer dosage table in Appendix C.3, the full treatment of a stringer will frequently require the use of 6 litres or more of Boracol 400 or equivalent borate fungicide. To minimise the need for creation of such a large treatment void in the stringer, a technique has been developed to allow the slow diffusion of borate/glycol fungicide into small treatment holes from 1 litre reservoir bags attached to the stringer or to the underside of the decking.

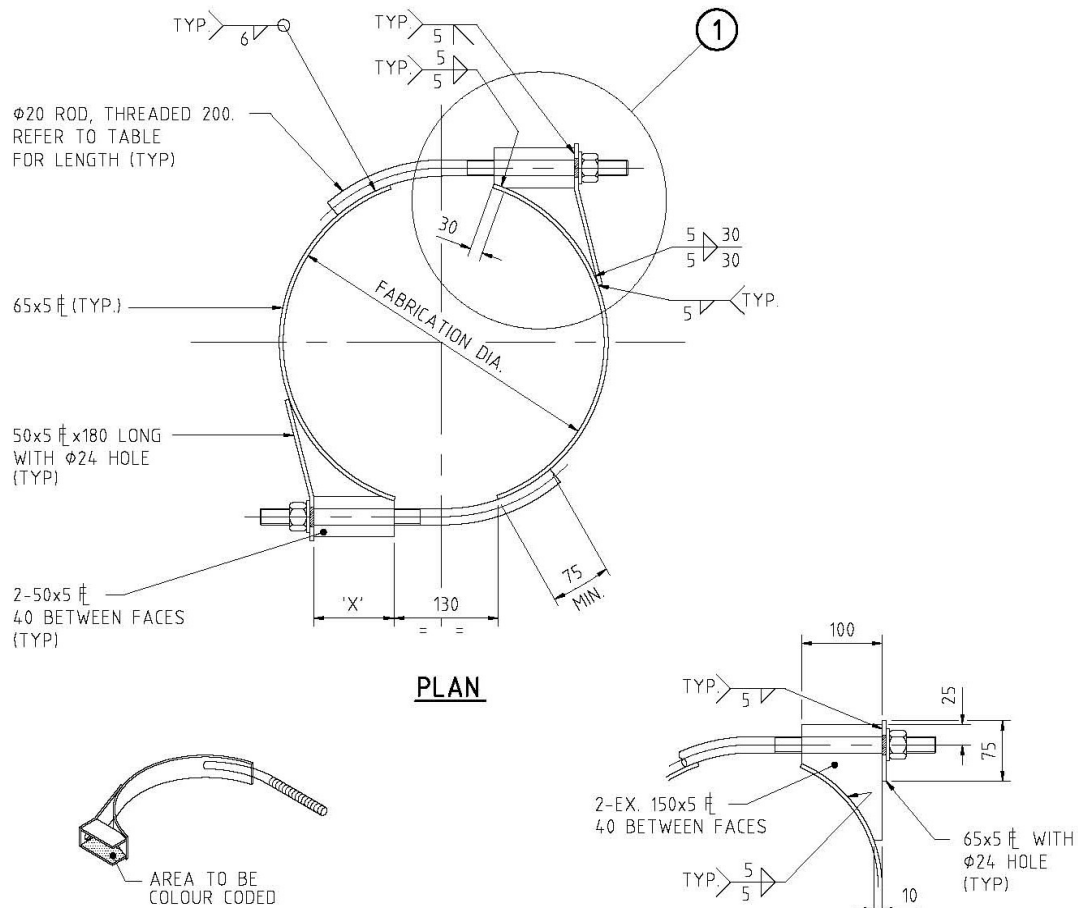
1. Stringer diameter is measured, and a dosage is selected from Appendix C.3 (select the nearest whole litre rounded upwards, based on the average diameter of the stringer).
2. Pairs of crossed 22mm diameter treatment holes to be drilled at selected positions along the stringer (typically at midspan and then about 1 metre from each end). Note the need for crossing of the hole directions, to allow better diffusion coverage of the stringer with the fungicide. Where holes need to be drilled upwards toward the deck, they need to be sealed at the bottom to enable filling from the top.
3. It is planned to develop a bio-degradable reservoir bag for this operation, but the bag used currently is a commercially-available medical blood bag, marketed as the Bridge Saver Bag. The “Bridge Saver Bag” is supplied filled, complete with a filler tube to allow connection to the stringer treatment hole.
4. Each bag is fixed in a position allowing its contents to drain into the top of the treatment hole, by means of a filler tube sealed onto the top of the treatment hole. The bag is left in place to diffuse the fungicide fully into the stringer – the process can take any time from a few hours to several months depending on factors such as timber porosity, moisture content, etc.
5. Note that there should be no need to re-apply this treatment later, as the leaching losses of borate from the bridge superstructure will be minimal. The bag can be removed (and the treatment hole capped) at the next programmed bridge inspection.



Reservoir bag in place. Note the need for care in positioning, to facilitate complete drainage.

APPENDIX D.1

TYPE	FABRICATION DIAMETER	PILE Ø RANGE	'X'	Ø20 ROD LENGTH	COLOUR CODE
1A	320	240-320		380	GREEN
1B	400	320-400	100	380	ORANGE
1C	480	400-480	125	405	BLACK
1D	560	480-560	150	430	BLUE
1E	640	560-640	175	455	WHITE



PIER PILE BAND DETAILS TYPES 1A TO 1E

DETAIL 1

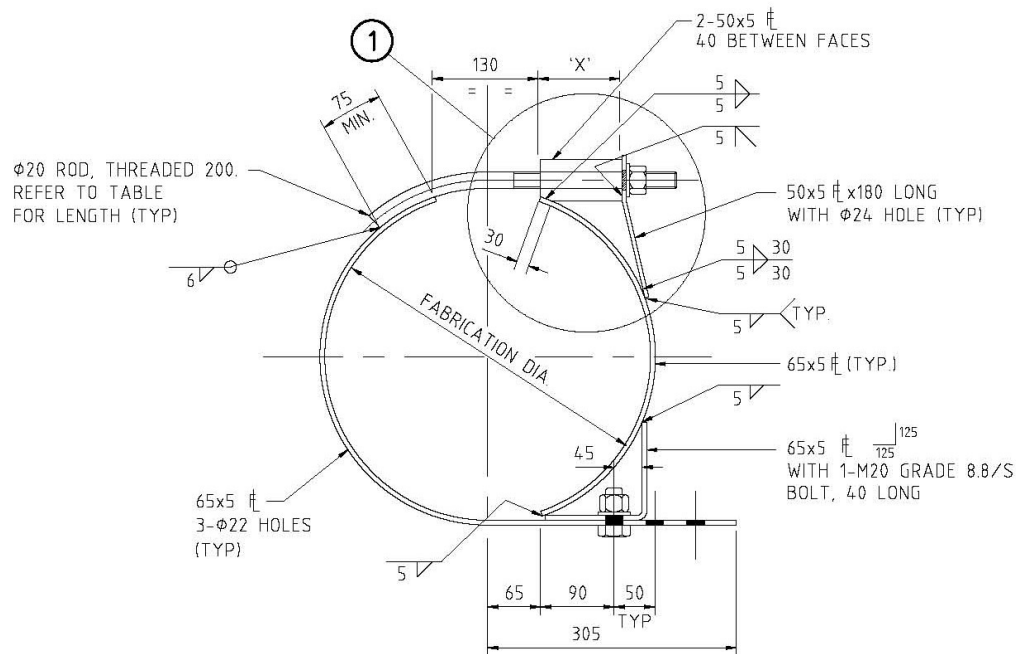
NOTES

- SURFACE TREATMENT TO STEELWORK AFTER FABRICATION SHALL BE AS FOLLOWS:
 - BOLTS, NUTS, WASHERS AND THREADED RODS SHALL BE HOT-DIP GALVANIZED TO A.S. 1214.
 - ALL OTHER STEELWORK SHALL BE HOT-DIP GALVANIZED TO AS/NZS 4680
- ALL STRUCTURAL STEEL BAR AND FLATS SHALL CONFORM TO A.S. 3679 GRADE 250.
- ALL WELDING SHALL BE STRUCTURAL PURPOSE TO CONFORM TO AS/NZS 1554.
- BAND SIZES SHALL BE COLOUR CODED AS TABLED WITH AN ENAMEL PAINT.
- BAND TO BE SUPPLIED ASSEMBLED WITH NUTS & WASHERS.

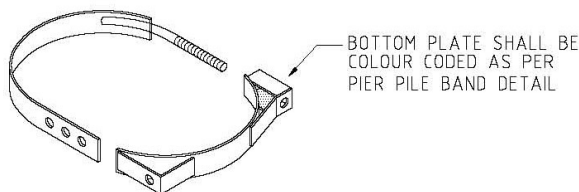
Figure 1 – TYPE 1 PILE BAND

APPENDIX D.2

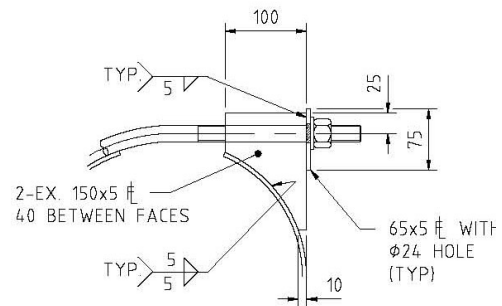
TYPE	FABRICATION DIAMETER	PILE ϕ RANGE	'X'	$\phi 20$ ROD LENGTH	COLOUR CODE
2A	320	260-320		380	GREEN
2B	400	320-400	100	380	ORANGE
2C	460	400-460	120	400	BLACK
2D	520	460-520	135	415	BLUE
2E	580	520-580	150	430	WHITE



PLAN



**ABUTMENT PILE BAND DETAILS
TYPES 2A TO 2E**



DETAIL 1

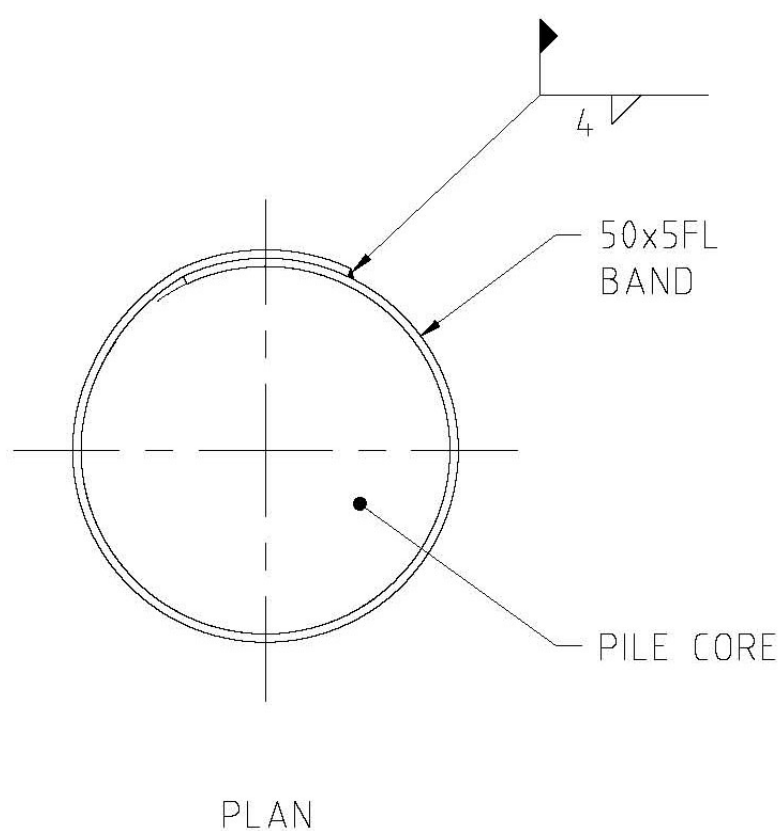
NOTES

1. SURFACE TREATMENT TO STEELWORK AFTER FABRICATION SHALL BE AS FOLLOWS:
 - 1.1. BOLTS, NUTS, WASHERS AND THREADED RODS SHALL BE HOT-DIP GALVANIZED TO A.S. 1214.
 - 1.2. ALL OTHER STEELWORK SHALL BE HOT-DIP GALVANIZED TO AS/NZS 4680
2. ALL STRUCTURAL STEEL BAR AND FLATS SHALL CONFORM TO A.S. 3679 GRADE 250.
3. ALL WELDING SHALL BE STRUCTURAL PURPOSE TO CONFORM TO AS/NZS 1554.
4. BAND SIZES SHALL BE COLOUR CODED AS TABLED WITH AN ENAMEL PAINT.
5. BAND TO BE SUPPLIED ASSEMBLED WITH NUTS & WASHERS.

Figure 1 – TYPE 2 PILE BAND

APPENDIX D.3

NOTE:
REMOVE ANY FOREIGN MATTER FROM TIMBER PILE GAPS.
PRECOMPRESS PILE RADially TO CLOSE ALL GAPS USING CHAIN AND RATCHET.
INSTALL STEEL BAND THEN FILLET WELD CLOSE WHILE APPLYING TENSION FROM A SECOND CHAIN AND RATCHET WHICH IS TACK WELDED TO BAND.



◎ PILE BANDING DETAIL – TYPE 3

N.T.S

Figure 1 – TYPE 3 PILE BANDS

Note: This is the non-preferred banding method for most piles, but this can be a useful technique for banding stringers and some abutment piles.

Type 1 and Type 2 bands generally quickest and most economical to install.

APPENDIX E

USE OF TERMIDOR TM DUST FOR TERMITE ERADICATION

1. Like any licensed pesticide, Termidor dust must be applied in accordance with the manufacturers label as approved by the APVMA. A link to the label is

http://www.asiapacific.basf.com/apw/AP/AsiaPacific/en_GB/function/conversions:/publish/AsiaPacific/upload/ANZ_Documents/Termidor/Termidor_Dust_V0207.pdf

or alternatively the label will be supplied on request by manufacturer BASF.

2. It is recognised, however, that the use of liquid termiticides as a barrier treatment in bridge approach embankments poses a risk of severe environmental damage if large flows result in removal of that treated soil via scour or erosion. For that reason, the use of soil protective zone treatments (either non-repellent chemicals such as Termidor liquid, or traditional chemicals such as chlorpyrifos or bifenthrin) is not recommended at bridges and another method needs to be employed to reduce the risk of re-infestation after eradication has been achieved.

3. As almost all re-infestation of bridges occurs through the soil contact at the abutments, the recommended method of 'barrier' control is to re-dust any old galleries still existing in the end spans of the bridge. This re-treatment should be done at a time from one to three months after the initial termite eradication treatment for the bridge. Little benefit is seen in re-treating the other spans at this stage unless further activity in them is confirmed by re-inspection.

APPENDIX F

SUPPLIERS OF PREVENTATIVE MAINTENANCE MATERIALS

CROMMELIN CHEMICALS (WA)

72 Division Street, Welshpool, WA 6106

Phone (08) 9458 5711 Facsimile (08) 9451 4749

<http://www.crommelin.com.au>

Products - 'Elastoseal HD' waterproofing membrane
- Cromproof Polyfab non-woven polyester fabric

DAVID GRAY & Co

99 Garling Street, O'Connor, WA 6163 Graham Sharp

Phone (08) 9337 4933 Facsimile (08) 9337 8316 mob. 0418 911 973

<http://davidgray.com.au> or tradecentre@davidgray.com.au

Products – Termiticides (Termidor, Premise)

DENSO (Australia) Pty Ltd

Phone (03) 9356 7600 or 1300 658 590 Facsimile (03) 9387 6973

Perth branch Spencer Macsween mob. 0413 700 171

<http://www.densoaustralia.com.au/> or denso@densoaustralia.com.au

Products - Denso Multi-Purpose Primer
- Denso 'Seashield Series 60' Timber Pile Protection System

ENSYSTEX AUSTRALASIA Pty Ltd

¾-6 Junction St, Auburn NSW 2144

Phone 133 536 mob. 0422 379 572 Terry Atkins

<http://www.ensystex.com.au> Or tatkins@ensystex.com

Products – Exterra Interception and Baiting system.

GARRARDS Pty Ltd

27 Guthrie St, Osborne Park, WA 6017

Ph 08 9444 4474 Facsimile 08 9443 2494 Glenn Bucar mob. 0429 996 619

<http://www.garrards.com.au> or bucarg@garrargs.com.au

Products – Mabon's Timber Protection Products

- Moisture Meters
- Cellavit products
- Termiticides (Termidor, Premise)
- Dusting equipment.

GLOBE AUSTRALIA

Unit 4, 24 Irvine Drive, Malaga WA 6090

Phone (08) 9249 6388 or mob. 0408 200 588 Facsimile (08) 9249 3488

<http://www.globeaustralia.com.au/> or perthpest@globeaustralia.com.au

Perth pest client manager Richard Douglas rdouglas@globeaustralia.com.au

Products – Boracol fungicides

- Moisture meters
- Termite dusting equipment
- Termiticides (Premise, Termidor, Termitafoam)

KARDON MARKETING SERVICES

6 Gawain Court, Glenhaven NSW 2156

Ph (02) 9680 3186 or mob. 0408 272 467 Facs (02) 9680 4027

<http://kardonmarketing.com.au> or kardonmktg@optusnet.com.au

Products – Cubor paste

- Koppers Arch timber preservative range (CN products)
-
- “Bridgewood” plywood replacement decking.

KOPPERS TIMBER PRESERVATION Pty Ltd

South Western Highway, Picton 6229

Phone 1800 099 840 or mob. 018 925 498 Bryan Duff

Products - CCA & Creosote - treated timber products (NOT Koppers Arch products)

KOPPERS ARCH WOOD PROTECTION (Australia) Pty Ltd

PO Box 2122, North Sydney, NSW 2060

Phone (02) 9954 5433 Facsimile (02) 9954 5467 Peter Carruthers

http://www.tanalised.com/home.asp?id=1&parent_id=0

Products - Koppers Arch timber preservation range (manufacturers)
- CNB Timber Protective Paste

LANOTEC AUSTRALIA Pty Ltd

PO Box 360, Archerfield, Qld 4108

Ph (07) 3373 3700 Facs (07) 3373 3777 Steve Green mob. 0417 638 004

<http://www.lanotec.com.au> or info@lanotec.com.au

Products – Lanotec Timber Seal Plus
- Lanotec Type “A” Grease

MABON'S TIMBER PROTECTION Pty Ltd

Unit 3, 20 Meadow Drive, Coopers Plains Qld 4108

Phone (07) 3274 4622 Facsimile (07) 3274 4688

<http://www.mabonstiberprotect.com.au> or sales@boronsolutions.com.au

Products - ProtecTimber borate fungicide

OSMOSE

PO Box 611, Mascot, NSW 2020

Ph 1800-088-809

<http://www.osmose.com.au/> or amanda@osmose.com.au

Products – Boracol fungicidal preservatives.

- Cellavit waterproofing.
- Impel rods.
- Protim Solignum XJ waterproofing
- Protim Timbercare CN Emulsion
- Protim Timbercare CN Timber Oil

PETRO COATING SYSTEMS Pty Ltd

50 Enterprise Drive, Bundoora Victoria 3083

Phone 1800 400 727 Facsimile +613 9945 2799

Nicolas Grenier

<http://www.petrocoating.com.au> or ngrenier@petrocoating.com.au

Products – PP Petrolatum Primer Paste

- MarineGard 60 Series timber pile protection system

PRESCHEM Pty Ltd

147-149 Herald Street, Cheltenham, Vic 3192

Laurie Woodward

Phone (03) 532 0679 Facsimile (03) 532 1041

<http://www.preschem.com/> or office@preschem.com

Products - Polesaver Rods
- Bioguard pole wrap system
- Aussie Clear timber oil finish

SPECTRUM DISTRIBUTORS (ICI/Orica Distributor)

50 Sheffield Road, Welshpool, WA 6106
Phone 1300 550 400 Fax 1300 550 440

<http://www.orica-spectrum.com/Business/CHE/spectrum/WCHE00007.nsf/all/index>

Products - Solubor (Polybor)
- 'Borax' range

TIMCARE DISTRIBUTORS

369 Holmes Road, Forestfield, WA 6058
Phone (08) 9359 3010 Facsimile (08) 9453 1876 Paul Phillips
Email: timcarewa@bigpond.com

Products - Boracol fungicidal preservatives.
- Impel rods
- Celtite waterproofing preservatives
- Preschem "Polesaver" rods.
- Aussie Clear waterproofing.

TIMTECH CHEMICALS Pty Ltd

7/12 Discovery Drive, North Lakes, Qld 4509
Ph 0412 629 600 Facsimile (07) 3491 7983 John Thorpe
<http://www.timtech.info/index.html>

Products – Eco-Bor fungicidal preservatives (borates)
- Micro-Bor powder
- Bridge Saver Bags

APPENDIX G

Material Safety Data Sheets (MSDS) for Recommended Products

Aussie Clear Timber Oil Finish	http://www.preschem.com/aclear.htm
Boracol 200RH	http://www.osmose.com.au/techinfo.html
Boracol 400RH	http://www.osmose.com.au/techinfo.html
Cellavit	http://www.osmose.com.au/techinfo.html
Crommelin Elastoseal HD	http://www.crommelin.com.au/pdfs/elastosealhd.pdf
Impel rods	http://www.osmose.com.au/techinfo.html
Intrigue (Triflumuron)	http://www.bayercropscience.com.au/products/list.asp?fun=misc
Koppers Arch	http://www.tanalised.com/guides.asp?id=15&parent_id=0
Osmose Protim Timbercare CN oil	http://www.osmose.com.au/techinfo.html
Preschem No Rot	http://www.preschem.com/nrmsds_print.htm
Preschem Polesaver	http://www.preschem.com/psmsds_print.htm
Preschem Timber Preserver (CN oil)	http://www.preschem.com/coppernap.htm
Premise (Imidacloprid)	http://www.bayercropscience.com.au/products/list.asp?fun=misc
ProtecTimber	http://mabonstimberprotect.com.au
Requiem (Chlorfuazuron)	http://www.exterra.com.au/label.html
Termidor (fipronil)	http://www.agro.basf.com.au
Timbor/Polybor	http://www.nisuscorp.com/pdfs/timbormsds.pdf

APPENDIX H

Plastic Plug Colours

If any treatment requires reservoir holes to be capped with plastic plugs, the colour of the plugs shall be as specified as follows:

Colour	Grey	Red	Blue	Yellow	Green	White	Pink
Year	NA	2015	2016	2017	2018	2019	2020
	2021	2022	2023	2024	2025	2026	2027
	2028	2029	2030	2031	2032	2033	2034
	2035	2036	2037	2038	2039	2040	2041