




Part Two Component Maintenance

Queensland Government
Department of Main Roads

2

Table of Contents

2

2

1.0 General

1.1 General

Routine and programmed maintenance activities applicable to individual timber bridge components and to the full bridge structure are described in this Section.

Bridge Inspection Manual Numbers and Maintenance Activity Numbers are provided for each component.

A general discussion of issues involved in routine and programmed maintenance of various individual components is given in Articles 2.2 to 2.4 of Part 1 of this manual.

1.2 Materials Supply

The supply and site storage requirements for most component materials are given in Specification MRS 11.87 - Supply of Timber Bridge Materials and Components.

These are:-

(a) All hardwood supplies
(b) Plywood components
(c) Precast prestressed concrete decking
(d) Steel trough decking

MRS 11.87 provides a list of approved hardwood timber species. Where unlisted species or species from other locations (such as New Guinea) are proposed by a supplier, the following procedure should be carried out.

(1) Submit details of proposed species to BAM.
(2) BAM in conjunction with DPI will determine suitability for specific component requirements.
(3) BAM will respond on species suitability.

2.0 Wearing Surface

2.1 Bituminous Wearing Surface (1O)

Bridge Inspection Manual Component No. 1O

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
105*	Patch potholes with asphalt	Tonnes
110*	Surface correction with premix or asphalt	Tonnes
118*	Seal coating	M^2
120*	Fill cracks	Litres
142*	Temporary pavement repairs	Tonnes
157*	Excavate & replace asphalt, full depth	Tonnes

* Refer to RMPC Document.

Purpose:

The main function of a bituminous wearing surface is to provide a smooth running or walking surface on bridge decks. On timber decks, this layer reduces the irregularities resulting from variable plank thickness.

Where plywood decking has been used, a bituminous wearing surface is essential to prevent wearing of the softwood surface layer due to wheel abrasion.

Crossfall for surface drainage is often formed by the DWS but it should be noted that bituminous surfacing is partially porous to surface water and cannot be considered to provide any significant waterproofing to the lower structure, even in an uncracked, intact state.

Significance: ***Significance Rating 2***

Although having no structural function, a smooth running surface provided by DWS is important as there will be a consequent minimizing of roughness induced wheel impact loads. Where surfacing is rough because of sags, potholes or cracking, the resulting increase in loads applied to the structure below will increase maintenance requirements, particularly with timber bridges.

A further benefit is the reduction in rattling associated with exposed timber plank decking, while an intact DWS still marginally improve the distribution of wheel loads to the planks below.

Details:

The system used for many early bridges was called penetration macadam which consisted of a graded coarse aggregate rolled on to the deck and hot tar poured over the surface to bind the layer together. Little of this type of DWS is expected to be found on bridges today.

For many years now, however, premixed asphalt has been used as DWS, rolled on for large scale replacement, or hand compacted for patching work. The use of embedded geofabric appears to have benefits when used over timber decking, reducing cracking resulting from movements in the decking because of its higher flexibility or possible looseness.

Asphalt has also been used as a top cover and running surface over steel trough decks where a bituminous infill is used and occasionally where concrete infill has been placed.

Figure 2.1 shows the general details of bituminous wearing surfaces as typically used on timber bridges.

2

General:

Failures in wearing surfaces are often the result of deterioration of the supporting structure resulting in excessive movement which cannot be withstood by the semi-rigid AC surface. Unless a very limited structure life is envisaged, DWS repairs should only be carried out subsequent to repairs to fix the actual cause of the problem.

A common defect that has been found is the cracking of the DWS between transversely placed plywood deck sheets, sometimes resulting in cracks up to 60mm in width due to lifting out of stressed material. This defect and repairs will be discussed under ply decking.

Maintenance Activities:

Refer to Part 3 Item 2.1 (1O) for recommended maintenance practices applicable to the various expected deterioration states for this component.

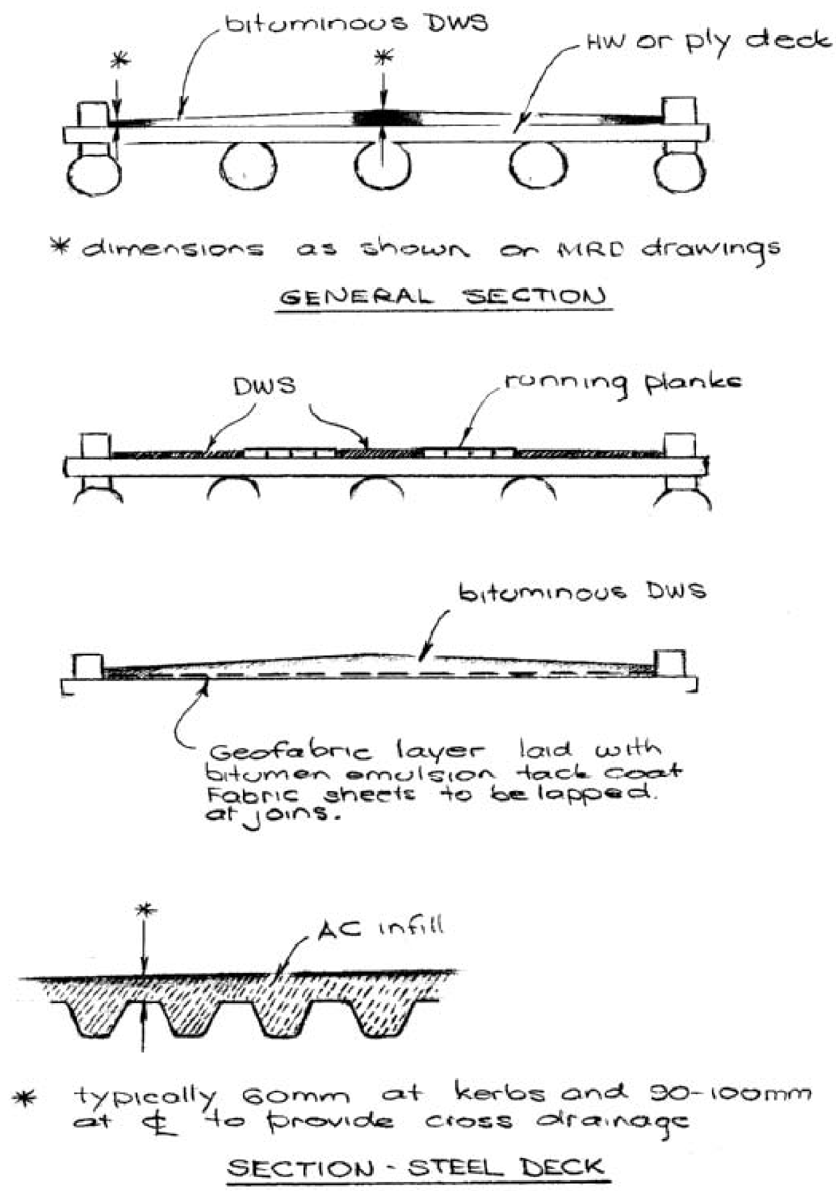


Figure 2.1 - Bituminous Wearing Surface

Refer to Part 4 for a description of applicable maintenance activities.

Extra Considerations:

Where an overlay is proposed over an existing wearing surface, approval must be sought from Structures Division as the extra loading will reduce carrying capacity of the structure. In some cases, existing DWS may need to be shaved or removed before the overlay is placed. Details shall be submitted to Structures Division in any case where asphalt thickness exceeds the depth shown on the design drawings by more than 40mm for the purpose of assessing bridge load-carrying capacity. Any apparent excessive DWS thickness (such as road surface flush with kerb top) must be reported for inclusion in the BIS.

3.0 Barriers

3.1 Timber Barrier (2T)

Bridge Inspection Manual Component No. 2T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
2T1	Replace timber post	Each
2T2	Replace timber rail	M
2T3	Replace timber barrier with steel bridge rail	M

Purpose:

The timber post and railing type was the original form of edge barrier used for timber bridges. Acting in conjunction with the bridge kerb, its purpose was to retain errant vehicles on the bridge deck. A secondary function was also to provide a safety barrier for possible pedestrian usage on road bridges, while it was always used on associated pedestrian walkways.

Significance: ***Significance Rating 1***

Even in good condition, the conventional timber handrail is considered to be ineffective for vehicle containment. In fact, the kerb is probably contributing greater lateral restraint than the rails. As well, because the system can be easily damaged in a crash situation, there is also the potential for a dislodged railing member to spear into a vehicle.

It should be noted that it is economically impractical to provide completely effective crash resistant rails to conventional timber bridges because of the lack of anchorage capacity within the superstructure members. Any deterioration of rail and post members will further reduce effectiveness in the event of an accident. Where used for walkways, any member deterioration will reduce pedestrian safety. As well, the design does not conform to current code requirements for child containment due to the large openings provided.

2

Details:

Figure 3.1 shows typical details for timber handrails, the most common form consisting of double timber rails on timber posts. Post attachment is by horizontal bolts at kerb and girder level.

Another common form consisted of a demountable wire rope with hinged posts, which could be lowered to reduce flood debris entrapment. However, it is believed that no examples of this system remain.

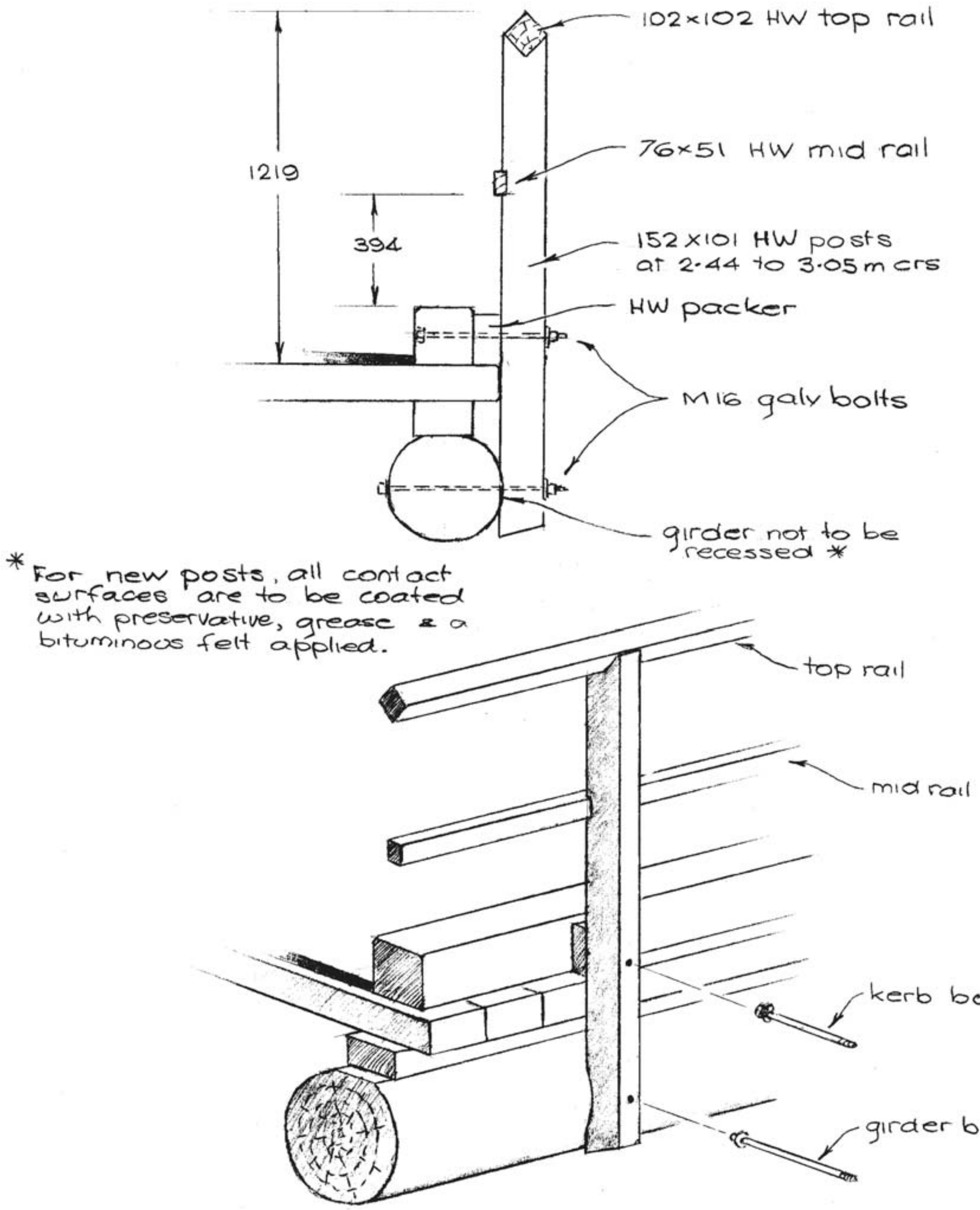


Figure 3.1 - Timber Barrier

Maintenance Activities:

Refer to Part 3 Item 2.2 (2T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Extra Considerations:

When installing new timber posts , the posts are to be trimmed to fit to the girder shape at the side contact area. Notching of the girder should not be carried out because of the resultant reduction in girder capacity due to loss of section and possible stress concentrations at the notch.

Where maintenance work is required on timber handrails, consideration should be given to replacing the barrier with an alternative system such as steel guardrailing because of potential hazards and ineffectiveness in retaining vehicles - item 2T3.

3.2 Steel Barrier (2S)

Bridge Inspection Manual Component No. 2S

Refer to BIM Appendix D for a description of the four condition states applicable this component.

Maintenance Activity Numbers		Units
2S1	Replace steel bridge rail	M
2S2	Replace steel post	Each
2S3	Relocate steel rail	M
2S4	Increase barrier height	M
2S5	Place post packer	Each

Purpose:

The corrugated steel bridge barrier is used as replacement for the original timber handrails on timber bridges. Acting in conjunction with the bridge kerb, its purpose is to retain errant vehicles on the bridge deck.

Significance: ***Significance Rating 1***

The corrugated steel barrier is considered to provide improved containment capability over that of the original timber bridge rails, due to the ability of the steel beam to deflect without shattering. However, its capacity on timber bridges is generally much less than desirable due to post attachment deficiencies. It should be noted that it is economically impractical to provide completely effective crash resistant barriers to conventional timber bridges because of the lack of anchorage capacity for the posts within the superstructure member. The kerb member will also be able to provide some lateral resistance to wheel impacts.

The packer between the post and the steel rail should always be incorporated as it helps to prevent the rail support posts from being snagged longitudinally by an impacting vehicle.

Details:

Figure 3.2(a) shows typical details of steel barriers likely to be found on timber bridges. Also shown in Figures 3.2(b) & (c) are further details developed by Bridge Design in order to provide enhanced attachment to the timber structure, using either the existing or a new timber kerb. It is recommended these details be used for placement of new steel barriers. Details of a barrier suitable for attachment to ply decks are shown in Figure 3.2(d).

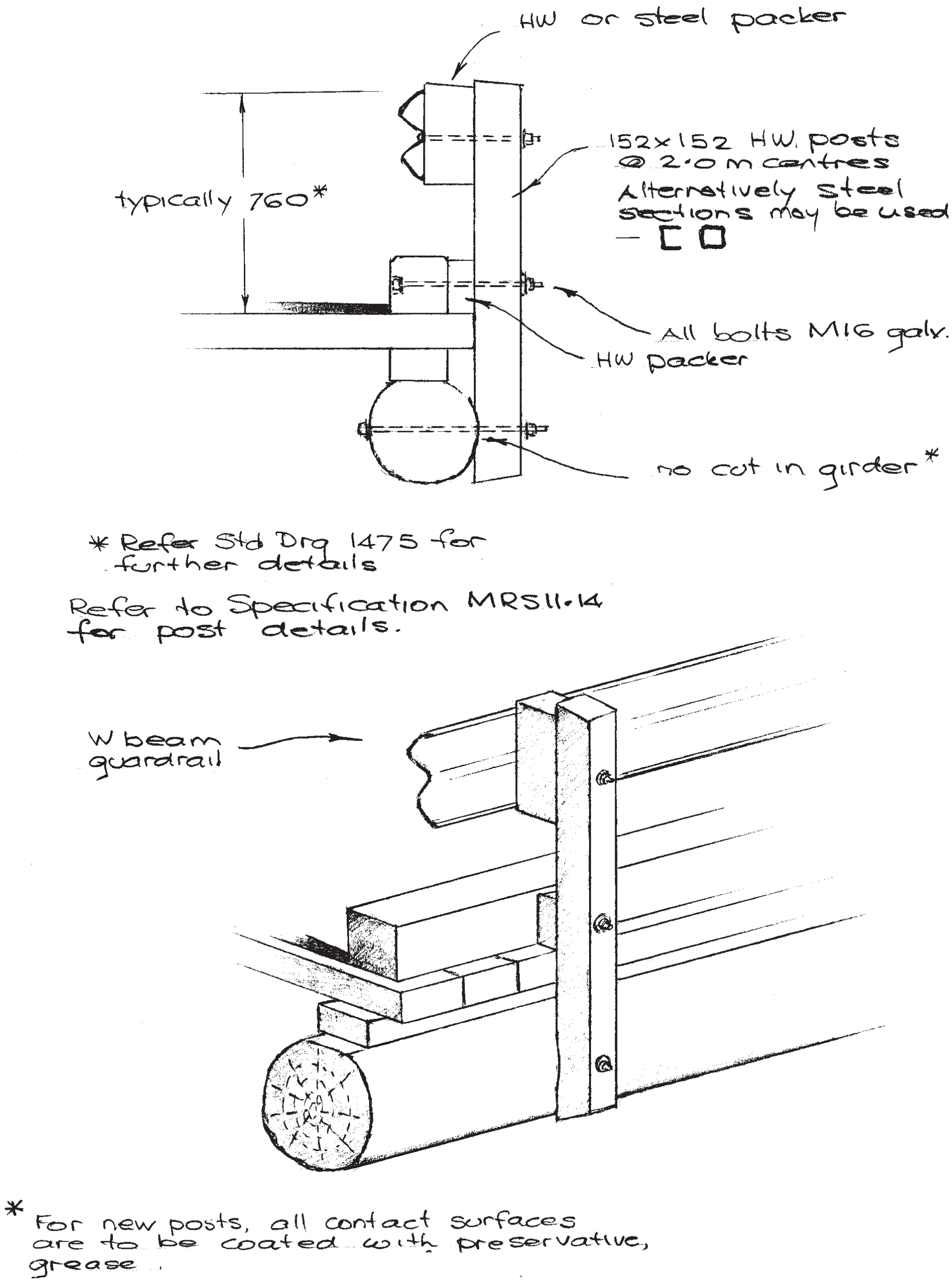


Figure 3.2(a) - Steel Guardrail Barrier

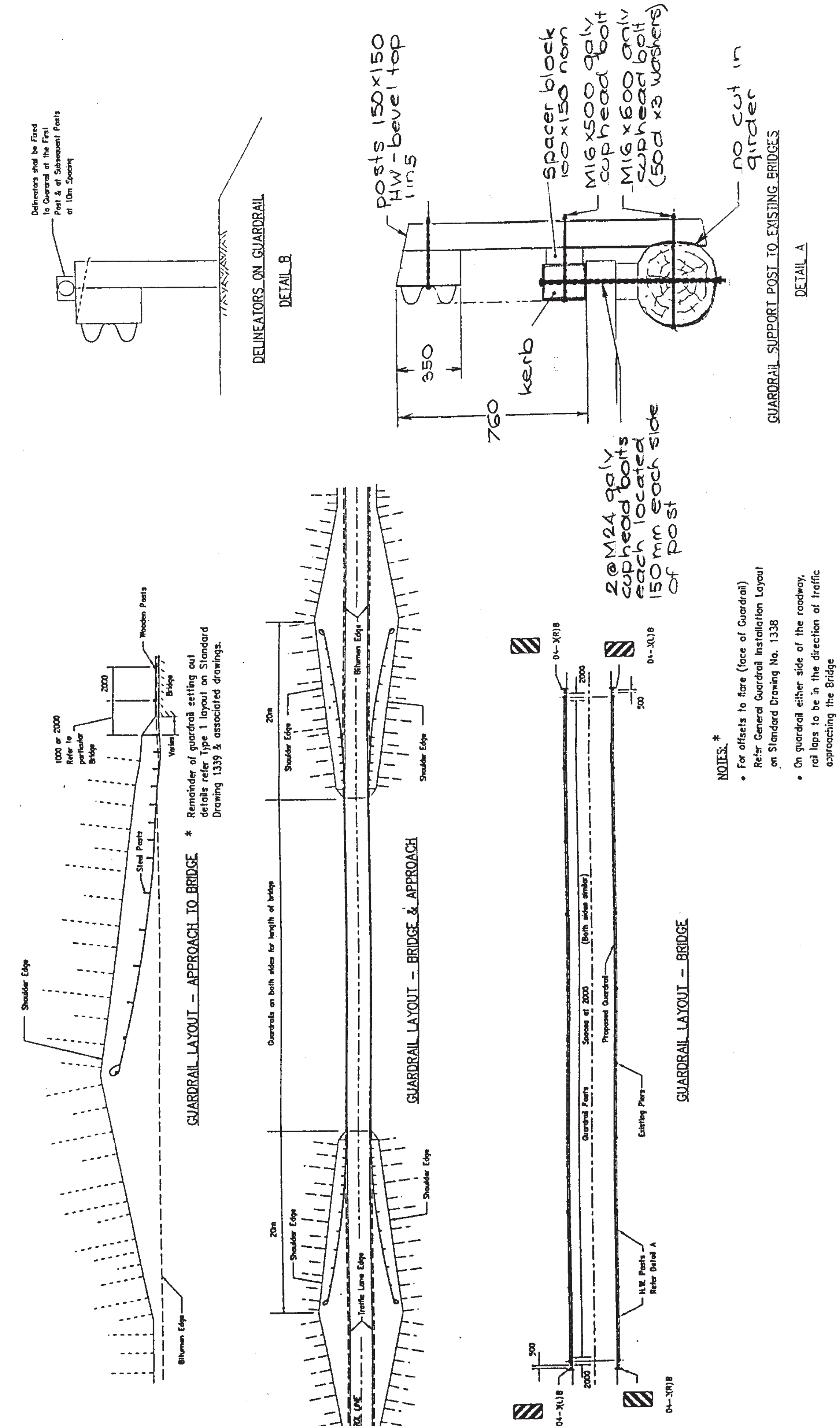


Figure 3.2(b) - Modified Steel Barrier 1

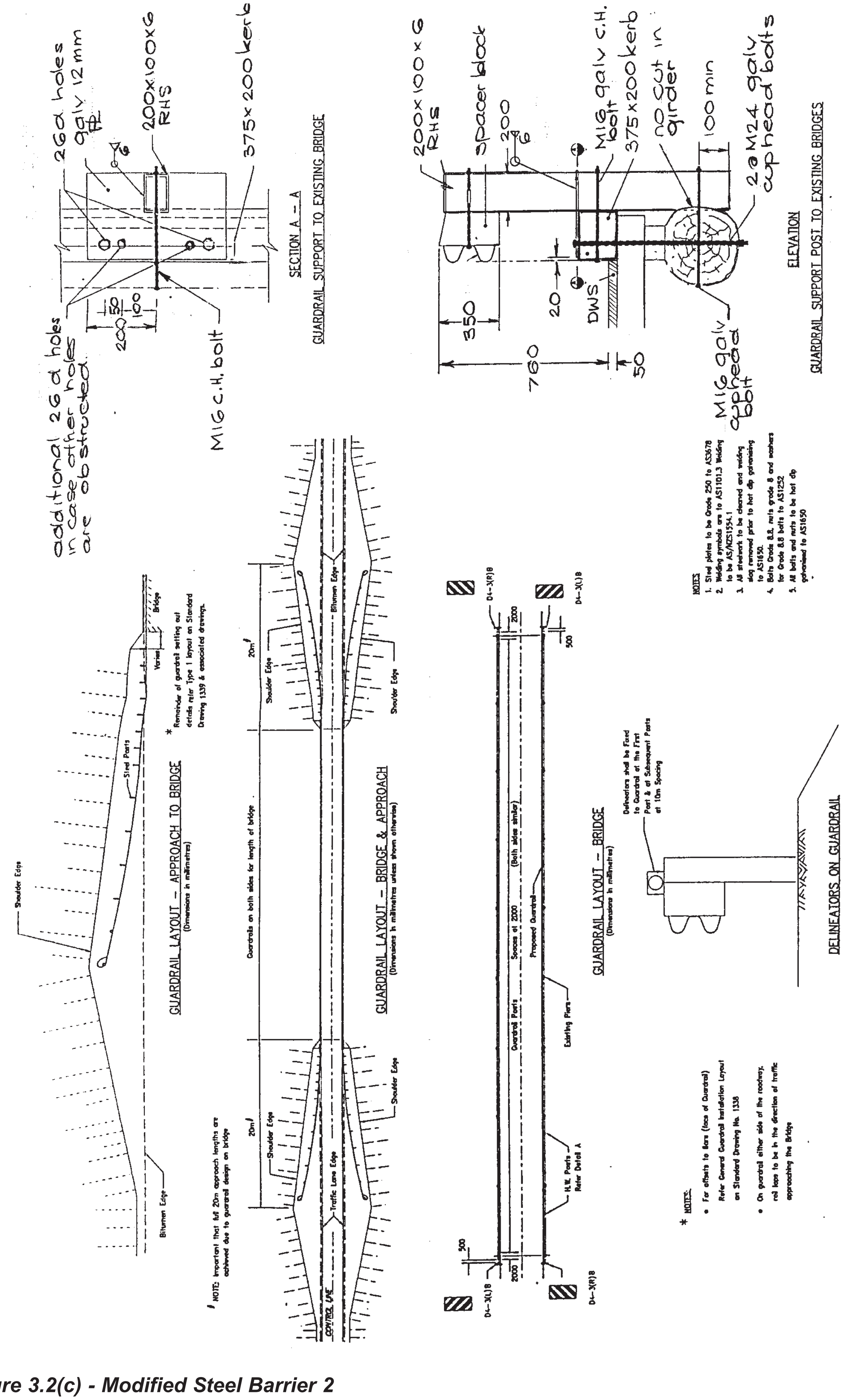


Figure 3.2(c) - Modified Steel Barrier 2

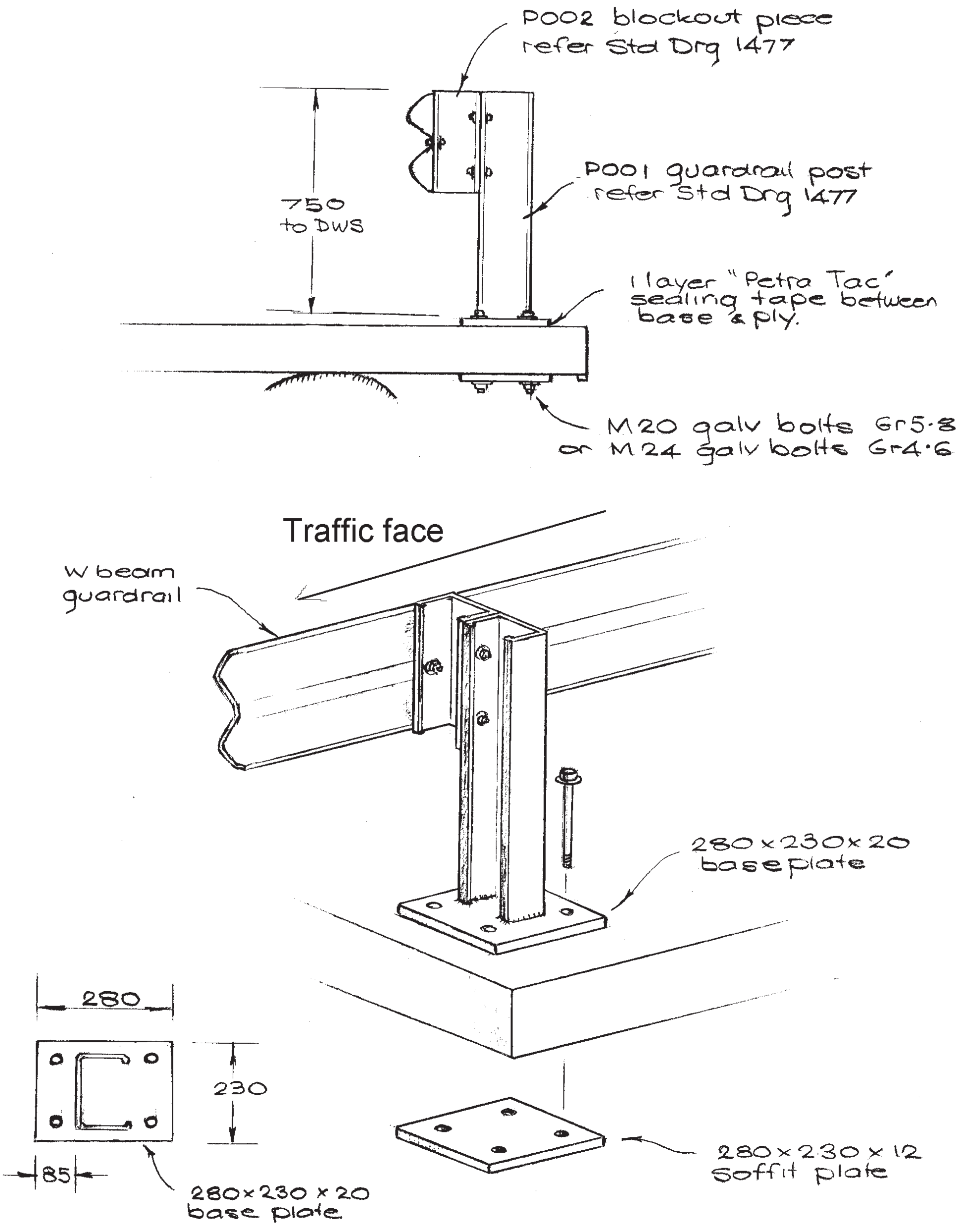


Figure 3.2(d) - Barrier - Ply Deck

Maintenance Activities:

Refer to Part 3 Item 2.3 (2S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Extra Considerations:

When installing new timber posts, the posts are to be trimmed to fit to the girder shape at the side contact area. Notching of the girder should not be carried out because of the resultant reduction in girder capacity due to loss of section and possible stress concentrations at the notch.

Use of hardwood timber posts on bridge structures is considered acceptable, but only steel posts should be used on approaches to conform to DMR Standards.

3.3 Guideposts (2T, 2S)

Bridge Inspection Manual Component No. 2T, 2S

Refer to BIM Appendix D for a description of the four condition states applicable to this component. Note that 2T or 2S for timber or steel posts respectively may be used, as shown in Items 3.1 & 3.2. Supply and installation of delineator markers are not covered in this Manual.

Maintenance Activity Numbers	Units
Refer Items 3.1 & 3.2	Each

Purpose:

Guideposts are used on bridges where its original timber handrails have been removed or were not erected. Delineator markers attached to the posts provide a reference for motorists at night or in low visibility situation. As well, in the event of submergence, the line of the bridge is defined by the posts.

Significance: ***Significance Rating 1***

Guideposts and delineators are important for the safety of road users as they provide guidance during traversing of often narrow bridge structures, particularly at night.

Detail:

Figure 3.3 shows typical details for guideposts.

Maintenance Activities:

Refer to Part 3 Item 2.4 (2T,2S) for recommended maintenance practices applicable to the various expected deterioration states for this component (posts only).

Refer to Part 4 for a description of applicable maintenance activities.

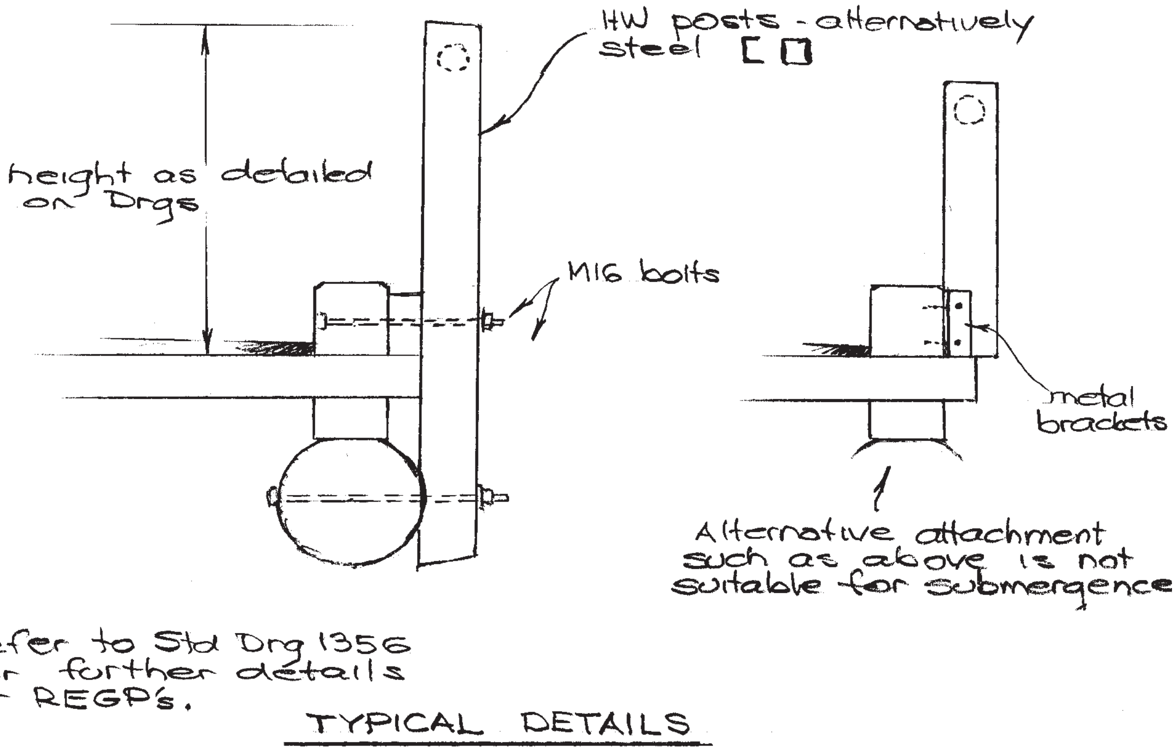


Figure 3.3 - Guideposts

3.4 Approach Guardrail (72S)

Bridge Inspection Manual Component No. 72S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
72S1 Replace guardrail section	M
72S2 Add posts	Each
72S3 Install guardrail	M
72S4 Provide connections to end post or rails	Lump sum

Purpose:

The main function of approach guardrails is to contain errant vehicles on approaches to bridges, preventing them from crashing into the stream or cutting.

Significance: ***Significance Rating 1***

Approach guardrails are important for the safety of road users, as they help to prevent out of control vehicles from the more serious consequences of running into a stream. Correctly placed, they also prevent a vehicle from impacting directly on to a bridge end post or kerb end. Ideally, they provide a transition between flexible vehicle restraint on approaches and rigid restraint on the bridge. Many timber bridges do not provide continuity of barriers (often no bridge barrier at all).

Details:

Figure 3.4 shows typical details for approach guardrails as used on timber bridges.

Note that the spacing of posts is decreased close to a structure in order to reduce horizontal deflection of an impacted guardrail in order to reduce the potential for the vehicle to impact the end of the railing system. A considerable increase in containment capacity also occurs where the approach guardrail has a continuity connection to the bridge guardrail. Where timber rails are used on a bridge, this may not be feasible, but as a minimum the guardrail face should be at least flush with the kerb front.

Though timber posts were used in the past, only steel posts should now be used to conform to DMR Standards.

Maintenance Activities:

Refer to Part 3 Item 2.5 (72S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

* These items may be considered interim until completion of the Bridge Maintenance Manual.

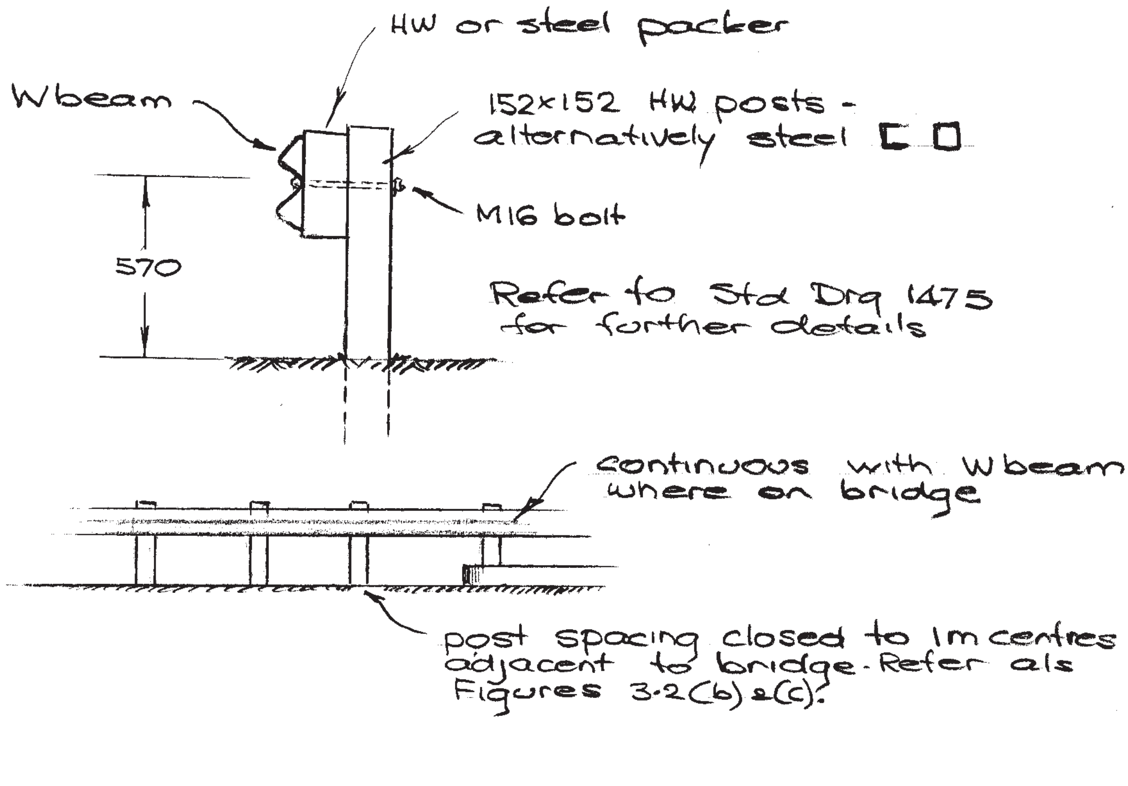


Figure 3.4 - Approach Guardrail

2

4.0 Kerbs

4.1 Timber Kerbs (3T)

Bridge Inspection Manual Component No. 3T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
3T1 Replace kerb in hardwood	M
3T2 Replace kerb in ply	M

Purpose:

Timber kerbs serve a number of functions on timber bridges:

(1) The main purpose is to act as a containment device for vehicle wheels, generally in conjunction with a timber or steel barrier. The kerb also provides an attachment point for the associated posts.

(2) The kerb also kelps to more firmly tie down the outer ends of transverse deck planks where the kerb is located above the outer girder.

Significance: ***Significance Rating 1***

Particularly on bridges with timber rails, the kerb is probably providing greater containment capacity than the railing system itself. However, timber kerbs are also generally very low, particularly after overlays of wearing surface have been placed.

Originally, many timber bridges were constructed with concrete kerbs, which have in many cases been replaced with timber kerbs as a result of on-going bridge maintenance.

Details:

The most common form of timber kerb consist of two hardwood members assembled to form a 200 x 200mm section. This helps ease component supply and also simplifies formation of scuppers.

An alternative form of kerb fabricated from plywood is being successfully used and has the advantage of straightness and long lengths.

Figure 4.1 shows typical details used for timber kerbs.

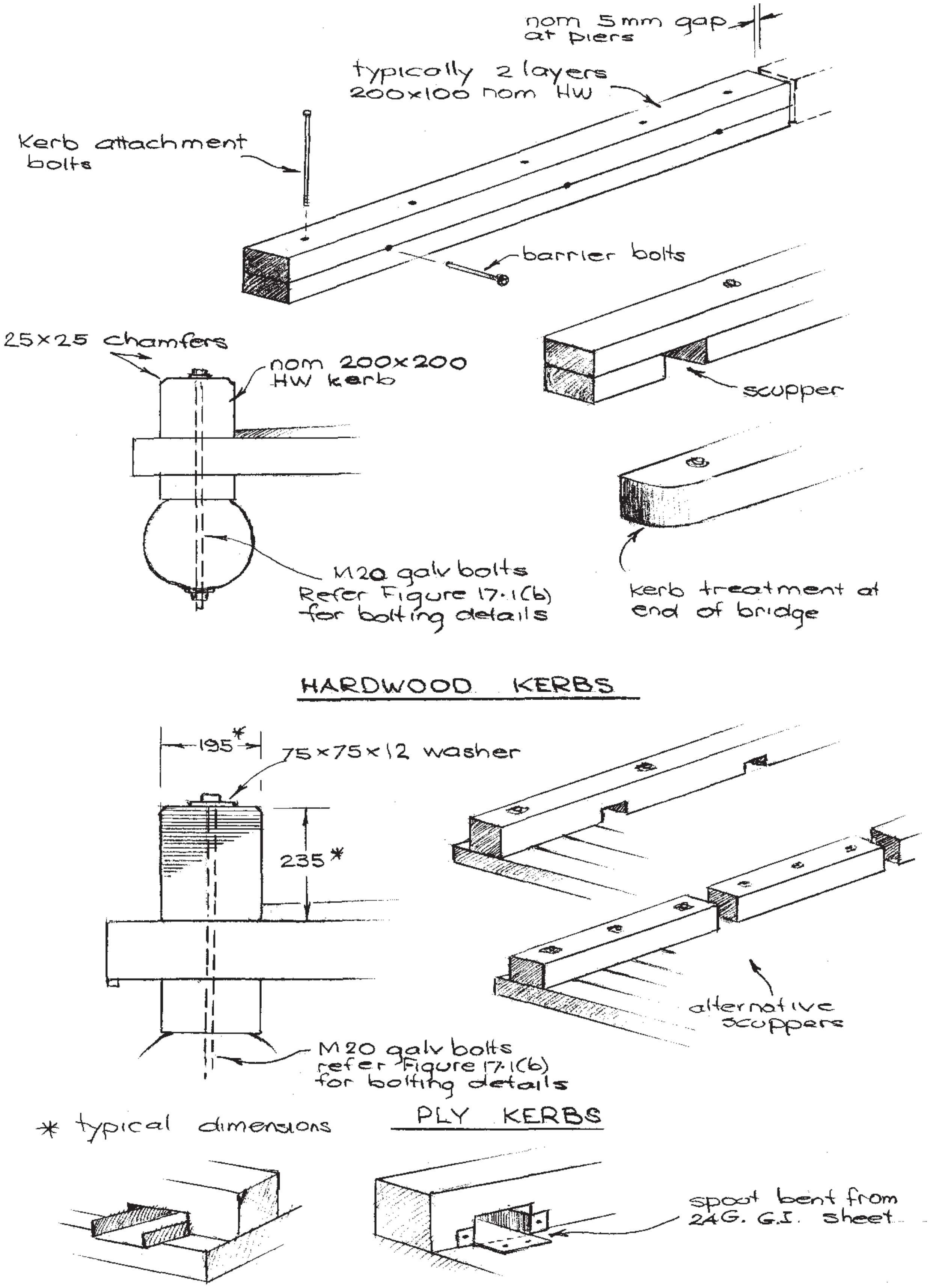


Figure 4.1 - Timber Kerbs

Materials:

Refer to Main Roads Specification MRS11.87 for acceptable timber species and properties for both hardwood and plywood kerbs.

Maintenance Activities:

Refer to Part 3 Item 2.6 (3T) for recommended maintenance practices applicable to the various expected deterioration states.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:-

Routine Maintenance

Routine or preventative maintenance actions for timber kerbs will generally be identified and carried out during Level 1 bridge inspections or follow-up RMPC actions. These activities would be:

- Tightening or replacing kerb hold down bolts
- Application of surface preservatives or waterproofing agents.

The kerb attachment bolts should be checked for tightness as any looseness will reduce wheel impact resistance, barrier post connection effectiveness, and possibly allow decking movements. Where corrosion of bolts is evident, they should be withdrawn and replaced by galvanised bolts of the same diameter if loss of section is evident. The bolt holes through the kerbs should be coated / packed with CN emulsion or thick grease before bolt insertion.

Where areas of decay or cracking are noted, these areas should be coated with a chemical timber preservative.

Where any active termite presence is detected during these operations, treatment shall be programmed as soon as practical.

Programmed Maintenance:

Where a kerb member has deteriorated to Condition State 4, its adequacy to withstand impact or to hold barrier posts will be compromised and it should be replaced. This will normally be accomplished by a full length member in hardwood with suggested nominal gaps of 5 mm at the pier butt joins (actual gap is not critical).

Unless a full bridge length of kerbing is being replaced, the cross section of the new member shall correspond to that being replaced. To maintain the line of the kerb faces, a maximum deviation of + 10mm measured by a string line on the inside face should be achieved.

Because plywood kerbs will generally be of non-standard size, they would normally only be used for full bridge length replacement.

The junction region of the kerb and decking is an area of very high decay potential, requiring particular attention. Timber decking should be dressed in the contact area to reduce high spots and allow the kerb to be pulled down tight. All contact surfaces should be treated with a preservative and preservative grease applied. In order to remove any remaining air gaps, a bituminous felt should also be laid over the contact area. (Where a kerb is formed from 2 layers of hardwood timber, the internal contact area shall be similarly treated). The end grain of kerb timbers shall be treated before assembly because of small end gaps. When ply kerbs are used, any faces showing veneer glue lines shall be treated with sealant in order to prevent drying out and opening up due to weather exposure. Painting of the kerb may satisfy this requirement.

Existing kerb attachment bolts may be used for the new kerb, unless corrosion of the bolts has occurred in which case galvanised M20 replacement bolts shall be used. Where bolts can't be extracted or a new girder is also installed, attachment bolt sizes and spacings as shown in Figure 17.1(b) should be used. As well, where bolt head washers bear directly on a ply kerb surface, larger washer sizes shall be used as shown in Figure 17.1(b).

All bolt holes through kerbs should be treated with a preservative and a grease or petroleum jelly applied to the bolt shank before insertion in order to improve water tightness.

On bridges up to 8 metres width, the kerbs should be painted white in order to provide enhanced protection to the timber and also extra delineation for traffic. For wider bridges, painting may still be considered in order to improve member durability.

Consideration may be given to providing light metal spouts at scuppers to shed water away from decking ends as shown in Figure 4.1.

4.2 Concrete Kerbs (3C)

Bridge Inspection Manual Component No. 3C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
3C1 Replace kerb in concrete	M

Purpose:

Concrete kerbs serve a number of functions on timber bridges:

(1) The main purpose is to act as a containment device for vehicle wheels, generally in conjunction with a timber or steel barrier. The kerb also provides an attachment point for associated posts.

(2) The kerb also helps to more firmly tie down the outer ends of transverse deck planks were the kerb is located above the outer girder.

Significance: ***Significance Rating 1***

Particularly on timber rail bridges, the kerb is probably providing greater containment capacity than the railing system itself. However, concrete kerbs are also generally very low, particularly after overlays of wearing surface been placed.

Details:

The kerbs were cast in-situ on the timber bridge decking, with details as shown in Figure 4.2.

Maintenance Activities:

Refer to Part 3 Item 2.7 (3C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

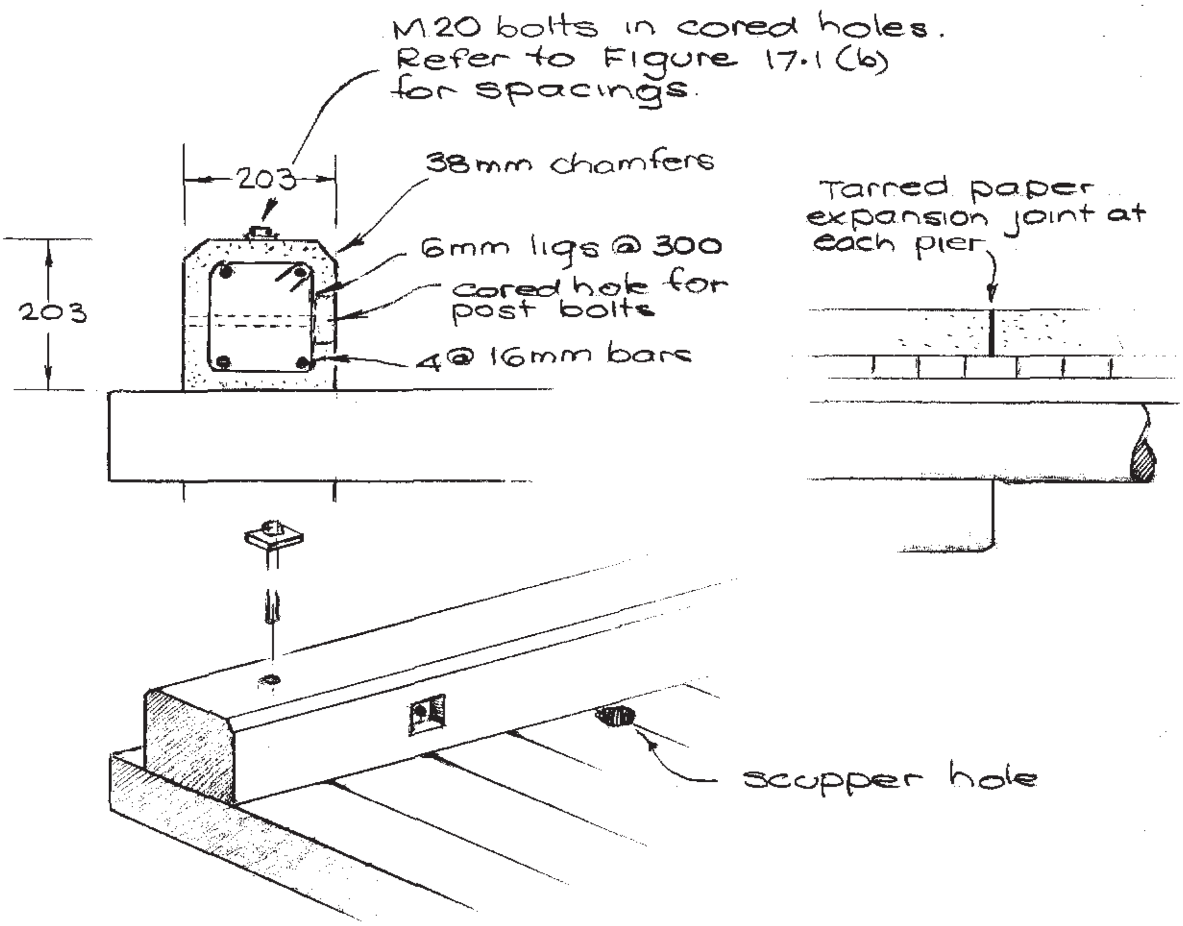


Figure 4.2 -Concrete Kerbs

2

5.0 Deck

5.1 Timber Planks (29T)

Bridge Inspection Manual Component No. 29T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
29T1	Replace hardwood deck planks	M^2
29T2	Replace end spiking plank	M
29T3	Replace and retighten running planks	M
29T4	Replace longitudinal deck planks in timber	M^2
29T5	Splice hardwood deck planks	Each

Purpose:

The main function of timber decking is to transfer traffic loads to supporting girder members.

It also helps transfer transverse loads from wind and flood debris across the full width of the bridge.

Significance: ***Significance Rating 3***

Failure of individual deck planks will not generally lead to bridge unserviceability as wearing surface or running planks may help wheel traversing of localised gaps. However , extensive areas of deterioration could lead to heavy vehicle breakthrough.

Details:

Except for a small number of concrete decks, hardwood timber decking was the traditional form of decking used. The decking was normally placed transversely (or skewed) across the bridge, as shown in Figure 5.1(a). The thickness of deck planks also varied according to design class and construction date.

Decking is spiked down at the outer girders only on to sacrificial spiking planks, with no mechanical connection to the inner girders, in order to reduce spike induced cracking of the girders.

A number of decks with longitudinally laid decking planks on top of transverse timber transoms (cross beams) are also in service.

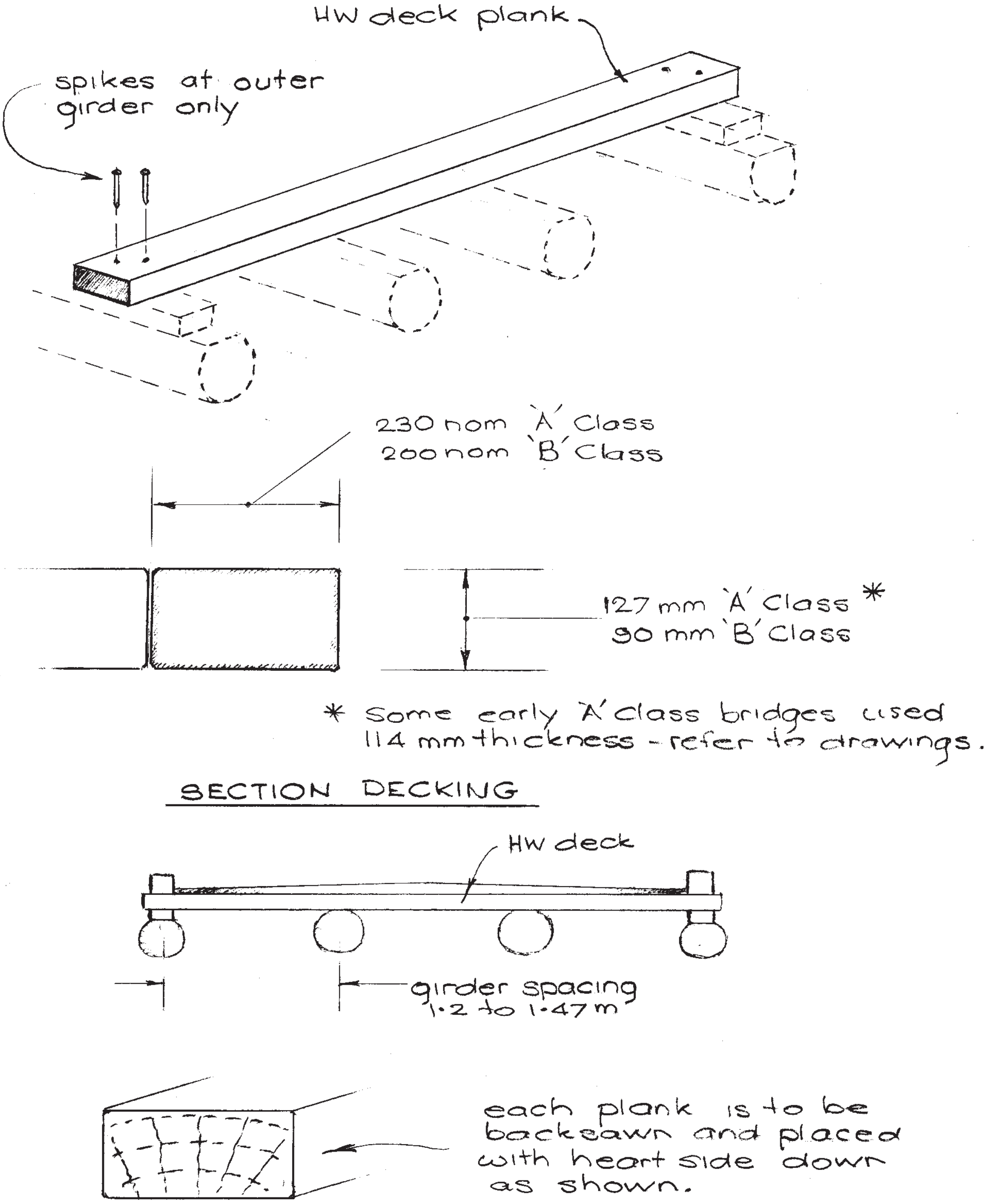


Figure 5.1(a) - Hardwood Decking

Failure Mechanism:

The major defect found in timber decking is rotting which generally begins in the contact area below the kerb because of moisture entrapment and also because of exposure of the plank ends to the weather. The normal failure mechanism is for hole to open in the deck allowing wheel loads to penetrate. Deteriorated planks with section loss due to rotting, termite or fire damage may also fail in bending under the action of wheel loads.

Materials:

Refer to Main Roads Specification MRS11.87 for acceptable timber species and properties for hardwood decking. Where full re-builds of decks are to be undertaken, supply of materials in one species only is preferred in order to maintain similar deflection and load carrying characteristics from plank to plank.

Maintenance Activities:

Refer to Part 3 Item 2.8 (29T) for recommended maintenance practices applicable to the various expected deterioration states.

Refer to Part 4 for a description of applicable maintenance activities.

Further Considerations are as follows:-

Routine Maintenance:

Routine or preventative Maintenance actions for timber deck planks will generally be limited to the application of preservative materials to the exposed ends of the planks. This would normally be accomplished using a preservative and a thick grease on the end grain of the planks. This should be renewed at least every 3 years or as required and would be carried out as an RMPC procedure.

During Level 1 inspections, where any active termite presence is detected, treatment shall be programmed as soon as practical.

Any looseness noted in decking would normally be the result of loss of girder camber or possibly crushing of spiking planks, requiring follow-up work on the relevant components.

Programmed Maintenance:

Where hardwood deck planks have deteriorated to Condition State 4, they must be replaced because of the very high potential for failure under traffic loads. Where individual planks or part areas of the deck require replacement, this will normally be accomplished by substitution of new hardwood planks, the main requirements being adequacy of both strength and tightness.

Plank strength will be determined not only by MRS 11.87 requirements (stress grade and durability), but also by plank thickness which was determined by bridge Design Class. Figure 5.1(a) shows the required thicknesses for 'A' and 'B' Class decks, while details for other classes will be shown on the original drawings.

In practice, existing plank thickness may vary from plan requirements, and the new decking should correspond in depth to adjacent members. Where new decking is supplied thicker than adjoining planks, the new timber should be sized to the same vertical dimension. In no case shall the spiking plank or girder be trimmed back to accommodate the overthick deck plank.

Unless shown otherwise on the drawings, deck planks should be replaced as single full length members, as continuity will then provide maximum strength. However, for short term repair situations, on in cases where insufficient decking length is available, splicing of short sections of decking may be used. Suitable details for making splice connections are shown in Figure 5.1(c)(1). Alternative splicing methods should be submitted to Structures Division for approval. Any length of decking must span over a minium of two girders.

Localised temporary repairs to deteriorated decking may be made prior to plank replacement by the method shown in Figure 5.1(c) (2).

The standard method for decker assembly on the girders requires each plank to be double spiked down on to the spiking planks on top of the outer girders. The planks are not to be spiked to internal girders. The spikes are to be staggered as shown in Figure 5.1(b) to reduce the potential for splitting in the spiking plank.

Spikes are to be 16mm diameter round and will typically be 230mm long for 125mm timbers, but the length requires adjusting for thinner timbers to prevent spike penetration of the actual girder top.

Old specification requirements of using cup head, pan head or ewbank heads, but not countersunk spike heads, should be adhered to. However, it is not practical to retain old requirements of not driving heads into the decker surface because of the requirement to seat timber kerbs. (This requirement was compatible with the old cast in-situ kerbs).

Deck rebuilds or replacement of areas of decking will require removal of kerbs (or kerb segments) in order to allow existing spike removal and re-spiking. Old decking will often require to be cut and split and spikes oxy cut off due to the difficulty in extracting old spikes.

Where individual planks are to be replaced, this is commonly achieved by cutting out the plank and spikes, and inserting the replacement plank under the kerb (possibly with some kerb loosening). If tightness cannot be achieved, bolted straps may be attached.

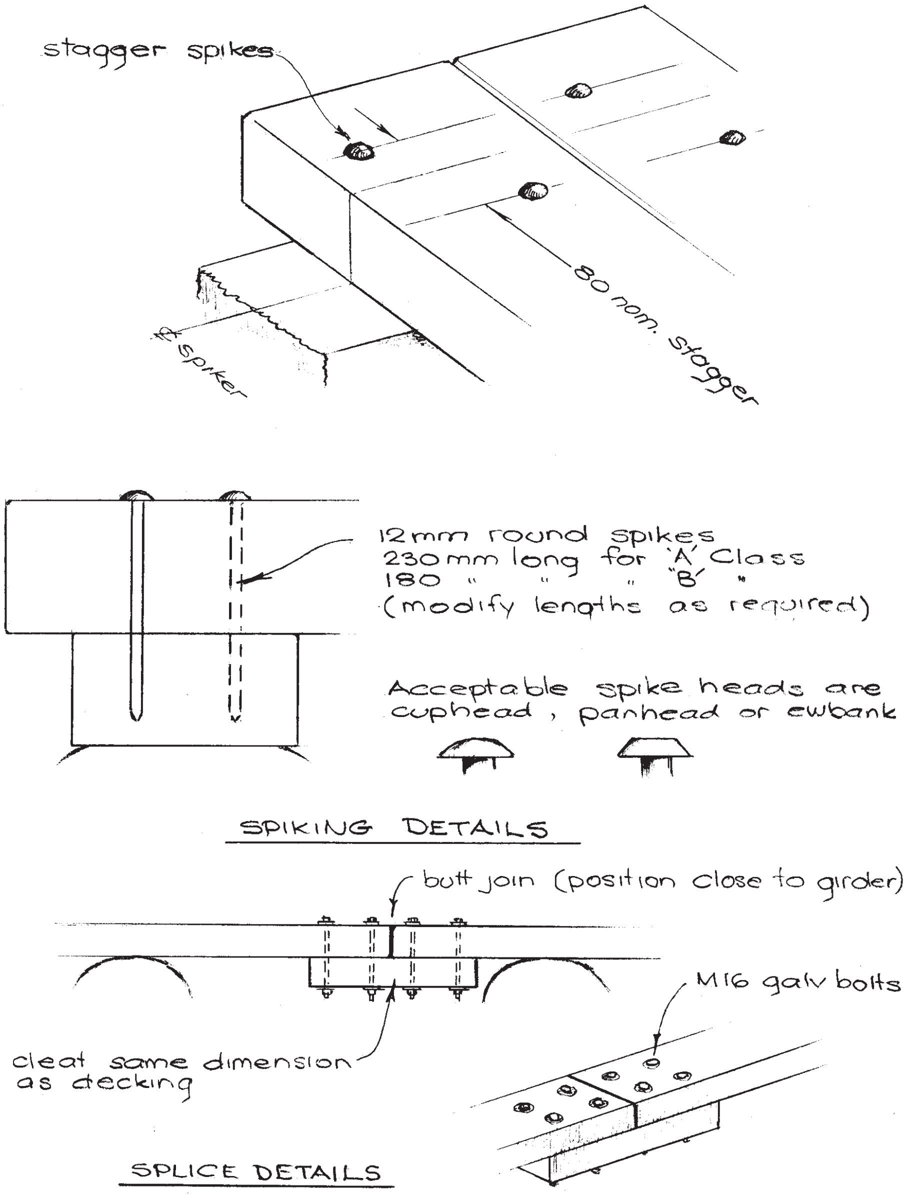


Figure 5.1(b) - HW Decking Details

In order to keep decking tight and so reduce movement wear and rattling under load, it is cambered or sprung down over the girders. Decking should be laid with the heart side downwards as this results in the outer ends bending upwards, with the action of spiking at the ends producing greater contact at inner girder supports. If a plank is warped towards the heart sufficiently to prevent full and tight bearing on all girders when spiked at the ends it shall be rejected or re-seasoned to eliminate warp. Saw cuts shall not be used to achieve this.

Decking timber shall be stacked on site to the requirements of MRS 11.87. The top layer of decking should be turned at frequent intervals so that it does not warp in one direction only.

The length of new planks should correspond to that adjacent members, but in no case should the decking protrude less than 50mm past the outside edge of the kerb.

The outer ends of hardwood deck planks at the kerb support area shall be dressed to allow the kerb to be pulled down tightly. Because of the potential for decay in the exposed outer ends and contact surfaces, a timber preservative should be applied in these regions of new planks.

The end grain of the plank and contact areas with the spiking plank, kerb and girders shall have a thick preservative grease applied. In order to further reduce any air gaps at the contact surfaces, a bituminous felt shall also be placed. Refer to Part 1 Section 7.5.2 for comments.

Where new planks are to be placed the basic procedures would be:-

- Remove wearing surface (& running planks) over defective area.
- Release bolts and lift kerbs (where required).
- Cut out defective planks and remove spikes (cut off where required).
- Place new planks and respike with 2 spikes at each end.
- Replace & rebolt kerbs
- Reinstate wearing surface
- Recamber girders if decking is loose.

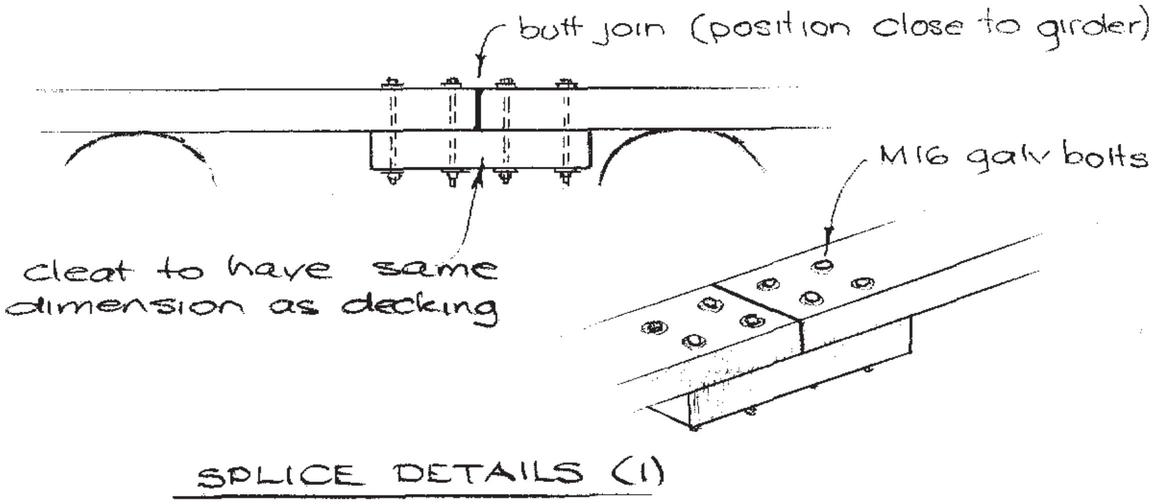
It should be remembered that when partial deck replacement is programmed, that the numbers of planks required often increases once a deck is opened up. Rotting under wearing surfaces or running planks is difficult to determine before removal of these components.

Where full span deck replacement is required, use of alternative materials such as plywood, steel decking or PSC decking may also be considered.

Where decking has deteriorated to Condition State 3, due to rotting, maintenance activities will generally consist of monitoring and the application of preservatives to the defect areas. Where there is extensive areas of deck rot such as adjacent to kerbs, some use has been made of screwed down thin galvanised steel sheeting to help spread wheel loads. Section 17.4 discussed the application and effectiveness of this process.

The use of a concrete overlay on defective timber decking is not recommended.

2



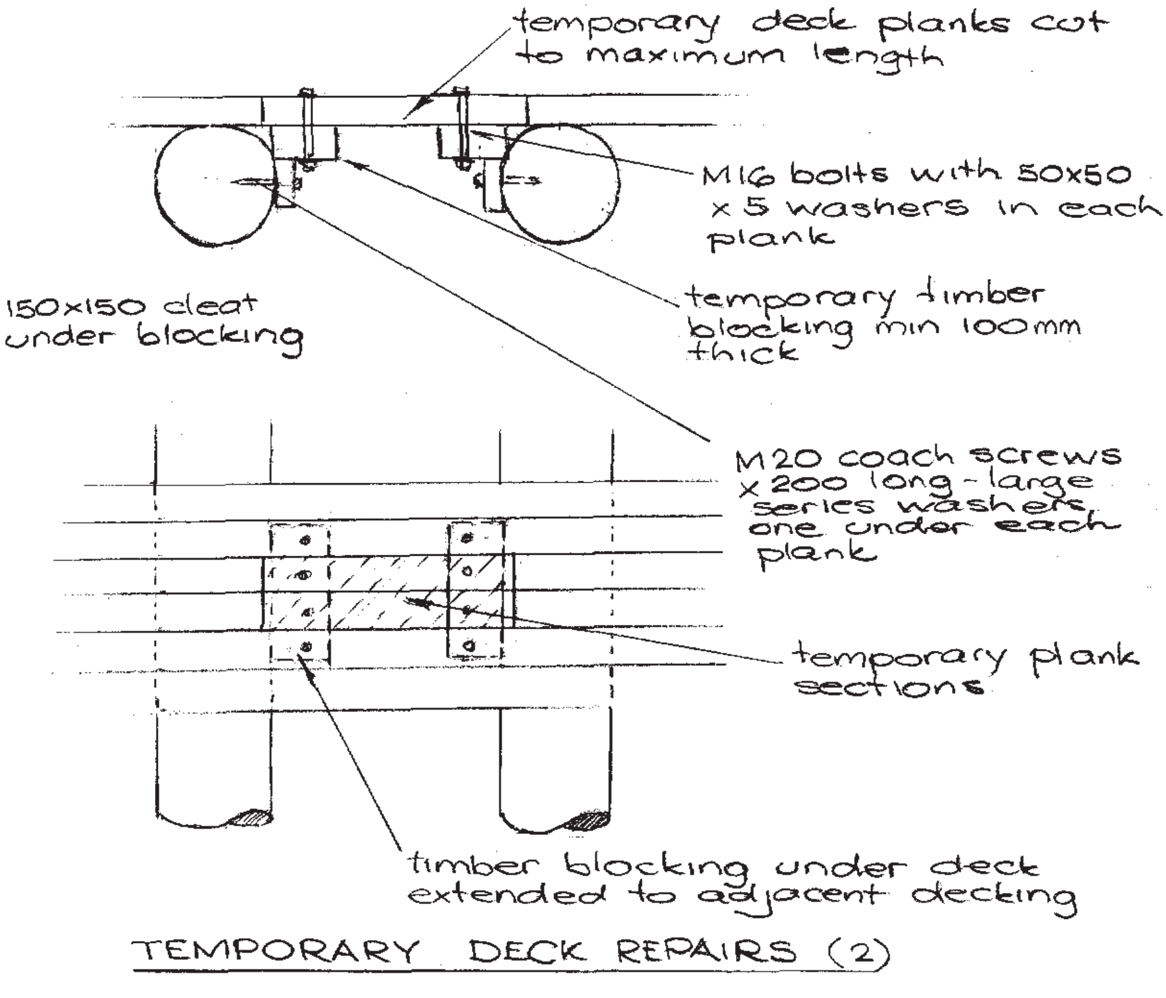


Figure 5.1(c) - Deck Repairs

5.2 Plywood Sheets (20T)

Bridge Inspection Manual Component No. 20T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
20T1 Replace ply sheet	Each
20T2 Replace deck planks in ply	Each
20T3 Replace longitudinal deck planks in ply	Each

Purpose:

The main function of plywood decking is to transfer traffic loads to supporting girder members.

It also helps transfer transverse loads from wind and flood debris across the full width of the bridge.

Significance: ***Significance Rating 3***

Because ply sheets are 1.2m width, partial deck plate action occurs, improving distribution of traffic loads.

Details:

Plywood decking or "Bridgewood" was developed commercially in Queensland as an alternative decking material for timber bridges and is installed as a maintenance replacement for original hardwood decks. The 1.2m wide sheets are generally placed transversely with a variety of hold down mechanisms. Figure 5.2(a) shows typical details for these decks. An alternative form of hold downs for ply decks as shown in Figure 5.2(c) may also be considered. The use of strap belting obviates the need for the normal extensive drilling of girders, thereby helping to improve girder durability. However, the number of holes to be drilled through the ply deck will double. It is essential for this bolting system to remain tight to stop movement of the ply sheets on the girders. Ply sheets have been used conventionally with kerbs, or without kerbs and with barrier posts bolted directly to the ply. Limited cantilevering of the ply past the outer girder is possible, the extent depending on ply thickness.

Ply sheets for bridge decks are formed from nominal 25 to 30mm thick conventionally made ply sheets which are cold bonded together (with self tapping screws applying the required pressure for glue setting).

For road decking, the ply is supplied in nominal 130 or 155 mm thicknesses, while for footways it may typically be 25 to 50mm thick.

2

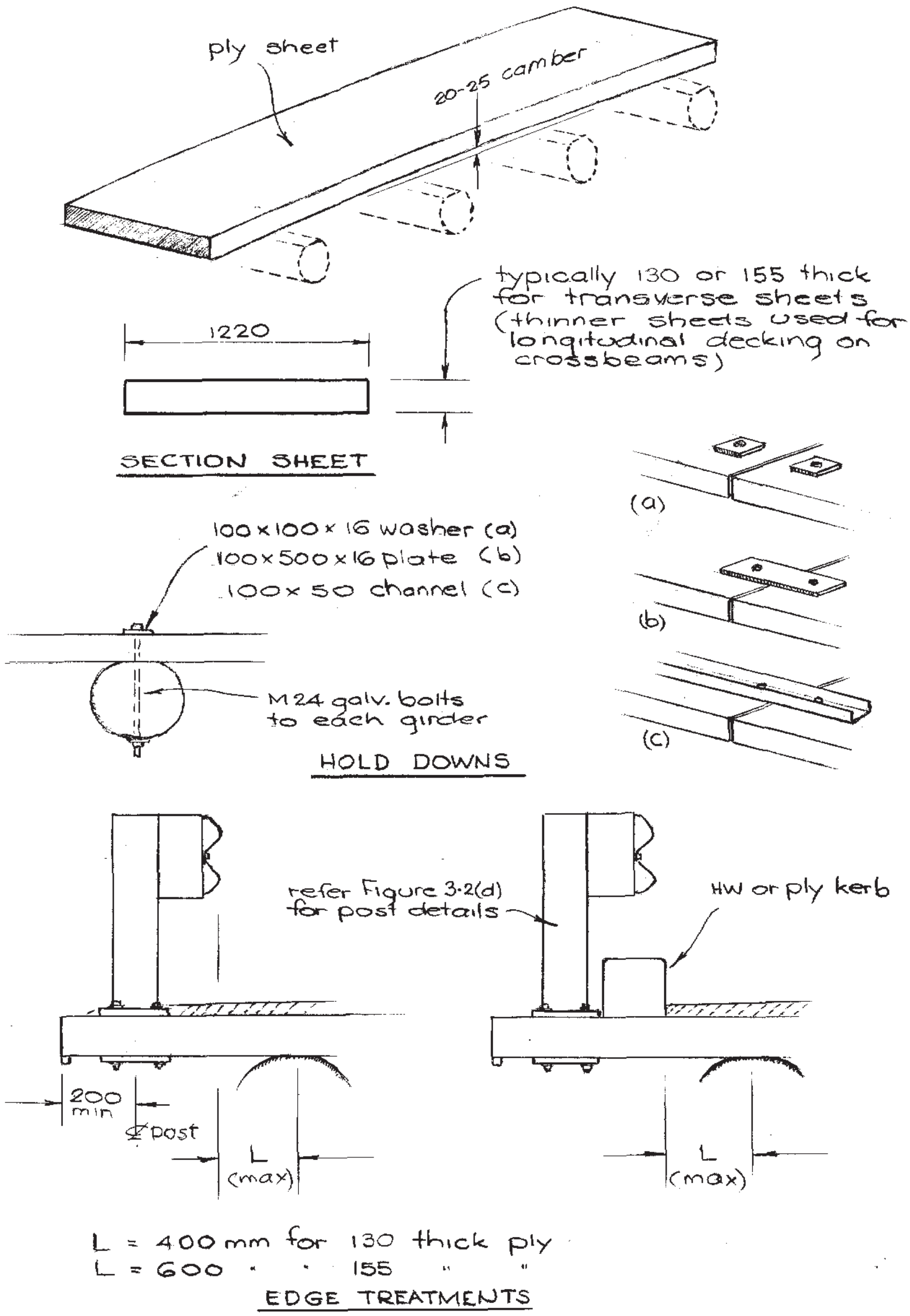


Figure 5.2(a) - Plywood Decking

Failure Mechanism:

Rotting of the pine veneers making up the ply sheets due to failure of the CCA treatment envelope would lead to failure under load from bending, shear or punching action.

Materials:

The supply of plywood components for roadway and footpath decking is covered in MRS 11.87 - Supply of Timber Bridge Materials and Components. It is important that the requirements for stacking at site are also adhered to.

Maintenance Activities

Refer to Part 3 Item 2.9 (20T) for recommended practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:

> **Warning:**
>
> Where existing bituminous wearing surface is to be removed from the top of ply decking, extreme caution must be observed to prevent accidental damage to the top of the sheets. Plywood is fabricated from F14 pine material and may be easily gouged by mechanical equipment which is suitable for similar activities on hardwood decking.
>
> Where site cutting of ply decking is required, care must be exercised to miss the internal self tapping assembly screws (visible on one surface). Staples in the outer sheets (used during scarfing processes) may also be present.

Routine Maintenance:

Routine or preventative maintenance will consist of:

(1)Maintaining holding down bolt tightness. If bolts are loose, movement of ply sheets may lead to wear of the ply at support surfaces and will contribute to the cracking of the wearing surface at transverse sheet joints.

Both holding down and distributor bolts hall be checked and tightened where required.

(2)Maintaining an effective sealant on the exposed ends of the ply sheets. Because the sheet ends are generally exposed to the sun and weather, delamination of the ply layers will occur unless a protective sealant is present. Refer to Figure 17.7(b) for recommended products.

Programmed Maintenance:

Maintenance work with plywood decking will generally be associated with full bridge re-decking as an alternative to using existing materials such as hardwood planks or steel trough. Generally the opportunity is taken to widen the deck during this process because of the ability of the decking to cantilever past the outside girders. The length of the cantilever is dependent on the ply thickness as shown in Figure 5.2(a). Where cantilevering is used, the outer girder and spiking plank must be removed and a girder with the same diameter as the internal girders substituted because traffic wheel loads can now track over the top of this girder.

Figure 5.2(b) shows current recommended details using a steel barrier and kerb which may be considered in developing re-decking proposals.

It has been found necessary to bolt ply decking down on to each girder in order to reduce movement and associated problems with the wearing surface. As a result, cambering is not required for deck tightness, but a positive camber of 20 to 25mm should be built in to prevent water collecting in sagged areas of decking.

Various hold-downs for the sheets have be used over the years, progressing from simple bolt and washers to continuous channel as shown in Figure 5.2(a). Provided a substantial distributor arrangement is used, however, the simple bolt and square washer is considered adequate and is currently still being used. It should be noted that non-standard large size washers are to be used for any bearing on ply surfaces.

The major defect associated with ply deck has been the cracking and break up of the AC wearing surface over the butt joints between sheets, caused by differential deflections of adjacent sheets under wheel passage. Even though both 130 and 155mm thick ply is structurally adequate for normal girder spacings, it is recommended that the 155mm thick ply be used to help reduce these deck deflections. As well, longitudinal steel channel distributors should be placed centrally between each line of girders to help prevent differential edge deflections in the sheets. Figure 5.2(b) provides recommended details for distributors. A distributor is also placed near the barrier post in order to control distortions in the ply sheets induced by post impacts.

Proposals for ply re-decking must be submitted to Structures Division for approval of details. This also entails a structural check of the existing girders and substructure to determine their adequacy (particularly where widening allows an extra lane of traffic on a bridge).

For a skewed bridge, the ply sheets will generally be supplied with the ends cut to the correct skew in order to reduce the need for site cutting. Special care needs to be exercised when cutting ply decking on site because of the embedded metal screws.

Ply sheets should be assembled to provide a uniform top surface to the deck and may need to be packed up with CCA treated timber. Where traffic is allowed to use the deck prior to wearing surface application, speed should be restricted to 20 km/hr because of the smooth surface of the ply sheets.

Ply sheets are CCA treated, but additional preservative treatments should be carried out. Anti-fungal preservative, grease and layer of bituminous felt should be placed at all contact surfaces with girders, spiking planks or kerbs. Overall waterproofing of the deck will be enhanced by the placement of a polyurethane elastomer joint filler at the transverse butt joints between sheets as shown in Figure 5.2(b). A timber drip strip should also be tacked to the outer edge of the sheet soffit to prevent water return under the sheet.

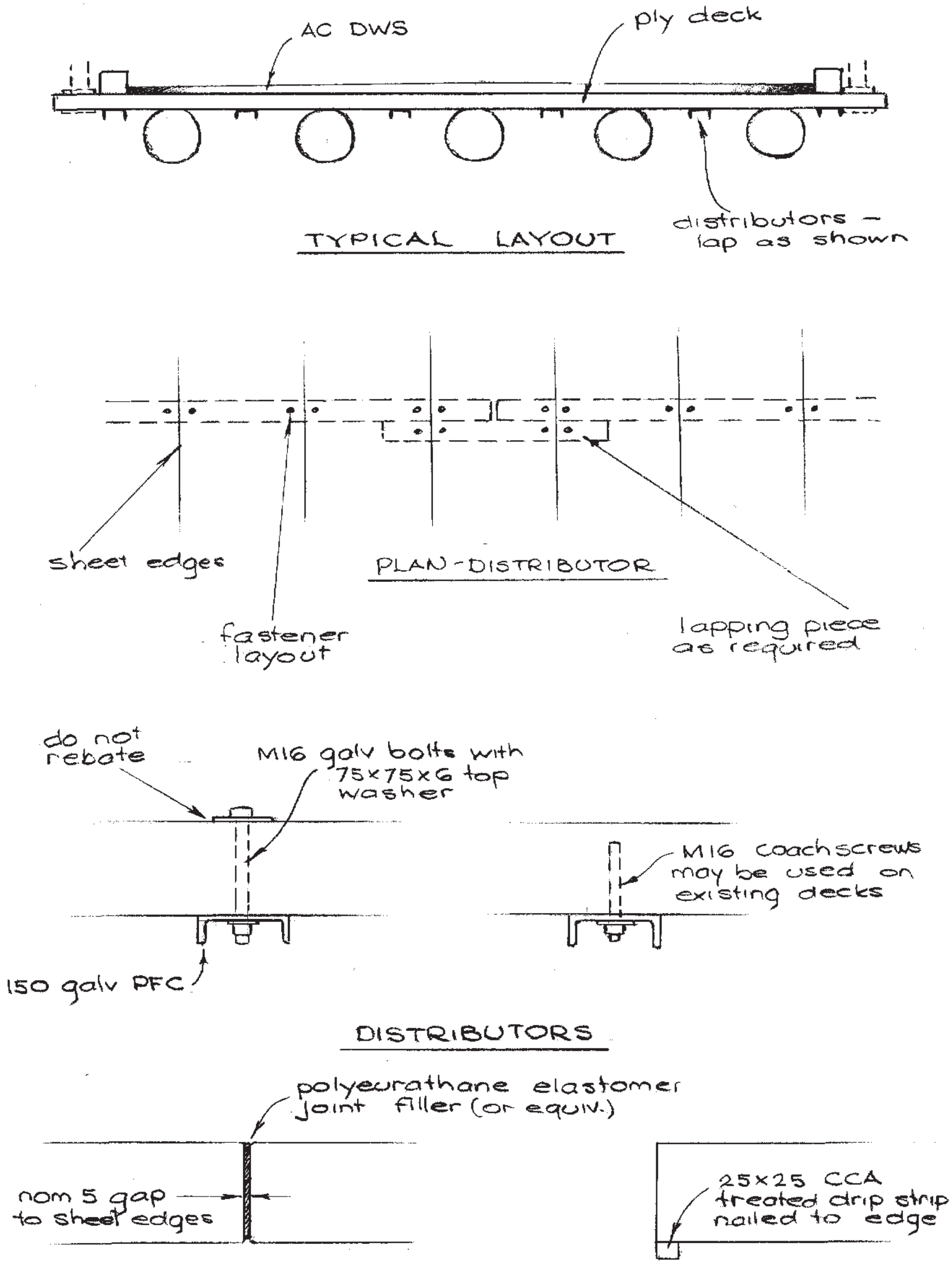
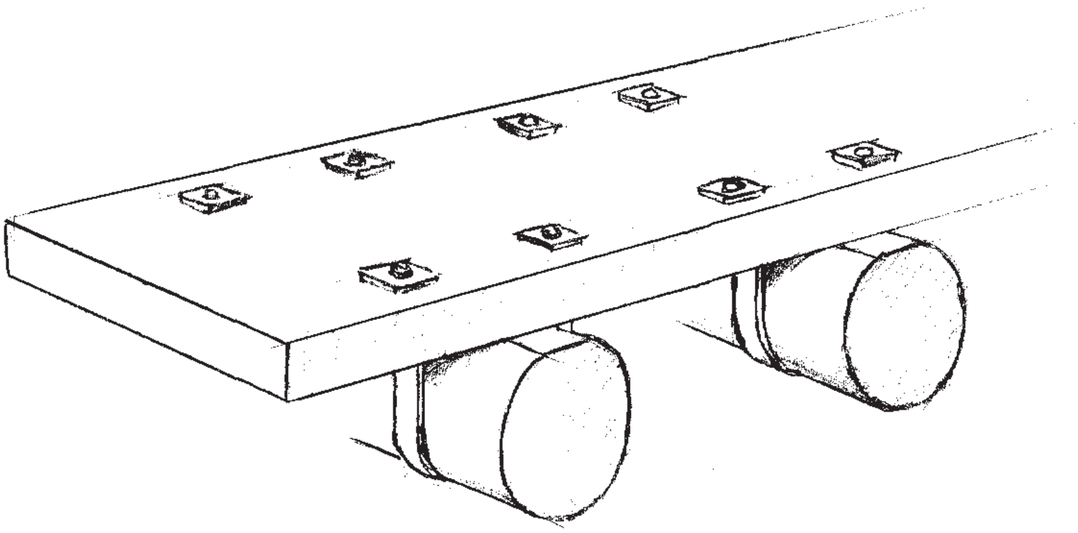


Figure 5.2(b) - Plywood Details 1

2



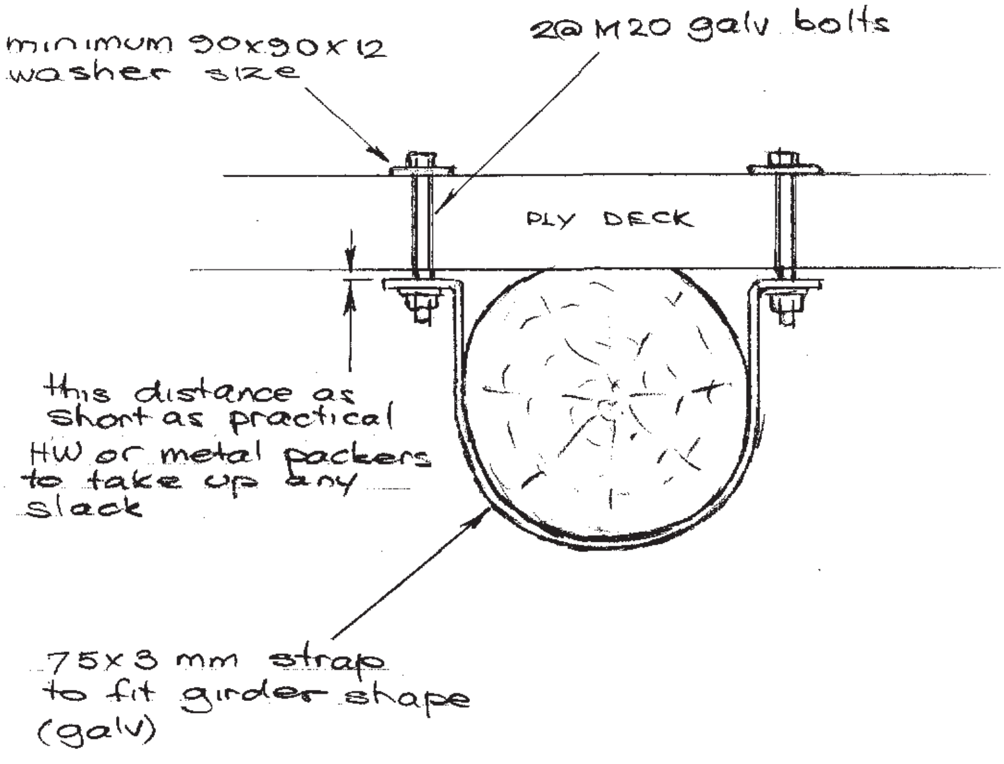
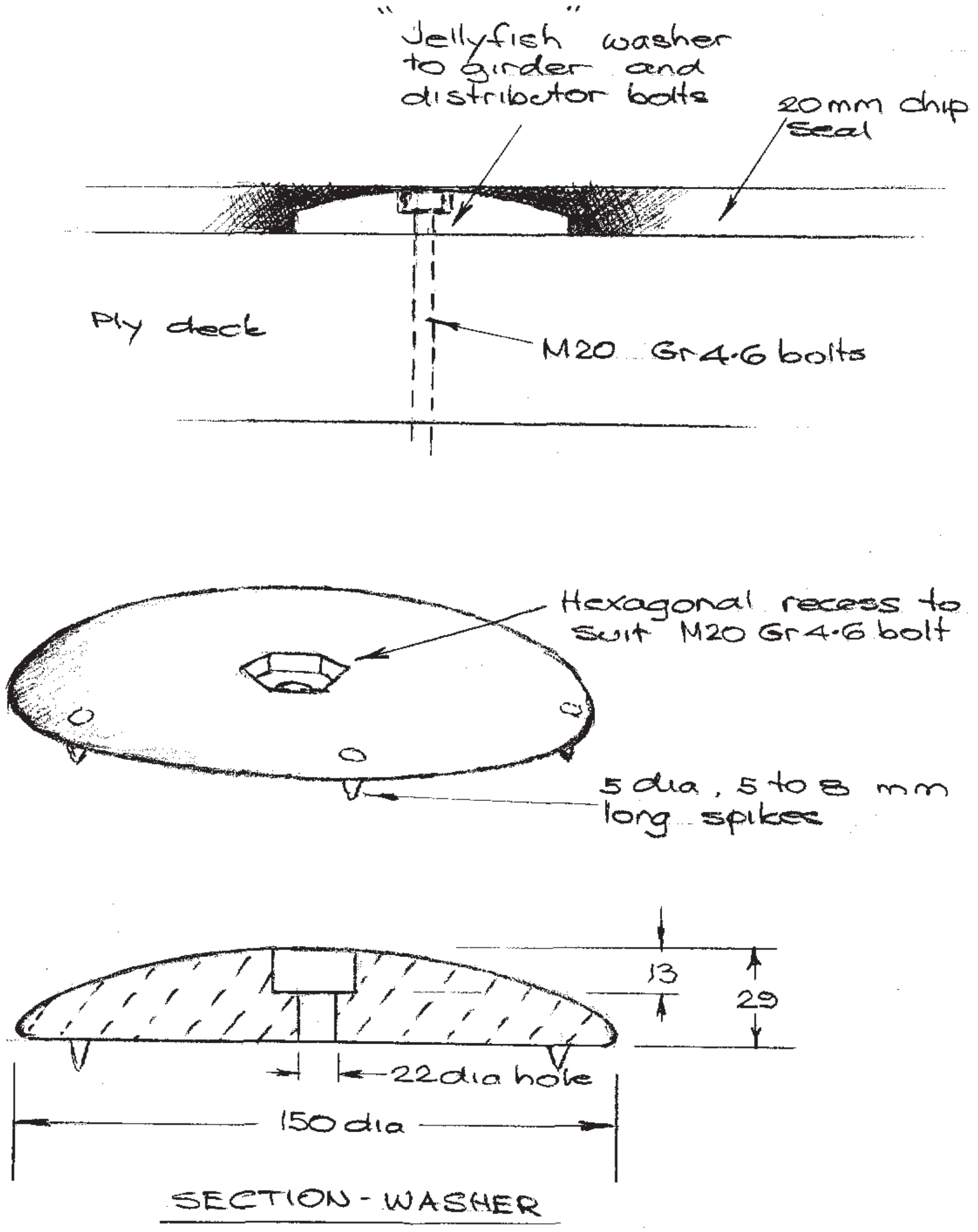


Figure 5.2(c) - Plywood Details 2



SUPPLY DETAILS
Contact Auscast Foundry, 9 Holland St, Northgate. Brisbane for supply & cost details. Alternative suppliers may be used.

Figure 5.2(d) - Special Washer

Before the application of a bituminous wearing surface, a primer should be applied to the ply top surface which must be dry and free from dust or salts. Where the ambient temperature is above 10°C, the bituminous primer shall be a cationic rapid set chemical emulsion.

Below 10°C, a rubberised emulsion (10% latex) could be used to maintain good adhesion. Prior to priming, the joints between sheets shall be filled with joint sealant, and other sealant such as self adhesive fabric joint tape added where detailed. The decking surface is then sprayed with the appropriate emulsion, including the exposed sheet ends for weather protection. Where detailed on the drawings, apply geofabric (non-self adhesive) to the entire deck or panel joints. A further coating of emulsion is then applied to the geofabric surface. The final wearing surface is then to be applied.

The basic procedure for redecking in plywood would be:-

- Remove existing DWS, kerbs and deck. Where carried out under traffic, progressive removal of old decking and replacement with ply sheets may be considered.
- Where deck cantilevering is detailed, the outer girders and spiking planks are to be replaced by girders of the same diameter as the inner girders.
- Place ply sheeting, attach hold downs and, where detailed, attach distributors.
- Place kerb / barriers and wearing surface.

A superstructure replacement option using ply decking on steel girders has recently been developed, utilizing a 20mm chip seal surfacing as opposed to the conventional AC surfacing used so far in Queensland. Similar details should also be applicable to ply redecking on timber girders. Because of the shallow thickness surfacing, a special top washer for girder and distributor bolt heads has also been developed. Details of this "jellyfish" washer are shown a Figure 5.2(c). This washer is still a concept and not yet available commercially "off the shelf", but could be produced if there were sufficient maintenance needs.

Where an existing ply sheet itself has deteriorated to Condition State 4, it must be replaced to restore deck capacity. The thickness of the replacement sheet should correspond to that of adjacent sheets in order to give compatible deflection characteristics. All details and processes will generally be as previously described for new decks.

Where sheet condition is satisfactory, but the DWS has deteriorated to Condition State 4 at transverse joints, producing excessive roughness, the full wearing surface should be replaced. As stated previously, care is needed during DWS removal from plywood as one bridge was seriously damaged during this process. Reduction in potential for further break up at the joints requires both:-

(1) Prevention of sheet movements / rotations on the girders.

(2) Prevention of differential sheet edge deflections between the girders.

In general, existing hold downs (as shown in Figure 5.2(a)) may be retained but additional items may be needed to ensure connection to each girder.

Simple bolt and square top washer arrangements are considered satisfactory provided substantial distributors are in place. The longitudinal channel type presumably supplies maximum restraint against movement.

Differential edge movement can only be reduced by using longitudinal distributors as shown in Figure 5.2(b) and these should be installed if not in place.

Assembly of the distributor system under traffic by using coach screws can also be considered. Waterproofing of the deck should also be carried out if such treatment is not in place.

(1) If gaps between sheets are 5mm or greater, place a foam backing strip and seal joint with a Megaprene 40 (or equivalent) filler.

(2) Where gaps are small, apply either a self adhesive fabric joint tape (Bitac or equivalent) or tack down light metal strips (Figure 7.7(c) Part1).

Refer to Appendix B for typical bridge drawings illustrating ply deck details.

5.3 Concrete Slab

Bridge Inspection Manual Component No. 20C

Refer to BIM Appendix D for a description of the four condition states application to this component.

Maintenance Activity Numbers	Unit
Refer to general concrete repair Activities	

Purpose:

The main function of the concrete deck slab is to transfer traffic loads to supporting girder members.

The slab also helps to transfer transverse loads from wind and flood debris across the full width of the bridge.

Significance: ***Significance Rating 3***

Because of ample thicknesses adopted in the past it is unlikely that a concrete deck slab will fail catastrophically. However, with severe loss of reinforcing area and spalling, it is possible for wheels to punch through a slab, causing traffic dislocation.

Details:

Concrete slab decks were incorporated on a number of bridges as an alternative to the normal timber deck. Figure 5.3(a) shows typical details for the most common type. Figure 5.3(b) shows another more complex type which incorporated steel shear connector plates embedded into both the timber girders and the concrete slab.

Failure Mechanism:

Where reinforcing has corroded away, the deck slab is expected to fail under punching shear action, with the essentially unreinforced concrete breaking through as a block.

Spalling of the kerb at barrier post anchor bolt locations will also lead to reduced barrier containment capacity.

Maintenance Activities:

Refer to Part 3 Item 2.10 (20C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

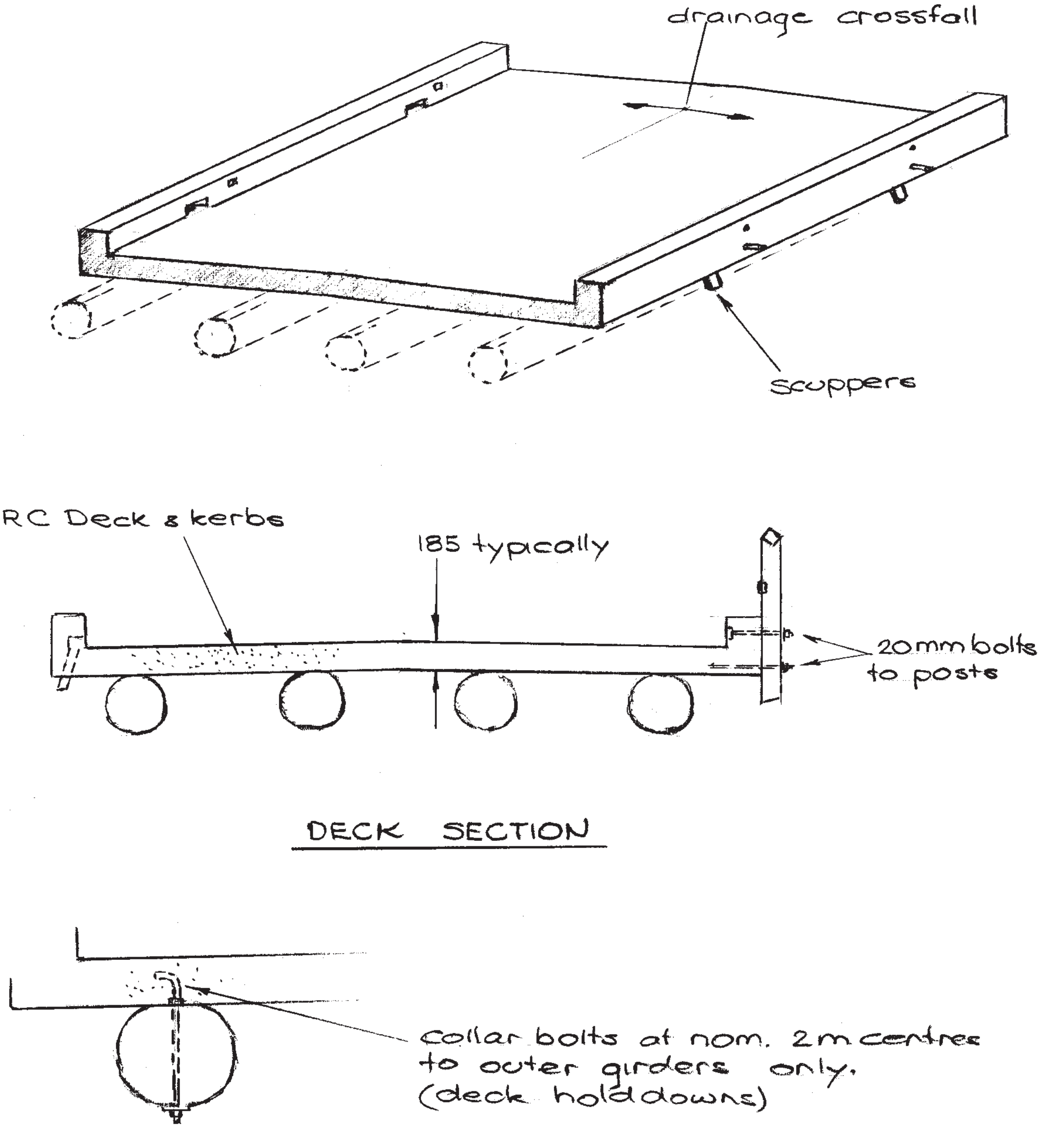


Figure 5.3(a) - Concrete Slab Deck - Type 1

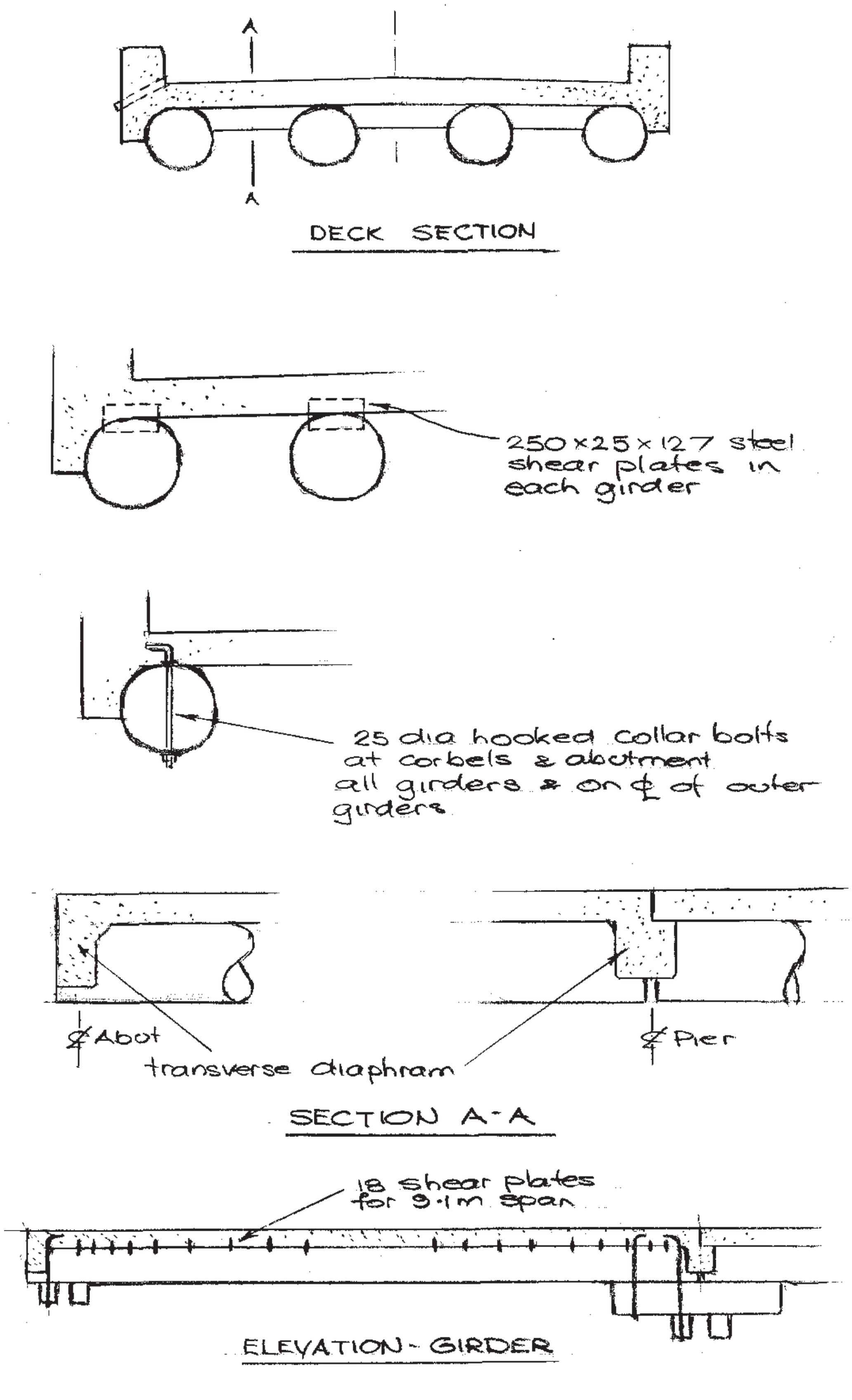


Figure 5.3(b) - Concrete Slab Deck - Type 2

5.4 Prestressed Concrete Planks (29P)

Bridge Inspection Manual Component No. 29P

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Unit
29P1 Replace PSC plank	Each
29P2 Reseat PSC plank	Each
29P3 Replace deck planks in PSC	Each

Purpose:

The main function of PSC plank decking is to transfer traffic loads to supporting girder members.

It also helps transfer transverse loads from wind and flood debris across the full width of the bridge.

Significance: ***Significance Rating 3***

Because PSC deck planks are 600 mm wide and carry no wearing surface, a failure would allow wheels to drop, with possible bridge closure depending on the extent of the deck collapse. Longitudinal steel distributors used in conjunction with these planks will partly reduce the potential for this eventuality due to the development of some longitudinal distribution of loads.

Details:

PSC planks are a proprietary product and have been installed as a maintenance replacement for the original hardwood decks. Figure 5.4 shows details applicable to this type of decking.

The precast units are bolted down to the girders with an open gap of approximately 12 mm between planks.

Failure Mechanism:

Because prestressing strands are under a high tensile stress, they are susceptible to the effects of corrosion. Excessive corrosion will lead to strands fracturing with loss of both bending and shear capacity in the units due to insufficient prestressing force. Because the slabs are quite rigid, they are prone to torsion (twisting) failure if the individual seatings on the timber girders are not coplanar.

Materials:

Refer to Specification MRS 11.87 for supply and site storage requirements for prestressed concrete decking planks.

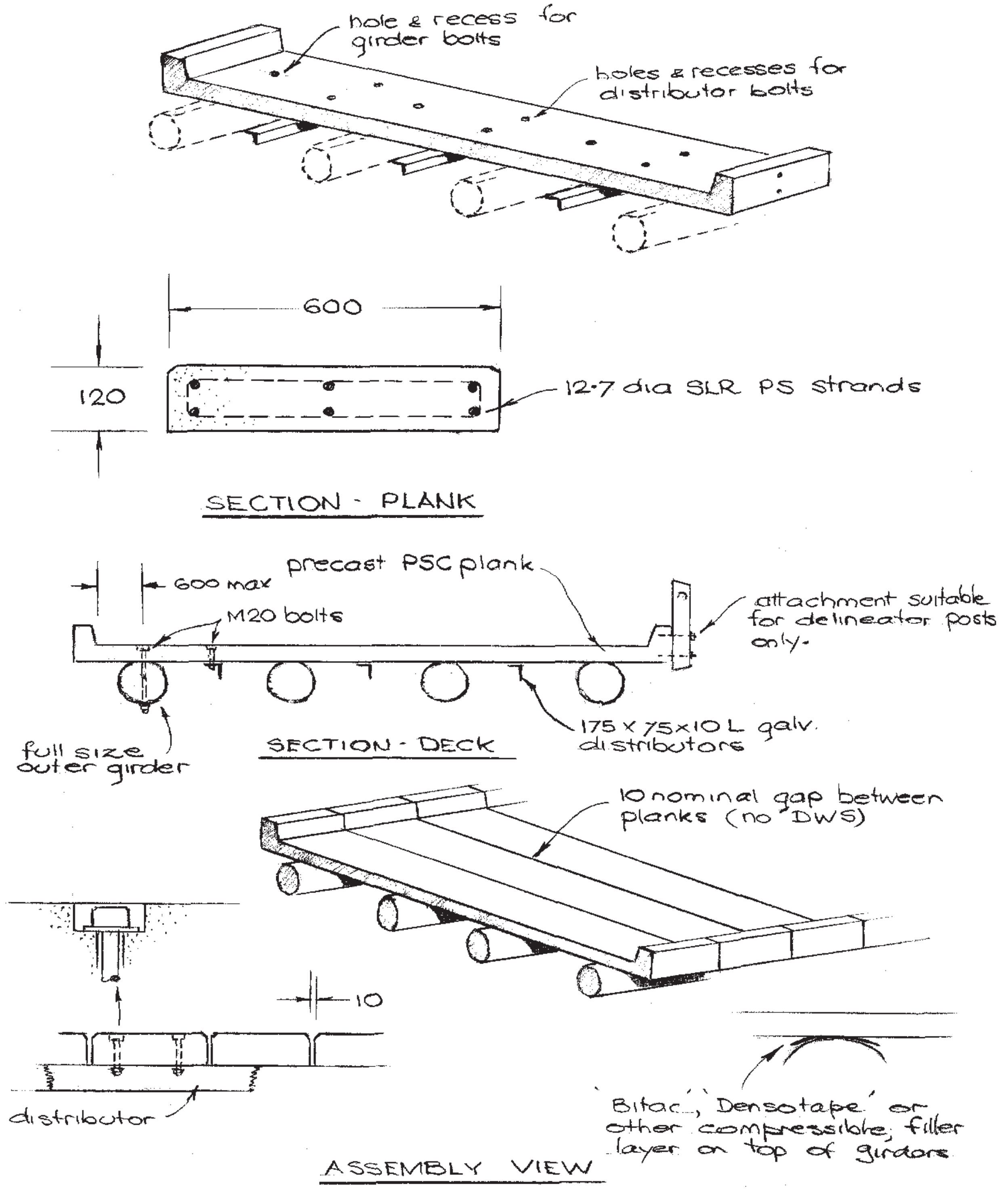


__Figure 5.4 - PSC Plank Decking__

Maintenance Activities

Refer to Part 3 Item 2.11 (29P) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:-

Routine Maintenance:

Routine or preventative maintenance will consist of maintaining bolt tightness for plank hold downs and distributors.

If hold down bolts are loose, plank movement may lead to wear of the timber support surfaces. However, the major concern is that any twisting occurring in the rigid planks can lead to a torsion failure of the plank. If distributors are loose, wheel loads taken on individual planks will increase due to reduction in load transfer provided by the distributors.

Any stones or debris lodged in transverse gaps may lead to edge spalling due to movements or wheel loading and should be removed where practical.

Programmed Maintenance:

Maintenance work using PSC Planks will generally be associated with full deck replacement as an alternative to using existing materials. PSC planks are a commercial proprietary product and details need to be initially sought from the manufacturer. The new decking proposal shall then be submitted to Structures Division for approval of details. Because of the increased mass and width of the deck, a structural check of the existing substructure and proposed girder arrangement will also need to be carried out to determine adequacy of piles, headstocks and girders.

PSC plank decking has been used successfully for square bridges. However, it may be possible to use it on small skew bridges, provided it is also placed on the skew. The feasibility of such a geometry would need to be determined by consultation with the manufacturer.

Because of PSC planks are detailed to cantilever past the outer girder line, some widening of a deck will normally occur, as shown in Figure 5.4. The manufacturer's drawings allow adjustment of girder spacing to 1.5m maximum, but there is no limit set for cantilever length. It is recommended that the distance between the inner face of the kerb and the centre line of the outer girder be limited to 600mm provided slab design and structure checks are satisfactory. Because of the cantilevering, the outer girder and spiking plank should be replaced by a girder of the same diameter as the inner girders.

There are two deck layout possibilities:-

(1) Using existing girder centres with holding down bolt holes located accordingly.

(2) Using modified girder spacing layouts as provided by the manufacturer to suit some standard deck / girder layout.

The most important consideration in placing of PSC plank decking is the provision of a planar surface to the top of the girders. Any lack of support at the girders may allow twisting of the deck planks to occur under wheel loads, giving a high potential for torsion failure. Limited trimming of girder tops may be made before using shims to take our remaining irregularities (preference is for no cuts, however). Localised notching of girder tops to accept individual planks must not be used.

Cambering of girders is not required, because the decking is bolted to each girder.

Because of open deck joints, protection must be applied to girder tops to reduce exposure to water. This may take the form of continuous metal flashing along the girder tops, after application of timber preservative and grease to the contact surface. Alternatively, a grease impregnated tape (densotape or equivalent) may be used. Refer to typical details shown in Figure 7.5(c). Part 1 the recesses in the top of the concrete deck planks for girder bolt heads should also be sealed after bolt placing in order to reduce water penetration into the drilled girder holes.

Where delineator posts only are required, fasteners may be incorporated in the outer faces of the kerbs for post attachment. Where, however, continuous barrier is required because of bridge height etc, significantly larger post loads are possible. The manufacturer should be informed of this requirement, to determine if modification of the standard slab design is required to safely transfer such barrier loads.

The basic procedure for redecking using PSC planks would be:-

- Remove existing DWS, kerbs and deck.
- Replace outer girders with full size and modify internal girder locations if detailed.
- Trim girder tops to provide suitable seating and provide top protection.
- Place PSC decking, drill and attach holding down bolts.
- Install metal distributors, and barriers where so detailed.

Where an individual PSC plank has deteriorated to Condition State 4 it must be replaced by a new member. The reason for the defect must be determined, in case modifications to the supports are required to prevent a repetition of the deterioration. The new PSC plank shall have the same cross-section dimension as that being replaced. Details of the proposed replacement members shall be submitted to Structures Division for approval.

The timber contact surfaces at the girders shall be treated with a chemical preservative, a grease and a bituminous felt. After assembly the girder bolt recesses shall be sealed. Distributor bolts must also be re-assembled.

5.5 Steel Trough Decking (30S)

Bridge Inspection Manual Component No. 30S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
30S1	Remove and replace steel trough decking	M^2
30S2	Strengthen steel trough decking	Lump sum
30S3	Replace deck planks in steel	M^2
30S4	Place reinforced concrete infill	M^3
30S5	Replace tap screws	Lump sum
30S6	Place reinforced concrete slab	M^3

Purpose:

The main function of steel trough decking is to transfer traffic loads to supporting girder members. It also helps to transfer transverse loads from wind and flood debris across the full width of the bridge.

Significance: ***Significance Rating 3***

Because steel troughing sheets are stitched together with screws, fracture of any one trough section will not necessarily lead to bridge closure, but possible consequent sagging may lead to surface depressions. Where deterioration is over a larger area, traffic wheels may break through the decking in the event of failure.

Details:

Steel trough decks have been in service since the 1970's as a replacement for the original hardwood timber decking. Originally, the troughs were filled and overlaid by a bituminous fill, material such as AC, but this has, in general, proven to be unsuccessful. Because the DWS is porous, water is collected at the interface between the fill and the steel troughing. This, combined with mechanical abrasion due to differential movement between the trough upstands and the fill, eventually causes full loss of the galvanizing layer on the tops and sides of the troughing. This then results in severe corrosion and loss of steel section area. Surprisingly however, the galvanising is sometimes found intact on the top of the lower surface.

Where, however, a reinforced concrete fill has been placed in the troughs, the system has worked successfully with little or no reported deterioration.

Deck cantilevers past the outer girder support should be limited to 500mm, as experience has shown difficulty in retaining fill material, particularly with bituminous material, due to movements under the action of wheel loads.

Longitudinal troughing, placed on transverse steel transoms (crossbeams) has been used and has performed satisfactorily.

Figure 5.5(a) shows general details for steel trough decks.

Failure Mechanism:

One common defect found in steel troughs is transverse cracking indicating complete structural failure - refer to Figure 5.5(c) for the general appearance. This cracking may be between girders or over the top and parallel to girders, in which case it is difficult to detect by observation from below. Refer to Reference 11 for further information.

Corrosion of the upper surfaces of the troughing often causes excessive loss of section area, which will lead to folding and buckling distortions or the punching through of vehicle wheels. Perforation of the corroded trough sections also commonly occurs, with pin holes and associated rust stains. The extent of severe deterioration may be gauged by impacting the area with a geologist's pick.

Materials:

The supply and site storage requirements for steel trough decking are covered in MRS 11.87 - Supply of Timber Bridge Materials and components.

Maintenance Activities:

Refer to Part 3 Item 2.12 (30S) for recommended maintenance practices applicable to the various expected deterioration states.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:-

Routine Maintenance:

Routine or preventative maintenance will consist of ensuring maintenance of holding down bolt tightness. If decking is loose, movements under load can lead to failure of AC infill material.

Programmed Maintenance:

Maintenance work with steel trough decking will generally be associated with full bridge redecking as an alternative to using existing material such as hardwood planking. Generally, the opportunity is taken to widen the deck during this process because of the ability of the decking to cantilever past the outside girders. Cantilevering is limited to 500 mm as shown in Figure 5.5(a). Where cantilevering is used, the outer girder and spiking plank must be removed and a girder with the same diameter as the internal girders substituted because traffic wheel loads can now track over the top of this girder.

It has been found necessary to bolt steel decking down on each girder in order to reduce movement and associated problems with infill and wearing surface. As a result, cambering is not required for deck tightness, but a positive camber of 20-25mm should be built in to prevent water collecting in sagged areas of decking.

Currently, the normal hold-down method for steel decking is continuous steel channel bolted along the girder as shown in Figure 5.5(a). Previous use of coach screws as hold-downs does not appear to have been successful.

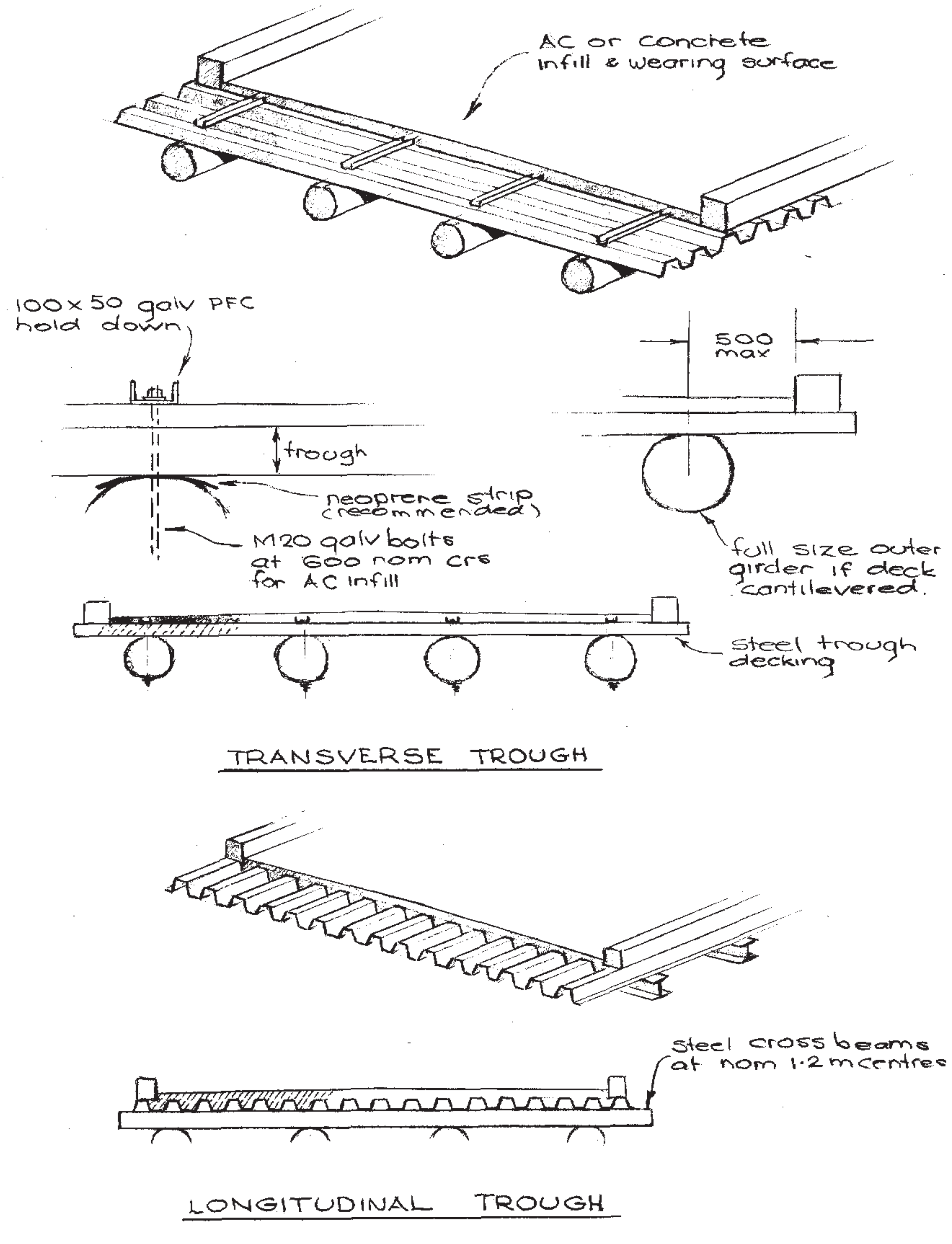


Figure 5.5(a) - Steel Trough Decking

Any redecking proposal shall be submitted to Structures Division for approval. This process will include a structural analysis of the existing girders and substructure because of the increased deck mass.

As well, loads will increase if an additional lane of traffic has access as a result of widening.

It is recommended that a reinforced concrete infill rather than AC be used with steel decks because of proven superior performance. Typical details are shown in Figure 5.5(b).

It is recommended that a neoprene strip be laid along girder tops prior to decking placement to reduce wear at the contact surfaces. The top surfaces of the girders and spiking plank should also be treated with an anti-fungal preservative, grease and a bituminous felt material placed.

The basic procedures for redecking in steel would be:-

- Remove existing DWS, kerbs and deck. Where carried out under traffic, progressive removal of old decking and replacement of steel trough sheets may be used. Individual sheets should be screwed together prior to allowing traffic access.
- Where deck cantilevering is detailed, the outer girders and spiking planks are to be replaced by girders of the same diameter as the inner girders.
- Place steel decking, install screws, and hold downs.
- Place kerb and infill / wearing surface. Where concrete infill is used, provision shall be made to allow extraction of girder and hold down attachment bolts.

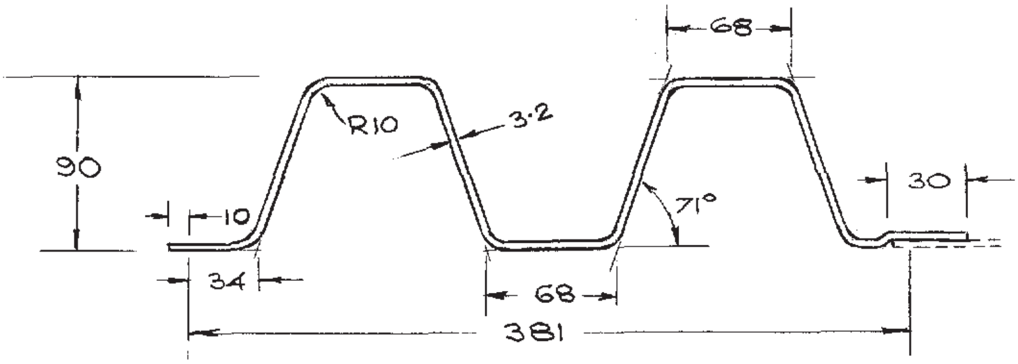
Where a part or all of the existing steel troughing has deteriorated to Condition State 4, it must be replaced to restore deck capacity. Details and processes will generally be as described above. If the existing troughing is found to cantilever more than 500mm past the outer girder (to inside face of kerb), advise Structures Division to determine if cantilever lengths require to be modified.

In some cases, where cracking failure of the troughing has occurred as shown in Figure 5.5(c), an alternative repair method sometimes used is to place strengthening plates bent to the profile of the existing troughing. For cracking between girders, these may be welded from the bottom, while for cracking over a girder, removal of DWS will be required to give access to the top surface. Care should be exercised when welding on the thin 3mm troughing plate and any galvanised surface damaged by welding shall be protected by a cold galvanising product.

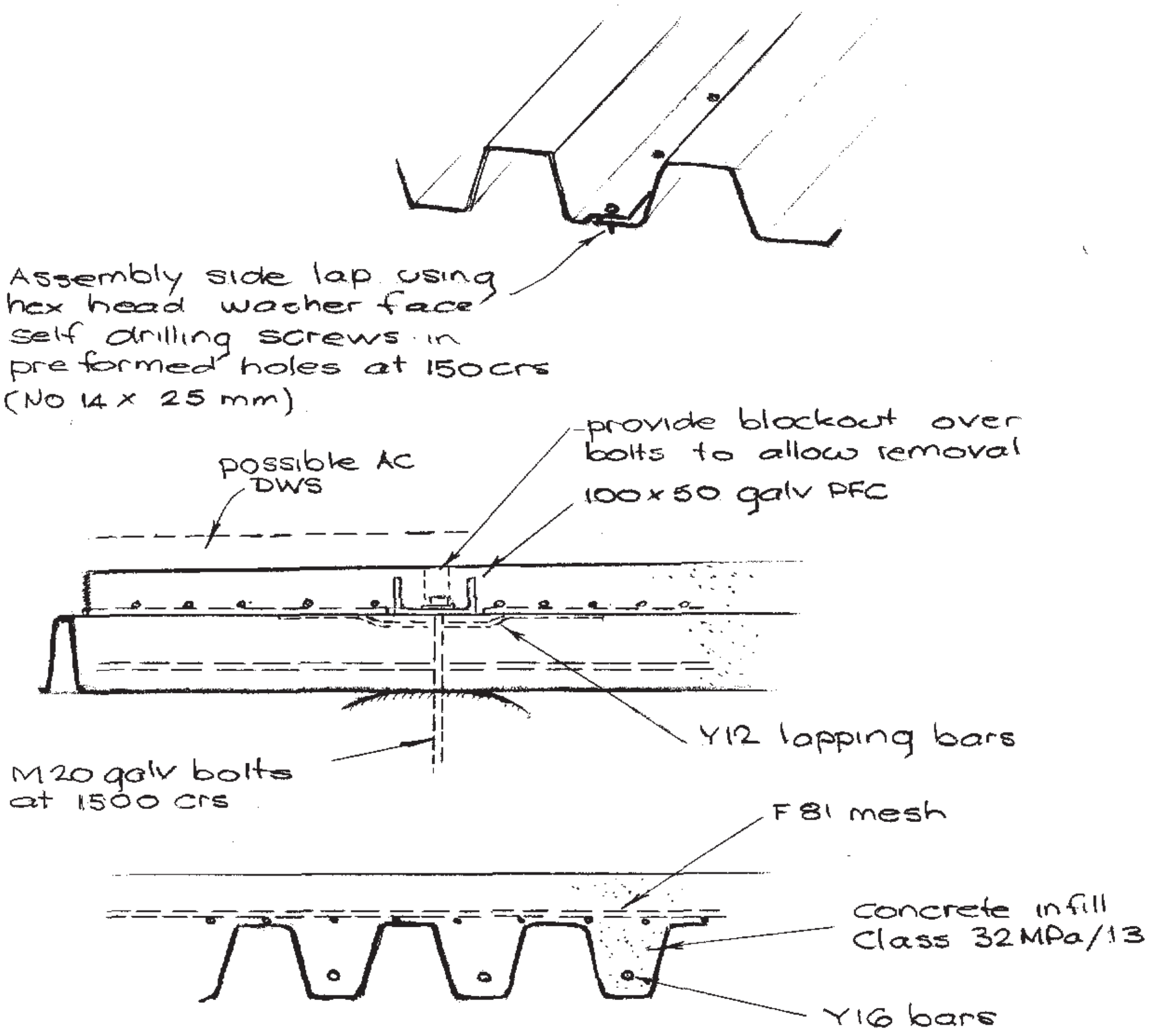
In cases where troughing is in a very poor condition, it may be used as permanent formwork for the placement of a structurally reinforced concrete slab, as an alternative to replacement. Figure 5.5(c) shows details for a typical job. As opposed to all cases above, the troughing is assumed to have no residual capacity. If this option is required, submit details to Structures Division for preparation of suitable details. It is essential that provision is made to allow extraction of the channel / girder hold down bolts after concrete deck placement in order to simplify any possible removal and replacement of defective timber girders.

Reference

11. Infratech Systems and Services. (1998). Performance of Steel Trough Decks on Timber Girder Bridges.



TROUGH PROFILE



CONCRETE INFILL

Figure 5.5(b) - Steel Decking

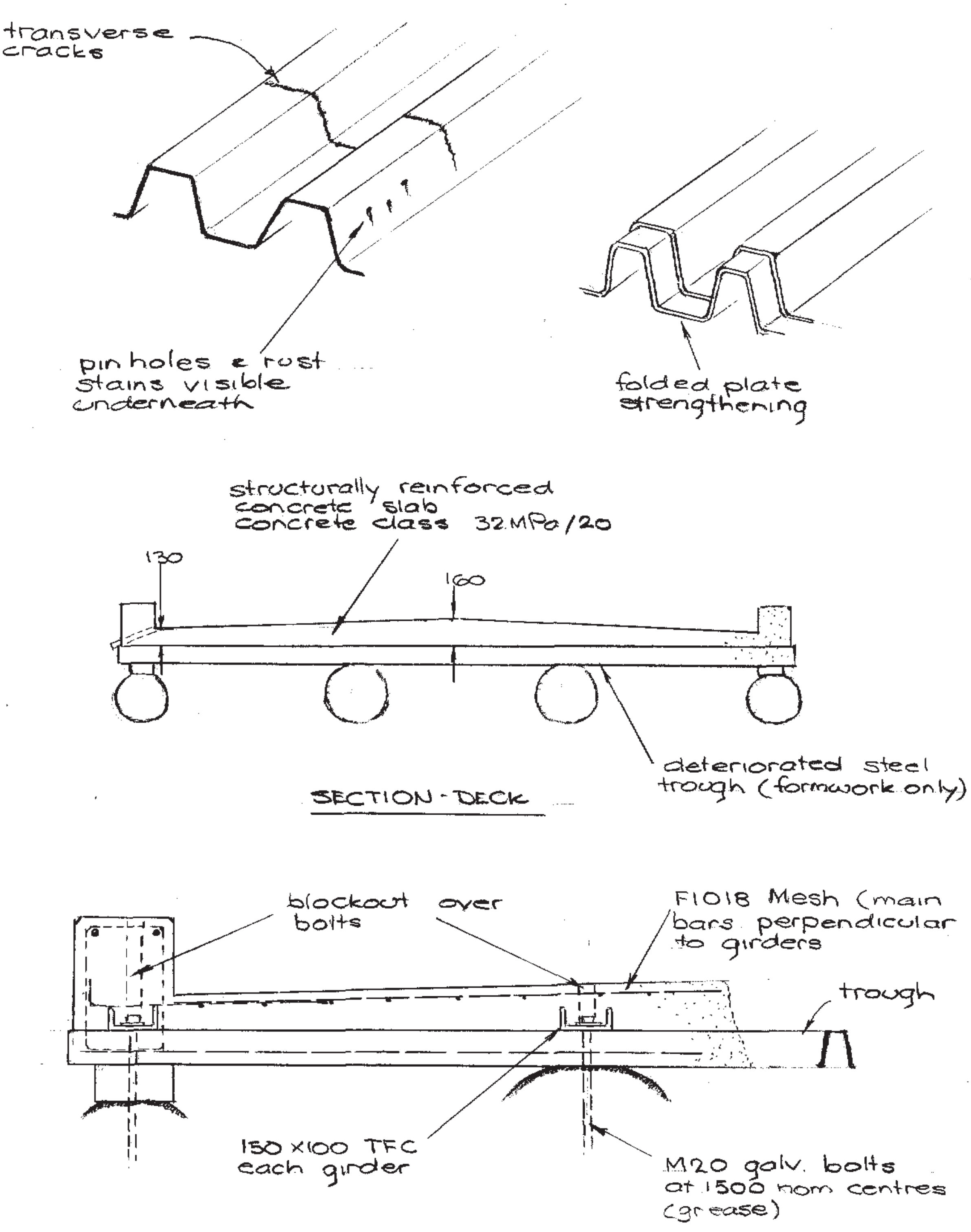


Figure 5.5(c) - Concrete Slab

5.6 Timber Crossbeams

Bridge Inspection Manual Component No. 28T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
28T1 Replace crossbeam	M
28T2 Place additional crossbeams	M

Purpose:

The function of timber crossbeams is to support timber decking which is laid longitudinally.

Significance: ***Significance Rating 3***

Timber crossbeams are important because the failure and collapse of a number in a group could lead to failure of the longitudinal decking if it is required to span an excessive gap.

Details:

Decks composed of longitudinal timber planks supported on transverse timber cross beams (or transoms) have been used on a number of bridges. Figure 5.6 shows typical details.

Failure Mechanism:

These members will generally fail in bending due to loss of member capacity as a result or rotting or cracking.

Maintenance Activities:

Refer to Part 3 Item 2.13 (28T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

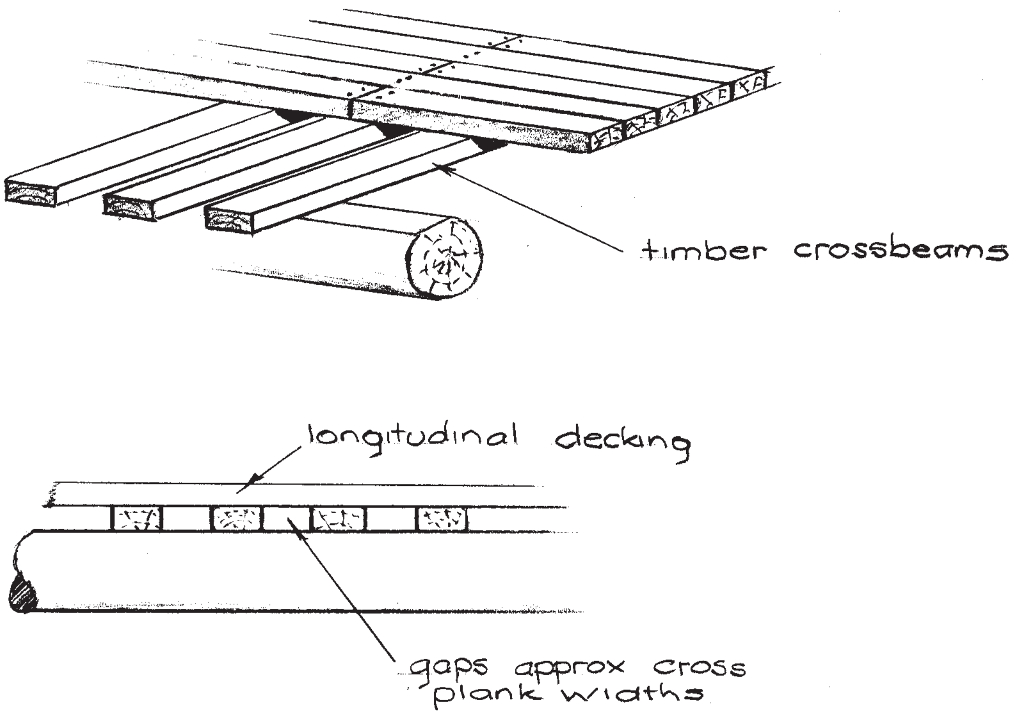


Figure 5.6 - Timber Crossbeams

5.7 Steel Crossbeams (28S)

Bridge Inspection Manual Component No. 28S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
28S1 Replace crossbeam	M

Purpose:

The function of steel crossbeams is to support steel trough or ply decking where this is laid longitudinally.

Significance: ***Significance Rating 3***

Steel cross beams are important because the failure and collapse of a number would lead to failure in the trough decking because of its inability to now carry loads over a double span length.

Details:

Figure 5.7 shows common details and fastening methods for these members.

Most existing crossbeams have been placed in an unpainted state because of benign site locations. However, it is recommended that for new bridge applications that galvanised or painted member be used to reduce the potential for corrosion. This is particularly important for the top of the upper flange in contact with the deck troughing.

Failure Mechanism:

These members will generally fail in bending due to yielding of the steel due to loss of section from corrosion, or from loss of girder support.

Maintenance Activities:

Refer to Part 3 Item 2.14 (28S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

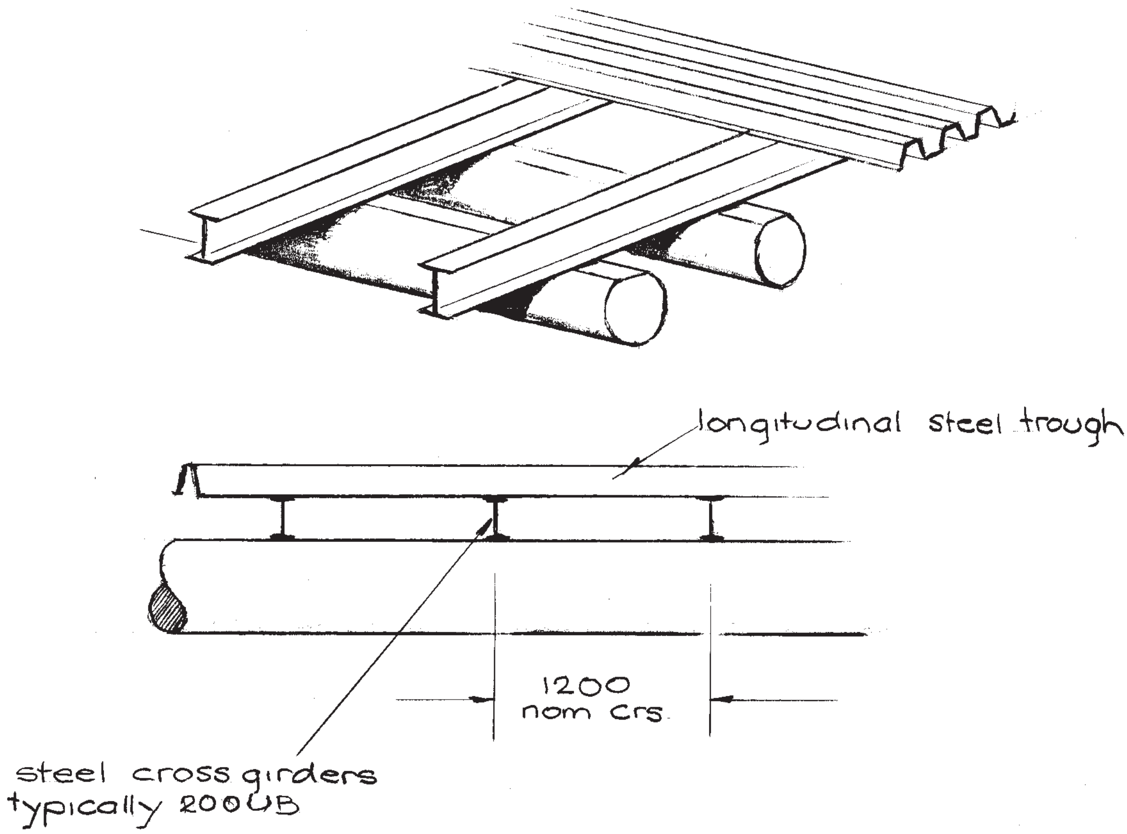


Figure 5.7 - Steel crossbeams

2

5.8 Concrete Overlay (20C)

This system is not considered appropriate for future deck repairs and is included here for completeness because two such treated bridges remain on our roads.

Bridge Inspection Manual Component No. 20C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
20C1 Remove & replace cracked overlay	M^2

Purpose:

The main function of the concrete overlay was to try and extend the life of deteriorated timber plank decks. The concrete was poured directly on top of the existing timber decking with very little preparatory or repair work carried out on the timber members. The concrete layer also formed the traffic surface, providing a smooth running surface which helps to reduce the increased dynamic loads induced by traffic wheels as a result of deck roughness.

Significance: ***Significance Rating 2***

The concrete overlay has been thought of as a wearing surface but it does have some structural action. It is reinforced with a layer of steel mesh, enabling it to span across localized deck gaps resulting from rotting in timber planks below. As well, there will be some minor improvement in the distribution of wheel loads to individual deck planks and to the girder.

One benefit claimed for this system was that the overlay will effectively waterproof the members below, reducing the rate of deterioration due to rotting. However, any significant cracking of the concrete layer could negate this improvement.

The reduction in roughness induced wheel impact loads due to the smooth running surface is probably the most significant benefit arising from this system.

Details:

Figure 5.8 shows typical details that have been used for concrete overlays. An increase in steel quantity is suggested, however, as considerable cracking is sometimes observed in the slab, both due to concrete shrinkage and the flexibility of the timber structure compared to the relatively rigid overlay. There is also a weight penalty on the girders and substructure due to the extra mass of the concrete overlay, compared to the normal AC wearing surface.

General:

The main defects noted with this system have been transverse shrinkage cracks, indicating inadequate shrinkage reinforcement was traditionally used. However, severe crazed cracking with loss of sections has occurred in a number of bridges, generally associated with a very flexible superstructure or high vehicle impact areas (bottom of a sag alignment).

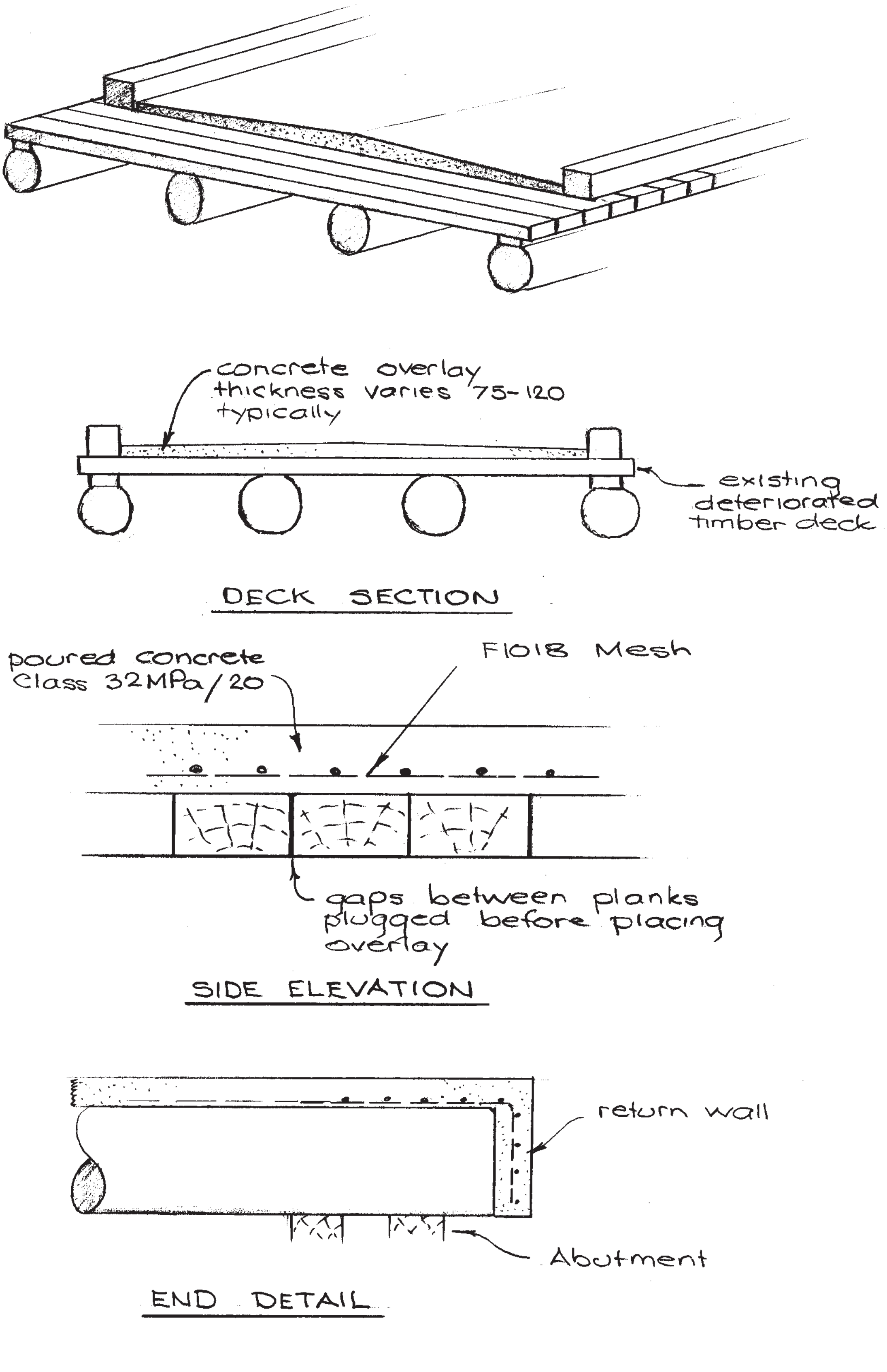


Figure 5.8 - Concrete Overlay

The concrete surfacing was intended to be placed over deteriorated timber decking with little or no timber repairs. The process used was to:

(a) pack excessive width gaps between planks

(b) place mesh reinforcement

(c) pour concrete decking

Because of the contact between the slab and the timber, the timber surface needed to be sprayed with timber preservative to try and reduce the rate of timber degradation at the interface.

Use of the concrete overlay is not considered to be compatible with general strategies for maintenance as given in 2.1.1 Part1 because of retention of deteriorated components. The question of when the timber decking should be further considered is made more difficult because the defective areas have been covered up. On-going rotting or termite attack may not become apparent until the damage has reached the deck soffit.

Prior to any obvious failure of the overlay, visual inspection of the deck soffit, including impacting with a crow bar, or drilling from below could be considered in order to estimate support adequacy. Once a Condition State 4 failure of the overlay has occurred, however, it will be necessary to determine if deterioration of the decking is the prime cause. Replacement of timber planking may be then necessary. If the majority of the decking requires replacement, it is recommended the full deck be replaced with timber planks with a bituminous wearing surface.

Programmed Maintenance Activities

Refer to Part 3 Item 2.15 (20C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

5.9 Stress-Laminated Timber (20T)

Bridge Inspection Manual Component No. 20T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
20T4	Check stressing bars	Each
20T5	Sleeve bolts	Each
20T6	Restress SLT deck	Lump sum
20T7	Replace stressing bar	Each
20T8	Sleeve stressing bar	Each
20T9	Replace anchor plates	Each
20T10	Replace laminates	Lump sum

Purpose:

Where a stress-laminated deck is placed as an alternative to a span of superstructure, its main function is to transfer vertical and longitudinal traffic loads on a span to the substructure. It also acts to transfer transverse loads such as wind and flood debris to the end supports. Alternatively, a stress-laminated deck system may be supported by timber or steel girders where it is used as a replacement for original decking.

Significance: ***Significance Rating 4***

The full span deck is a primary structural member and any failure would lead to bridge unserviceability and closure.

Details:

Only one stress-laminated timber bridge has so far been built in Queensland, consisting of timber slab composed of vertical timber boards laid longitudinally, stressed transversely together at intervals with conventional stressing bars to form a homogeneous slab - refer to Figures 5.9(a) & (b) for details. This stress-laminated deck replaced the original timber deck, girders and corbels and so spans from pier to pier.

A alternative forms of this construction are also shown in Figure 5.9(a). It should be noted that any further construction using stress-laminated technology will almost certainly be using plantation grown pine timber species, rather than hardwood because of its increasing supply difficulty. Where pine timber is used, the form of construction would be a hollow box with stress-laminated top and bottom flanges, in order to chive an adequate structural depth.

Failure Mechanism:

Stress-laminated decks function as a structural member due to shear transfer across the interface between boards due to the imposed prestressing force from the transverse bars. If bar forces reduce significantly due to timber shrinkage and creep or bar relaxation, the boards will begin to slip vertically under wheel loads, causing excessive distortions. The resultant loss of load transfer across the width of the deck could lead to overstressing and breaking of boards under heavy wheel loads.

Maintenance Activities:

Refer to Part 3 Item 2.16 (20T - Stress Laminated) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:-

Routine Maintenance

SLT decks generally require less maintenance than traditional timber construction and should not exhibit loosening of components due to shrinkage etc.

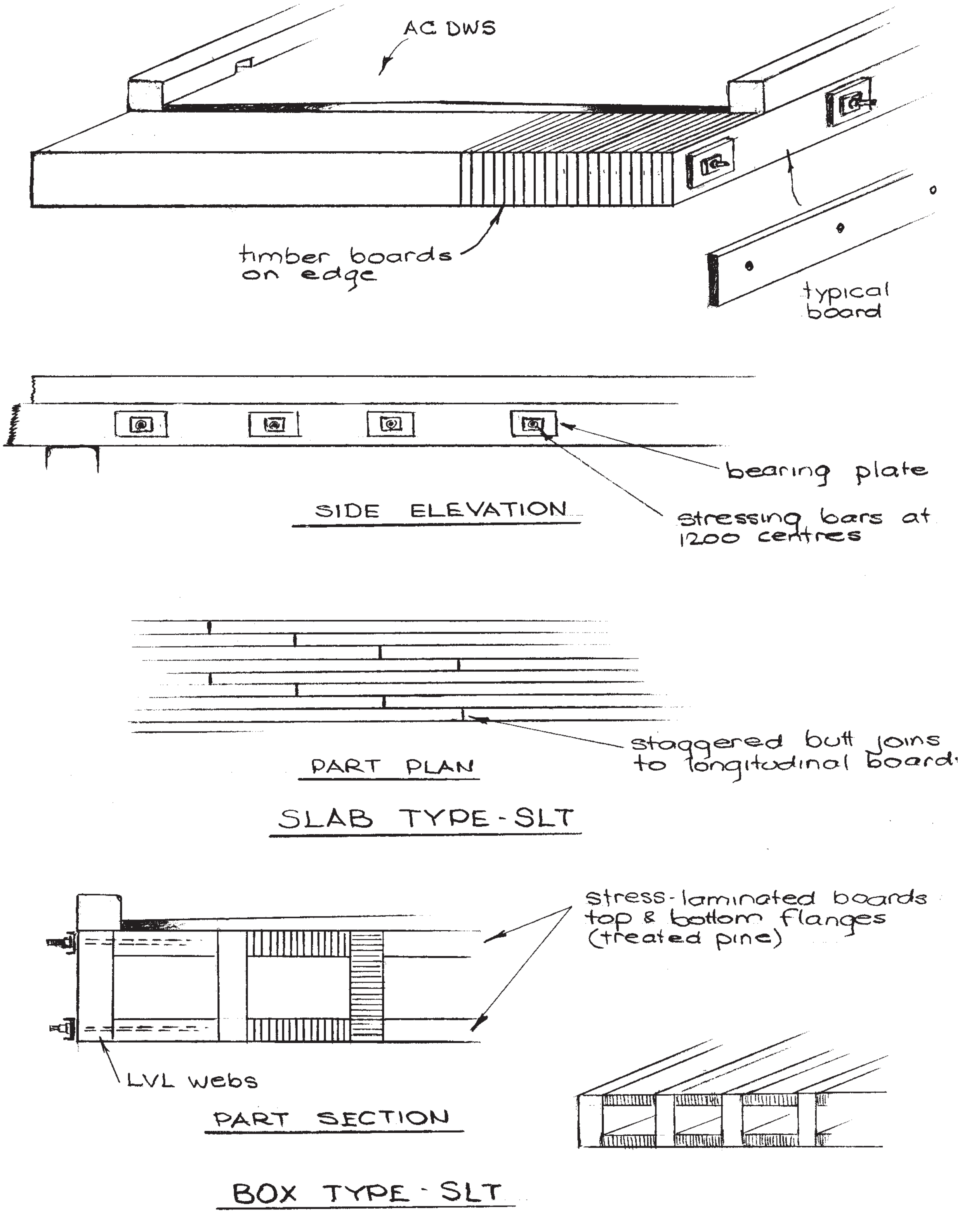


Figure 5.9(a) - Stress-laminated Timber Deck

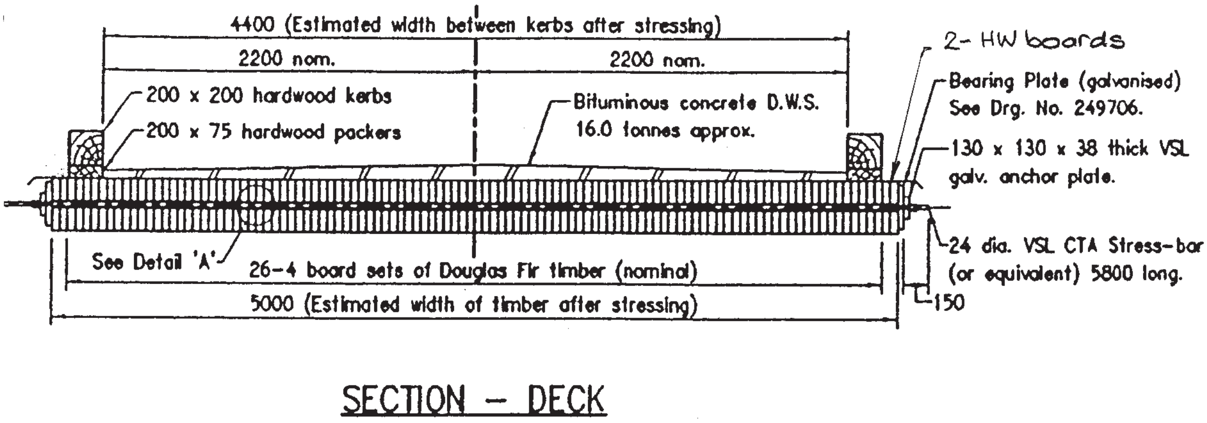


Figure 5.9(b) - Stress- Laminated Bridge

2

Slippage of laminates

Distorted soffit prior to Jacking level

Figure 5.9(c) - S.L. Deck Failure

The main objectives of preventative maintenance are to maintain protection against moisture ingress through deck top and sides and to ensure a minimum level of prestress in the deck to maintain structural actionof the deck slab. As each individual laminate board is envelope treated with preservative, long term protection is expected.

- To prevent water access to the timber below, the integrity of the wearing surface and deck water proofing system should be checked. Any cracks in the AC or depressions allowing ponding should be repaired.
- The deck drainage should be clear and all scuppers unblocked (as regularly as possible).
- Prestress levels in the transverse stressing bars should be checked once per year. Reliance on load cells has proven inadequate due to long term calibration requirements for the cells. However, "lift off" tests using a hollow core prestressing jack may be used. This is performed by pulling the end of a stressing bar and noting Jack load at the time the bar anchor lifts off the main anchor plate. BAM will advise minimum bar forces required to maintain a safe level of stress in the deck.

  If bar forces are found to be below the minimum required, the SLT deck must be restressed. Required stressing forces shall be as shown on the drawings and BAM will provide a required specific stressing sequence. This is because any adjustment to a particular bar force will affect the force in adjacent bars.
- Any minor corrosion of the exposed ends of stressing bars shall be cleaned and spot painted to reduce the rate of deterioration.

Programmed Maintenance Activities:

If the wearing surface or waterproofing layer is found to be in a condition requiring replacement, extreme care needs to be exercised in removing the material from softwood SLT decks.

If more than 1 or 2 laminates in a deck are found to have fractured, an engineering evaluation will be needed to determine the cause and consequent repair method. Because of the difficulty of replacing laminates (deck has to be supported and distressed), a fully designed replacement procedure will be necessary.

If laminate slippage has occurred due to inadequate transverse stressing, an attempt should be made to jack the deck soffit back to line before restressing, by jacking off falsework below the deck.

Where a stressing bar is to be replaced due to corosion, the new bars shall be of the same form, grade and diameter as the original bar and shall be painted using the product noted in Figure 17.10. The bar shall also be coated with grease before insertion in its duct.

2

6.0 Footway

6.1 Timber Surface - HW Planks (4T)

Bridge Inspection Manual Component No. 4T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
4T1	Replace timber planks	M^2
4T2	Reposition / reseat timber planks	M^2

Details:

Timber planks on footways are generally bare and of thinner dimension than roadway decking (though roadway decking extension may sometimes be used). Figure 6.1 shows typical details.

General:

Generally comments applicable to roadway decking (Item 29T) will apply. Footways have the added potential of danger to pedestrians due to surface roughness from gaps, non-planar top surface or rot holes.

A Significance Rating of 1 for footway surface is appropriate.

Maintenance Activities:

Refer to Part 3 Item 2.17 (4T) for recommended maintenance practice applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

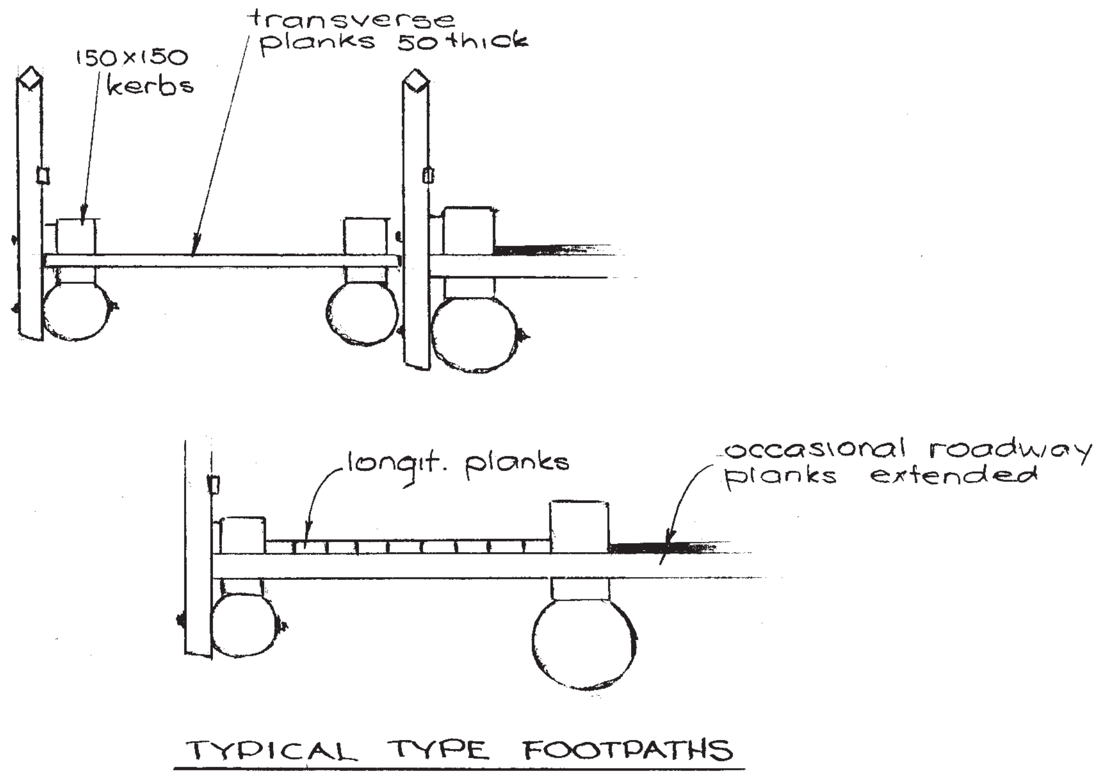


Figure 6.1 - Hardwood Timber Footpath

2

6.2 Timber Surface - Ply Sheets (4T)

Bridge Inspection Manual Component No. 4T

Refer to BIM Appendix D for a description of the four condition state applicable to this component.

Maintenance Activity Numbers		Units
4T3	Replace ply sheet	Each
4T4	Reseat ply sheet	Each

Details:

Plywood sheets on footpaths are covered by a non-slip painted surfacing and are generally of thinner dimension than regular decking (though roadway decking extensions have been used). Figure 6.2 shows typical details.

General:

Generally comments applicable to roadway decking (Item 20T) apply. Footways have the added potential of danger to pedestrians due to surface roughness from gaps or steps in level at sheet junctions. As well, loss of anti-slip surfacing may lead to pedestrian safety concerns.

A Significance Rating of 1 for the footway surface is appropriate.

Maintenance Activities:

Refer to Part 3 Item 2.18 (4T-Ply) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for description of applicable maintenance activities.

Additional:

Plywood sheets up to 34 mm thickness shall be attached with self drilling type fasteners.

Self drilling fasteners used to connect to a steel girder shall be 14 gauge hexagonal head self drilling screws with a minimum of 20 threads per inch, or 14 gauge hexagonal head screws (self tapping or non-self tapping) with 10 threads per inch utilising a 5.8 mm diameter pilot hole, and manufactured in accordance with AS3566 and shall have a minimum of 40 micron hot dipped galvanising or 50 micron mechanical / chemical galvanised corrosion protection over the length of the screw. The Contractor shall produce a manufacturer's test certificate if requested by the Superintendent.

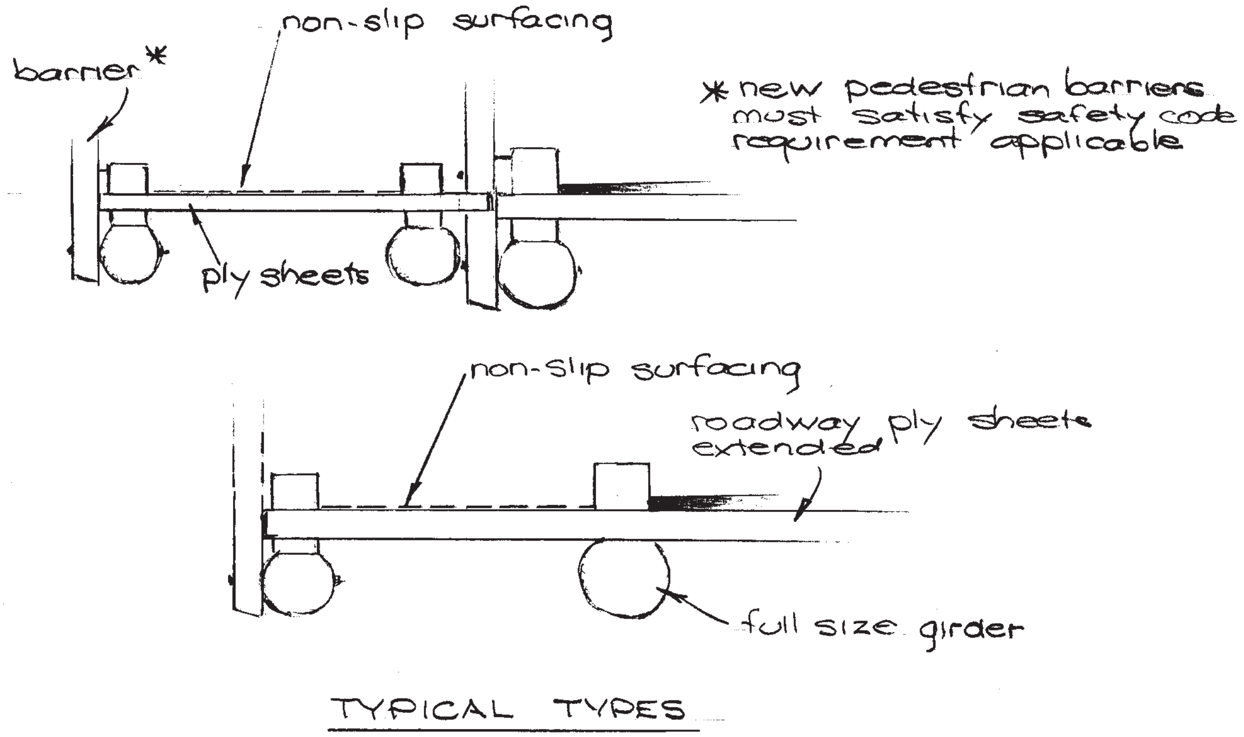


Figure 6.2 - Plywood Footpath

2

6.3 Asphalt Surface - Steel Trough (4O)

Bridge Inspection Manual Component No. 4O

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to bituminous wearing surface for Activities	

Details:

An asphalt surface on a timber bridge footway will generally be associated with steel trough infill. Steel troughing used for footways uses the same steel section as for roadways and may be filled with bituminous or concrete infill. Figure 6.3 shows typical details for timber bridges.

General:

Generally comments applicable to roadway decking (Item 30S) will apply to the troughing. Footways have the added potential of danger to pedestrians due to surface roughness due to potholes, severe cracking or loss of infill.

A Significance Rating of 1 for footpath surfacing is appropriate.

Maintenance Activities:

Refer to Part 3 Item 2.19 (4O) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

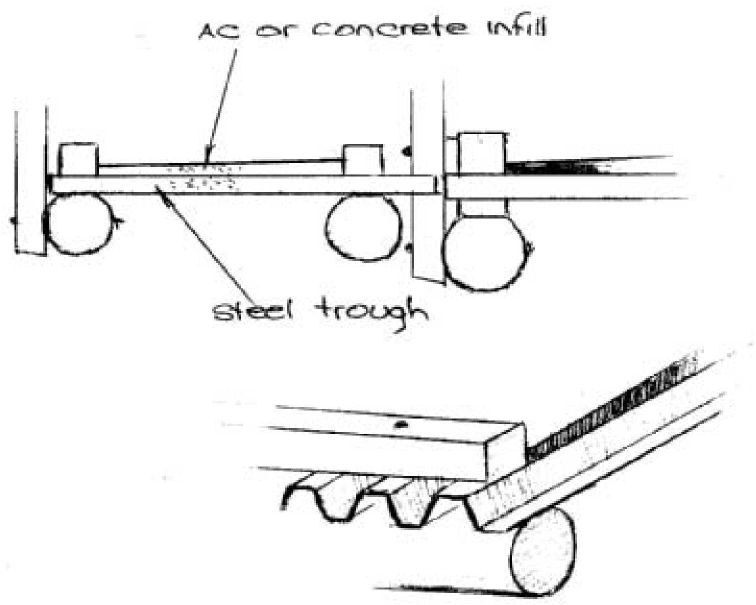


Figure 6.3 - Steel Trough Footpath

7.0 Spiking Plank

7.1 Timber Spiking Plank (33T)

Bridge Inspection Manual Component No. 33T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
33T1 Replace spiking plank	M

Purpose:

The function of timber spiking plank is to act as a sacrificial member to prevent the splitting of a girder as the result of deck spiking.

Significance: ***Significance Rating 1***

The spiking plank acts as a packer and has no structural importance. Deterioration of this member will lead to loosening and/or dropping of adjacent decking, causing deck roughness and accelerated wear in the deck system.

Details:

Figure 7.1 shows typical details for the timber spiking plank. Layout and length of spikes to be used are shown in Figure 5.1(b), and in particular, spike length must be such that spikes do not penetrate into the girder below.

Failure Mechanism:

The most common form of failure in spiking planks is crushing as a result of rotting. Rotting normally commences at the top &/or bottom contact surfaces and the member may eventually rot out internally resulting in insufficient capacity to resist the vertical loads from the deck planks.

Maintenance Activities:

Refer to Part 3 Item 2.20 (33T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:-

Routine Maintenance:

Preventative maintenance will normally be limited to treatment of any exposed areas of fungal rot with a chemical preservative.

2

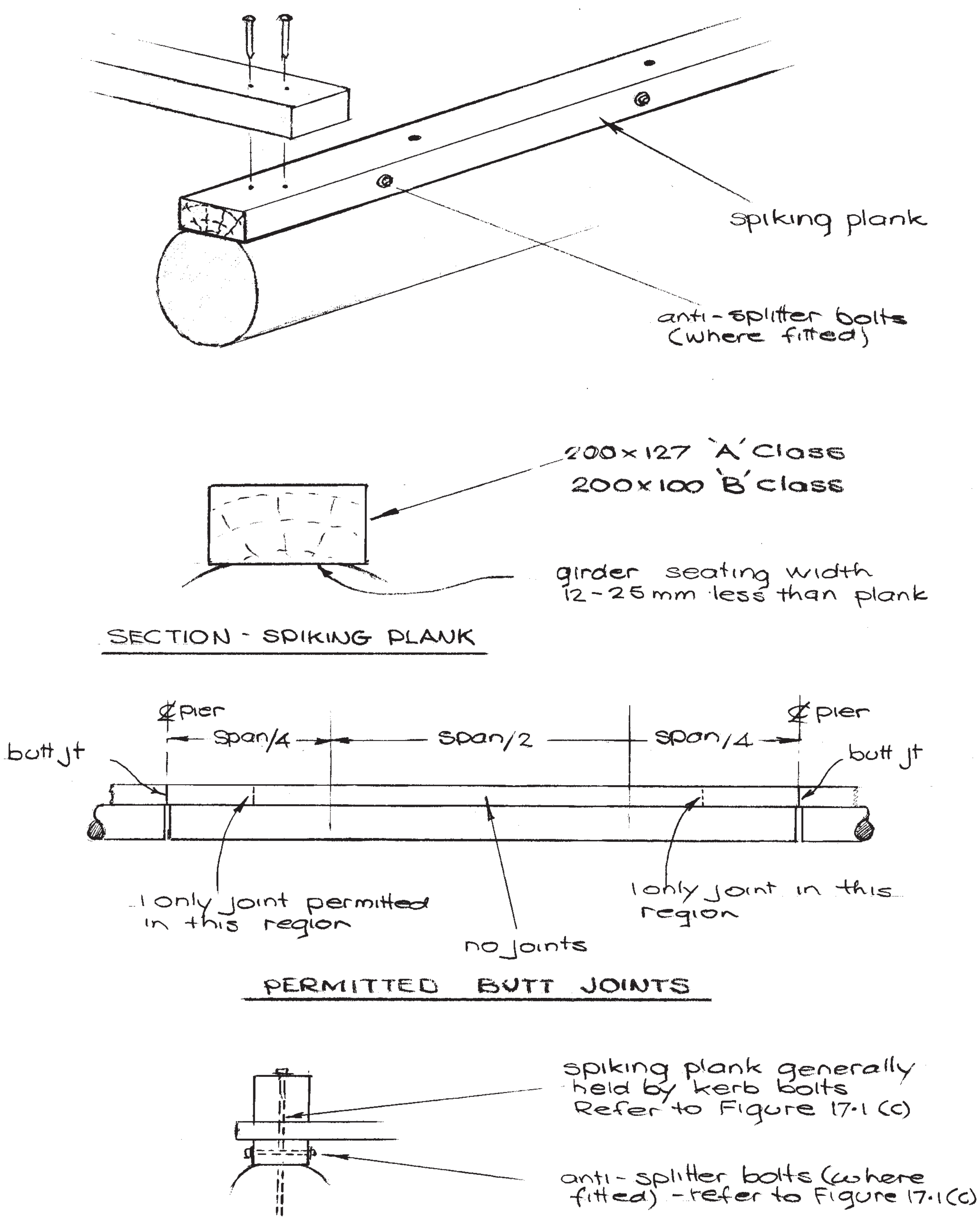


Figure 7.1 - Spiking Plank

Programmed Maintenance:

Where a spiking plank has deteriorated to Condition State 4, it shall be replaced, because of the potential loss of support to the adjacent decking ends.

Spiking planks may either be detailed to cover the length of a span, with butt joints over each pier, or may be formed from butt joined segments. A maximum of two internal butt joins may be used provided these fall outside the middle half of the span, as noted in Figure 7.1. The butt joins shall have a maximum width of 5mm.

Bolting and attachment methods for spiking planks are shown in Figure 17.1(c).

The dimensions of spiking planks may vary for different bridge classes, but should correspond to the component being replaced. It is noted that most standard drawings show horizontal anti-splitter bolts through spiking planks, corresponding to 16mm diameter bolts at 1.5m maximum centres. These bolts were obviously detailed to prevent longitudinal splitting of the member under a vertical compression load. These do not appear to be fitted to many timber bridges but should be considered if there appears to be pre-existing cracking of the new spiking plank member.

Spiking planks are in intimate contact with the girder and decking and care is needed to try and reduce rotting potential. All contact surfaces and the end grain shall be treated with an anti-fungal preservative and grease before assembly. A bituminous felt shall also be laid at contact surfaces to remove the potential for trapping water in air pockets.

General work operations require separation of decking and spiking plank over the length being replaced to allow extraction. If the spiking plank only is being replaced, this would entail:-

- Removal of DWS as required.
- Unbolting and lifting of kerbs.
- Removal or cutting of deck spikes and lifting or lateral sliding of decking.
- Removal of bolts to spiking planks and removal of old spiking plank (or segment).
- Replacement of new component and rebolting generally using existing bolt holes in the girders.
- Replacement of decking, kerbs and DWS.

In situations where the outer girder is also to be replaced, the spiking plank / girder combination would generally be removed and replaced as a unit.

Though later clamped down by kerb bolts, new spiking planks will need to be fixed in position to allow deck spiking. This should be accomplished with bolts or coach screws as required to prevent dislodgement, but should not be spiked to the girder as this defeats their purpose.

2

8.0 Girders

8.1 Timber Girders (22T)

Bridge Inspection Manual Component No. 22T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
22T1	Strengthen split or sniped girder	Each
22T2	Replace timber girder	Each
22T3	Place supplementary member	Each

Purpose:

The main function of timber girders is to transfer both the self weight of a span and also vertical and longitudinal traffic loads to the substructure. They also act to distribute transverse loads such as wind and flood debris forces to the pier supports.

Significance: ***Significance Rating 4***

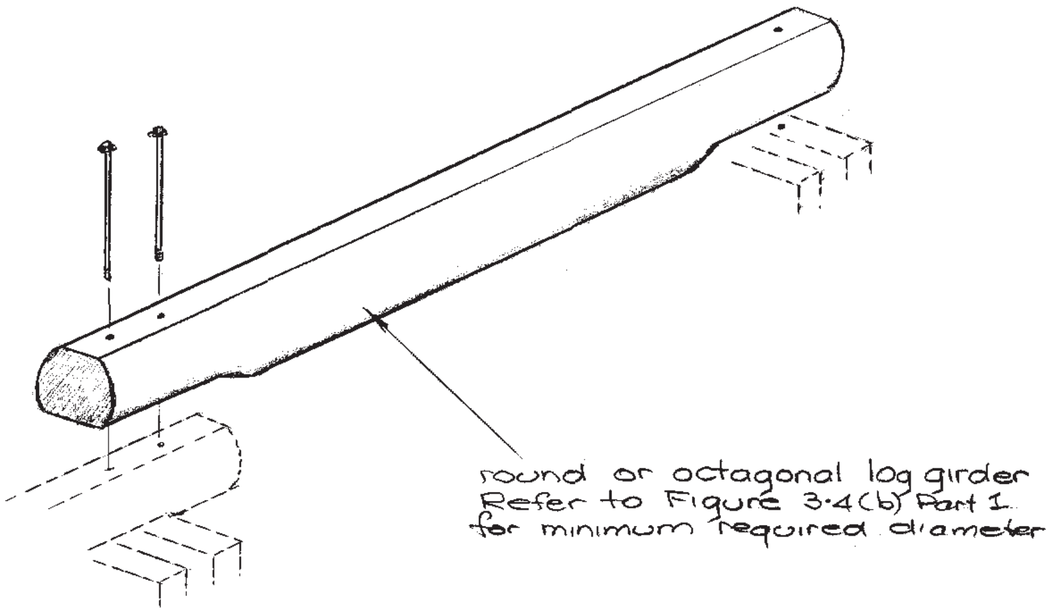
Girders are primary structural members and form probably the most critical component of a bridge superstructure. In the event of a girder failure, the consequences of a failure can vary from deck surface deformation to complete span collapse. The outcome depends on the degree of redundancy or redistribution of loads in the bridge, which depends on location and numbers of girders and the condition of overlying decking and its ability to span to adjacent girders.

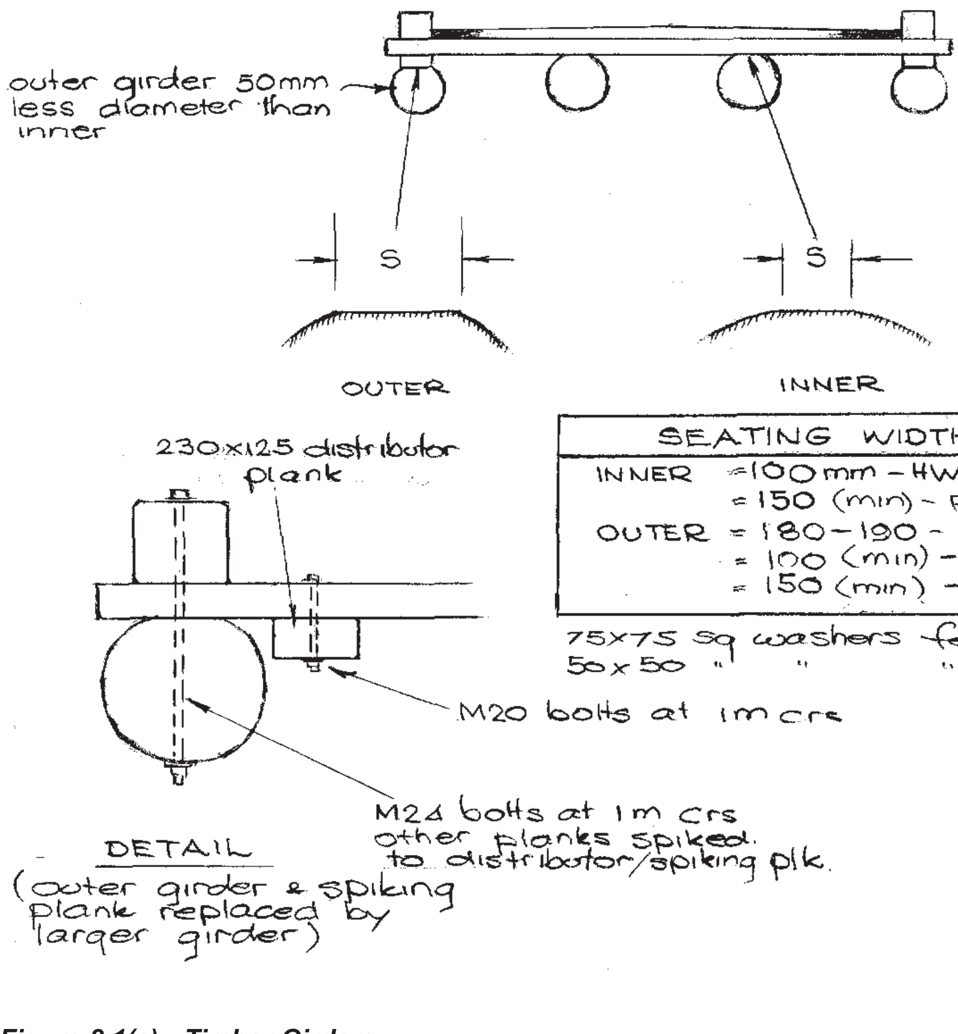
Details:

Traditionally bridge girders are round log members with the sapwood removed. Contact flats are cut on the top surface and at corbel or headstock interfaces. Today, logs sawn to an octagonal shape are generally used for replacement members. Figure 8.1(a) shows typical details for timber girders. Outer girders which support a spiking plank are detailed to have 50mm less diameter than the inner girders. Figure 3.4(b) (Part 1) shows the required diameters of girders which vary according to span length and design class.

Failure Mechanism:

Girders will generally fail either in bending near the centre of the span (vertical jagged crack) or in shear at a support end (horizontal splitting). This may be the result of excessive overload or reduction in capacity due to deterioration. Horizontal splitting emanating from the end of snipe cuts due to stress concentrations associated with notching may also occur with the potential to propagate towards the girder centre region with consequent loss of bending capacity. Where the end section of a girder is significantly weakened by piping and splits, crushing or compression failure of the ends may occur, causing settlements in the overlying deck area.





SEATING WIDTH 'S'	
INNER	=100mm – HW, PSC, Steel
	= 150 (min) – ply
OUTER	= 180–190 – HW
	= 100 (min) – PSC & Steel
	= 150 (min) – ply

75x75 sq washers for M24 bolts
50x50 " " " M20 "

Figure 8.1(a) - Timber Girders

Materials:

Refer to Main Roads Specification MRS 11.87 for acceptable species and properties for timber girders. It will be noted that the stress grading (strength) required for girders is the highest of all bridge components because of their critical importance. Because sawing reduces the strength of timber from that in a naturally round member, special requirements are given for octagonal girder supply (refer Table 3 of timber supply specification). This accepts F22 timber provided it is defect free in the middle third of its length, over the tension (lower) faces.

Girders may be supplied as:

(a) Naturally round timber with sapwood removed or round timber with preservative treated sapwood.

(b) Octagonally sawn members.

Refer to Article 6.2 Part 1 for a discussion on alternative girder materials such as steel.

Maintenance Activities:

Refer to Part 3 Item 2.21 (22T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations and detailed explanations are as follows:-

Routine Maintenance:

Routine or preventative maintenance activities for timber girders will generally be identified and carried out during Level 1 bridge inspections. These activities would be:

- Tightening or replacing girder / corbel bolts
- Application of surface preservatives or waterproofing agents, especially for sawn members.
- Emergency propping of cracked or sagging girders.

Girder attachment bolts should be checked for tightness as this reduces potential movements and consequent wear between girder and corbel or abutment headstock. Tightness will also help reduce girder stresses and deflections by providing some degree of structural continuity at pier corbels. Where corrosion of attachment bolts is noted, they should be noted for later programmed maintenance.

Where surface rotting is detected an application of chemical preservative should be made to the affected surfaces to try to slow the fungal attack. In general, application of end sealant to girder ends may not be possible as end gaps will normally be inadequate, but should be considered if feasible. Figure 8.1(h)(3). Shows a possible procedure.

Refer to Section 17.7 for recommended materials.

Where a girder is found to be sagging noticeably or has other severe structural defects, emergency tomming may be used to allow continued operation of the bridge. Where bending strength appears to be compromised, a prop placed near the centre of the span is appropriate to reduce effective span length. Where crushing of the girder ends at abutments or piers has occurred, temporary props close to the supports may be appropriate in order to take load of the effected are. Figure 17.11(a) shows typical tomming details. These props are only to be considered as short term supports piror to girder repairs being carried out.

Additional preventative maintenance actions for timber girders will take the form of close monitoring during site visits for signs of termite infestations such as trails or activity in cracks or joints between girder and corbel or decking. Termite activity should be terminated as soon as possible after discovery before excessive damage can be done. Refer to Section 17.8 for further details.

Programmed Maintenance:

Any girder identified by inspection as being in Condition State 4 will generally have lost sufficient section due to decay or termite attack that its ability to carry load is compromised. Even though the bridge appears to be successfully carrying general traffic loads, the probability of collapse under an overloaded vehicle is greatly increased. Replacement of girders in this condition is the required option. Girders are primary structural elements and the functioning of the bridge depends on their continued operation.

Where a girder replacement is not deemed to be justified because of short remaining structure life, (due to imminent replacement etc.), the options available would be tomming or placement of load restrictions.

Another situation which may modify the above requirements occurs in the ends of corbelled girders as shown in Figure 8.1(b) (1). Even though the extreme ends of both girder and corbel are in Condition State 4, load may still be transferred from girder to corbel in a "comfort zone" if pipe sizes have reduced sufficiently. This has the effect of extending the time before replacement is needed. BAM will give advice on this situation if requested.

Where localised girder replacements are made, replacement of outer girders will be more difficult than for inners because of the need to release kerbs, decking and spiking plank and remove the various attachment bolts.

The main considerations for girder replacement are:-

(1) Girder sizes required.

(2) Girder trimming and snipes.

The size of a replacement girder will depend on the bridge span length and the design class of the bridge. Minimum sizes to be used are shown in Figure 3.4(b) (Part 1).

Where a cantilevered deck such as ply, PSC or steel troughing is proposed, the existing outer girder will in general need to be replaced with a member of the same size as the existing inners. Consideration may also be given to using a larger girder and dispensing with the spiking plank during normal maintenance replacement of an outer girder. This will be an advantage if an alternative cantilevered deck is placed in the future. (Refer to Figure 8.1(a)).

Trimming of deck seating areas on the top of round and small octagonal outer girders is required, to the details shown in Figure 8.1(a).

2

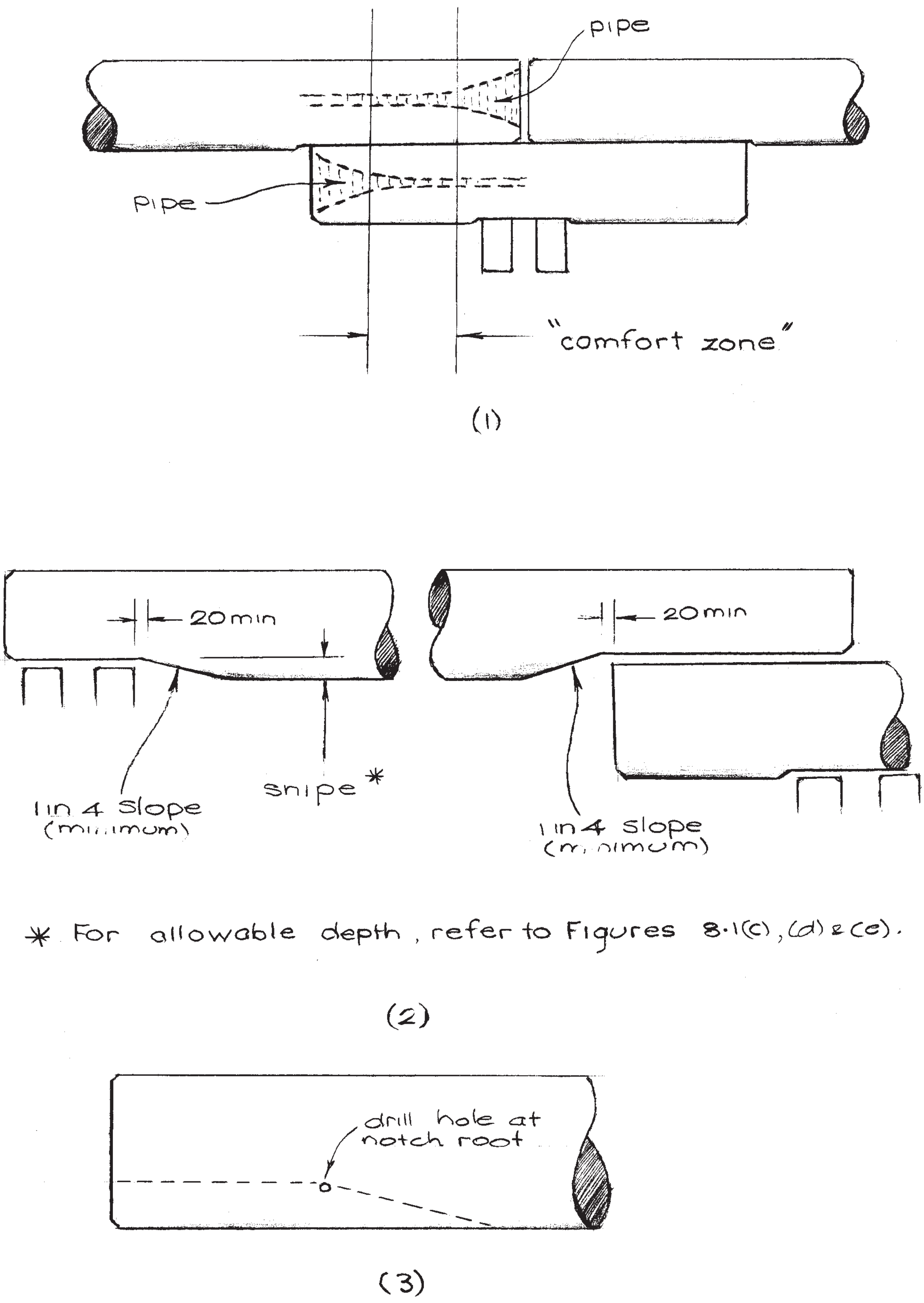


Figure 8.1(b) - End Details

Notching (or sniping) of the end support areas of girders is required for seating purposes, but limits on the depth of snipes are required to prevent stress concentrations at the change in section of the girder.

As discussed in Section 4.6 (Part 1), the maximum recommended loss of girder depth due to sniping is 15% of residual depth (i.e. after top seating formed) and an absolute maximum loss of 30% provided bolted strengthening is applied.

Figures 8.1(c), (d) & (e) give recommended depths of snipe cuts for various girder sizes. Where strengthening is required, this shall be carried out as shown in Figures 8.1(f) and (g).

It is important to avoid over cutting at the root of a snipe. One possible method to limit over cutting is to drill a hole in the member at the root of the notch. This hole provides a stop point for cutting while giving a rounded edge to minimise stress concentrations. (See Figure 8.1(b)(3).

Where new girders are being installed, it is recommended that snipe slope be made 1:4 (depth to length ratio).

The correct size of girder should be selected if possible to minimise cutting. Consideration should also be made of any other adjustments that could be made to minimise the required notching.

Figures 8.1(m) (n) (o) show support cut depths and horizontal cut seating widths for the range of 'A' Class round girders. These are provided to give an indication of seating widths resulting from standard drawing requirements.

It should be noted that Figure 3.4(b) Part 1 details the minimum sizes required for girders to satisfy design class requirements. When preparing girder replacement schemes, consideration should be given to use of readily available girder sizes, in particular larger sizes. For full superstructure replacement, it would be preferable to raise deck levels to accommodate larger size members rather than to cut deeper snipes.

Similarly, for full superstructure or span replacement, it may be possible to utilize smaller size girders by increasing numbers of girders in a span. Structures Division will provide advice on this amendment.

It is not always possible, however to achieve recommended maximum snipe depths for various reasons. For example, where an individual girder is being replaced, existing deck soffit and abutment headstock levels dictate residual girder depth. Similarly pier corbel levels will dictate adjacent girder depth, though there is a possible option of using a reduced corbel size. This situation may also arise with round logs due to natural taper, and where larger than standard girder sizes are being used as replacements. Where assembly requirements result in snipe depths exceeding the upper limits specified above, contact BAM for advice.

It will also be noted in Figure 4.6(b) (Part 1) that the snipe depth for outer girders at abutments, as shown on all standard MRD timber bridge drawings, exceeds that recommended. It may be appropriate to add strengthening at this location.

2

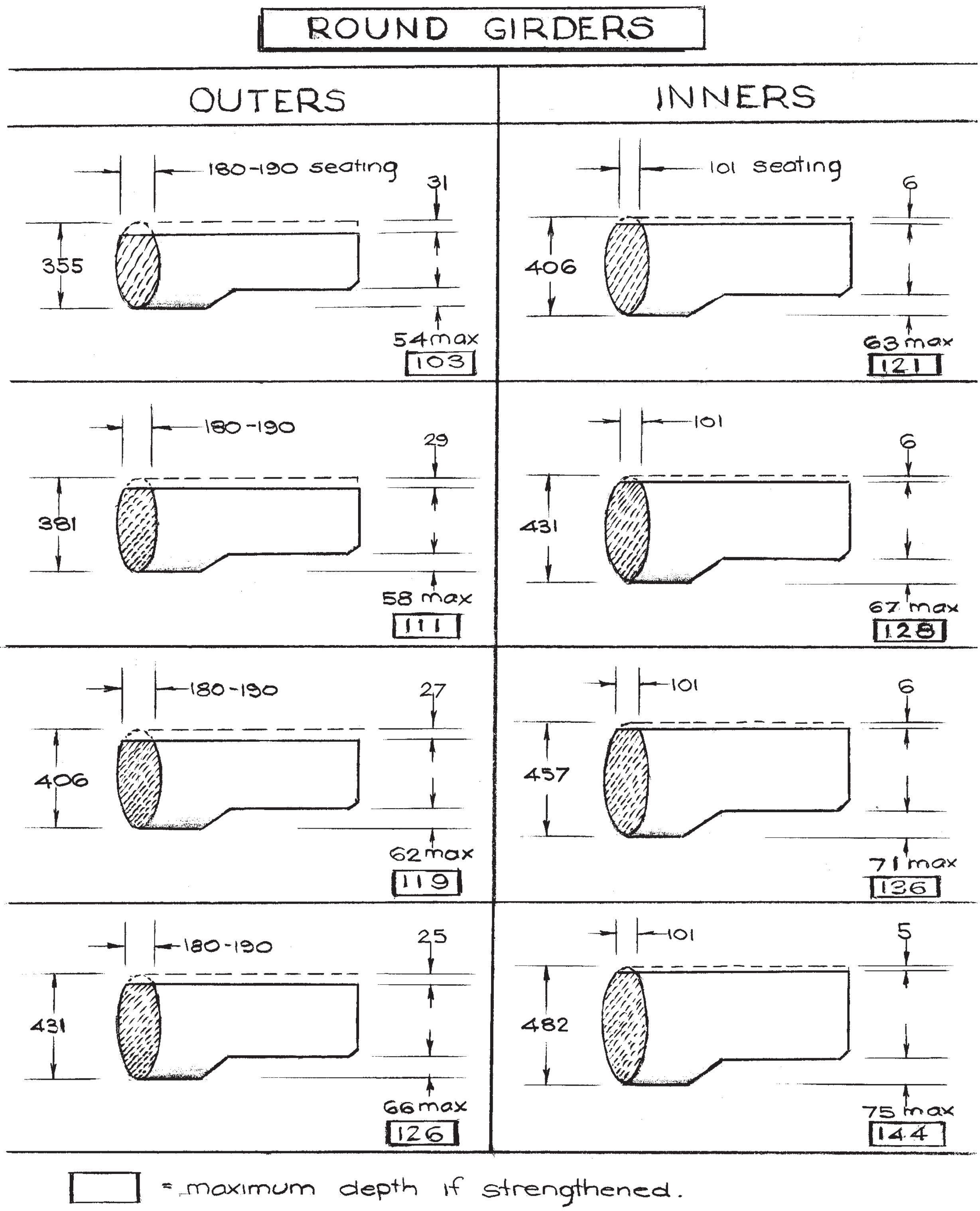


Figure 8.1(c) - Snipe Depths - Round Girders

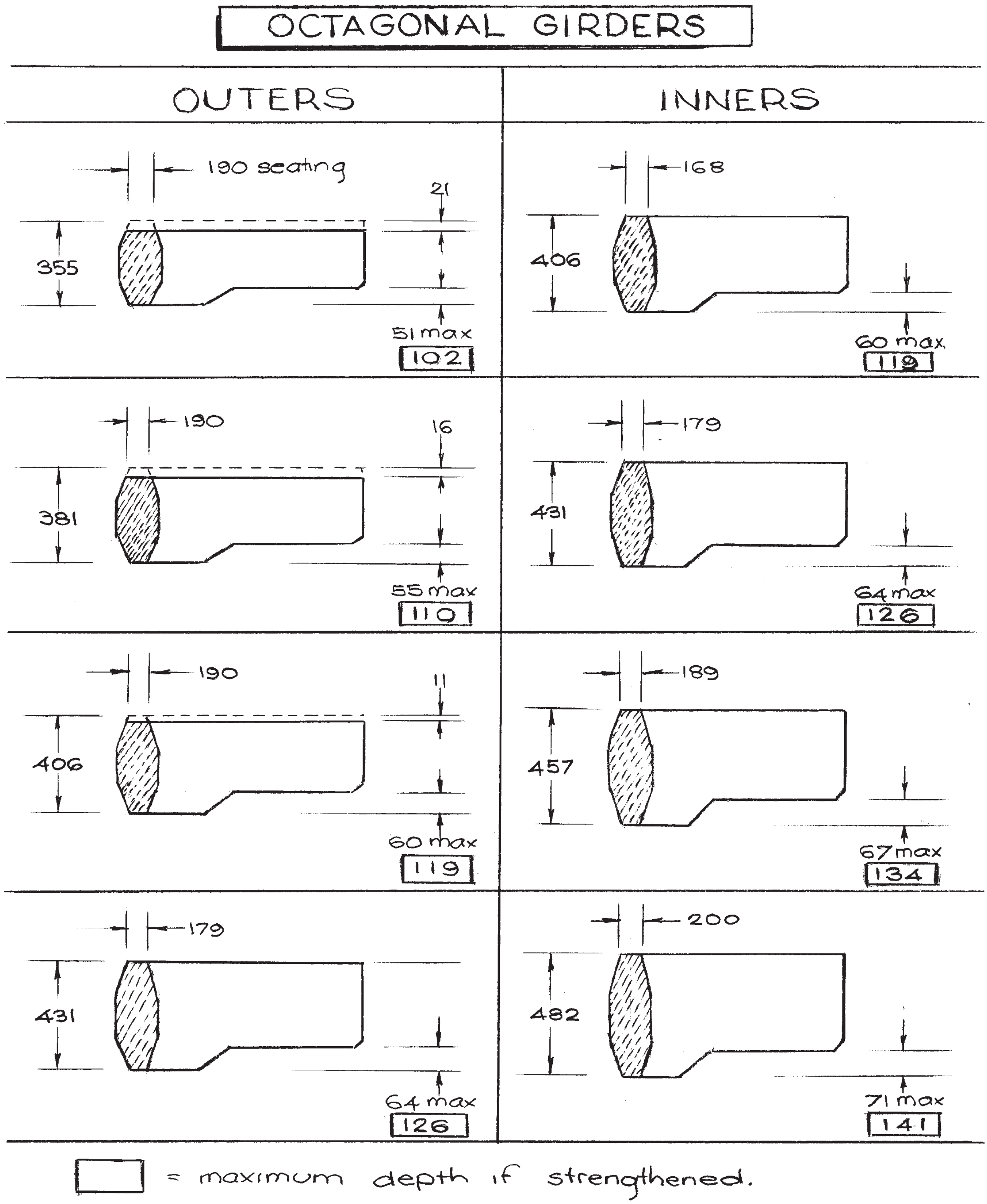


Figure 8.1(d) - Snipe Depths - Octagonal Girders

2

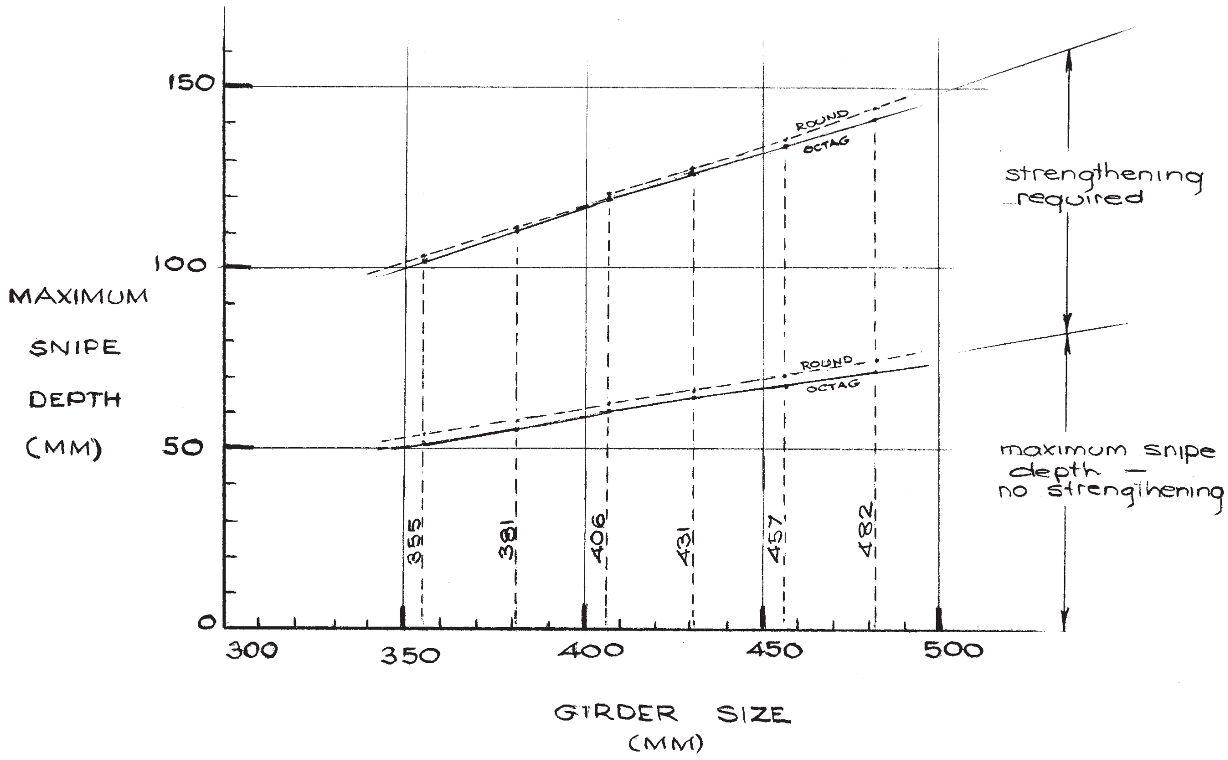


Figure 8.1(e) - Girder Snipes - General

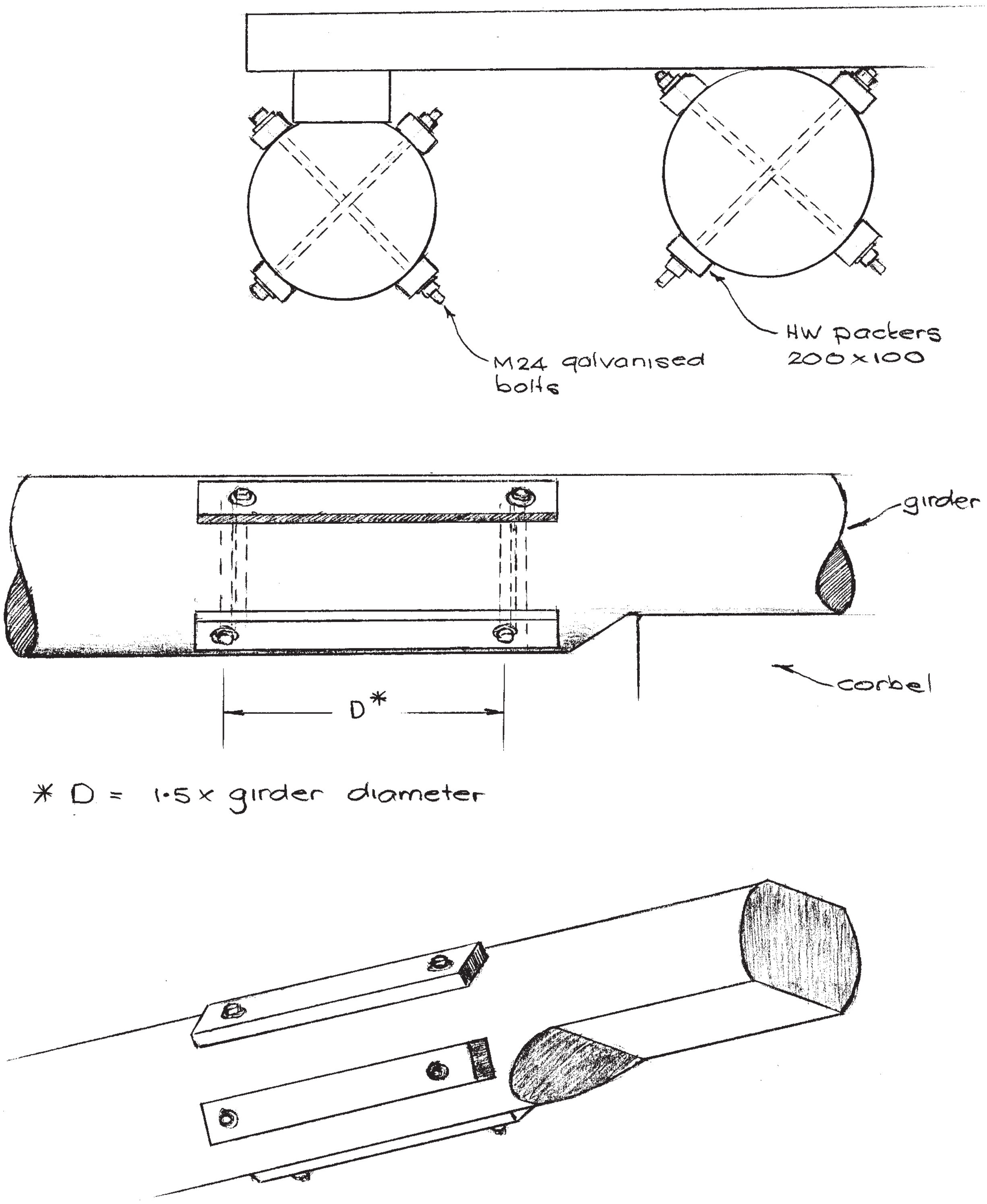


Figure 8.1(f) - Girder Strengthening (1)

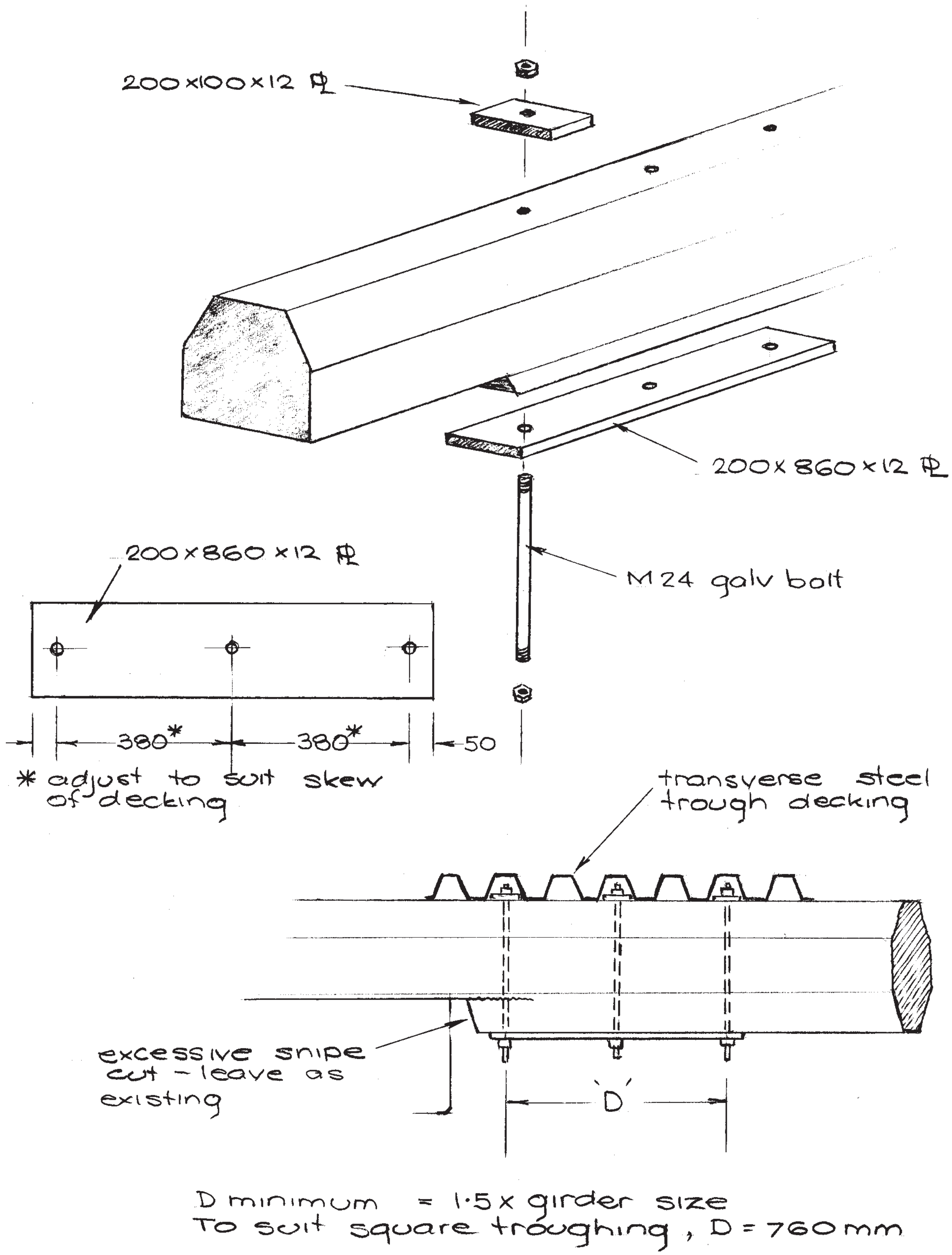


__Figure 8.1(g) - Girder Strengthening (2)__

The gaps between ends of girders at piers should normally be set at 20 to 25mm. (note the old MRD drawings showed (38 to 64mm). Where an individual inner span girder is being replaced, a gap of 30 to 40 mm would be more appropriate in order to ease assembly. The ends of girders should be neatly trimmed a shown in Figure 8.1(h)(1).

Where new girders are supplied with a pre-existing pipe (up to 35mm allowed), this shall be plugged before erection as shown in Figure 8.1.1(h).

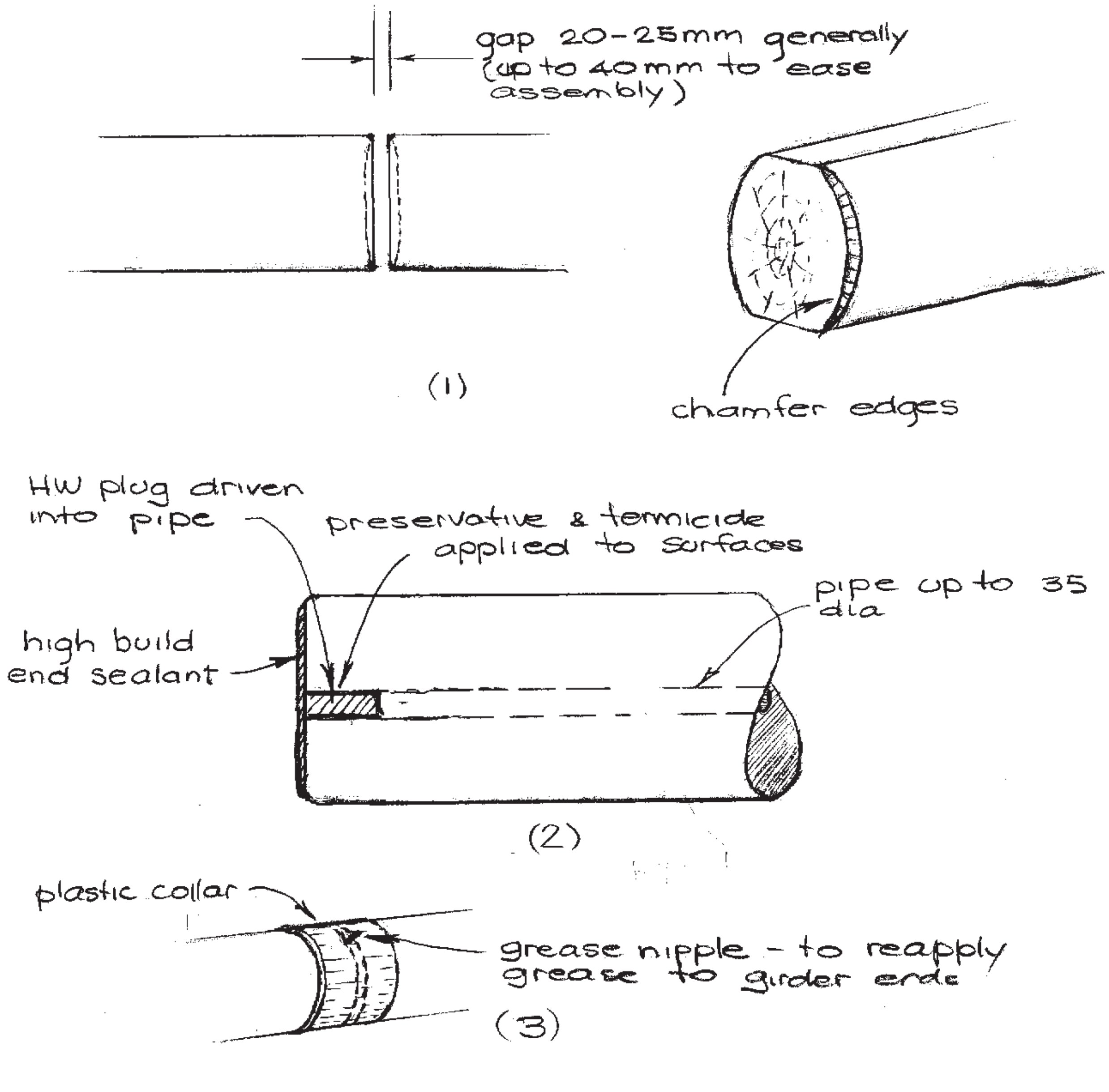


Figure 8.1(h) - Girder Treatments

Where girders are supplied with longitudinal cracks exceeding 10mm in width, anti-splitter bolts shall be installed to reduce further tendency to split. Refer to Figure 17.1(d) for recommended details.

Before girder erection, the ends shall be treated with a timber preservative and a thick grease applied (refer to Figure 17.7). After a girder is removed, a similar treatment should be applied to adjacent girder ends.

If end nailing plates are attached to the girder when supplied, these should be re-applied after trimming and end sealing.

All contact surfaces between the new girder and corbels, headstocks, spiking plank or deck shall be treated with a preservative, grease and a bituminous felt placed to help remove moisture traps.

Girders will generally be placed with any bow upwards. If assembled with a lateral bow, this should not exceed 30mm for a 9m length, particularly on outer girders.

Figures 8.1(i) & (j) show typical methods which may be used to replace an internal girder.

The general work operations involved would be:-

- Release girder bolts and jack up decking at headstocks. It may be necessary to jack up adjacent corbels to remove decking load over the length of the girder.
- Remove DWS and deck planks over girder bolts and any required lifting points.
- Extract girder bolts. If these cannot be removed cut bolts. Remove defective girder.
- Lift new girder into position.
- Drill and assemble girder bolts. If the original hold-down bolts were cut, an alternative girder / headstock hold-down will be required.
- Remove jacks to decking / corbels.
- Replace deck planks and wearing surface.

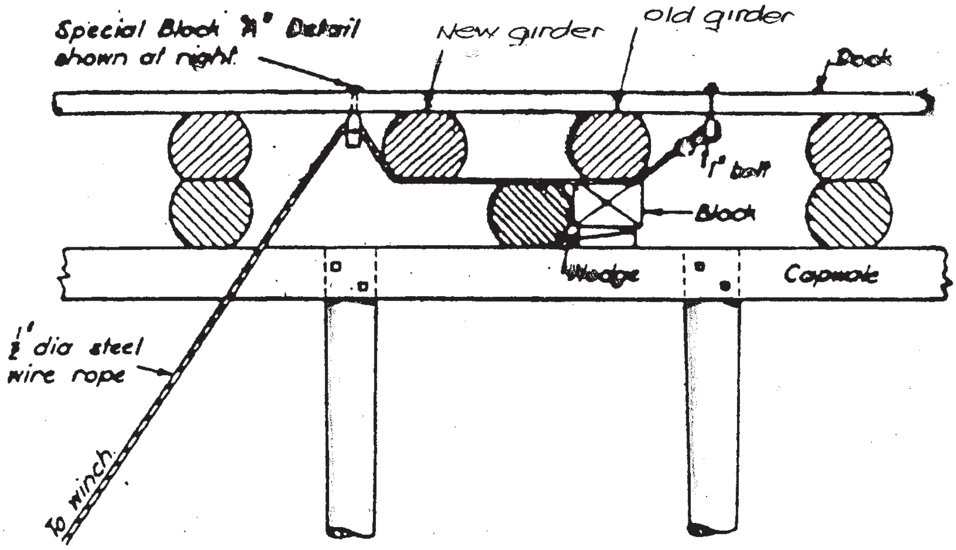
If decking over the new girder is loose, a recamber of the span should be carried out. Poisoning of the new girder should also be carried out.

Replacement of an outer girder will generally follow the same sequence, but requires removal of kerb bolting as well. If the spiking plank requires renewal as well, this will normally be assembled on the girder before erection.

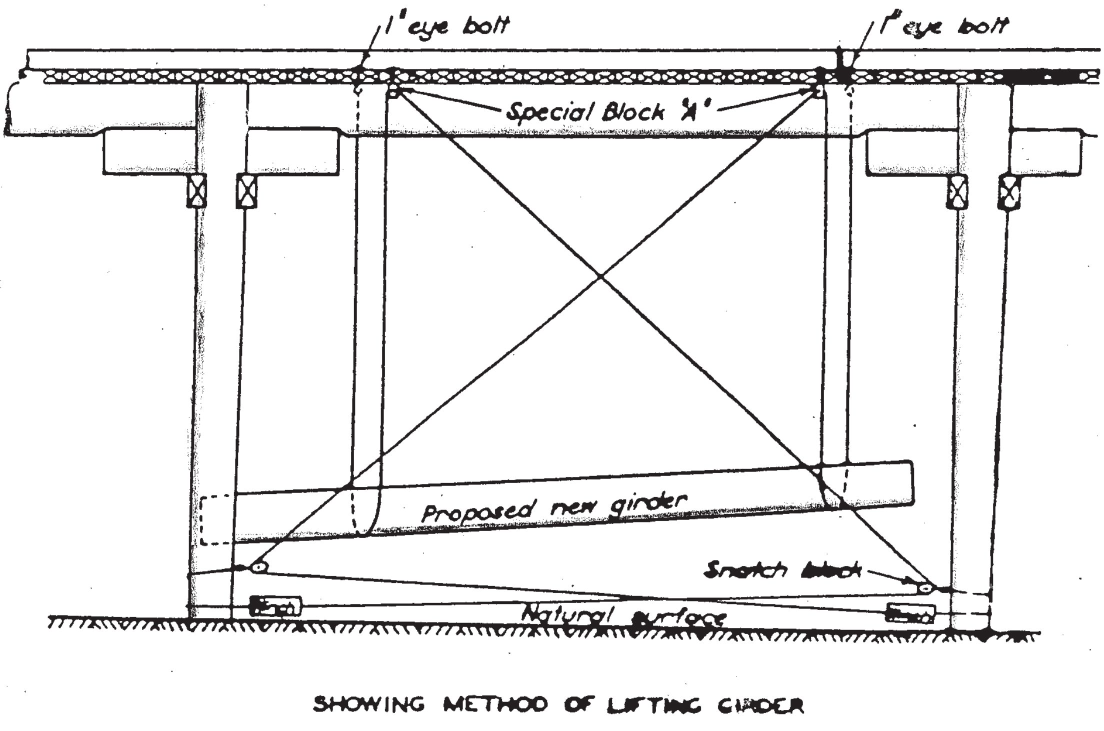
Timber girders supporting an RC deck slab generally appear to have enhanced life due to the extra protection provided. However, where a girder is required to be replaced, there will be increased difficulty compared to timber decked bridges. Figures 5.3(a) and 5.3(b) show the two types of RC deck bridges that will be encountered.

Hook or collar bolts were used at corbel and abutment ends and at intermediate parts along outer girders. These will need to be cut off at the top of the girder and the bolts removed from the corbel/headstocks to allow extraction of the defective girder. With the Type 2 slab, there are also a substantial number of shear plates embedded into the slab. These will need to be oxycut off flush with the slab soffit after girder removal (which may entail cutting the girder into pieces to allow removal), In addition, sufficient of the transverse concrete diaphrams at the ends will have to be broken back to enable erection of the new girder.

Care will need to be exercised in propping the structure during girder removal, and advice should be sought from Structures Division because of the need to prevent cracking of the RC slab. In general, jacking up components that would cause bending in the deck slab will not be acceptable. A layer of epoxy putty will be needed along the new girder top to provide continuous support for the deck slab. In order to reinstate deck hold down, coring of the slab should be carried out in order to place hold down bolts as shown in Figure 8.1(k). These are also needed along internal girders of a Type 2 deck in order to provide some shear connector action which was lost because of the removal of the shear plates.



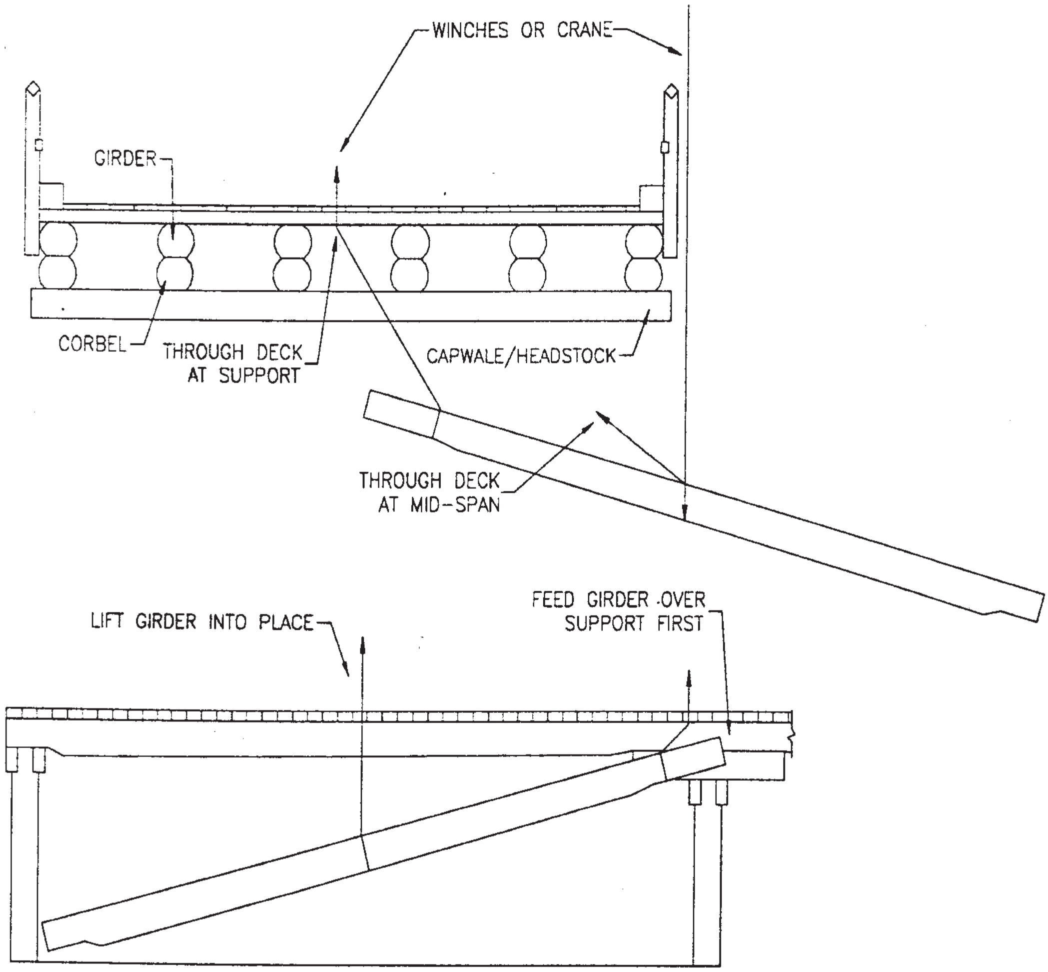
SHOWING OLD GIRDER PUSHED OUT AND NEW GIRDER READY TO PUSH IN.



SHOWING METHOD OF LIFTING GIRDER

Figure 8.1(i) - Girder Erection 1

2



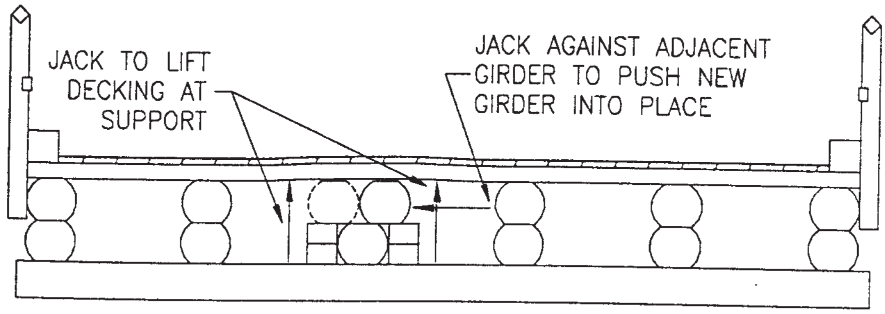


Figure 8.1(j) - Girder Erection 2

Where a girder defect produces a Condition State 3 description, it may be possible to place temporary supplementary members to extend the period before replacement becomes necessary. If the ends of a girder are crushing as a result of excessive pipe size, a detail as shown, in Figure 8.1(i) may be used to help transfer girder end loads to the headstock.

If a girder is approaching Condition State 4 as a result of rotting, an additional girder may be placed immediately adjacent to the defective girder in order to take load. This arrangement, however, modifies the path of loads because of the changed stiffness and layout of the superstructure and has the potential to produce excessive loads to the headstock.

Advice should be sought from Structures Division before using this procedure.

In both these cases, the replacement option should be considered if other major repairs are to be soon carried out or the structure.

Concerns

1. Girders which have been filled with a cementicious material (Set 4S) are occasionally found. This is presumably to stop crushing of a voided girder end. This process is not generally recommended because the rotting at pipe surface will continue and possibly accelerate its rate. However, as a temporary measure, there would be some benefit in transferring load without girder collapse. Bridge Asset Management is examining this process to determine limitations and possible variations using epoxy fillers.

2. Where an outer girder is reused on its side, the combination of old and new cuts for seatings may reduce residual area excessively. Contact Structures Division to determine if this process gives adequate capacity.

Girder Competency

Questions have been raised whether the current practice of using mainly sawn octagonal girders compared to the older round girders is having a detrimental effect on life and functioning of timber girders.

Intuitively, and in practice it is known that the more that cutting into outer layers of a round log occurs, the greater the reduction in life etc. up to a certain point. The least interference with a round girder would occur if the sapwood were left on and pressure treatment (CCA) carried out.

The old DMR process was to trim off the sapwood before use. The effect of this with current design methods is to reduce allowable strength to about 85% of the unshaved member. Likewise design methods for sawn timber intrinsically reduce the strength of an unsawn member.

The reason for the switch from round to sawn girder supply is indeed obscure. From the 1970's, the skills associated with girder de-sapping began to die out, possibly leading to the ready acceptance of sawn members for which the only site work was seating cuts. Less instability problems with stacking etc. associated with flat sided members may also have been a consideration.

Girder Competency cont'd

The Bridge Asset Management position on overall girder durability and strength is that the preferred option is the use of un-sapped round girders (bark only removed) that have been pressure treated with CCA. This will provide the highest strength possible as it reduces the fibre damage caused by shaving off round girders (de-sapping) or the major cuts into the log when sawn to an octagonal shape. It should be noted that CCA treated sapwood will have a strength at least equal to that of the underlying heartwood, and will also provide an effective envelope treatment against fungal and termite attack. Additional protection will need to be applied where seating cuts, drilled holes etc penetrate this layer.

The use of round girders implies a natural taper in a log, which has implications for snipe treatment at the larger end. The dimensional tolerance requirements of MRS 11.87 must also be met.

Bridge Asset Management is currently monitoring a new type of girder log harvesting wherein saw cuts are made on 2 opposite sides for seatings (2 surfaces instead of the normal 8) leaving an essentially round log which is then preservative treated. This method is expected to provide improved durability over the normal sawn girder type, but aethetic and other dimensional tolerance problems of unsapped logs has still to be fully determined.

Girder Preservation

There is much anecdotal evidence that more recent girder installations appear to deteriorate faster than in earlier times when de-sapping round girders were exclusively used and external surfaces envelope treated with creosote. Subsequent to the cessation of creosote use a considerable number of years ago, DMR has not issued advice or recommended alternative products, and the general use of envelope surface treatment of timber girders would appear to have ceased.

Undoubtedly, some improvement in untreated girder longevity would be provided by the application of a suitable surface preservative which could reduce the effect of weathering, drying out and surface rotting. No information is available on cost / effectiveness of such external protection to a girder without the necessary associated trial and monitoring, however.

If a District was to consider a trial use of an overall envelope preservative, the outer girders at least should be so treated. Bridge Asset Management recommends the application of the deffusing preservative Borocol followed by a covering of copper napthanate timber oil. The boron fungicide will diffuse into the timber while the CN oil will help prevent the leaching out of the boron product, preserve the surface layer of timber and reduce water entry. The following procedure is applicable:-

- Wash down girder to remove dirt
- Ensure girder surface is water saturated and spray full surface with Borocol.
- Allow Borocol to dry for 24 to 48 hours.
- Spray full surface with copper napthanate timber oil.
- Pack girder cracks and checks with thick copper napthanate emulsion paste.

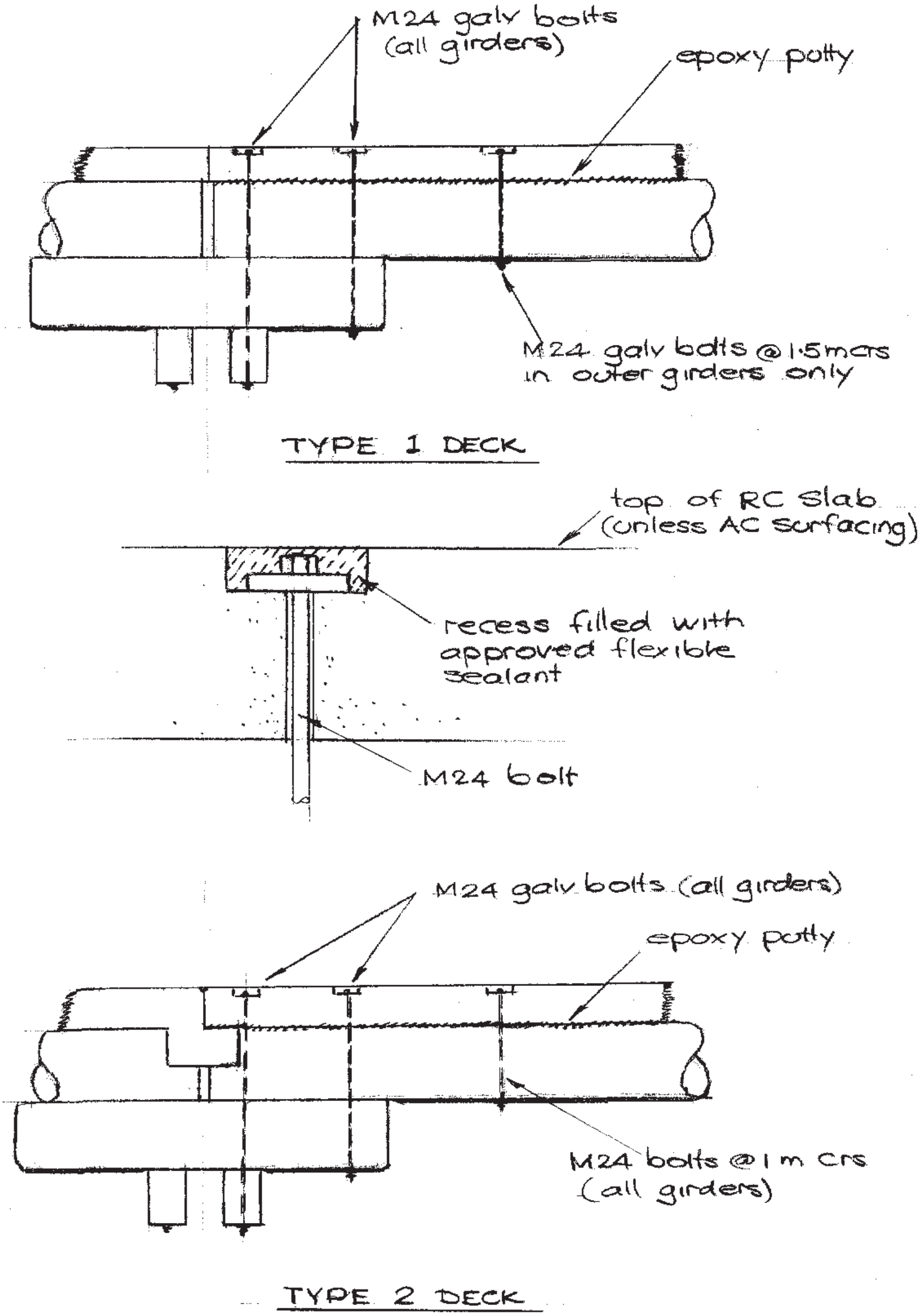


Figure 8.1(k) - Girders - RC Deck

2

Though this procedure is recommended, the expected effective life of the CN Oil, particularly in areas exposed to direct sunlight is not currently known, and monitoring will be needed to determine rates of re-application. It should also be noted that although sawn octagonal girders may be CCA treated before supply, the treatment is only effective in the residual sapwood remnants. All surfaces should be treated as shown above. Where un-sapped CCA treated girders are used, no additional surface treatment is considered necessary.

Although safety concerns associated with the use of CN and boron products are much less than those with creosote, the manufacturers application and other safety requirements shall be strictly followed.

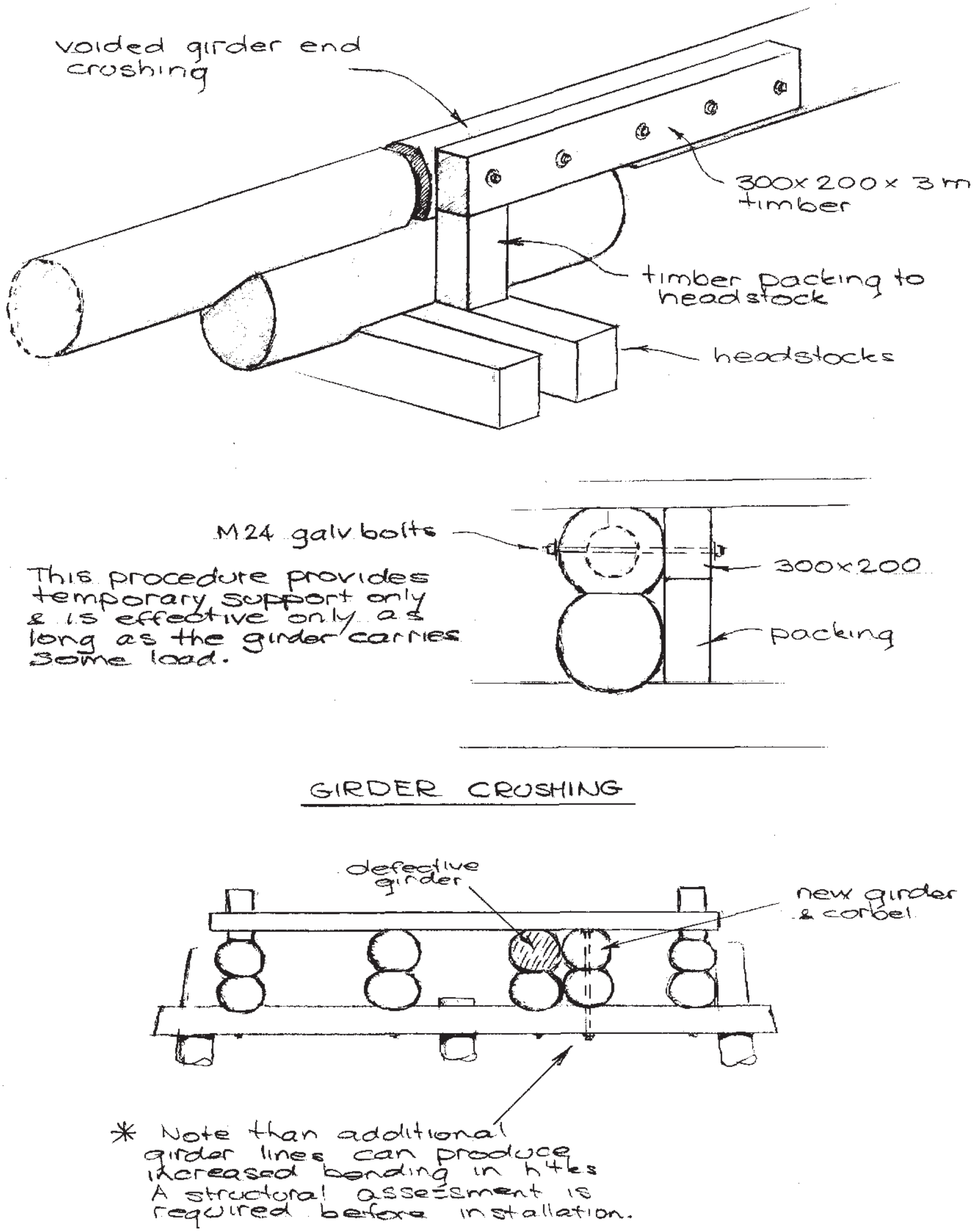
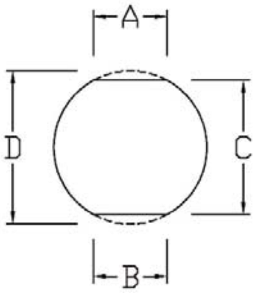


Figure 8.1(l) - Supplementary Members

SEATING WIDTHS - GIRDERS



O = outer
I = inner
C = centre
Dim 'A' for outer girder is taken as average based on specified seating limits
* indicates snipe depth exceeds limit for no strengthening

Bridge Width (m)	O	I	C	Dia D (mm)	A(mm)	B(mm)	C(mm)	Comments
'A' CLASS AT PIER (8.5 - 9.1M SPANS):-								
3.66	0	-	-	4.31	184	256	368	-
5.49	0	-	-	4.31	184	256	368	-
6.1	0	-	-	406	184	225	349	-
'A' CLASS AT ABUT (8.5 - 9.1 M SPANS):-								
3.66	0	-	-	431	184	341	327	83 snipe*
5.49	0	-	-	431	184	341	327	83 snipe*
6.1	0	-	-	406	184	320	305	79 snipe*
'A' CLASS AT PIER (8.5 - 9.1 M SPANS):-								
3.66	-	I	-	482	102	219	451	-
5.49	-	I	-	482	102	219	451	-
6.1	-	I	-	457	102	196	428	-
'A' CLASS AT ABUT (8.5 - 9.1 M SPANS):-								
3.66	-	I	-	482	102	166	463	-
5.49	-	I	-	482	102	166	463	-
6.1	-	I	I	457	102	136	441	-
'A' CLASS AT PIER (8.5 - 9.1 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	482	102	192	457	-
6.1	-	-	C	457	102	167	435	-
'A' CLASS AT ABUT (8.5 - 9.1 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	482	102	124	470	-
6.1	-	-	C	457	102	86	447	
'A' CLASS AT PIER (7.3 - 8.2 M SPANS):-								
3.66	0	-	-	406	184	225	349	-
5.49	0	-	-	406	184	225	349	-
6.1	0	-	-	381	184	240	314	-
'A' CLASS AT ABUT (7.3 - 8.2 M SPANS):-								
3.66	0	-	-	406	184	320	305	79 snipe*
5.49	0	-	-	406	184	320	305	79 snipe*
6.1	0	-	-	381	184	311	276	80 snipe*

Figure 8.1(n) - Girder Seating Widths

2

Bridge Width (m)	O	I	C	Dia D(mm)	A(mm)	B(mm)	C(mm)	Comments
'A' CLASS AT PIER (7.3 - 8.2 M SPANS):-								
3.66	-	I	-	457	102	196	428	-
5.49	-	I	-	457	102	196	428	-
6.1	-	I	-	432	102	222	394	
'A' CLASS AT ABUT (7.3 - 8.2 M SPANS):-								
3.66	-	I	-	457	102	136	441	-
5.49	-	I	-	457	102	136	441	-
6.1	-	I	-	432	102	141	413	-
'A' CLASS AT PIER (7.3 - 8.2 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	457	102	167	435	-
6.1	-	-	C	432	102	202	400	-
'A' CLASS AT ABUT (7.3 - 8.2 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	457	102	86	447	-
6.1	-	-	C	432	102	100	419	-
'A' CLASS AT PIER (7.0 M SPAN):-								
3.66	0	-	-	381	184	240	314	-
5.49	0	-	-	381	184	240	314	-
6.1	0	-	-	355	184	227	289	-
'A' CLASS AT ABUT (7.0 M SPAN):-								
3.66	0	-	-	381	184	311	276	80 snipe*
5.49	0	-	-	381	184	311	276	80 snipe*
6.1	0	-	-	355	184	289	254	77 snipe*
'A' CLASS AT PIER (7.0 M SPAN):-								
3.66	-	I	-	432	102	222	394	-
5.49	-	I	-	432	102	222	394	-
6.1	-	I	-	406	102	196	374	
'A' CLASS AT ABUT (7.0 M SPAN):-								
3.66	-	I	-	432	102	141	413	-
5.49	-	I	-	432	102	141	413	-
6.1	-	I	-	406	102	118	390	-

Figure 8.1(n) - Girder Seating Widths

2

Bridge Width (m)	O	I	C	Dia D (mm)	A(mm)	B(mm)	C(mm)	Comments
'A' CLASS AT PIER (7.0 M SPAN):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	432	102	202	400	-
6.1	-	-	C	406	102	168	381	-
'A' CLASS AT ABUT (7.0 M SPAN):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	432	102	100	419	-
6.1	-	-	C	406	102	68	397	-
'A' CLASS AT PIER (6.1 - 6.7 M SPANS):-								
3.66	0	-	-	355	184	227	289	-
5.49	0	-	-	355	184	227	289	-
6.1	0	-	-	-	-	-	-	-
'A' CLASS AT ABUT (6.1 - 6.7 M SPANS):-								
3.66	0	-	-	355	184	289	254	77 snipe*
5.49	0	-	-	355	184	289	254	77 snipe*
6.1	0	-	-	-	-	-	-	-
'A' CLASS AT PIER (6.1 - 6.7 M SPANS):-								
3.66	-	I	-	406	102	196	374	-
5.49	-	I	-	406	102	196	374	-
6.1	-	I	-	-	-	-	-	-
'A' CLASS AT ABUT (6.1 - 6.7 M SPANS):-								
3.66	-	I	-	406	102	138	387	-
5.49	-	I	-	406	102	138	387	-
6.1	-	I	-	-	-	-	-	-
'A' CLASS AT PIER (6.1 - 6.7 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	406	102	168	381	-
6.1	-	-	C	-	-	-	-	-
'A' CLASS AT ABUT (6.1 - 6.7 M SPANS):-								
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	406	102	68	397	-
6.1	-	-	C	-	-	-	-	-

Figure 8.1(o) - Girder Seating Widths

8.2 Steel Girders

Bridge Inspection Manual Component No. 22S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
22S1 Strengthen steel girder	Each
22S2 Install top flange restraints	Lump sum
22S3 Straighten steel girder	Each
22S4 Replace timber girder with steel girder	Each
22S5 Replace buckle area	Lump sum

Purpose:

The main function of steel girders is to transfer both the self weight of a span and also vertical and longitudinal traffic loads to the substructure. They also act to distribute transverse loads such as wind and flood debris forces to the pier supports.

Significance: ***Significance Rating 4***

Girders are primary structural members and form probably the most critical component of a bridge superstructure. In the event of a girder failure, the consequence of a failure can vary from deck surface deformation to complete span collapse. The outcome depends on the degree of redundancy on redistribution of loads in the bridge, which depends on location and number of girders and the condition of the overlying decking and its ability to span to adjacent girders.

Details:

A small number of steel girder bridge superstructures were built on timber piers and abutments while substitution of steel girder for individual timber girders has also occurred in some past maintenance jobs. As noted in Part 1 Section 6.2, a superstructure design consisting of steel girders with a plywood deck has been developed for use as a full span replacement option on timber bridges. Figure 8.2 shows general details of this and other steel girder usage.

Failure Mechanism

Steel girders will generally fail in bending at the centre of the span as the result of yielding of the lower girder flange, most likely as the result of gross overload, though corrosion could reduce section capacity causing failure at normal loadings. As well, if the top girder flange is not adequately laterally supported by the decking, lateral buckling may occur, drastically reducing bending capacity.

Maintenance Activities:

Refer to Part 3 Item 2.22 (22S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

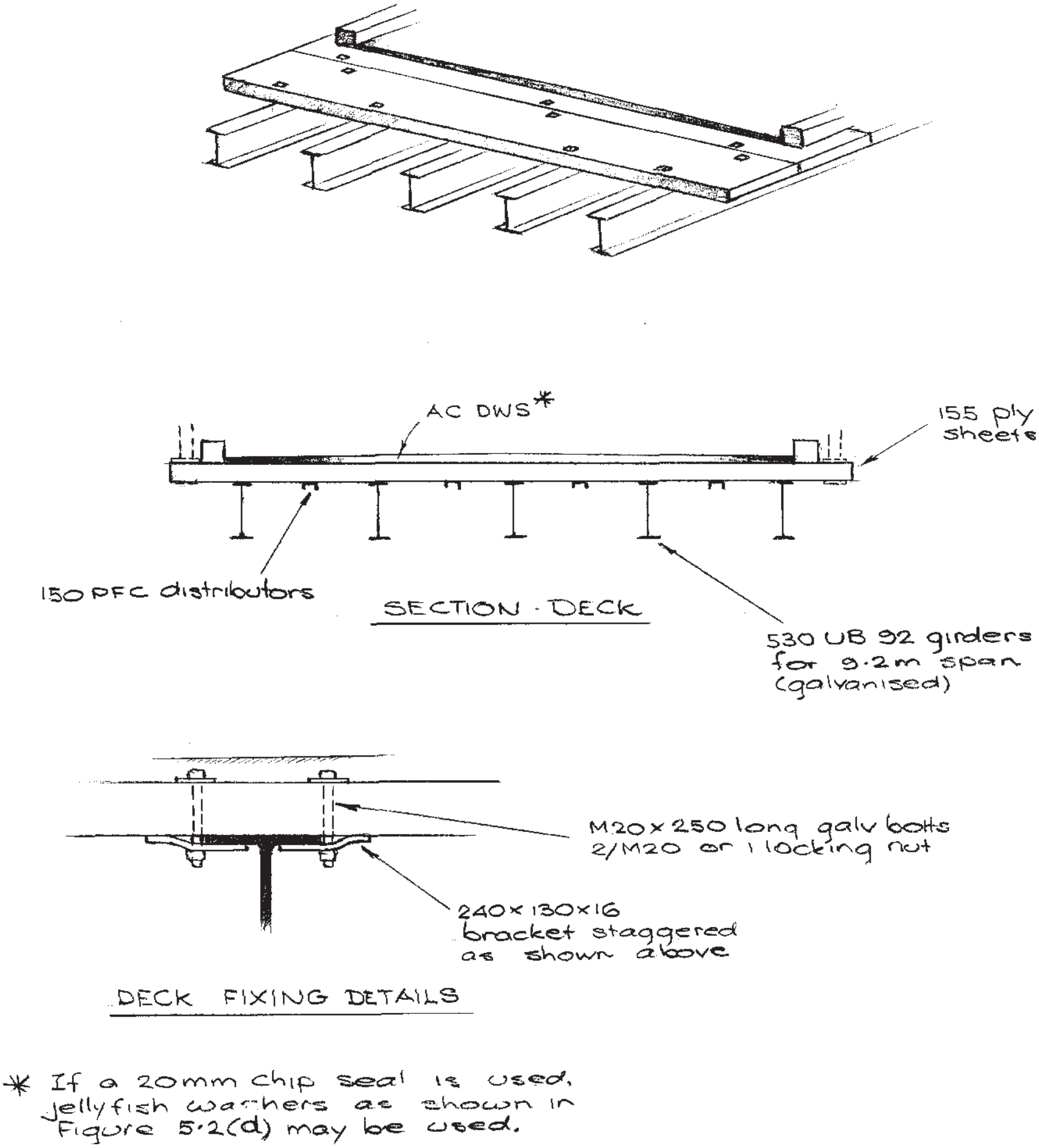


Figure 8.2 - Steel Girders

8.3 Approved Alternative Girders

Future Bridge Inspection Manual Component No. 22O

This component is currently under development as an alternative girder member, which may be substituted for individual timber girders.

Once a suitable alternative girder has been approved, the 4 condition states applicable to this member will be included in Appendix D of BIM.

Maintenance Activity Numbers	Units
22O1 Replace girder with approved alternative girder	Each

9.0 Corbels

9.1 Timber Corbels (27T)

Bridge Inspection Manual Component No. 27T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
27T1 Strengthen corbel	Each
27T2 Replace timber corbel	Each

Purpose:

The main function of a timber corbel member is to support the ends of timber girders at piers transferring vertical and horizontal girder loads to the headstock. Timber corbels are not normally incorporated at abutments, and where found, are generally the result of a bridge shortening process.

Traditionally, effective shortening of girder spans due to corbel support has not generally been considered for capacity analysis due to general timber member looseness reducing any continuity benefits at piers. This is being reconsidered pursuant to recent research findings.

The rationale behind the use of corbels was to reduce the potential for girder collapse at pier ends, thereby extending timber girder life. Where the ends of girders are severely rotted, a supporting corbel allows the transfer of girder loads to take place further out from the region of the relatively narrow pier headstock. For this interaction to work, however, the corbel itself requires sufficient supporting capacity.

2

Significance: ***Significance Rating 3***

Though not a primary structural member, the consequences of corbel failure could vary from the settlement of the supported girder to the girder end dropping off the head stock, resulting in bridge unserviceability and closure.

Details:

Timber corbels consist of round log or sawn octagonal members of generally standardized lengths and diameters depending on location and bridge class. Figure 9.1(a) shows typical details normally found. Some variations have occurred in longer span bridges, where longer or doubled corbels have been used to try to reduce the effective span length of the girders.

Failure Mechanism:

Lack of end treatment or maintenance thereof leads to susceptibility to insect or fungal attack and timber corbels will generally fail by crushing or collapse as a result of loss of section due to piping, generally combined with severe longitudinal splitting. Bending failure may occur if excessive notching at headstock seating locations has taken place.

Materials:

Refer to Specification MRS 11.87 for acceptable species and properties for timber corbels.

Corbels may be supplied as

(a) Naturally round timber with sapwood removed.
(b) Octagonally sawn members.

Maintenance Activities:

Refer to Part 3 Item 2.24 (27T) for recommended maintenance practices applicable to the various expected deterioration states for the component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations and detailed explanations are as follows:-

Routine Maintenance:

Routine or preventative maintenance activities for timber corbels will generally be identified and carried out during Level 1 bridge inspections. These activities would be:-

- Tightening or replacing corbel / headstock bolts.
- Application of surface preservatives or waterproofing agents.

Headstock attachment bolts should be checked for tightness as this reduces potential movement or rocking of the corbel on the headstock.

Where corrosion of attachment bolts is noted, they should be noted for later programmed maintenance.

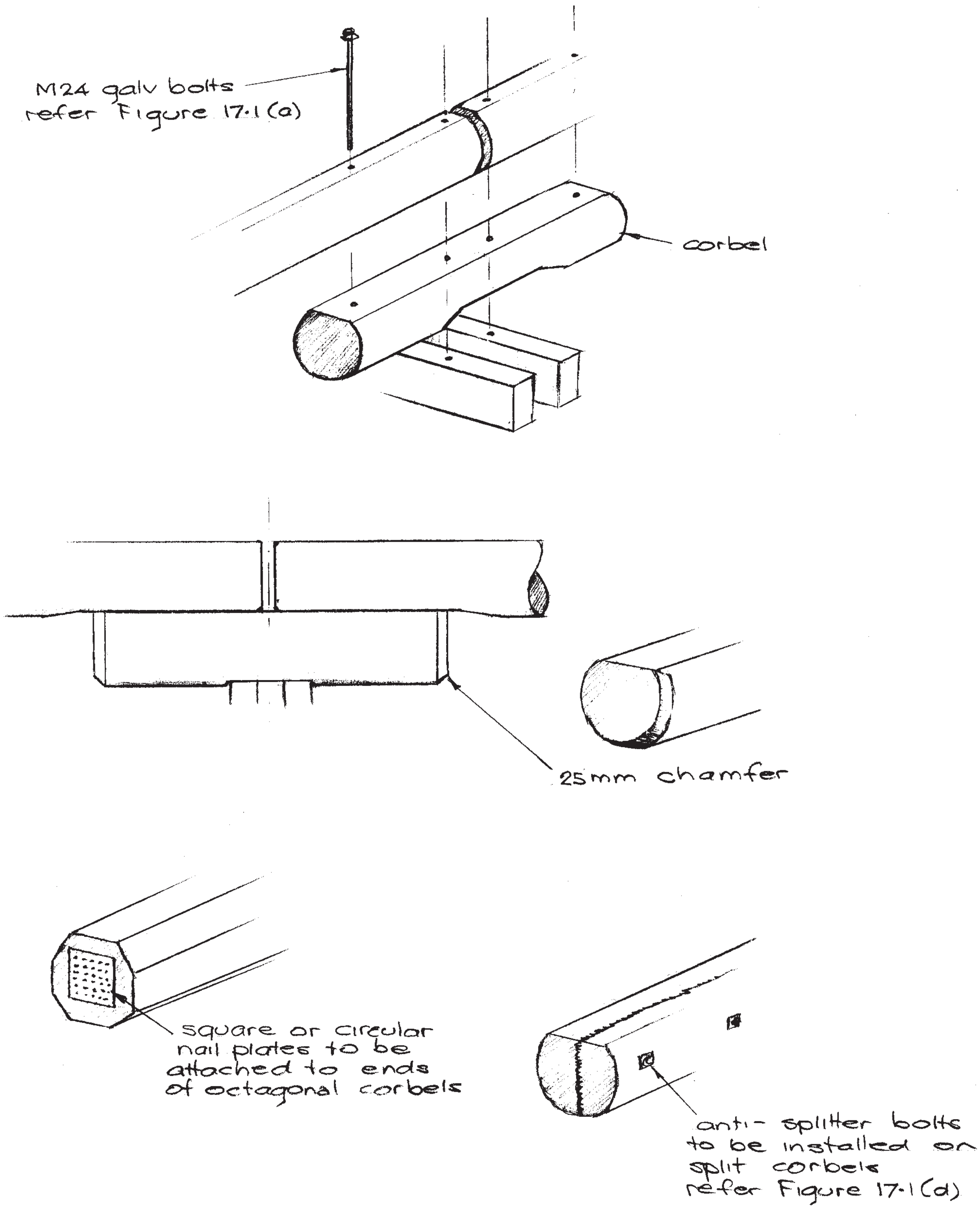


Figure 9.1(a) - Timber Corbels

Where surface rotting is detected, an application of chemical preservative should be made to the effected surfaces to try and slow the fungal attack. Sealant on the ends of the corbels should also be checked and replenished where required. Refer to Section 17.7 for recommended materials.

Additional preventative maintenance actions for timber corbels will take the form of close monitoring during site visits for signs of termite infestations, such as trails or activity in cracks or joints between corbel an girder. Termite activity should be treated as soon as possible after discovering before excessive damage can be done. Refer to Section 17.8 for further details.

Programmed Maintenance:

Any corbel which is identified by inspection as being in Condition State 4, will generally have lost sufficient Section due to decay or termite attack, that the probability of collapse under traffic loads is greatly increased. Corbels in this condition should be replaced.

Where severe deterioration has occurred in the extreme corbel ends only, there may be potential for continuing load transfer between the girder and corbel, however. Figure 8.1(b) (1) shows this situation, which has the effect of extending the time before replacement is necessary. BAM will give advice on this situation if requested.

The main considerations for corbel replacement are:-

(1) Corbel sizes required

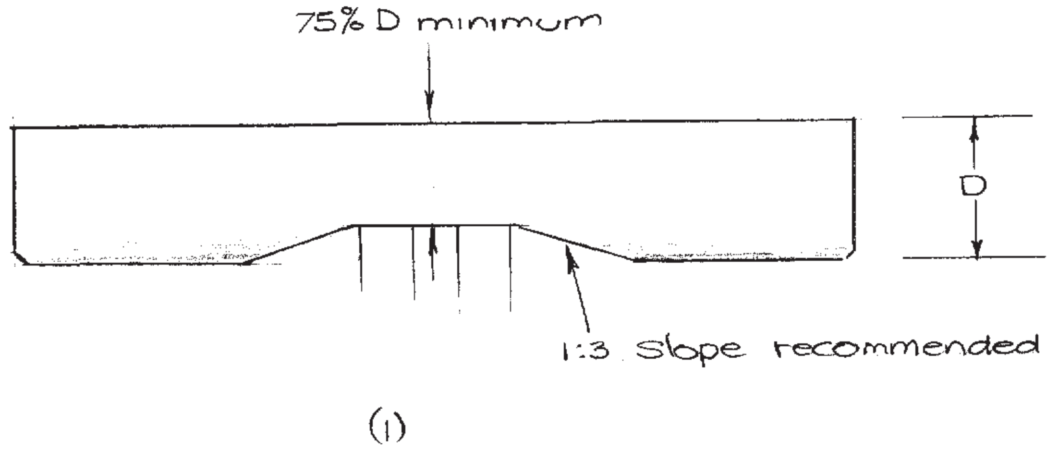
(2) Corbel trimming and snipes.

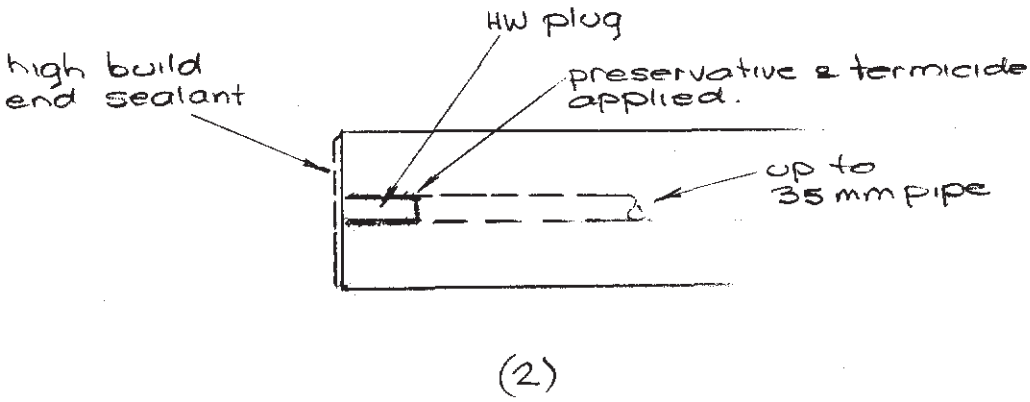
The size of a replacement corbel generally corresponds to that of the girder sizes which are shown in Figure 3.4(b) (Part 1). Length generally depends on bridge design class, but must also be as shown on the specific bridge drawings, as modified lengths or numbers of corbels (vertically) also were not uncommon. Where an increased size outer girder is to be incorporated, generally the corbel size may correspond. However, because corbels are not full structural members, some modification of size may occur to ease assembly.

Trimming of the top and bottom surfaces of the corbel for contact with the girder and headstock helps reduce bearing stresses to acceptable levels. No minimum widths have ever been detailed but the horizontal seating widths obtained for 'A' Class round girders are shown in Figures 9.1(c) & (d) for information.

Notching (or sniping) of the central support area of the corbel for seating on the headstock is required, but care must be taken not to cut away excessive amounts of timber in this process. Section 4.6 (Part 1) briefly discusses requirements for snipes in corbels.

It is recommended that sniping be limited 25% of the corbel depth in order to allow sufficient bending strength over the headstock area to support the loads from the girders. Figure 9.1(b) (1) shows these requirements.





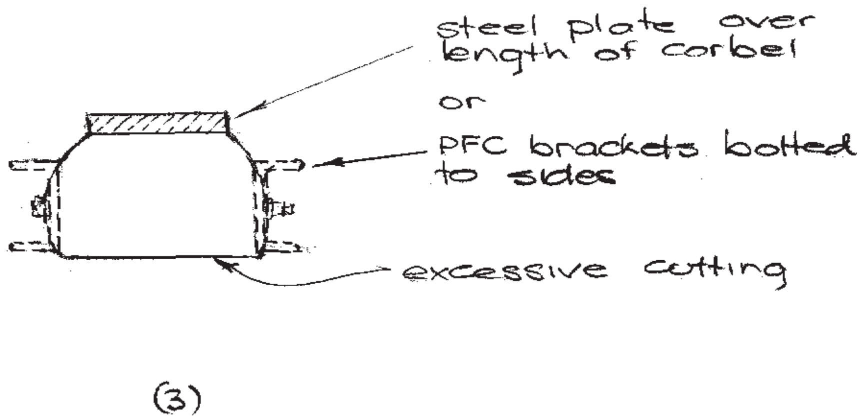
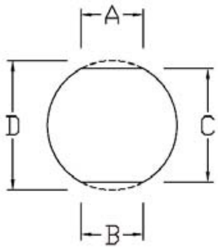


Figure 9.1(b) - Corbel Details

2

SEATING WIDTHS - CORBELS

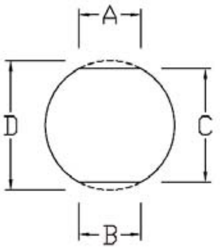


O = outer
I = inner
C = centre
Note: 'A' and 'B' have been made equal

Bridge Width (m)	O	I	C	Dia D (mm)	A(mm)	B(mm)	C(mm)	Comments
'A' CLASS (8.5 - 9.1 M SPANS):-								
3.66	0	-	-	431	202	202	381	-
5.49	0	-	-	431	202	202	381	-
6.1	0	-	-	406	201	201	352	-
3.66	-	I	-	482	206	206	435	-
5.49	-	I	-	482	206	206	435	-
6.1	-	I	-	457	204	204	409	-
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	482	206	206	435	-
6.1	-	-	C	457	204	204	409	-
'A' CLASS (7.3 - 8.2 M SPANS):-								
3.66	0	-	-	406	201	201	352	-
5.49	0	-	-	406	201	201	352	-
6.1	0	-	-	381	210	210	317	-
3.66	-	I	-	457	204	204	409	-
5.49	-	I	-	457	204	204	409	-
6.1	-	I	-	432	214	214	374	-
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	482	204	204	409	-
6.1	-	-	C	457	214	214	374	-
'A' CLASS (7.0 M SPAN):-								
3.66	0	-	-	381	210	210	317	-
5.49	0	-	-	381	210	210	317	-
6.1	0	-	-	355	202	202	292	-
3.66	-	I	-	432	214	214	374	-
5.49	-	I	-	432	214	214	374	-
6.1	-	I	-	406	219	219	343	-
3.66	-	-	-	-	-	-	-	-
5.49	-	-	C	432	214	214	374	-
6.1	-	-	C	406	219	219	343	-

Figure 9.1(c) - Corbel Seating Widths

SEATING WIDTHS - CORBELS



O = outer
I = inner
C = centre

Bridge Width (m)	O	I	C	Dia D (mm)	A(mm)	B(mm)	C(mm)	Comments
'A' CLASS (6.1-6.7M SPANS)								
3.66	0	-	-	355	227	227	289	-
5.49	0	-	-	355	227	227	289	-
6.1	0	-	-					
3.66	-	I	-	406	219	219	343	-
5.49	-	I	-	406	219	219	343	-
6.1	-	I	-					
3.66	-	-	-	-				-
5.49	-	-	C	406	219	219	343	
6.1	-	-	C					

Figure 9.1(d) - Corbel Seating Widths

Where existing details are such that snipe depths would exceed the above requirements, contact BAM for advice. A strengthening procedure such as shown in Figure 9.1(b) (3) may be possible.

Where new corbels are supplied with a pre-existing pipe, (up to 35mm allowed), this shall be plugged before erection as shown in Figure 9.1(b) (2). The ends of corbel shall be neatly trimmed as shown in Figure 9.1(a).

Where corbels are supplied with longitudinal cracks exceeding 10mm in width, anti-splitter bolts shall be installed to reduce further tendency to split. Refer to Figure 17.1(d) for recommended details.

Before corbel erection, the ends shall be treated with a timber preservative and a thick grease applied (refer to Figure 17.7). Where sawn octagonal corbels are supplied, an end nailing plate shall be attached as shown a Figure 9.1(a). Nail plates are recommended on the ends of all corbels irrespective of section.

All contact surfaces between the new corbel and girders or headstock shall be treated with a preservative, grease and a bituminous felt placed.

The general corbel replacement procedure would be:-

- Prop overlying girder to remove all load from the corbel.
- Remove or cut out corbel / girder and corbel / headstock bolts. This will generally require lifting of kerbs and overlying deck planks.

- Remove defective corbel.
- Installation of new corbel including drilling and bolt assembly. If existing bolt holes cannot be reused, a modified hold down to the headstocks may be required.
- Remove jacks to transfer loads back on to corbel.
- Replace deck planks and kerbs and DWS where required.

9.2 Concrete Corbels (27C)

Bridge Inspection Manual Component No. 27C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to general concrete repair Activities	

Purpose:

The main function of a concrete corbel is to support the ends of timber girders at piers (and possibly abutments), helping to transfer girder loads to the headstocks. Effective shortening of girder spans due to corbel support is considered to occur.

Significance: ***Significance Rating 3***

Concrete corbels were sometimes used with concrete substructures to provide the same function as timber corbels, i.e. to reduce the potential for girder collapse at the ends, thereby extending timber girder life. Where the ends of timber girders are severely rotted, a supporting corbel allows the transfer of girder loads to take place further out from the normally narrow headstock. The concrete corbel is not a primary structural member and failure should not lead to bridge serviceability problems (provided the girder end is sufficiently sound) as load will now transfer directly to the headstock area. Where girder ends are rotted, however, girder failure could still occur outside the limit of the deteriorated corbel.

Details:

Figure 9.2 shows typical details used for concrete corbels, which are used on concrete piers.

Failure Mechanism:

The most common form of defect found is spalling due to either corrosion of reinforcement or due to superstructure induced edge loading. Significant spalling may reduce support area for the corbel. If the end of the girder is sound, vertical loads will transfer through and area closer to the pier stem. If there is also crushing occurring in the girder end, there could be a significant girder settlement.

2

Maintenance Activities:

Refer to Part 3 Item 2.25 (27C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

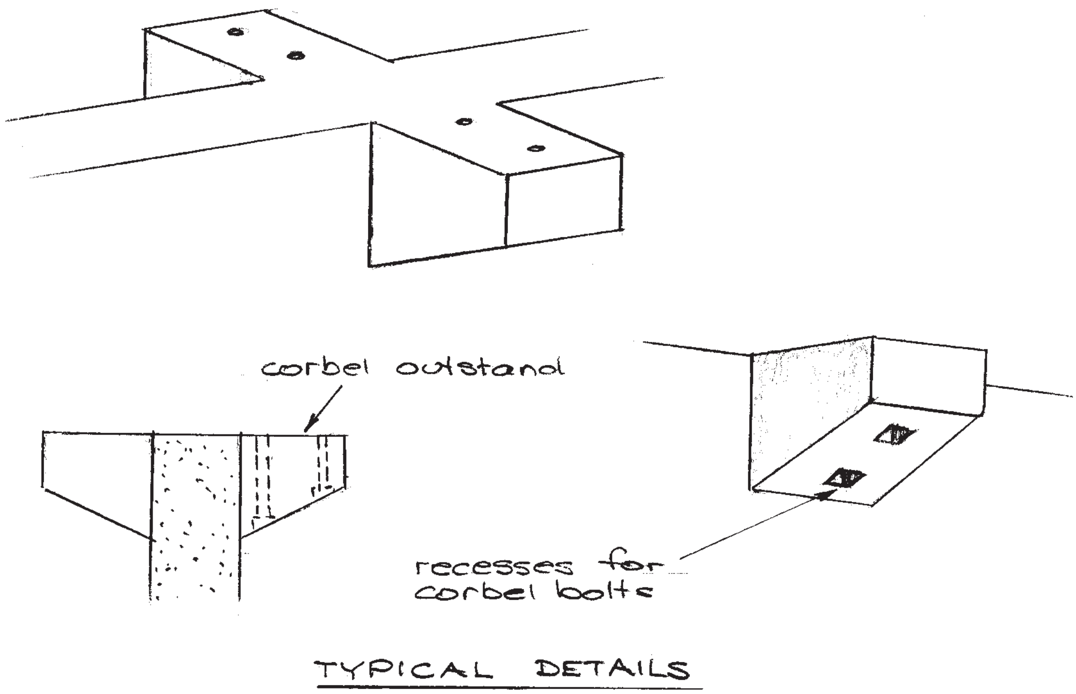


Figure 9.2 - Concrete Corbels

2

10.0 Headstocks

10.1 Timber Headstocks (54T)

Bridge Inspection Manual Component No. 54T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
54T1	Place supplementary member	Lump sum
54T2	Reconstruct splice	Each
54T3	Relocate headstock	Each
54T4	Jack girders or headstock to level	Lump sum
54T5	Replace headstock in timber	Each
54T6	Splice in new headstock section	Each

Purpose:

The main function of headstock members is to transfer vertical and longitudinal loads from the girders and corbels to substructure piles.

They also act in conjunction with diagonal bracing and wales to distribute horizontal loads such as wind and debris forces through the substructure.

Significance: ***Significance Rating 4***

Headstocks are primary structural members and form a critical component of piled substructures. Failure of headstock members will lead to partial collapse and unserviceability of the complete structure.

Details:

The most common form of headstock is an open type, consisting of double members in sawn hardwood, notched into and bolted to the top of the timber piles. This configuration was adopted for ease of member replacement. Note that vertical load transfer to the pile is meant to be through bearing on the pile notch rather than through shear of the connection bolts.

Figure 10.1(a) shows the general details for this type of headstock. Member sizes have been standardized depending on the design class of the bridge, and these must be adhered to as minimum sizes.

An alternative solid headstock which could be a sawn, hewn or round log member was also used in early bridges, but very few of these now remain. In these, the headstock was morticed to fit over tenons on the pile tops, as shown in Figure 10.1(b).

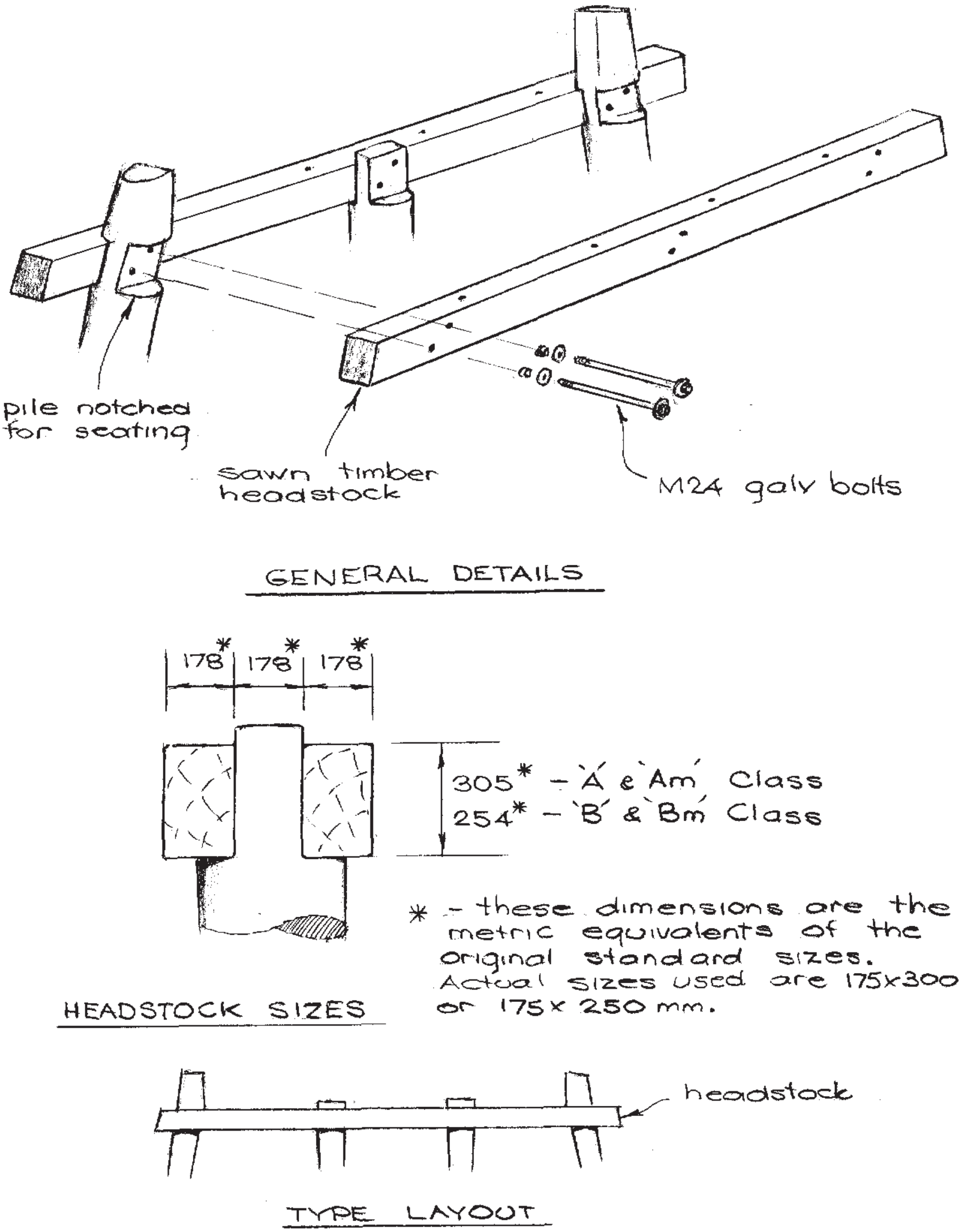


Figure 10.1 (a) - Timber Headstocks - Open Type

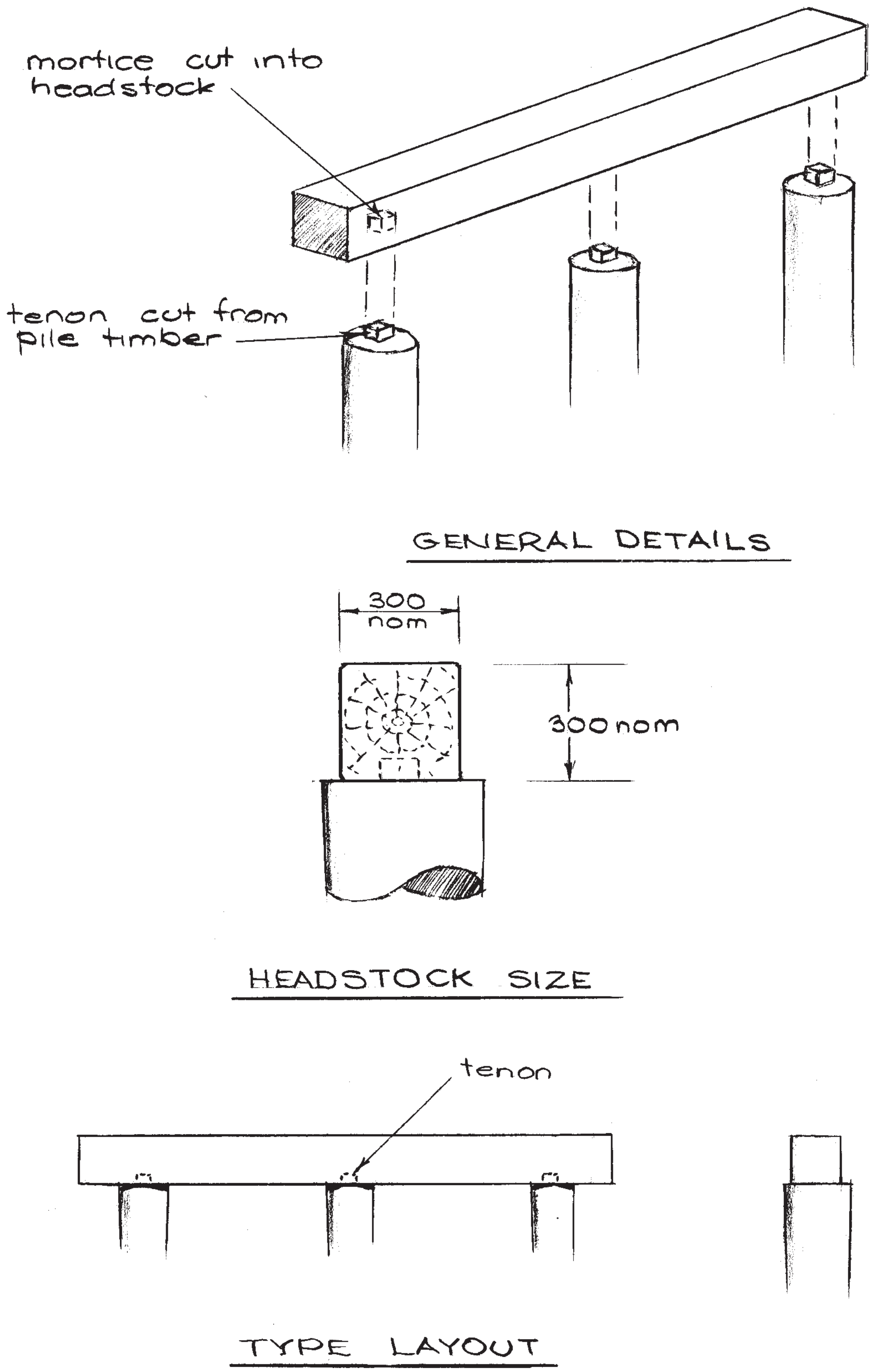


Figure 10.1(b) - Timber Headstock - Solid Type

Failure Mechanism:

Because of the conventional arrangement of girders and piles in timber bridges, both bending and shear are important considerations in headstocks, though most recorded failures appear to be bending related.

In addition to Part 3 Item 2.26 (54T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Though some headstock failures appear to be the result of a passage of a grossly overloaded vehicle, in most cases, reduced member capacity caused by deterioration processes such as decay, insect attack or fire, has led to an inability to support normal legal loads.

Horizontal cracking, particularly where it occurs across the full width of a member will also significantly reduce a headstock member capacity. Bending failure will normally result in vertical cracking over pile supports or under centrally placed girders.

Materials:

Refer to Main Roads Specification MRS 11.87 for acceptable timber species and properties for timber headstocks.

There is currently widespread acceptance within Main Roads that central heart material should not be present in sawn timber for open headstocks because of the potential for accelerated decay within this region of the member. However, DMR Specifications up to the latest issue (circa 1950) specifically allowed the presence of heart in timber above decking size, proved it was not exposed along the sides of the member.

It would appear that excluding heart material would be the most cost effective strategy considering cost versus life of a headstock member.

However, it is noted that supply of large section sawn timber is becoming increasingly difficult to secure. As well, back and quarter sawn timbers have the potential for significant warp or bowing due to the differing rates of radial shrinkage (refer to Article 4.5) (Part 1). This can result in assembly and seating difficulties. To overcome these problems, it is considered acceptable to allow heart centrally in the headstock member, provided its width is increased to 200mm. In addition, end protection in the form of a heavy application of grease or copper napthenate emulsion should be applied and the end enclosed in a galvanised capping.

Refer to Article 6.4 (Part 1) for a discussion of alternative headstock materials such as steel section or plywood (softwood) and their acceptability for maintenance work.

Maintenance Activities:

Refer to Part 3 Item 2.26 (54T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

2

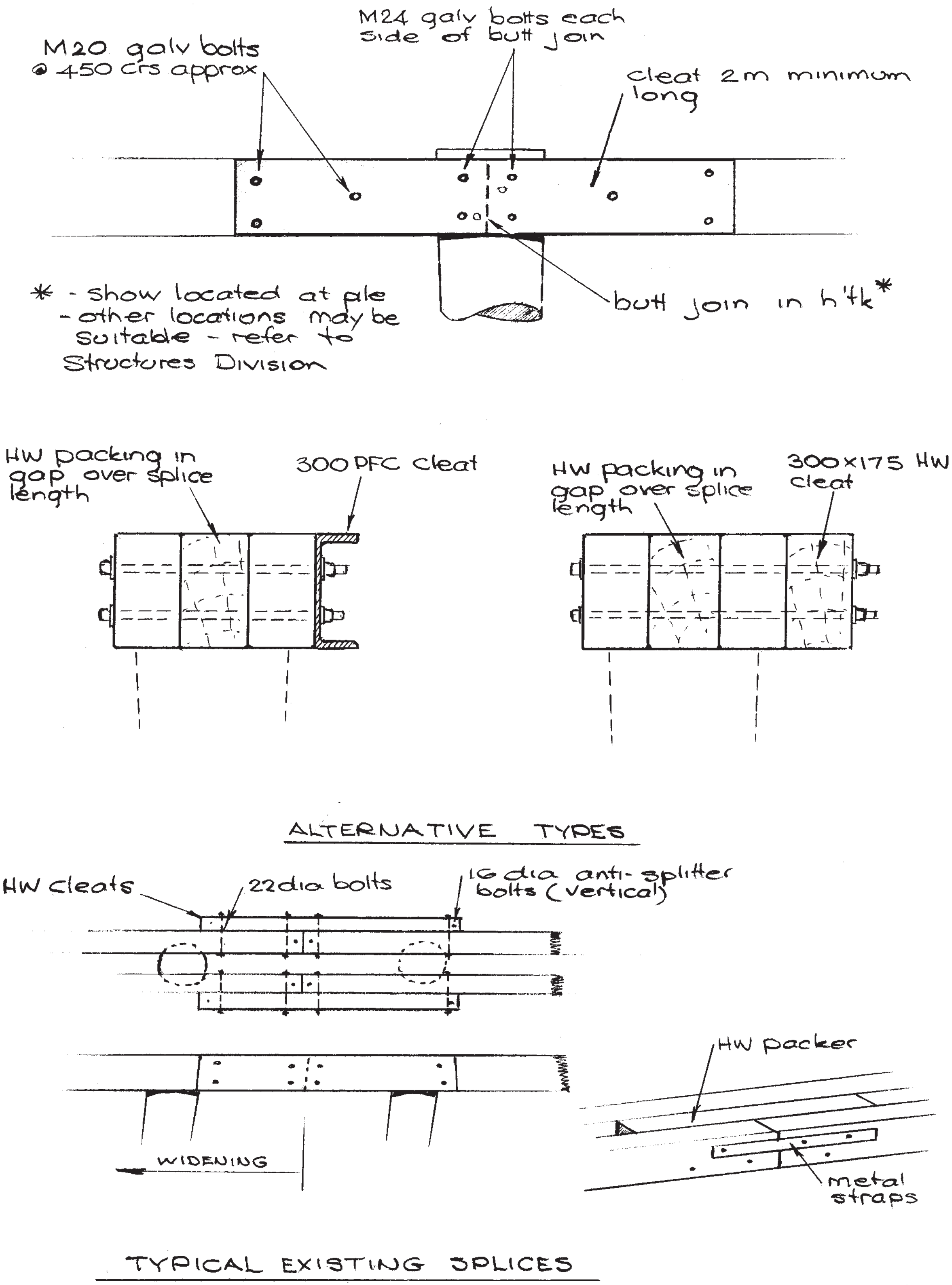


Figure 10.1(c) - Headstock Splicing

Further consideration and detailed explanations are as follows:-

Routine Maintenance

Routine or preventative maintenance actions for timber headstocks will generally be identified and carried out during Level 1 bridge inspections. These activities would be:

- Tightening or replacing headstock/pile bolts
- Application of surface preservatives or waterproofing agents
- Emergency propping of cracked or sagging headstock member, or checking existing propping for tightness

The pile attachment bolts should be checked for tightness as this will prevent possible differential movement between headstock and pile. Where corrosion of bolts is evident, they should be withdrawn and replaced by galvanised bolts of the same diameter if loss of section is evident. The bolt holes through the headstock should be coated/packed with CN Emulsion or thick grease before bolt insertion. Adjacent seating of the headstock on the pile notch should be checked.

The tin caps at the ends of the headstocks should be removed to check for signs of decay or severe splitting and drying out of the previous end treatment. For headstocks determined to be in Condition State 4, replacement should be programmed. Up to CS3, however, end treatment with CN emulsion and petroleum jelly or grease should be carried out and the tin cap replaced.

Where a headstock is found to have broken, sagged noticeably or has other severe structural defects, emergency tomming may be used to allow continued operation of the bridge. Figure 17.11(a) shows typical prop details.

A number of alternative propping arrangements have been used to temporarily (often long term in practice) support failing headstock members. Figure 17.11(a) shows a number of these, which, in general, will be carried out subsequent to the Level 1 inspection.

Programmed Maintenance

Headstocks in Condition State 4 will have significantly reduced capacity and must be programmed for replacement, or alternatively a new replacement section spliced to an acceptable portion of the length. In general, replacement of the full length of a headstock member is recommended as this provides maximum member strength and reduces the number of potential areas of deterioration. Where splicing of a new section is used, details shall be generally as shown in Figure 10.1(c). Note that splicing away from a pile support has been used as a standard detail and may be retained if it appears to be functioning satisfactorily. Contact surfaces and end sections of timber components at the splice must be treated with a timber preservative such as CN oil before assembly.

As an alternative, replacement of a defective headstock with a steel member may also be considered, particularly if there is difficulty in obtaining timber material Refer Article 6.4 (Part 1) and Section 10.2.

General procedures to carry out member replacement would be:

- Prop the girders/corbels to relieve loads on the headstock. Particular attention should be given to bracing the props to prevent slippage, especially if loads are being allowed to use the bridge while it is being repaired. In general it is considered safer to close the bridge, if possible, during headstock replacement.

- The girders/corbels then need to be raised slightly to allow pile/headstock bolting to be undone and the defective headstock removed.
- The new headstock section needs to be slipped into position & drilled, the bolts coated with grease and retightened. The new headstock needs to bear on the pile notch, or steel packers installed to provide direct bearing support. All contact surfaces should be treated with a preservative and grease, and a bituminous felt placed.
- The props are then removed, allowing the girders/corbels to bear on the headstocks again.

Where the headstock is showing minor cracking but is considered to be only Condition State 3, strengthening of the member may be carried out. One solution is to provide a new headstock member immediately below and supporting the deteriorated member as shown in Figure 10.1(d).

The general procedure is:

- The piles beneath existing headstock should be progressively cut, chiseled out and an additional headstock slipped in below the existing member. The new headstock bolts to the piles should be in a different line to those above, to prevent excessive splitting of the pile top. All contact surfaces should be treated with preservative and grease.
- The new headstock should bear hard against the existing headstock as well as the pile notch for good bearing support rather than the bolts providing physical support.
- The additonal support will allow the original headstock to withstand loads placed on it.

Longitudinal cracking on headstock sides has the potential to markedly effect bending and shear capacity if the crack extends the full width of the section. As an example, a full width crack at ½ depth reduces bending strength to ½ that of the solid section. The strength of the member may be reinstated by a full or part length steel plate bolted as shown in Figure 10.1(d). The steel plate is to be galvanised, and preservative such as CN oils is to be placed on the contact area of the timber before assembly.

Additional:

Standard drawings require bracing to be let 25mm into the soffit of headstock members, potentially reducing member strength. A 25mm notch, taken full width reduces bending strength by 16% and shear strength by 9%. Care should be taken to limit such cuts in headstock members to the minimum specified.

Where headstocks have sagged up to 50mm, as a result of pile settlements, the girders should be jacked back to level and shims placed between the headstocks and corbels as shown in Figure 10.1(e).

For larger headstock sags, and if it can be determined that pile settlement is not continuing, the headstock bolts may be released and the headstock jacked back to level. Packing is then placed below the headstock as shown in Figure 10.1(e) to maintain level.

Any sagging in a headstock effectively reduces its capacity in bending and shear.

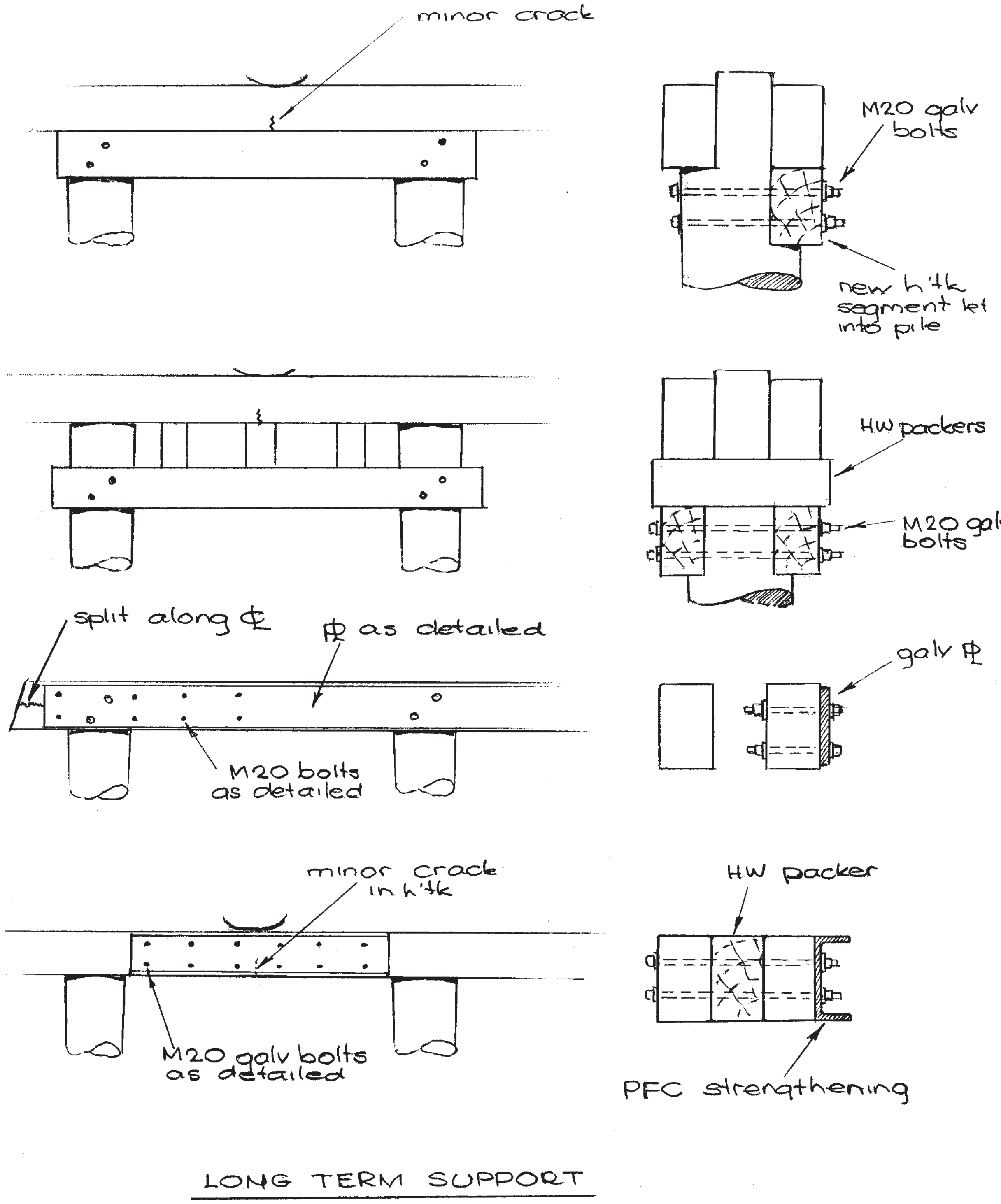
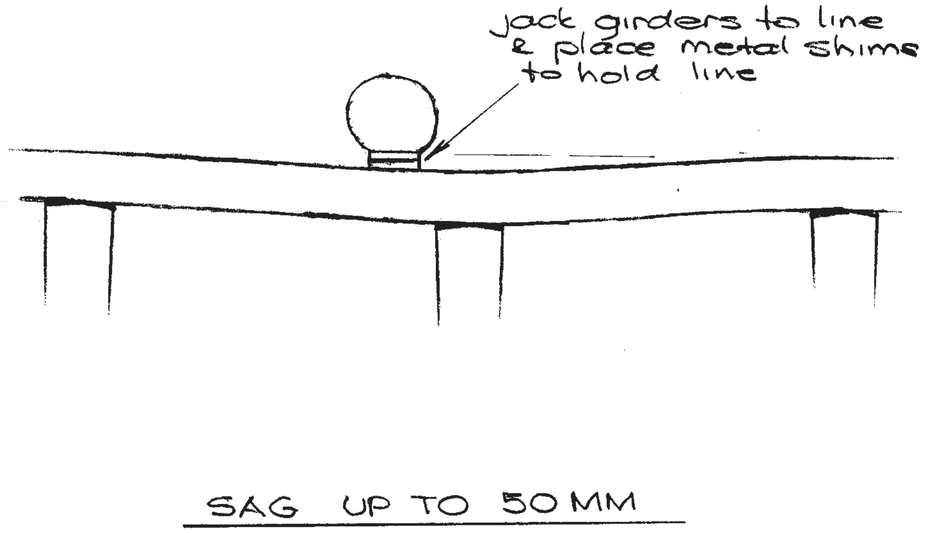


Figure 10.1(d) Headstocks - Supplementary Supports

2



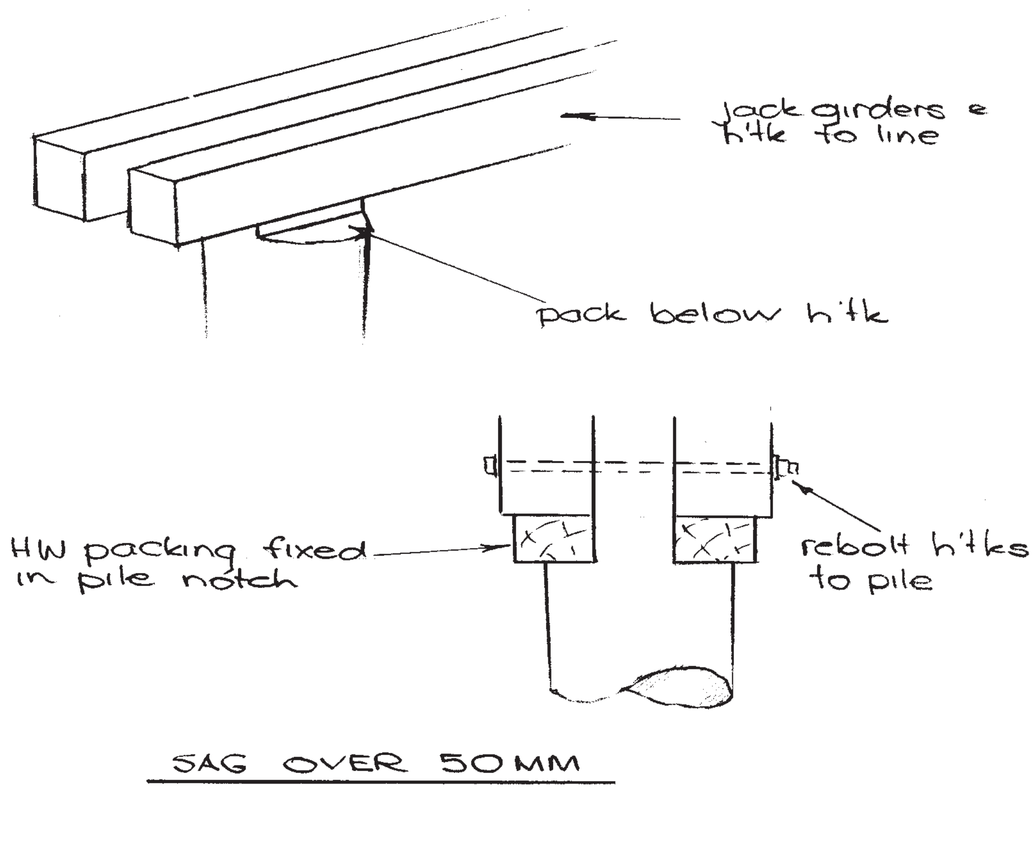


Figure 10.1(e) - Restoring Headstock Levels

10.2 Steel Headstocks (54S)

Bridge Inspection Manual Component No. 54S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
54S1 Relocate headstock	Each
54S2 Replace steel headstock	Each
54S3 Strengthen steel headstock	Each
54S4 Replace timber headstock with steel alternative	Each
54S5 Jack girders or headstock to level	Lump sum

Purpose:

The main function of headstock members is to transfer vertical load from girders and corbels to substructure piles.

They also act in conjunction with diagonal bracing and wales to distribute horizontal loads such as wind and debris forces through the substructure.

Significance: ***Significance Rating 4***

Headstocks are primary structural members and form a critical component of piled substructure. Failure of headstock members will lead to unserviceability of the complete structures.

Details:

Steel headstocks were not, in general, originally used on timber bridges and where found, are normally the result of maintenance replacement of the original timber members.

Steel headstocks are generally of a steel channel section, seated in the original pile notches and clamped to the piles by bolts. Figures 10.2(b), (c) & (d) show recommended details for steel headstock substitution. Figure 10.2(a), shows older details commonly found. Both headstocks must be replaced in order to keep a constant stiffness for each member at a particular pier.

Failure Mechanism:

Steel headstocks will generally fail in bending either under a girder or over a pile support as a result of material yielding in the flanges. This could be the result of gross overloading or the result of significant section loss due to corrosion. Buckling of the top flange of the headstock is considered unlikely.

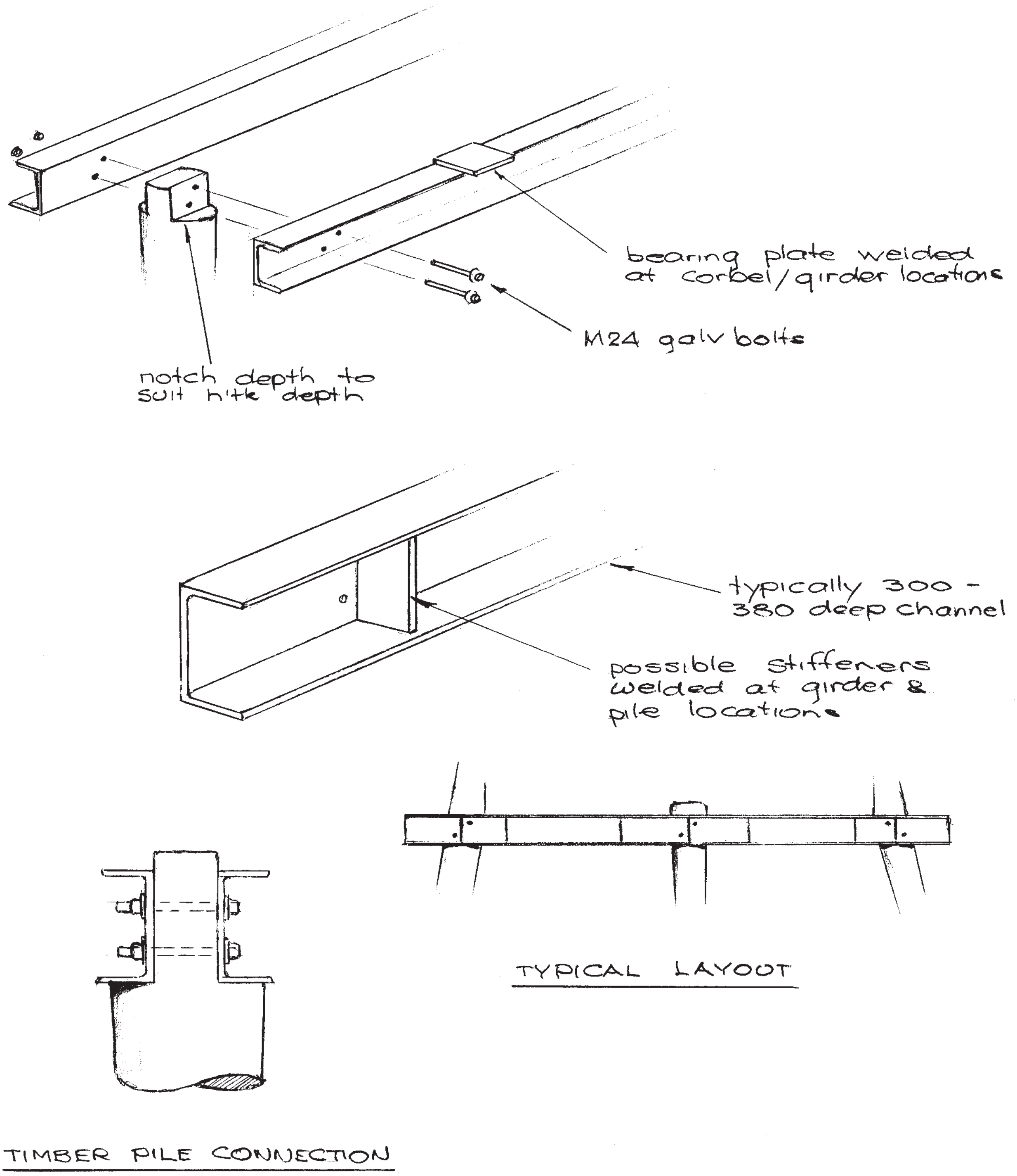


Figure 10.2(a) - Steel Headstocks - General

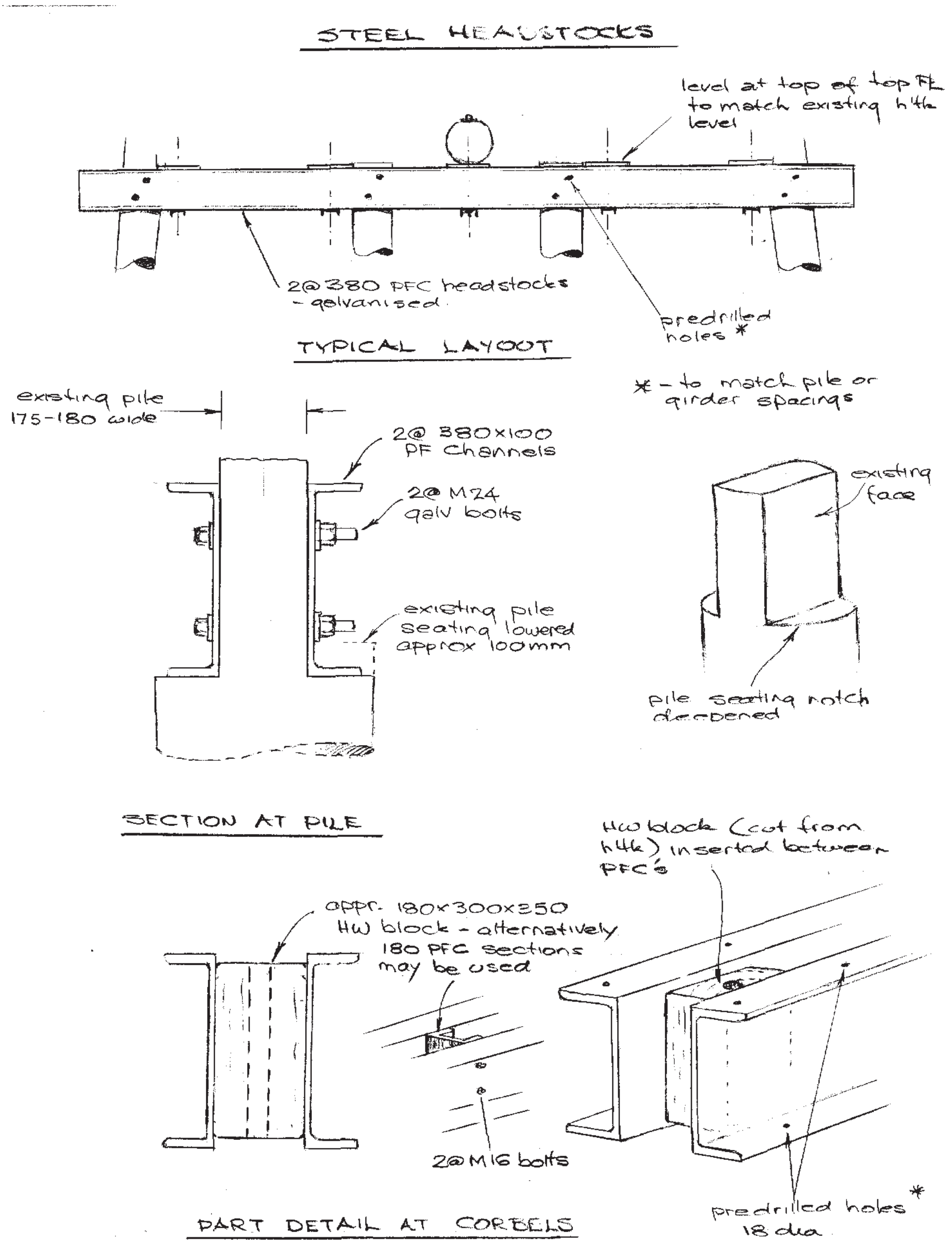


Figure 10.2(b) - Steel Headstocks (1)

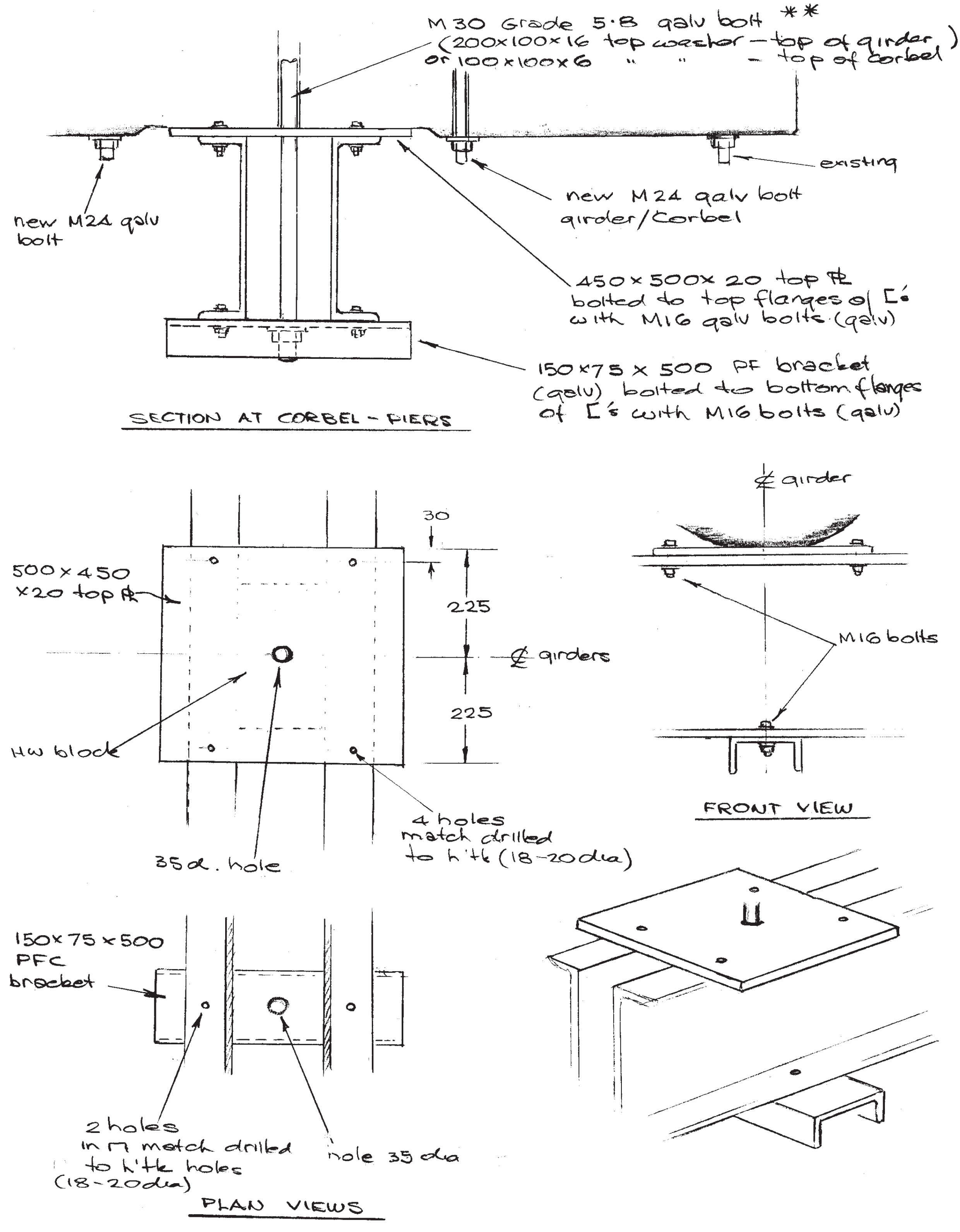


Figure 10.2(c) - Steel Headstocks (2)

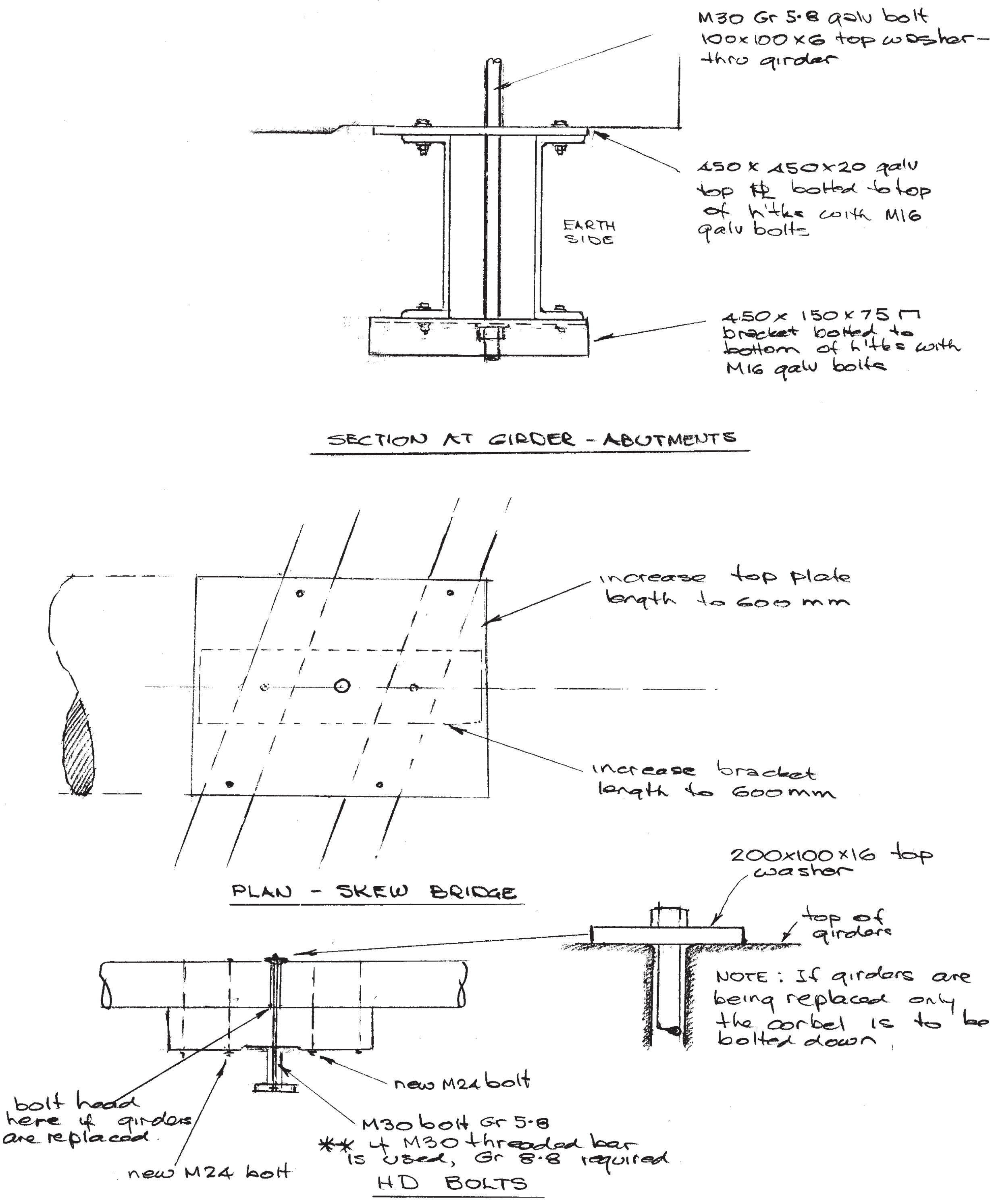


Figure 10.2(d) - Steel Headstocks (3)

2

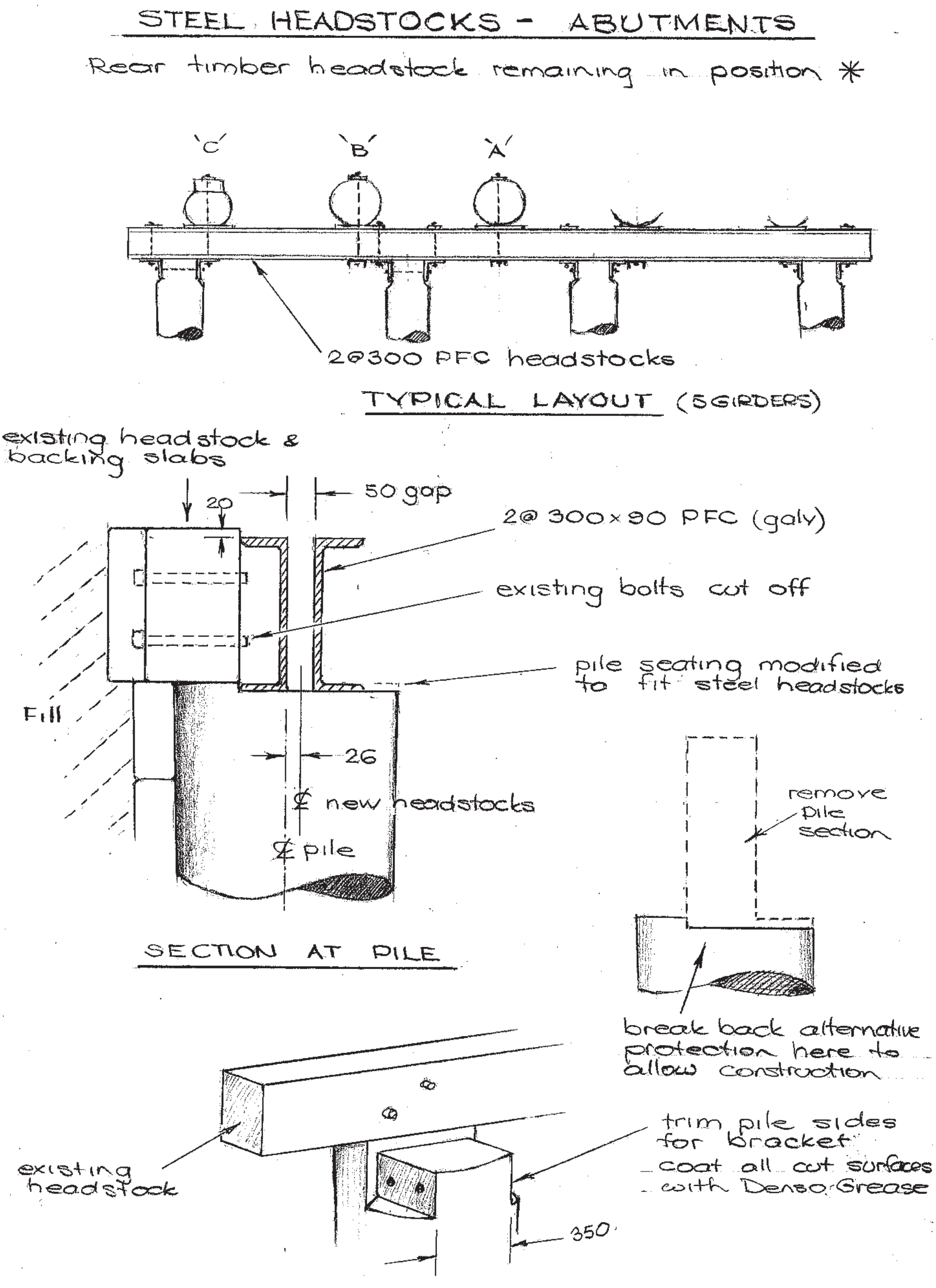


Figure 10.2(e) - Steel Headstocks (4)

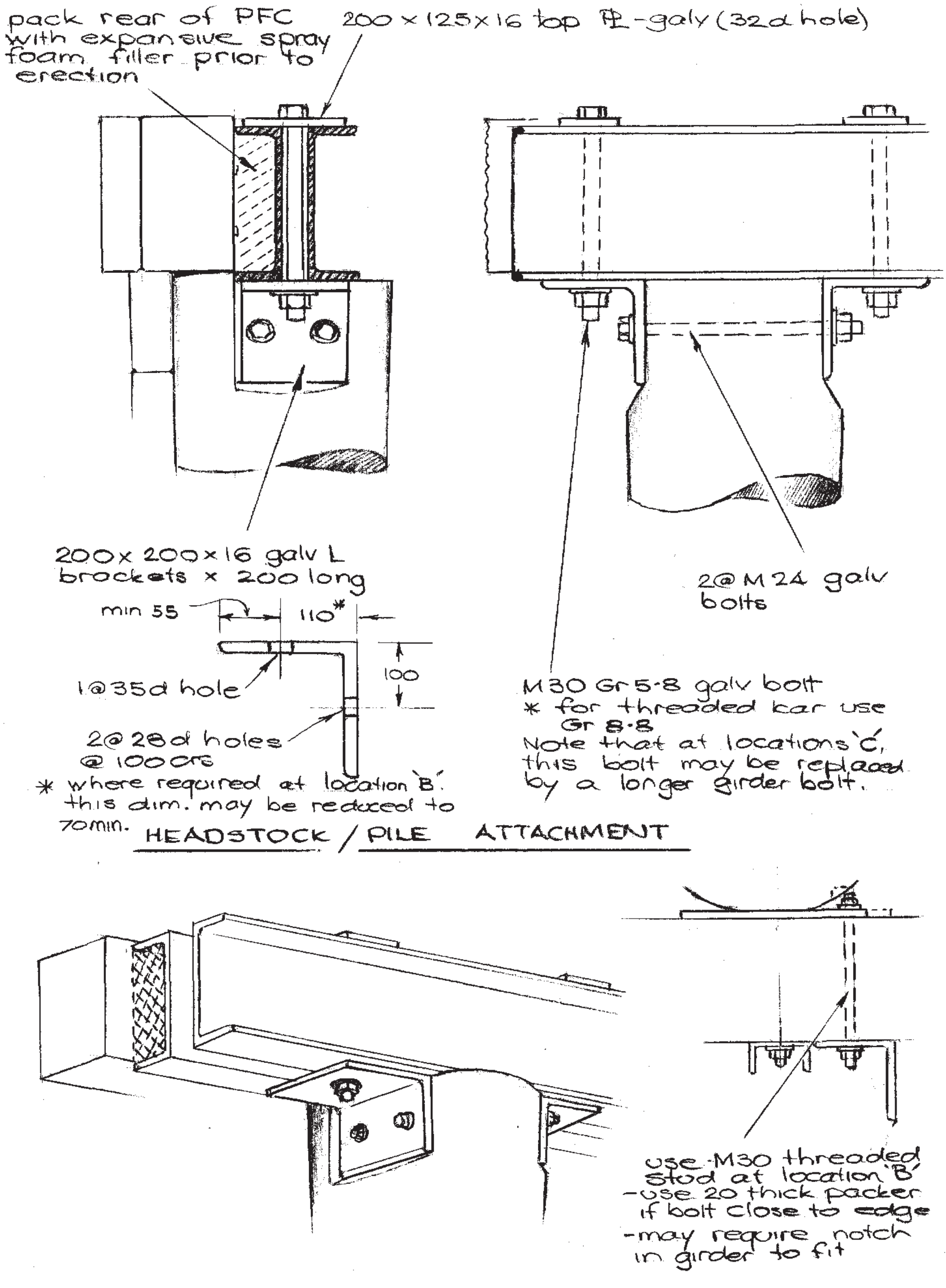


Figure 10.2(f) - Steel Headstocks (5)

2

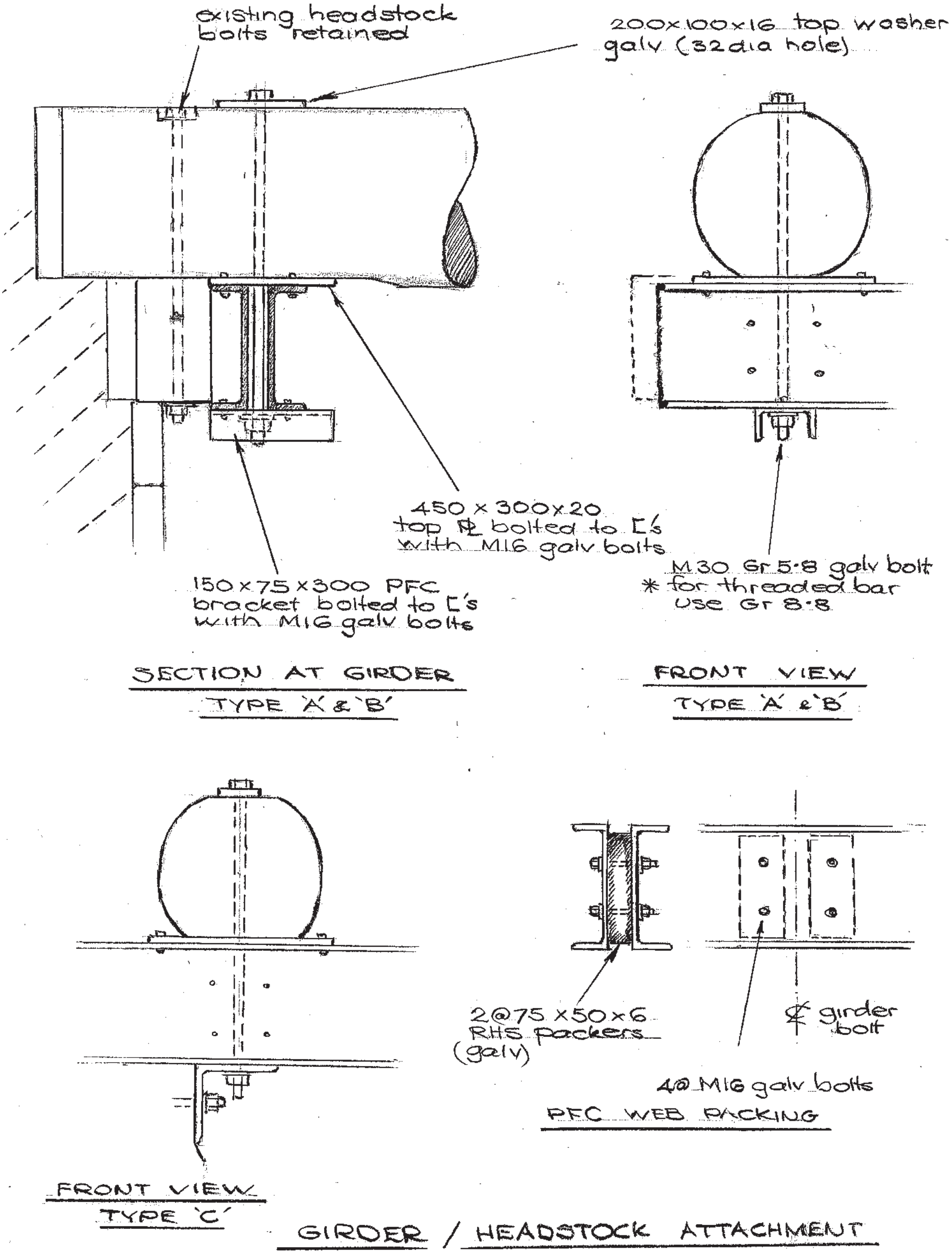


Figure 10.2(g) - Steel Headstocks (6)

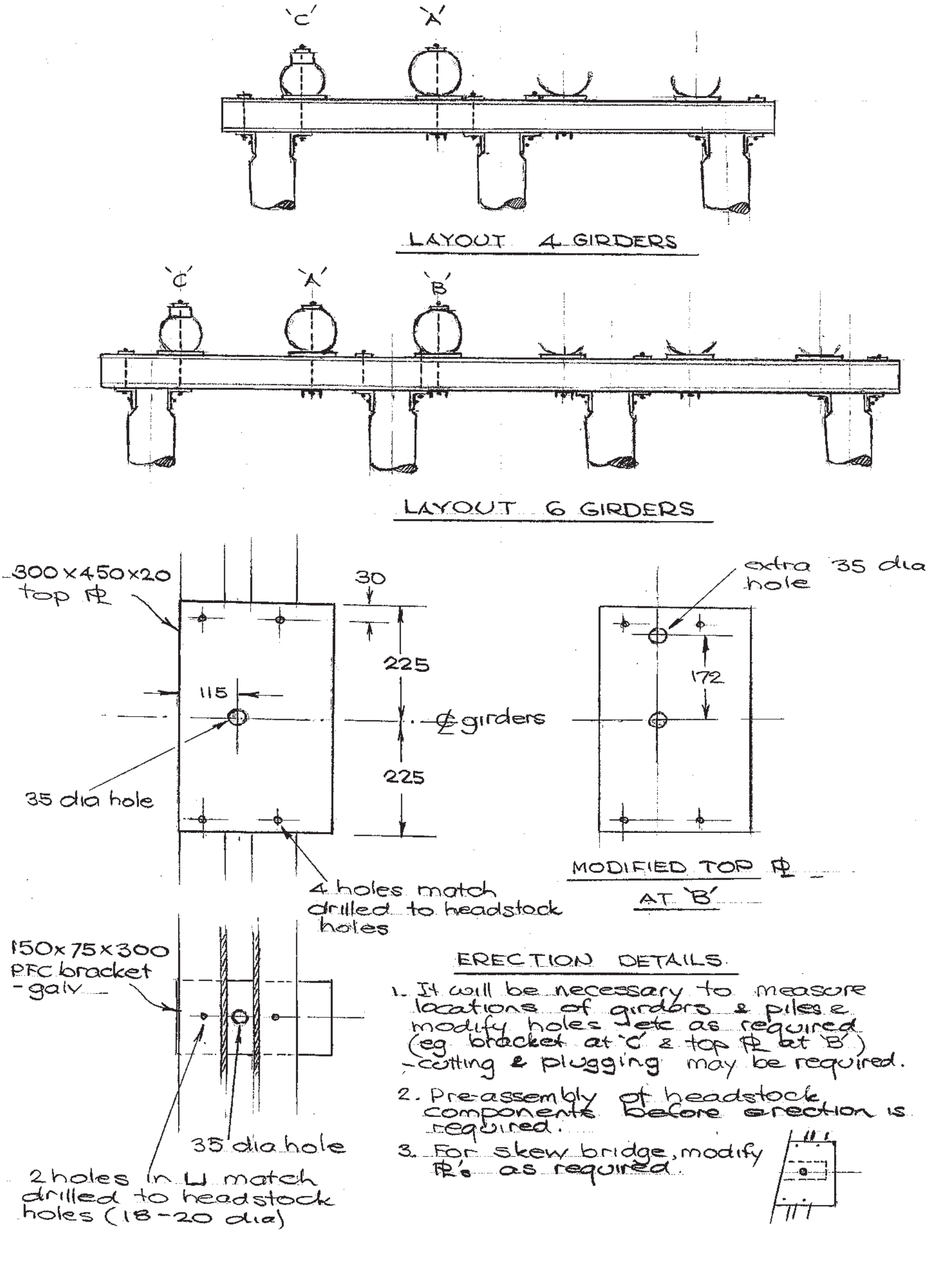


Figure 10.2(h) - Steel Headstocks (7)

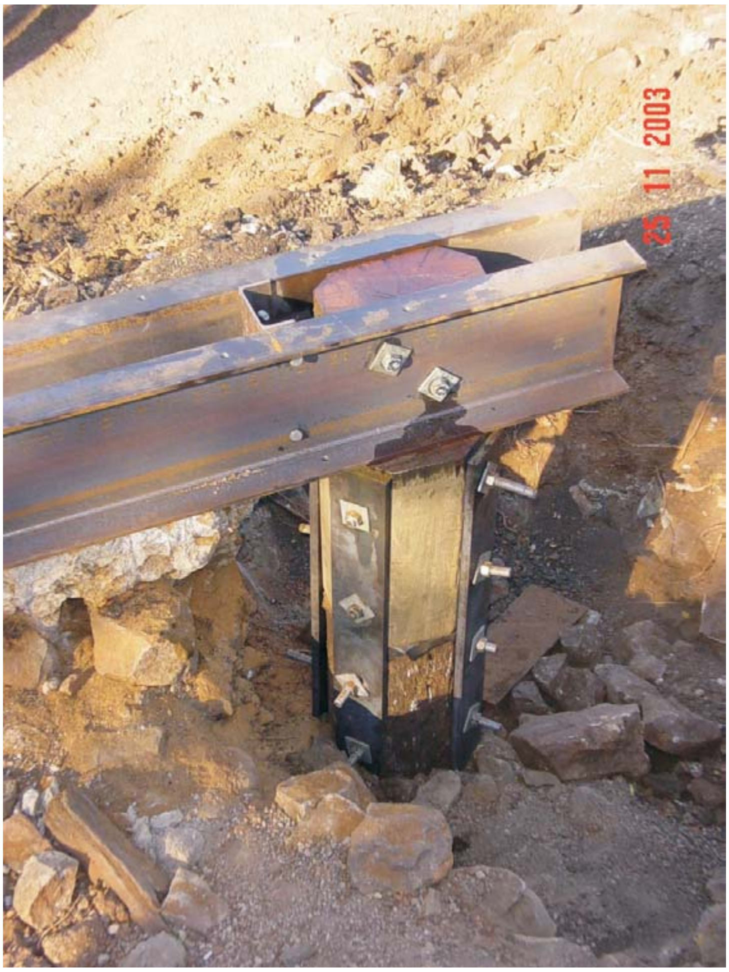


Figure 10.2(i) - Steel Headstocks

Maintenance Activities:

Refer to Part 3 Item 2.28 (27S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations are as follows:

Routine Maintenance:

Routine or preventative maintenance actions for existing steel headstocks will generally be identified and carried out during Level 1 bridge inspections. These activities would be:-

- Tightening or replacing headstock / pile bolts
- Removal of any aggressive contamination.

The pile attachment bolts should be checked for tightness as this will prevent possible differential movement between headstock and pile. Where corrosion of bolts is evident, they should be withdrawn and replaced by galvanised bolts of the same diameter if loss of section is evident.

Programmed Maintenance:

Where it is proposed to use steel headstocks as an alternative to hardwood members, the details shown in Figures 10.2(b), (c) & (d) are recommended. The details shown have been developed to provide enhanced support and hold down capacities. Contact Structures Division to obtain suitable details for a specific job. The fabricated headstock sections will generally be detailed as galvanised, but Districts may request unpainted surfaces if climate or short time service life will safely allow this. Any galvanised surfaces damaged by site drilling etc. should have a cold galvanising product applied.

Work operations will generally be:-

- Jack corbels and girders to remove all load from the headstock.
- Release all bolts and remove timber headstocks. Where hold down bolts cannot be removed, they should be cut off.
- Trim corbel seating to take top plate.
- Deepen pile recesses to take depth of new steel headstock.
- Install new headstocks and bolt to piles.
- Attach M30 hold down bolts and brackets.
- Drill holes for girder / corbel bolts as required. If new girders are being replaced care should be exercised to stabilise the girder on the corbels prior to bolting down. Removal of kerbs may be necessary for this operation as well.
- Replace kerbs if required, and remove jacks to allow all load to be taken on the new headstock.

The contact surfaces with the pile notch and the corbel / girder shall be treated with a preservative and grease, and a bituminous felt placed to remove air gaps.

The details shown in Figures 10.2(e) to (h) may be used to place steel headstocks at abutments where the rear timber headstock remains in place. This removes the need for excavation behind the abutment. Some additional preservative and termite treatment should be applied to the exposed faces of the remaining headstock because future access will be restricted.

Work operations would be:-

- Measure locations of piles and girders and adjust attachment details as required.
- Jack girders to remove load from existing headstocks.
- Release all bolts and remove front headstock.
- Cut and trim pile heads as detailed.
- Assemble PFC members with top plates and brackets, and spray expanding foam protection.
- Erect steel headstock assembly and install headstock / pile and girder / headstock attachment bolts.

The details shown in Figure 10.2(e) to (h) are based on theoretical plan dimensions and may not cover all situations. Prior to ordering materials the location of girders with respect to the piles should be measured. Where there are wide departure from the standard drawings, advice should be sought from Bridge Asset Management for consideration of further details.

Figure 10.2(i) shows photographs of steel headstock installation.

Refer to Appendix B for typical bridge drawings showing steel headstocks.

10.3 Concrete Headstocks (54C)

Bridge Inspection Manual Component No. 54C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
54C1 Strengthen headstock	Each

Purpose:

The main function of the headstock is to transfer vertical load from girder and corbels to substructure piles, columns or walls. Transverse loads such as wind and debris, and longitudinal loads such as braking are also transferred from the deck to the supporting structure below.

Concrete capping on masonry walls is used to provide a neat and levelled superstructure support area and to transfer vertical loads to the masonry below.

Significance: ***Significance Rating 4***

Discrete headstocks are primary structural members and form a critical component of piled or columned substructure. Cantilevered headstock sections protruding from solid wall piers are also critical components. Failure of these members will lead to unserviceability of the structure.

Failure Mechanism:

Where headstocks are continuously supported on a stem wall, the most extreme defect expected will be localized spalling below girder support areas or cracking resulting from construction joint shrinkage opening. Depending on location and extent, these defects may compromise load transfer to the substructure, but will generally not lead to total unserviceability of the structure. Other structural forms of concrete headstocks are uncommon in timber bridges. Refer to the Bridge Maintenance Manual for further discussion.

Details:

Figure 10.3 shows details of various in-situ concrete headstocks which have been used in timber bridge construction. Also shown is a procedure for spall repair below bearing areas.

Maintenance Activities:

Refer to Part 3 Item 2.27 (54C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

2

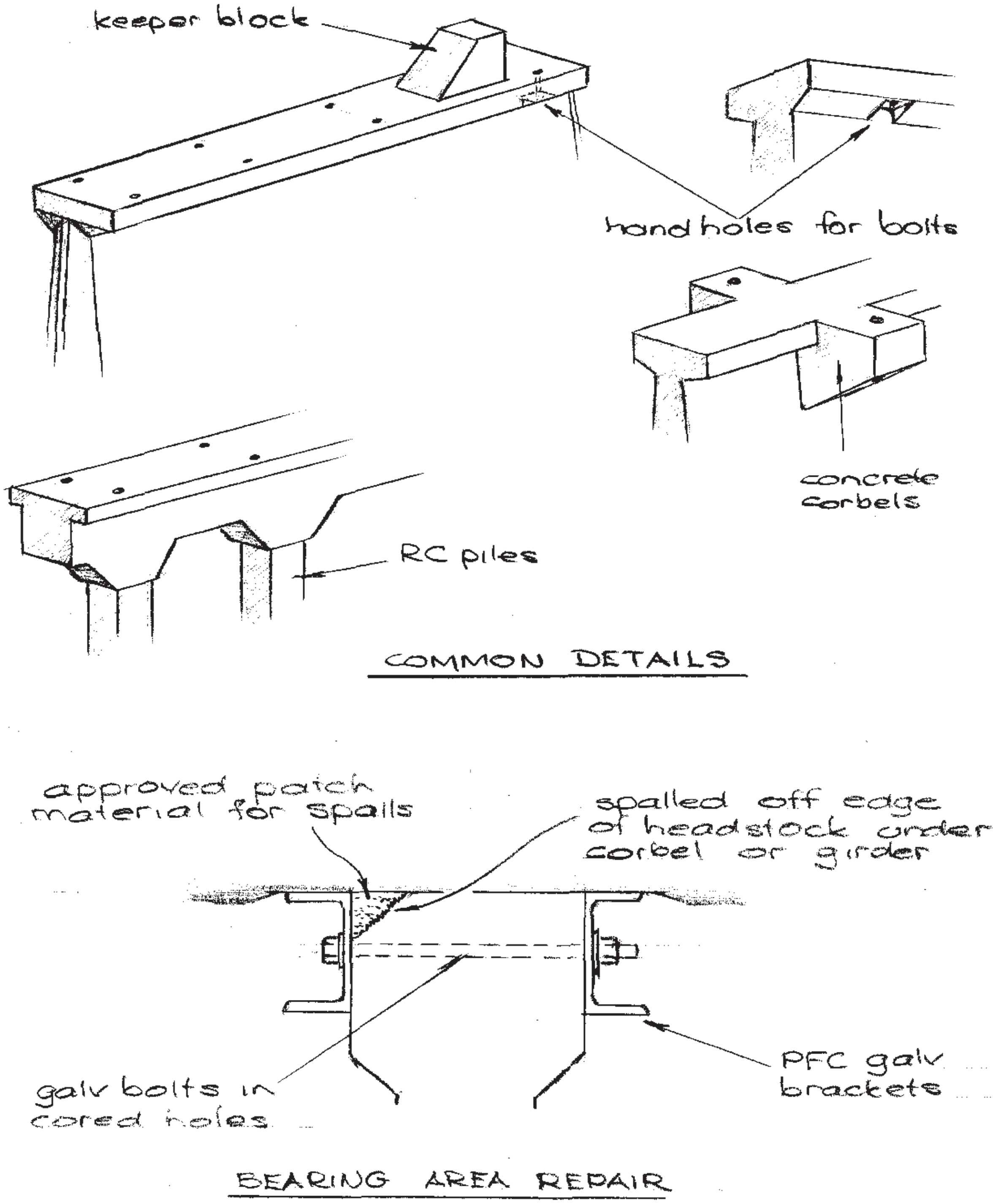


Figure 10.3 - Concrete Headstocks

10.4 Concrete Packer (54C, 54P)

Bridge Inspection Manual Component No. 54P, 54C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to general concrete repair Activities	

Purpose:

Both precast and in-situ concrete packers are used to establish or vary deck levels on existing bridges.

Precast concrete members have been used on top of existing timber substructures where a replacement superstructure has a reduced depth such as with stress-laminated timber slab decks.

In-situ concrete blocks, poured on top of existing timber headstocks, have been used to raise deck levels while retaining existing superstructure components.

Significance: ***Significance Rating 2***

The function of packer members is to transfer loads between adjacent sections of structure and as such are not considered to be structural members. However, where the depth of the concrete packer is structurally significant, for example, 500m or greater, the member is very much stiffer than the supporting timber headstock. As a result, the packing member itself would effectively provide the main pathway for transfer of superstructure loads into the piles. If the packer failed, however, it would loose structural significance as the original timber headstock could resume the status of primary structural member. Packers placed on top of rigid concrete stem substructure would have no structural importance.

Details:

Figure 10.4 shows typical details of packer members like to be found on timber bridges.

Maintenance Activities:

Refer to Part 3 Item 2.29 (54P, 54C) for recommended maintenance practices applicable to the various deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

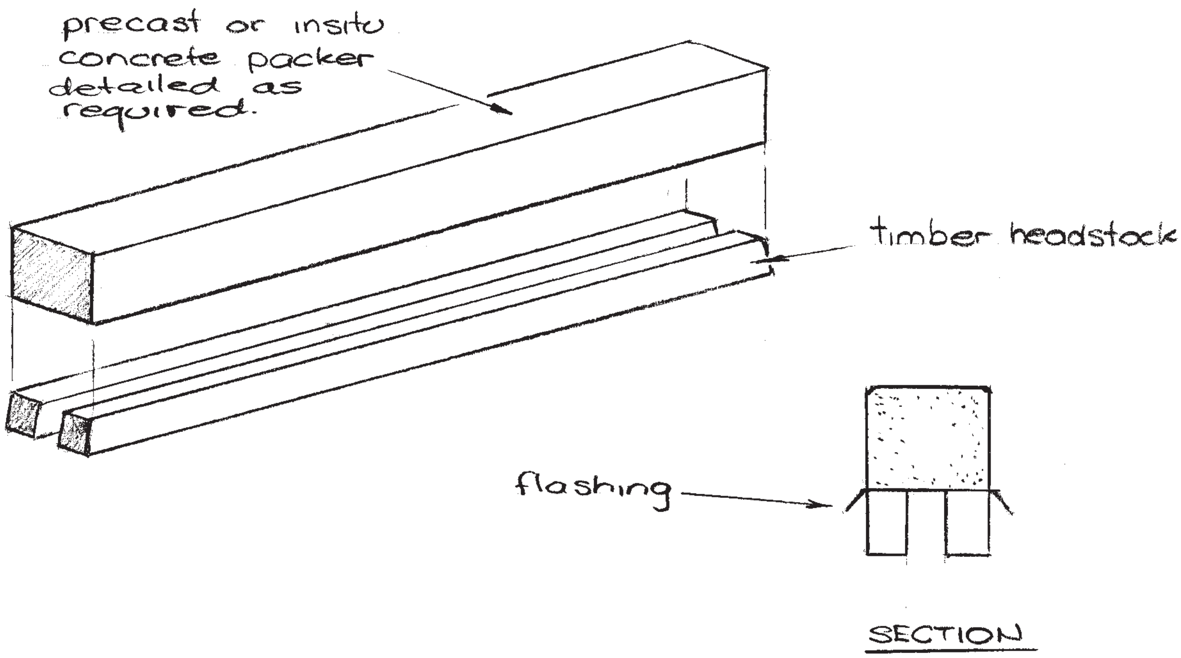


Figure 10.4 - Concrete Packers

11.0 Piles

11.1 Timber Piles (56T

Bridge Inspection Manual Component No. 56T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
56T1 Replace timber pile	Each
56T2 Splice timber pile	Each
56T3 Place supplementary member	Lump sum
56T4 Provide banding	Lump sum

Purpose:

The main function of timber piles is to transfer vertical loads from span self weight and traffic into the ground foundation. Other axial loads which may include uplift forces are induced by lateral wind and flood debris loads. These loads, together with longitudinal traffic braking forces also induce bending in the pile members. The use of pier bracing and wales helps reduce the amount of bending incurred in the direction of stream flow.

Significance: ***Significance Rating 4***

Piles may be considered to be primary structural members and form a critical component of the substructure. Failure of a pile will require all loads it supports to be redistributed through the headstock to other members. Depending on pile location and headstock soundness the result could vary from deck surface settlements to partial collapse of the superstructure. Likewise, loss of pile section in a significant number of piles in a pier, such as from marine borer attack can (and has) lead to complete pier collapse, under a heavy load or flooding.

Details:

Timber piles consist of natural round logs which have been debarked, but with sapwood left on for added protection. There is generally an obvious natural taper in these members, with top dimensions standardized depending on bridge design class. Driven piles are the most common type and metal piles shoes are generally fitted to pile tips before driving. Generally a minimum penetration of 5 metres was required to withstand the expected bridge loads and provide scour protection. Where ground testing indicated less penetration due to very firm ground or rock, piles were often supported on timber sill beams as shown in Figure 13.1, or were planted in preformed holes.

Once piles are in place, they are notched to accept other components such as headstocks and bracing.

Where rock was close to the surface, a common form of base support for pier piles was the concrete sill as shown in Figure 13.2. This was essentially a concrete footing with tie-downs for the shortened timber piles. Typical timber pile details are shown in Figure 11.1(a).

Other pile types which do not affect the load carrying ability of a bridge are strut & fender piles which help stabilise a structure under flood, and wing piles.

Failure Mechanism:

In timber bridges, piles are essentially columns which function as compression members. Where they are unable to support axial load due to section loss, they will fail in compression. Where there are very large pipes and significant longitudinal splitting, the individual pile segments act as slender columns which may fail in buckling mode, further reducing pile capacity from that determined by residual pile area alone.

If bracing is ineffective due to rotting or bolt loss, the large forces from flood debris may cause piles to fracture due to bending failure.

This can contribute to total structure loss under flood. Uplift failure of upstream piles due to reduced hold down resulting from scour or hold down bolt failure on sills is probably also a major factor in bridge loss.

However, pier piles are unlikely to fail in bending if the bracing system is adequate, and pile condition is sound. It is possible for abutment piles to fail in bending if excessive earth pressure loads are applied to piles. This may happen if long lengths of piles are exposed by scour and particularly if a considerable depth of backing slabs exists or is added.

A pile is also deemed to have failed if it moves or settles noticeably under load. This pumping may result from loss of ground friction support on the pile shaft after scour erosion of the surrounding soil. Where a number of piles in pier have lost ground support, permanent settlement of the pier may also occur. A pile may also be considered as having failed if it is unable to provide support to a headstock as a result of longitudinal splitting at the support notch.

Materials:

Timber piling requirements today are generally for splicing in of new sections of sound timber for deteriorated pile sections above ground, or for pile sections above sill beams.

Refer to Main Roads Specification MRS 11.87 for acceptable timber species and properties for timber piles.

MRD specifications have always required the sapwood to be left on piles, but now MRS 11.87 also requires the piles to be preservative treated. This allows utilization of the sapwood area of the pile and provides enhanced protection. Where timber piles are to be used in a tidal environment, a double preservative treatment using CCA and also creosote is specified.

Note that pile diameters depend on bridge class. (refer to Figure 11.1(a)). A minimum diameter of 300mm is required at the toe end to give adequate bearing area and external skin friction for vertical soil support

Maintenance Activities:

Refer to Part 3 Item 2.30 (56T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations and detailed explanations are as follows:-

Routine Maintenance:

Routine or preservative maintenance actions for timber piles will generally be identified and carried out during Level 1 bridge inspections. These activities would be:-

- Tightening or replacing of headstock / pile bolts.
- Application of surface preservatives or waterproofing agents.

The headstock attachment bolts should be checked for tightness as this will prevent possible differential movement between the headstocks and piles. Where corrosion of bolts is evident, they should be withdrawn and replaced by galvanised bolts of the same diameter if loss of section is evident. The bolt holes through the pile should be coated / packed with CN emulsion or thick grease before bolt insertion. The pile seating area for headstocks should be checked to ensure there is no rotting or splitting which would affect support.

The tin caps on the tops of pile heads (where fitted) should be removed to check for signs of decay or drying out of the previous end treatment.

If the pile is determined to be in Condition State 4, it should be programmed for replacement.

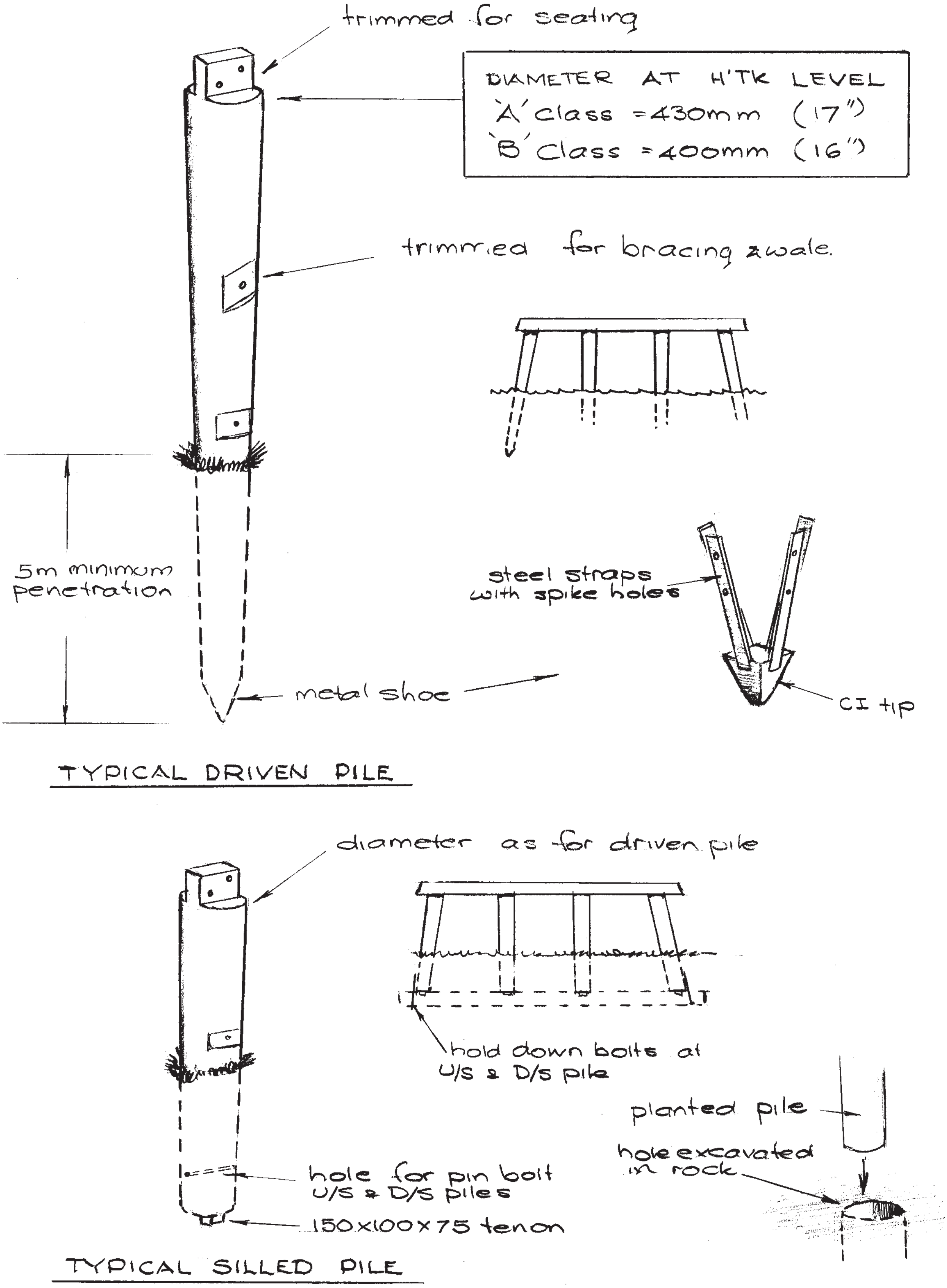


Figure 11.1(a) - Timber Piles

For lower condition states, end treatment with CN emulsion and petroleum jelly or grease should be carried out and the tin cap replaced.

Where metal capping is not in place, and the pile end has dried out, a similar treatment with preservative and grease should be carried out. Refer to Part 1 Section 7.5 for a discussion on the effectiveness or need for metal capping of pile heads.

It is recommended that end treatment of pile tops be carried out at least every 3 years.

Additional preventative maintenance actions for timber piles will take the form of monitoring during site visits for signs of termite infestations, particularly termite trails from ground to headstock areas.

Termite activity should be terminated upon discovery before excessive damage is done. Refer to Section 17.9 for further information.

Where diffusible boron rods have been installed in the base of piles, they should be checked and replenished where required.

Programmed Maintenance:

Piles in Condition State 4 will have significantly reduced capacity and must be programmed for replacement.

Unless splicing is possible, this would normally entail driving of a new timber pile immediately adjacent to the existing defective pile. The alternative method of withdrawing the existing pile and redriving a new pile on line is feasible, but is not normally carried out.

Where new piles are to be driven, advice should be sought from Structures Division to determine the expected pile tip levels. This may require foundation testing if adequate foundation information is not already available, or changed conditions resulting from scouring has occurred.

In addition, pile driving sets to suit the particular driving equipment to be used on the job must be obtained.

Useful Information:

Old DMR Specifications give the driving requirements for timber piles as :-

Minimum hammer mass = 1.27 tonnes (1.25 tons)

Maximum drop = 2.44 metres (8 ft)

Average Set / blow (for last 4 blows) 12.7 mm (1/2 in) per blow using Hiley Formula, for a 9 m pile this equates to an ultimate pile resistance of 760kN. For working stress this corresponds to an allowable pile load of 250kN using a factor of Safety of 3.

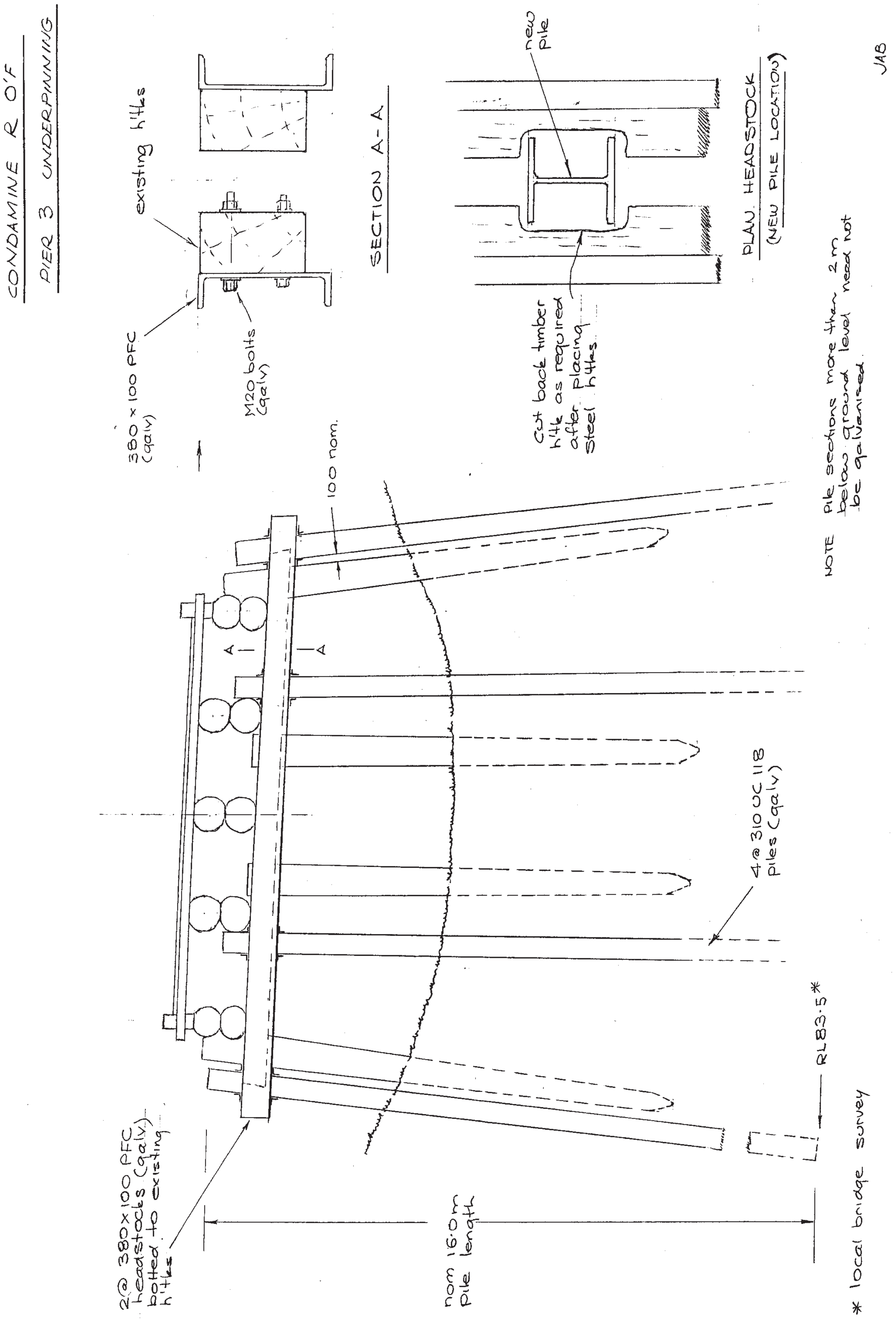


Figure 11.1(b) - Pier Modifications

Where pile spacings have changed due to new pile installation, the adequacy of the existing headstock needs to be checked and there may be a requirement for headstock strengthening.

Where replacement piles are driven to stabilise a settling pier, the support of the existing piles has to be disregarded and all loads taken on the new piles.

Figure 11.1(b) illustrates these concepts for a particular stabilisation job.

New Driven Piles

Where new piles are to be driven, the general procedures would be :-

- Remove surfacing and decking as required to allow placement and driving of the new pile. The ability of the existing bridge and propping to safely support the construction equipment shall be considered.
- Prop the superstructure to remove all load from the headstocks.
- Separate the headstocks sufficiently to provide clearance for driving of the new pile. Temporary removal of pier bracing and wales will generally be required as well.

For the case of single solid headstocks, the general options are to either remove the member or to drive new piles on either side to straddle the headstock. Consideration might also be given to substitution of conventional open headstocks at this stage to ease future headstock replacements.

- Install the new pile to follow the line of the defective pile and nominally 100 mm clear of that member. Metal driving shoes as details in Figure 11.1(a) shall be used.
- Trim the pile top and form the headstock seating notch.
- Ensure headstock member is seated on the rebate - any gaps should be packed.
- Re-locate headstocks, drill and install headstock / pile bolts using bolt details as shown in Figure 17.1(a). Strengthen headstocks if they have been trimmed.

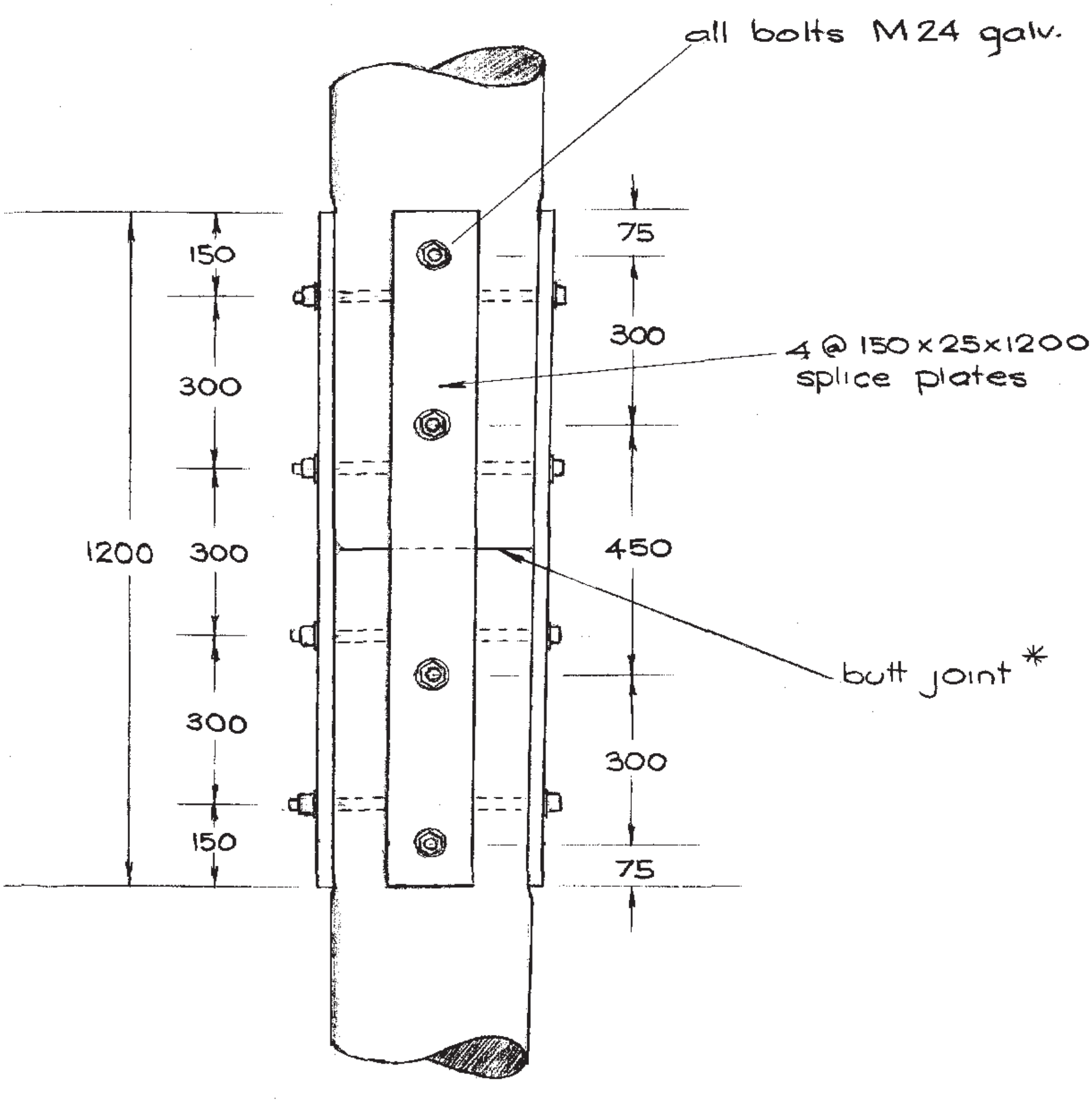
All surfaces to be in contact with the headstocks shall be treated with a chemical preservative and grease and a bituminous felt material placed. A similar treatment should be applied to the remaining piles.

- Re-install bracing and wales including preservatives at pile contact surfaces as noted above.
- Remove superstructure propping and replace bolts, decking, kerbs and wearing surface where required.
- Apply anti-termite poison to the new pile as detailed in Section 17.8.

Pile Splicing:

Where the upper portion of a pile has defects which severely reduce load carrying ability, but the lower section is sound and there is adequate ground support, splicing in of a new section of timber pile may be used.

Figure 11.1(c) shows a splice detail to connect the new upper section of pile to the existing member. This detail provides the same bending moment capacity as the original section as well as transfer of axial load. It is suitable for any locations in the pile and for any pier height. However, if greater than 50% of piles are to spliced at the the same level advice should be sought from Structures Division on any further requirements.



* butt join surfaces to be coated with an anti-fungal preservative & grease.
It is recommended that a bituminous felt is also placed.

NOTE: This splice provides the same capacity as the original section.
If an alternative form of splice is required, details shall be submitted to Structures Division for approval.

Figure 11.1(c) - Timber Pile Splice

The interface between the two components will become a moisture trap and a location for future deterioration.

It is recommended that a bituminous felt, as well as the preservative and grease be applied to the contact surfaces as shown in Figure 11.1(c) in order to remove any air gaps and to improve the durability of the repair.

If this procedure is found inadequate, a galvanised iron flashing across the joint may also be recommended in the future.

It is noted that many different types of splices have been used over the years - stepped joints with two metal plates, butt joins with spigot and socket and two plates, bolted metal cylinders, four timber splice planks etc. Some of these details were issued as DMR Standards, while others appear to have been developed and handed down over the years.

In general, splice types with two metal plates are suitable for bending in one direction only and need to be oriented correctly (pier piles require most bending capacity in the stream flow direction, while abutment piles require strength in the earth load direction). As well, multiple pile splicing near ground level in a particular pier has the potential to introduce points of weakness in one plane, partially reducing pier stability. With these types of splices it has been recommended that only one pile in four be spliced, unless an engineering analysis is carried out.

It is strongly recommended that the splicing detail shown in Figure 11.1(c) be used as the general splice for timber piles, in order to overcome the above problems.

Where an alternative type of splice is required, details shall be submitted to Structures Division for approval.

General pile splicing procedures would be:-

- Prop the headstock to remove all load from the defective pile.
- Remove defective pile headstock bolts and loosen others as required to allow partial separation of headstocks.

Temporary removal of bracing and wales may also be required.

- Cut off the existing pile in sound timber and remove the top section.
- Cut the replacement pile section to length and trim the top headstock notch support. The base of pile section may require trimming to the dimensions of the existing pile to allow installation of the metal plates.
- Place the butt joint preservative treatment as detailed and install the new pile section. Apply CN emulsion and grease to the contact surfaces with the headstocks and splice plates.
- Drill and assemble splice plates as shown in Figure 11.1(c). Drill and install headstock / pile bolts using details shown in Figure 17.1(a). Where the existing bolts are in good condition, they may be re-used.
- Retighten all headstock / pile bolts.
- Re-install bracing and wales including preservatives at pile contact surfaces as noted above.
- Remove headstock propping.
- Apply anti-termite poison to the new pile as detailed in Section 17.8.

The recommended splice detail is considered to be suitable for use below the ground surface and in this case the butt join should be bandaged with a geotextile fabric to help contain the preservative treatment. The spliced area should be backfilled and compacted with non porous soil such as clay in order to reduce oxygen access to the splice area and so reduce deterioration potential.

Another form of in-ground splice which has been used and is believed to perform successfully is a concrete splice block similar to that shown in Figure 11.1(d). Again, a full bending moment connection at the top of the block is recommended, but this will only be practical with a full superstructure replacement. Where this type of splicing is proposed, details shall be submitted to Structures Division for detail preparation.

Silled Piles:

Where silled piles are to be replaced, general procedures will be as for spliced piles. The base of the pile will have to be cut to provide a spigot for location on the sill beam.

The contact area between the pile and sill beam shall be treated with a preservative, preservative grease and a bituminous felt placed.

Where sill / pile hold downs are incorporated, these shall be fitted to the new pile. If these components -(eye bolt and pin bolt) are deteriorated, new galvanised components shall be installed.

Refer to Figure 13.1 for details. These bolts are important because they provide a hold down function under flood conditions.

Pile Strengthening

Where inspection notes a pile to be in Condition State 3, it has significant defects, but does not normally require immediate replacement. However, increased monitoring is required to ensure that deterioration is proceeding at an expected rate. The reduced pile capacity is taken into account by BAM in the assessment of heavy load movements, when there is the potential for a load limit to be placed on the bridge.

With significantly deteriorated piles, a number of procedures are available to extend the period before major works such as pile replacement are required.

(a) Where there is considerable longitudinal cracking in a pile, application of metal banding straps may be used. These help reduce any buckling effect in individual segments of split piles. Suitable details for banding are shown in Figure 11.1(e). spacing of bands will be effected by crack severity, location of braces and wales etc. Structures Division can provide advice on such details.

    Where a crack occurs at the headstock seating notch, this is considered to be serious, and should be banded to prevent separation of the pile segments. Anti-splitter bolts may also be used for certain crack locations as shown in Figure 11.1(e).

(b) Where there is a significant reduction in pile area due to piping, supplementary components may be added as shown in Figure 11.1(f). This type of strengthening would also be appropriate as a temporary measure on Condition State 4 piles prior to replacement.

(c) Where a pile is showing signs of failure, temporary propping of the headstocks adjacent to the pile may be to used to reduce pile load in order to allow continued traffic operation prior to replacement. Adequate fixing to the structure to prevent dislodgment and adequate base support need to be considered.

(d) Occasionally, piped piles are found which have been fully or partially filled with concrete. This procedure would help provide some additional column action but will most likely accelerate the deterioration of the remaining timber.

It is strongly recommended that this procedure is not carried out, though it could be of use over a short period of time.

CONCERNS TO BE CONSIDERED:-

(1) *Adequacy of headstock bolt uplift capacity if tops of piles are deteriorated.*

Normal headstock loads are taken on bearing on the pile notch. However, under flood submergence, there may be uplift forces develop on the bridge superstructure.

* At least one multi-span timber bridge superstructure (intact with headstocks and one silled pier is known to have floated away after the headstock attachement bolts had pulled vertically through the defective pile tops. Refer to Figures 11.1(g) (1) & 11.1(h) for an illustration showing consequences of this defect.

(2) *Seatings for headstocks compromised by cutout for diagonal bracing*

Care must be taken to ensure that excessive depths of cuts for bracing members are not made adjacent to headstock seatings as shown in Figure 11.1(g) (2). Insufficient seating width may lead to crushing of the headstock over the pile seating. If the headstock bolts shear, the headstock may drop.

(3) *Pile strap bolts not installed*

Care must be taken to ensure pile strap bolts that may be removed during repair work are replaced. Omission of these bolts will reduce structure strength under flood conditions.

Refer to Figure 11.1(g) (3).

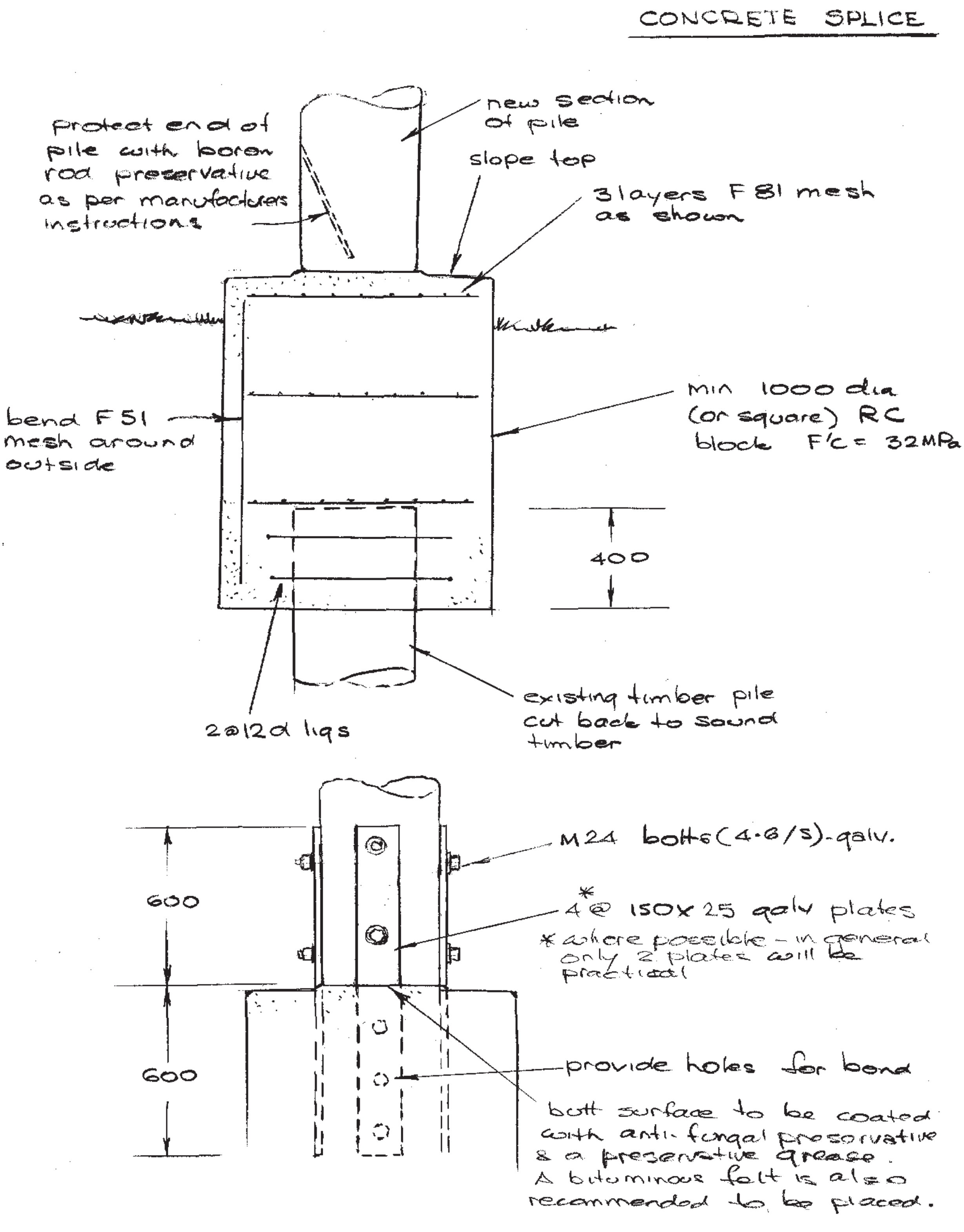


Figure 11.1(d) - Concrete Splice

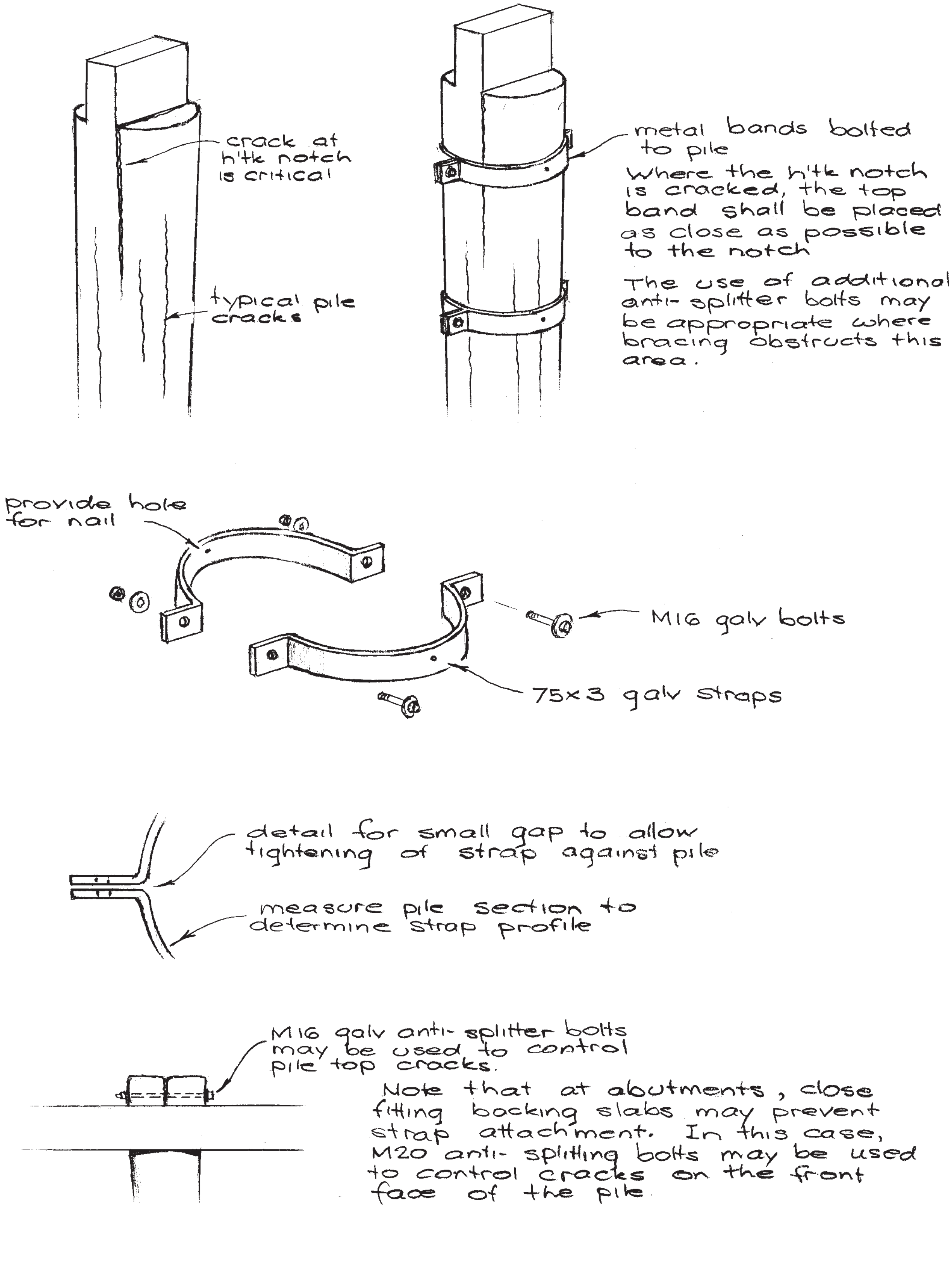


Figure 11.1(e) - Pile Banding

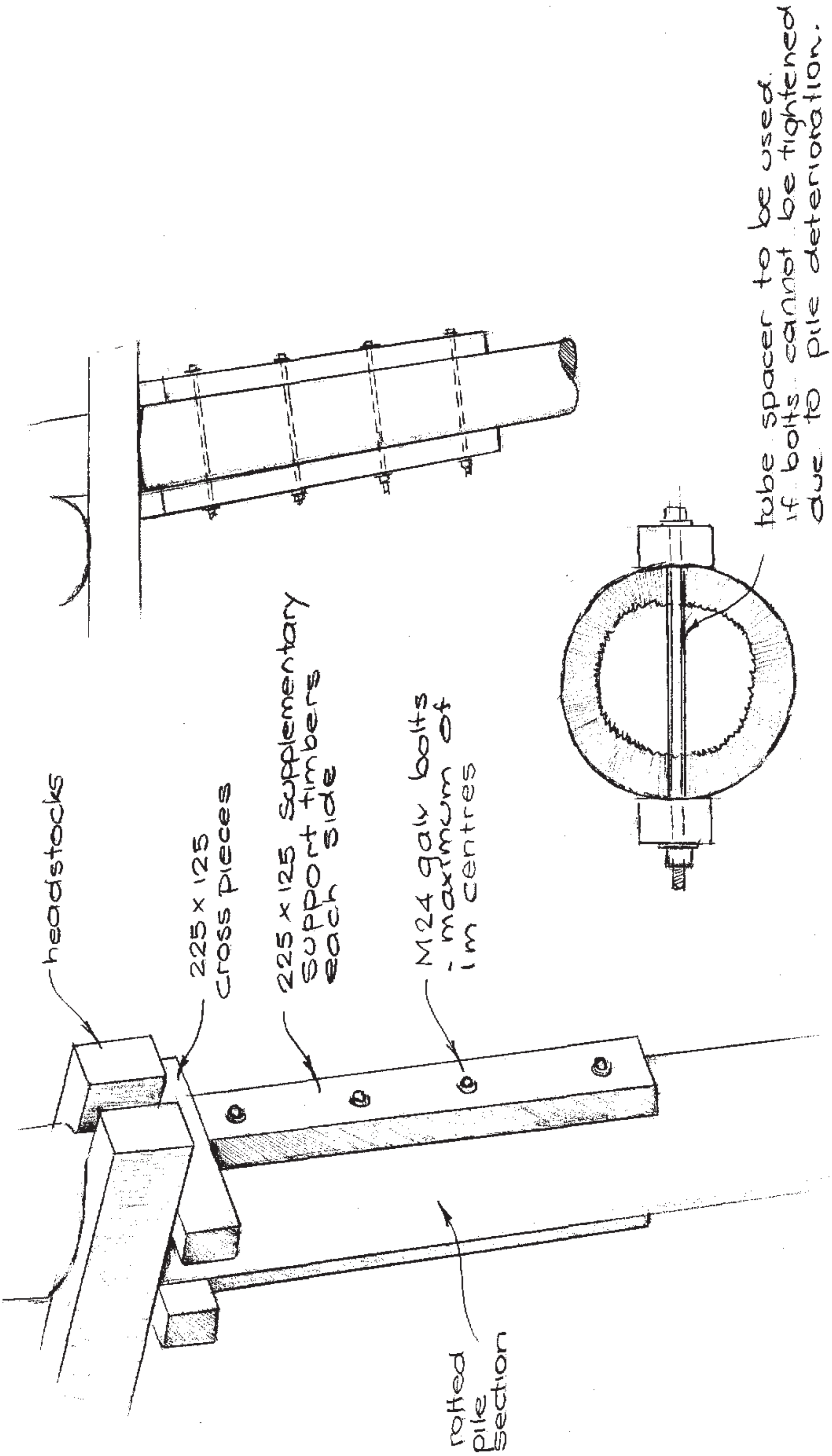


Figure 11.1(f) - Supplementary Supports

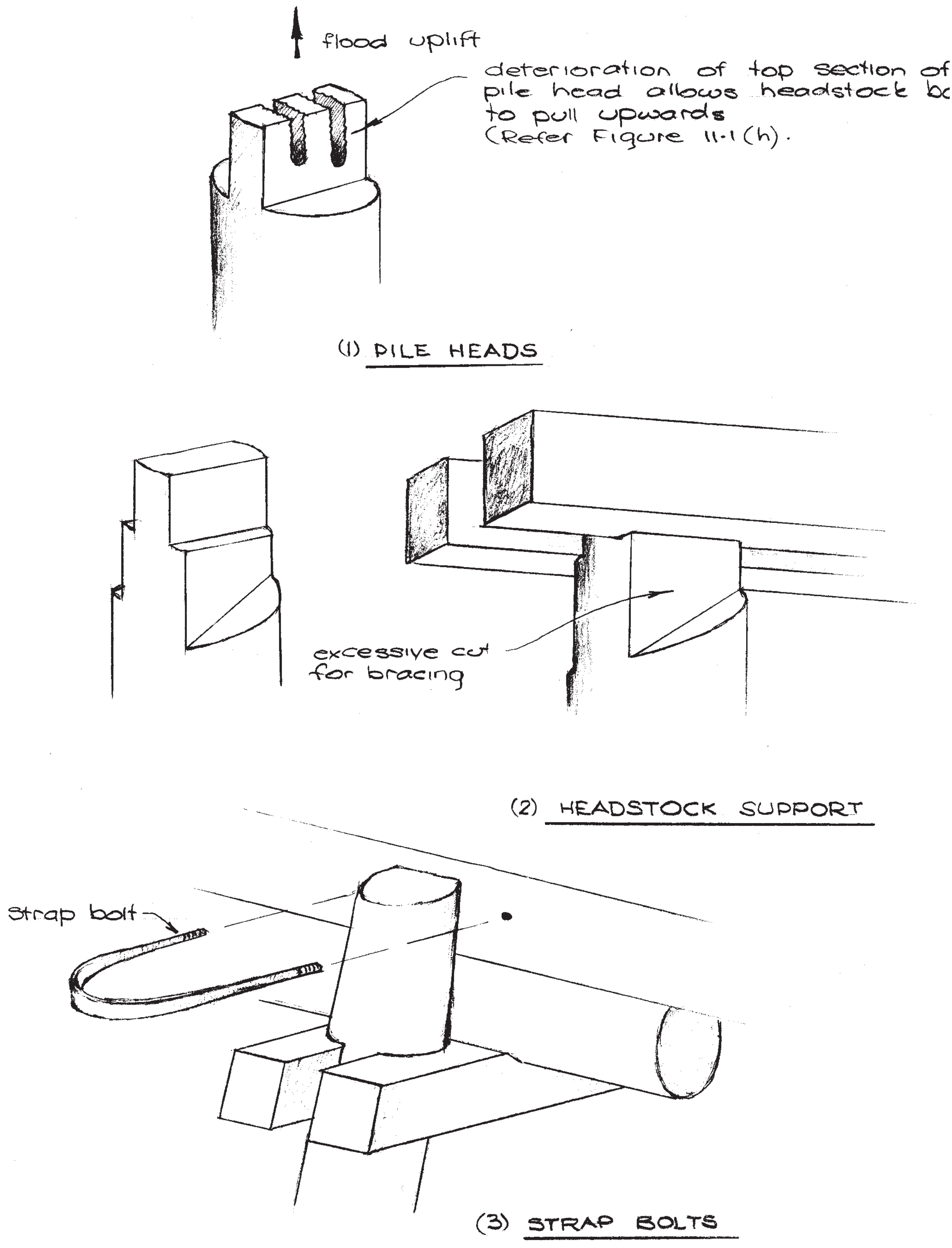
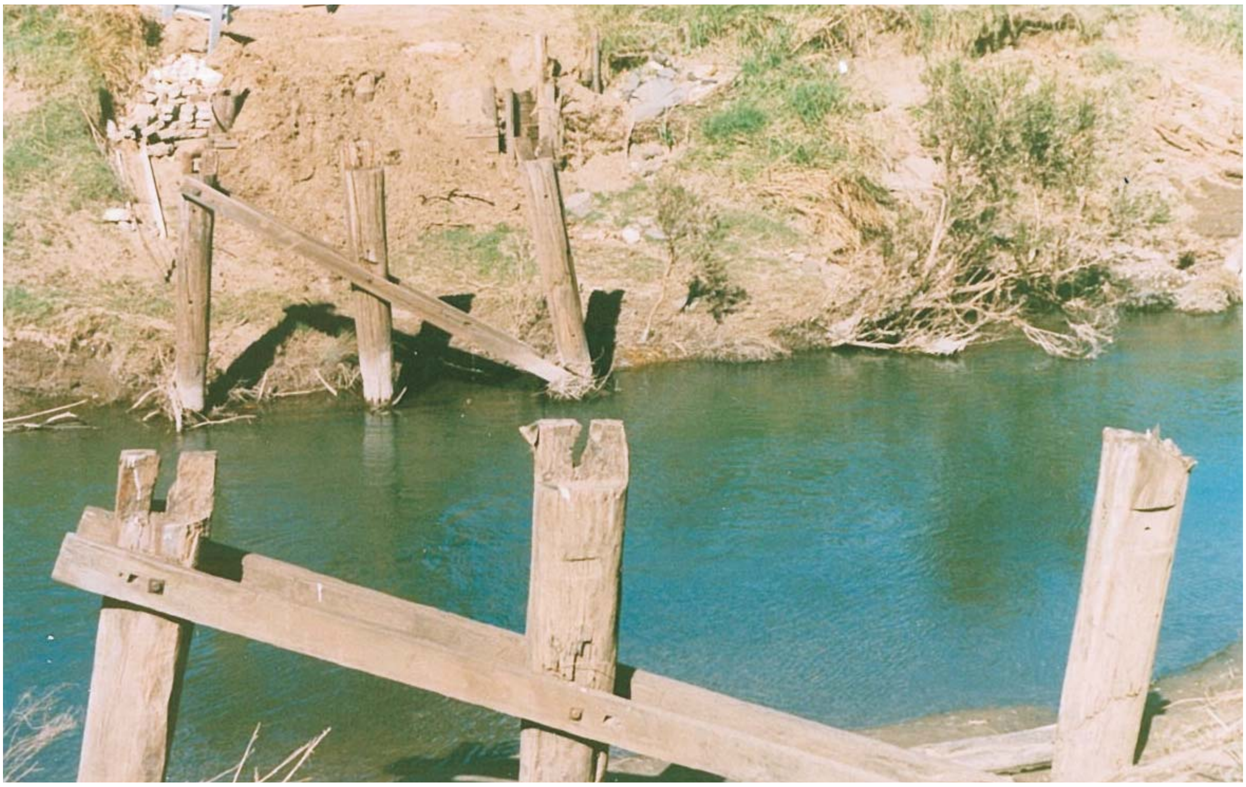


Figure 11.1(g) - Pile Concerns



Pier pile failure at top

Nearly intact Superstructure

Figure 1.1(h) - Bridge Failure

2

11.2 Steel Piles (56S)

Bridge Inspection Manual Component No 56S

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
56S1 Strengthen steel pile	Lump sum
56S2 Place new steel pile	Each

Purpose:

The main function of steel piles is to transfer vertical loads from span self weight and traffic into the ground foundation. Other axial loads which may include uplift forces are induced by lateral wind and flood debris loads. These loads, together with longitudinal traffic braking forces also induce bending in the pile members. The use of pier bracing and wales helps reduce the amount of bending incurred in the direction of stream flow.

Significance: ***Significance Rating 4***

Piles may be considered to be primary structural members and form a critical component of the substructure. Failure of a pile will require all loads it supports to be redistributed through the headstock to other members. Depending on pile location and headstock soundness, the result could vary from deck surface settlements to partial collapse of the superstructure.

Details:

Steel piles were not originally used on timber bridges and where found, are the result of maintenance replacement of the original timber members. Steel piles are generally of an RSJ, UC or PF beam section which may be unpainted or galvanised. Generally steel brackets are used to form the attachment support for the headstock. Figure 11.2 shows typical details for steel piles.

Failure Mechanism:

If bracing is ineffective due to rotting, corrosion or bolt loss, the large forces from flood debris may cause steel piles to fail in bending. Uplift failure of upstream piles due to reduced hold down resulting from scour of foundation material can lead to bridge loss.

Steel piles in timber bridges act essentially as columns and if pile section area is reduced by corrosion, the pile member may fail when the steel yields in compression.

Though bending is not generally a problem in the piles if adequate bracing is in place, abutment piles may have to sustain high bending loads from earth pressure. This may occur if long lengths of piles are exposed by scour, particularly if a considerable depth of backing slabs exists or is added.

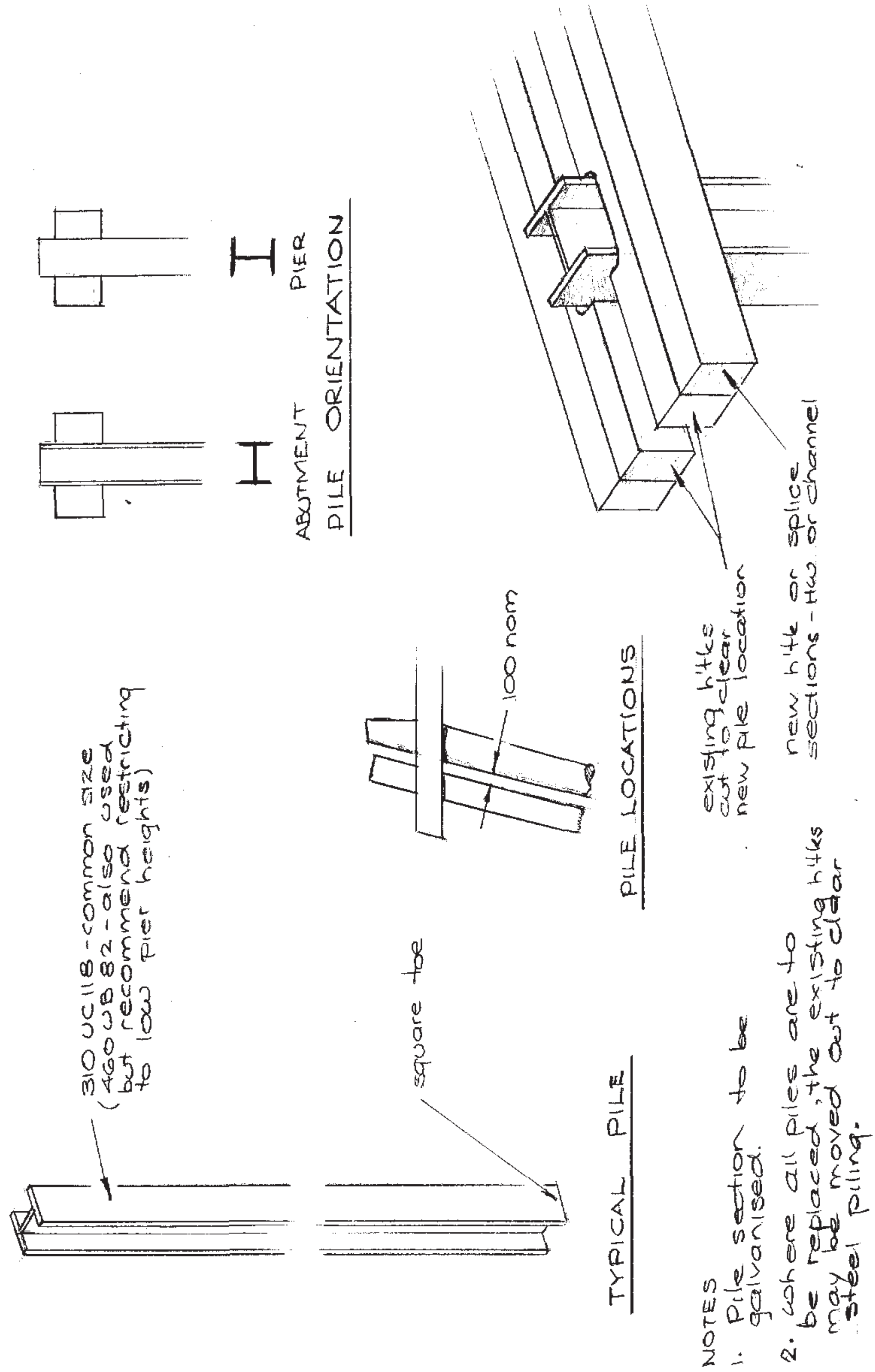


Figure 11.2(a) - Steel Piles (1)

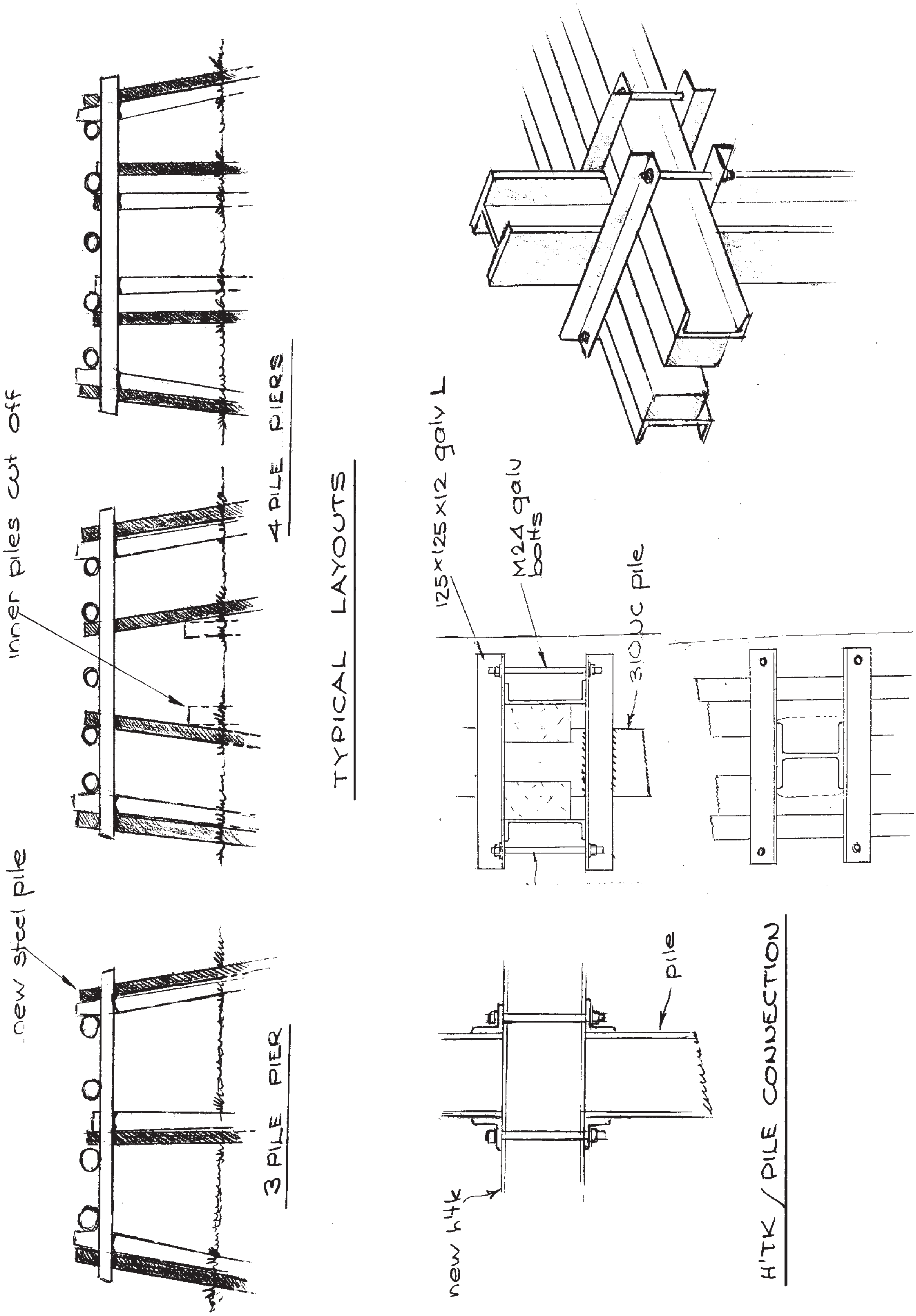


Figure 11.2(b) - Steel Piles (2)

Where piles have lost considerable section area due to corrosion, the axial load and bending moment in the pile may be excessive, causing the steel to yield and forming a hinge in the member.

A pile is also deemed to have failed if it moves or settles noticeably under load. This may result from loss of ground friction support on the pile shaft after scour erosion of the surrounding soil.

Maintenance Activities:

Refer to Part 3 Item 2.31 (56S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Further considerations and detailed explanations are as follows:-

Routine Maintenance:

Routine or preventative maintenance actions for steel piles will generally be identified and carried out during Level 1 bridge inspections. These activities would be:-

- Tightening or replacing of headstock / pile bracket bolts.
- Removal of any aggressive contamination from steel piles.

The headstock attachment bolts should be checked for tightness as this will prevent differential movement between headstock and piles. Where attachment brackets are welded to the pile and the brackets are attached directly to the timber headstocks (no steel supplementary headstocks), packing may be necessary to restore tightness.

Programmed Maintenance:

Driving of steel piles will be carried out as an alternative to using timber piles for existing pile replacements. The new pile will be driven immediately adjacent to the defective pile.

Advice should be sought from Structures Division to determine expected pile tip levels. This may require foundation testing if adequate foundation information is not already available, or changed conditions resulting from scouring has occurred. In addition, pile driving sets to suit the particular driving equipment to be used on the job must be obtained. Refer to Section 11.1 for information on expected pile capacity.

Where pile spacings have changed due to new pile installation, the adequacy of the existing headstock needs to be checked and there may be a requirement for headstock strengthening.

Where replacement piles are driven to stabilise a settling pier the support of the existing piles has to be disregarded and all loads taken on the new piles. Figure 11.1(b) illustrates these concepts.

New Driven Piles:

Where new piles are to be driven, the general procedures would be:-

- Where existing piles are to be removed, the headstocks are to be tommed to support all loads.

2

- Assemble supplementary strengthening members on the headstocks. Contact surfaces shall be coated with an anti-fungal preservative and grease.
- Cut access for pile driving clearance through the timber headstock. The width of the new steel pile will be generally greater than the gap between the headstocks. Refer to details in Figure 11.1(b). Remove the existing pile where required.

Temporary removal of pier bracing and wales will generally be required as well.

For the case of single solid headstocks, the general options are to either remove the member or to drive new piles on either side to straddle the headstock. Consideration might also be given to substitution of conventional open headstocks at this stage to ease future headstock replacements.

- Remove surfacing and decking as required to allow placement and driving of the new pile. The ability of the existing bridge to safely support the construction equipment shall be considered.
- Install the new pile to follow the line of the defective pile and normally 100mm clear of that member.
- Trim the pile head as required and install headstock attachment brackets.
- Reinstall bracing and wales including preservatives at pile contact surfaces (if timber bracing).
- Replace bolts, decking, kerbs and wearing surface where required.
- If new piles are galvanised and the exposed galvanising is damaged, apply a cold - galvanising product to the affected areas.

Pile Strengthening

Where there is significant loss of section in an existing steel pile due to corrosion, strengthening will be required. Details of repair work will vary depending on severity of the defect, but will generally take the form of additional plates welded to the flanges and/or webs of the pile. Defect details should be submitted to Structures Division for preparation of repair details.

Protection:

It is generally recommended that steel piles be galvanised. However, many piles have been installed without protective coatings, particularly in the dry areas of the State. Consideration will need to be given to expected service life and local deterioration rates to determine if protection is necessary.

11.3 Concrete Piles (56P)

Bridge Inspection Manual Component No. 56P

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
56P1 Place concrete encasement	M

Purpose:

The main function of piles is to transfer vertical loads from span self weight and traffic into the ground foundation. Other axial loads which may include uplift forces are induced by lateral wind and flood debris loads. These loads, together with longitudinal traffic braking forces also induce bending in the pile members. The use of pier bracing and wales helps reduce the amount of bending incurred in the direction of steam flow.

Significance: ***Significance Rating 4***

Piles may be considered to be primary structural members and form a critical component of the substructure. Failure of a pile will require all loads it supports to be redistributed through the headstock to other members. Depending on pile location and headstock strength, the result could vary from deck surface settlements to partial collapse of the superstructure.

Details:

Concrete piles have been used in a number of timber bridges where the pier has been built of concrete. The piles were formed of reinforced concrete and were of a square cross section. Figure 11.3 shows typical details.

Failure Mechanism:

Concrete piles in timber bridges are not generally braced and so must withstand axial load from column action as well as bending from such effects as flood debris and lateral wind or earth pressure behind abutments.

Failure of a concrete pile is generally the result of loss of section due to spalling of concrete. Typical causes of this spalling are corrosion induced bursting, salt penetration or fire damage. If section area is reduced excessively, the concrete will fail in compression (crushing of concrete).

Loss of reinforcing steel due to corrosion will also severely reduce the bending capacity of piles, causing fracture.

A pile is also deemed to have failed if it moves or settles noticeably under load. This may result from loss of ground friction support on the pile shaft after scour erosion of the surrounding soil.

2

Maintenance Activities:

Refer to Part 3 Item 2.32 (56C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

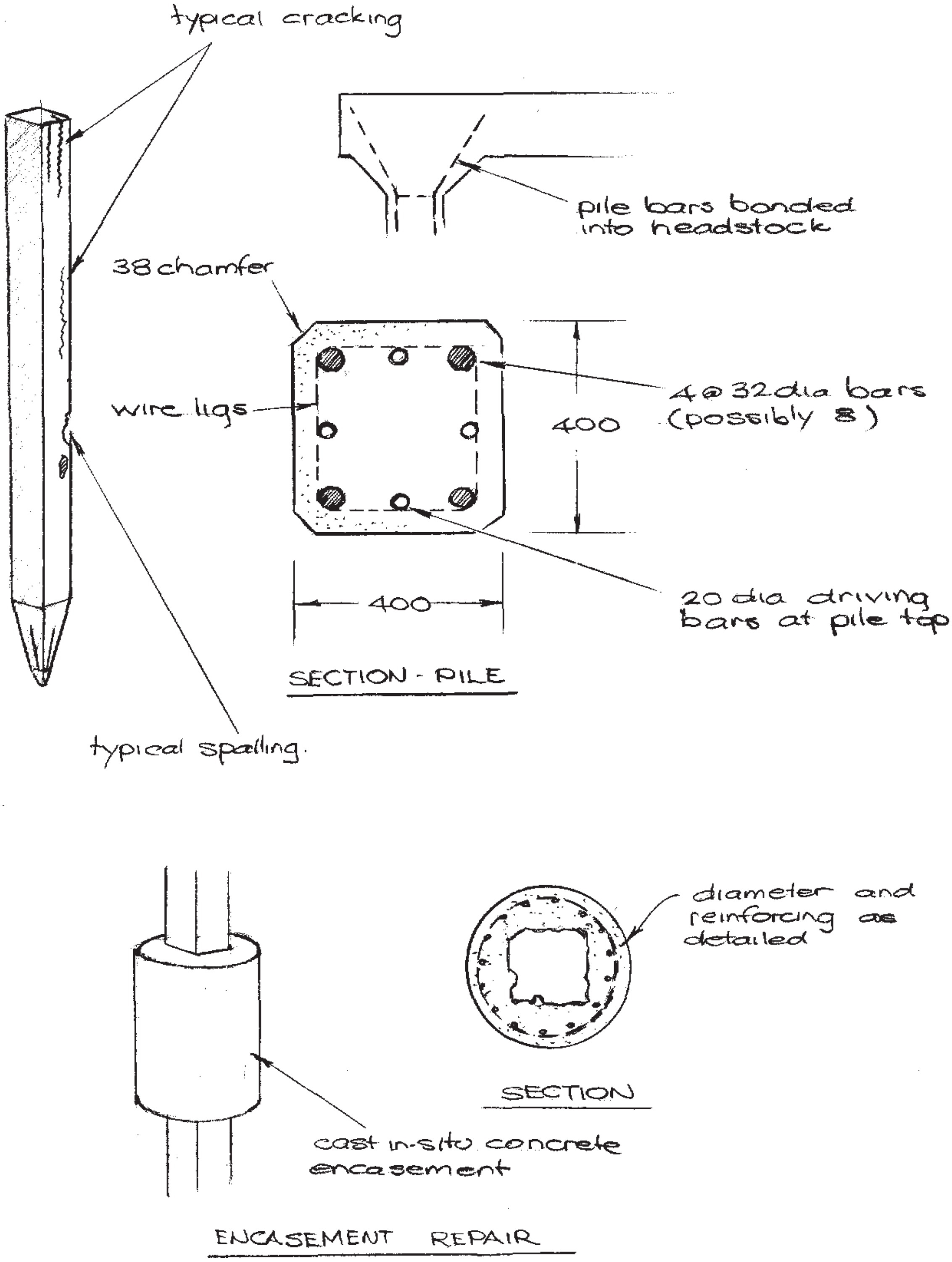


Figure 11.3 - Concrete Piles

2

11.4 Wing Piles

Bridge Inspection Manual Component No. 60T, 60S, 60C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
60T1	Replace timber wing pile	Each
60T2	Stabilise wing pile	Lump sum

For any possible steel or concrete wing pile, use item 60T2 for stabilisation and items from 56S or 56C for other activities.

Purpose:

The function of wing piles is to support backing slabs and earth pressures from retained embankment fill.

Significance: ***Significance Rating 3***

Failure of a wing pile will not affect the load carrying ability of abutment Structural files, but would lead to potential wing collapse and embankment instability or failure.

Failure Mechanism:

Wing piles are under high earth pressure loads and would face either in bending at or below ground level, or by rotation outboards due to lack of ground support (possibly a result of flood scouring).

Routine Maintenance:

Routine or preservative maintenance actions for wing piles will generally be as required for main piles (56T, 56S & 56C). For timber piles, it is recommended that preservative treatment and tin caps be applied to the tops as they are permanently exposed.

Programmed Maintenance:

Repair and replacement maintenance options for wing piles will generally be as required for main piles (56T, 56S & 56C).

Where wing piles are notching and leaning forward excessively (nominally more than 40 - 50 mm). Advice should be sought from Structures Division on stabilising procedures. Figure 16.1 shows a possible method consisting of a deadman and ties to prevent further movement.

Maintenance Activities:

Refer to Part 3 Item 2.33 (60T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

2

12.0 Bracing & Wales

12.1 Timber Bracing (57T)

Bridge Inspection Manual Component No. 57T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
57T1	Replace braces / wales	M
57T2	Add new braces / wales	M
57T3	Remove and replace braces / wales	Lump sum
57T4	Splice wale	Lump sum

Purpose:

The main function of bracing and wales is to help transfer lateral structure forces from wind and flood debris to the foundation. They act to reduce bending effects in the bridge piles.

Significance: ***Significance Rating 3***

Diagonal bracings is used in piers where pile height exceeds a specific amount and is important for reducing pile bending effects. If missing or defective, failure of the piles under debris loading is possible.

Details:

Diagonal bracing and wales consist of members on both sides of piers, with details generally as shown in Figure 12.1. Bracing is attached to all timber piled piers exceeding 1.5m in height.

Failure Mechanism:

The effectiveness of bracing will be lost if bolted connections become loose due to timber rotting or if the actual members have lost significant area due to rotting or termite attack. The member has failed if it is unable to transfer longitudinal load due to the above defects.

Materials:

Refer to Main Roads Specification MRS 11.87 for acceptable timber species and properties for timber bracing.

Maintenance Activities:

Refer to Part 3 Item 2.34 (57T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

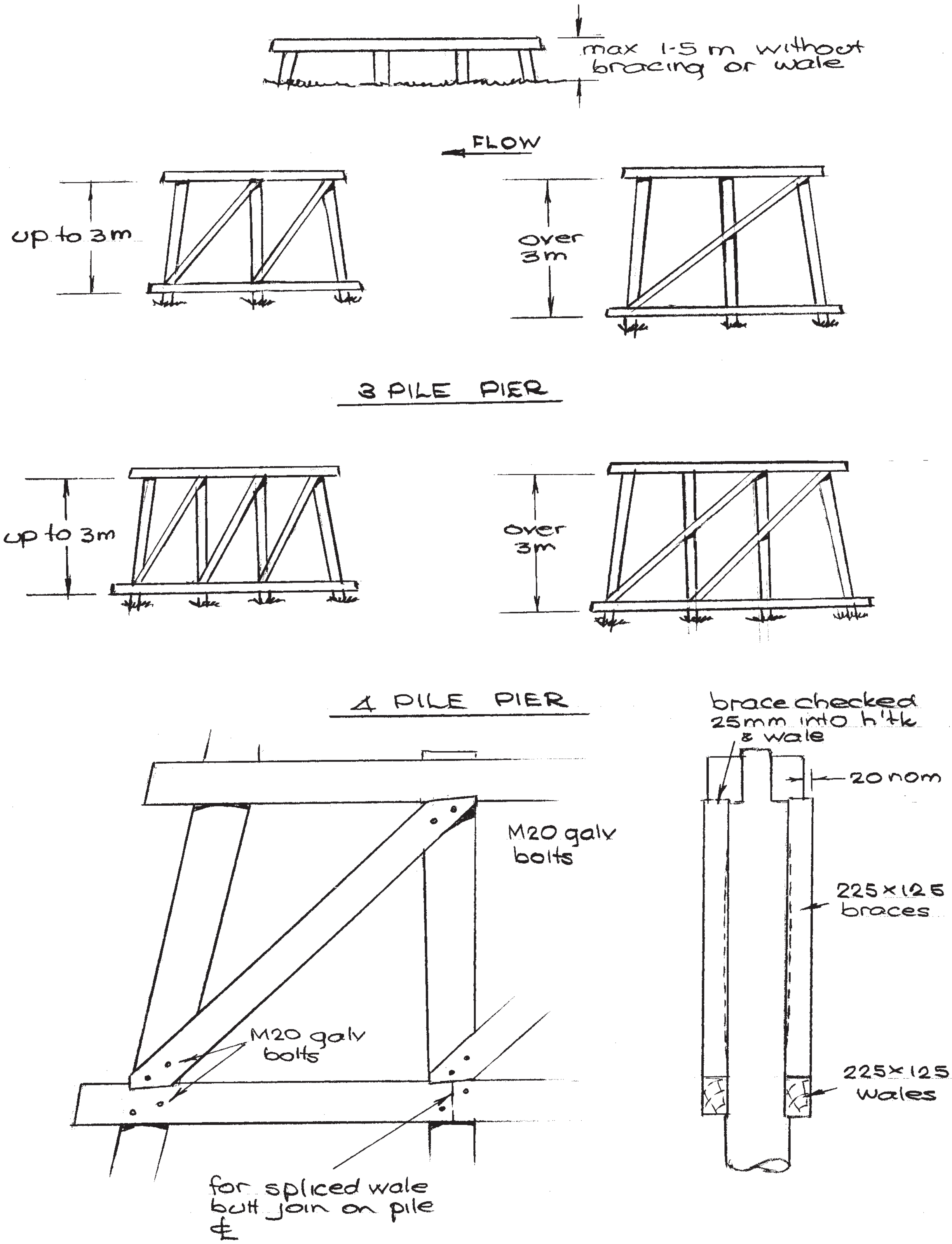


Figure 12.1 - Timber Bracing & Wales

2

12.2 Steel Bracing (57S)

Bridge Inspection Manual Component No. 57S

Refer to BIM Appendix D for description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
57S1 Replace steel braces / wales	M
57S2 Add new steel braces / wales	M

Purpose:

The main function of bracing and wales is to help transfer lateral structure forces from wind and flood debris to the foundations. They act to reduce bending effects in the bridge piles.

Significance: ***Significance Rating 3***

Diagonal bracing is used in piers where pile height exceeds a specified amount and is important for reducing pile bending effects. If missing or defective, failure of the piles under flood debris loading is possible.

Details:

Steel bracing and wales were not originally used in timber bridges and where found as a result of maintenance replacement of the original timber members. Members are generally of a channel section and may be unpainted or galvanised. Figure 12.2 shows typical details.

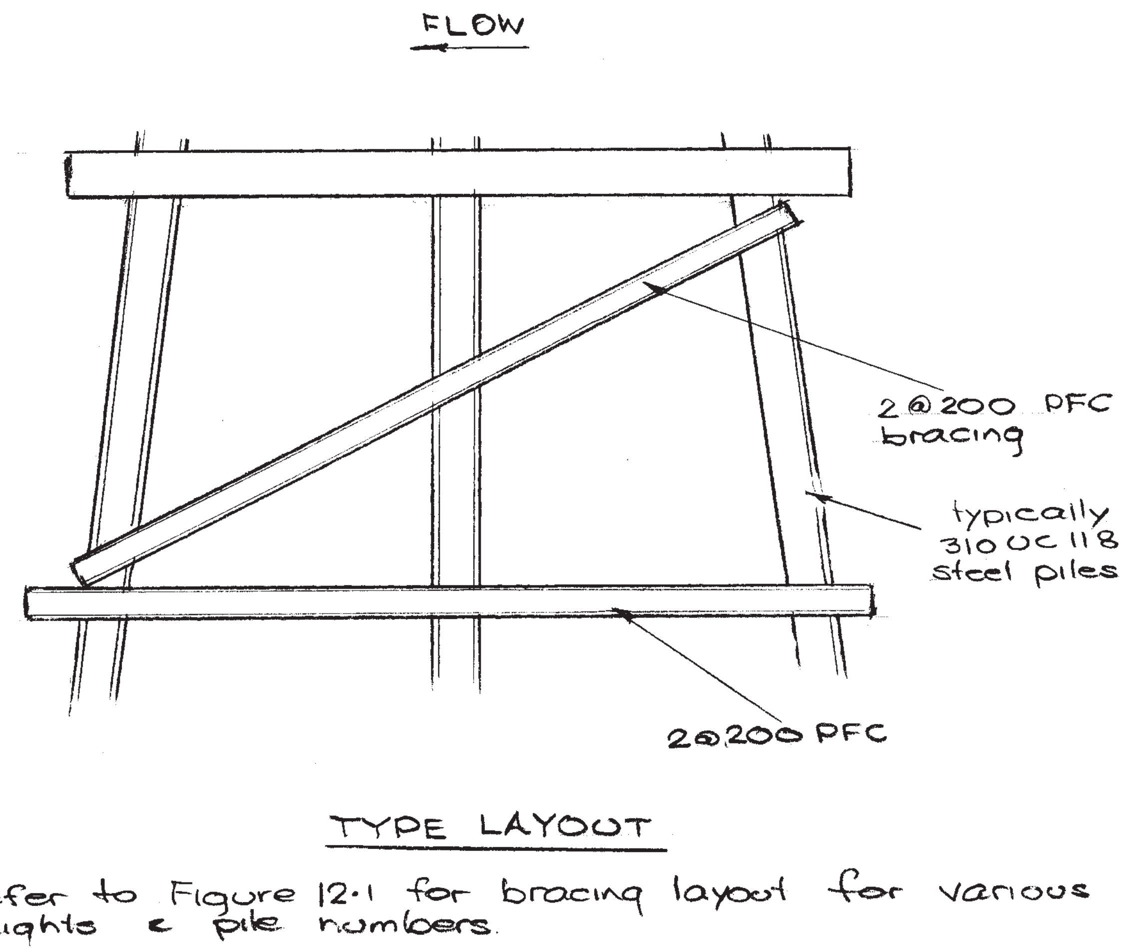
Failure Mechanism:

The effectiveness and function of bracing members will be lost if bolted connections become loose due to rot in timber piles or there is a significant loss of section due to steel corrosion, causing the member to buckle or fail in bearing or compression.

Maintenance Activities:

Refer to Part 3 Item 2.35 (57S) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.



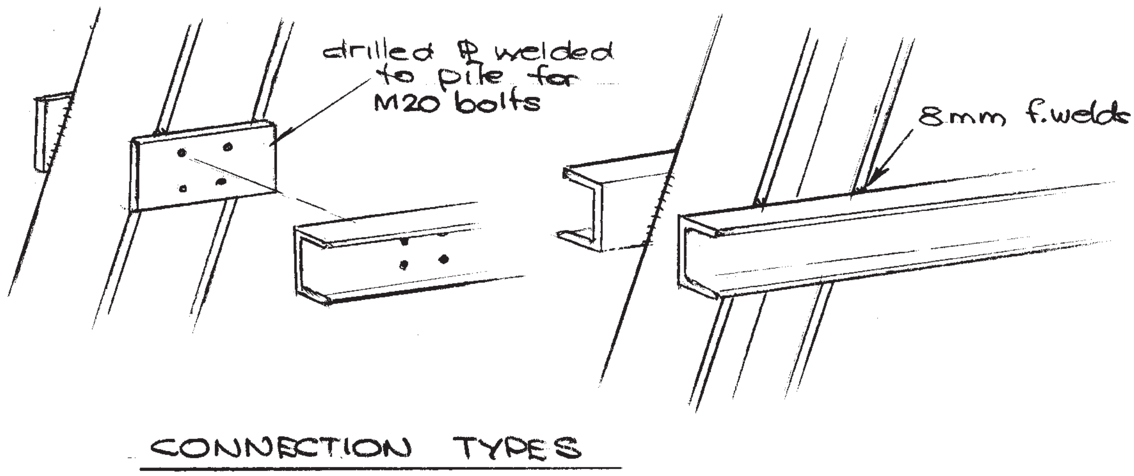


Figure 12.2 - Steel Bracing & Wales

2

13.0 Sill Log or Footing

13.1 Timber Sill (59T)

Bridge Inspection Manual Component No. 59T

Refer to BIM Appendix for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
59T1	Replace sill in timber	M
59T2	Partially replace sill in timber	M
59T3	Replace pile connections	Each

Purpose:

The function of a timber sill log is to support shortened piles at a pier or abutment and transfer loads into the foundations. They are used where is not possible to drive piles because of rock or excessively firm foundation material.

Significance: ***Significance Rating 3***

Failure of a timber sill log will normally be caused by rotting, allowing settlement of the overlying piles and deck.

Details:

Figure 13.1 shows details of timber sill members. The piles were keyed to the sill beam by a spigot and socket detail. Attachment bolts were placed and were particularly important on the upstream piles to resist any up forces resulting from flood loading.

Failure Mechanism:

Sill logs will most likely fail as a result of rotting, allowing the pile above to drop through the member as it loses integrity.

Materials:

Refer to Main Roads Specification MRS 11.87 for acceptable timber species and properties for timber sills.

Maintenance Activities:

Refer to Part 3 Item 2.36 (59T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

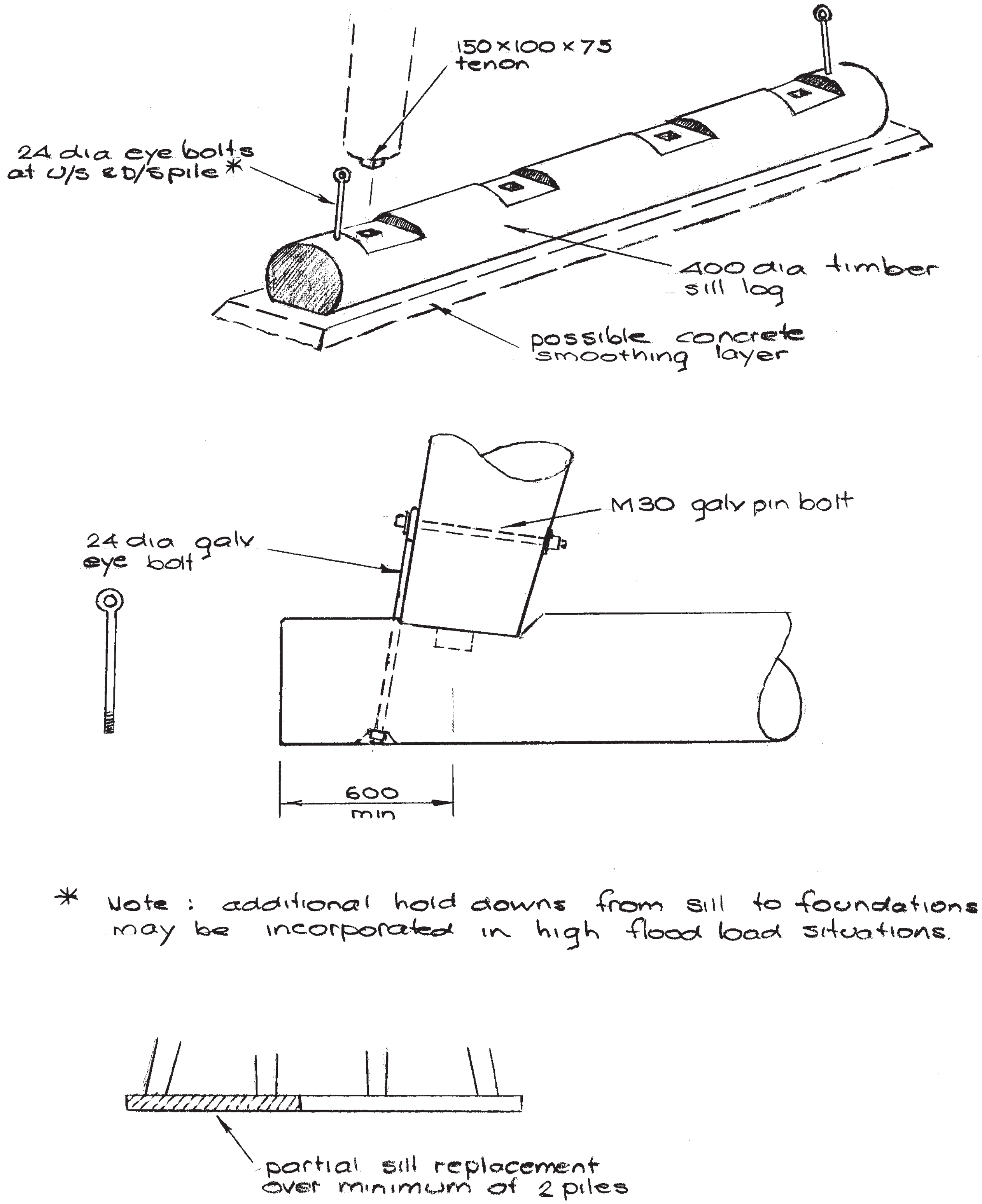


Figure 13.1 - Timber Sill

2

13.2 Concrete Sill (59C)

Bridge Inspection Manual Component No. 59C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
59C1 Replace sill in concrete	M^3
59C2 Partially replace sill in concrete	M^3
59C3 Replace pile connections	Each

Purpose:

The function of a concrete sill is to support shortened piles at a pier and transfer all pier loads into the foundations. They were used where rock material close to the surface precluded the driving of piles.

Significance: ***Significance Rating 3***

Failure of concrete sill could result from excessive spalling below pile contact areas, allowing the pile to settle.

Details:

Figure 13.2 shows details of concrete sills.

Failure Mechanism:

Spalling of concrete below piles due to bursting from corroding reinforcement or debris impacts could reduce the sill's ability to support the overlying pile, allowing it to settle.

Maintenance Activities:

Refer to Part 3 Item 2.37 (59C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

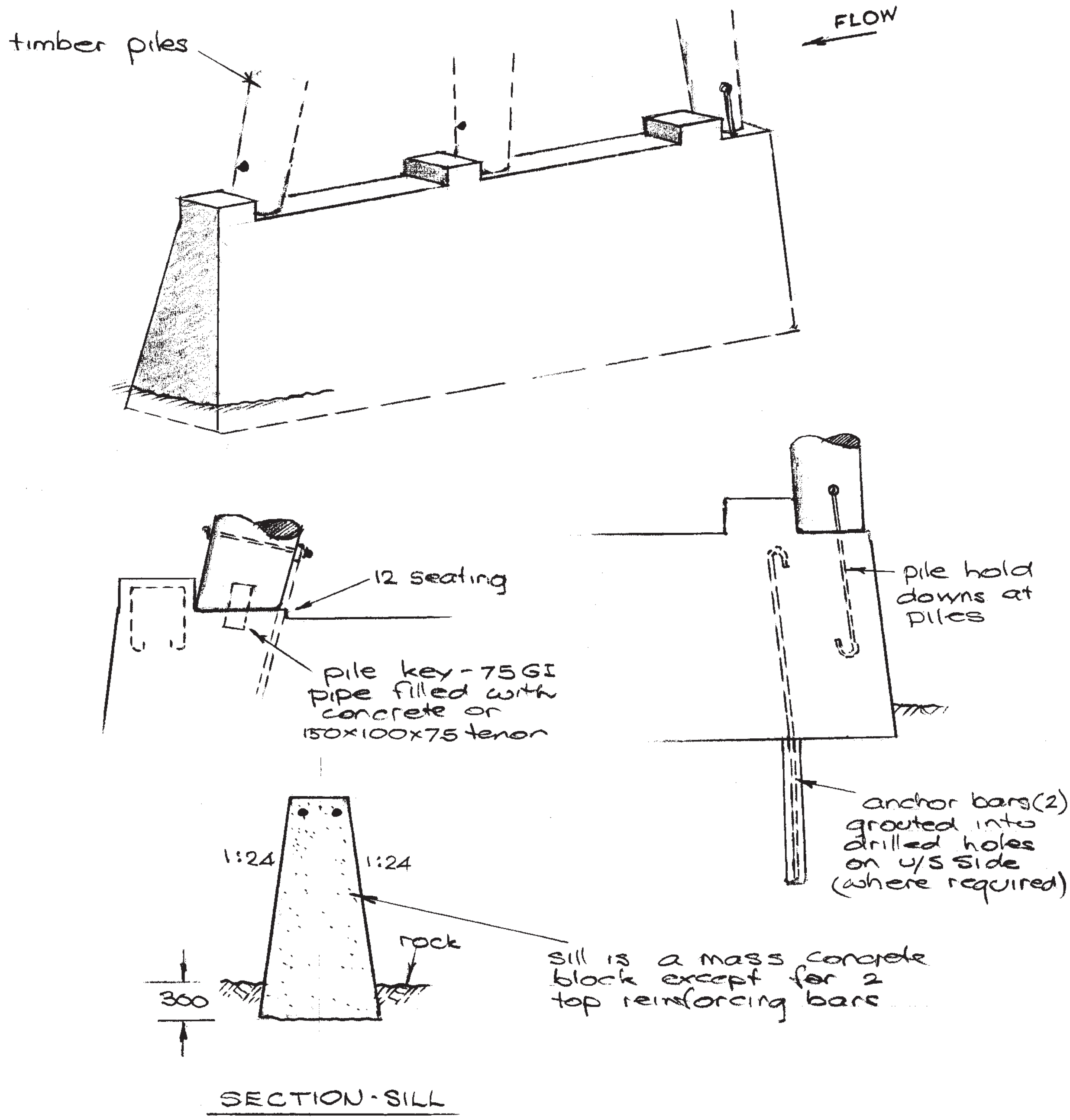


Figure 13.2 - Concrete Sill

2

14.0 Abutment

14.1 Concrete Abutment (50C)

Bridge Inspection Manual Component No. 50C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
50C1 Reconstruct ballast wall	M

Purpose:

The main function of an abutment is to transfer vertical and longitudinal loads on bridge and spans to the foundations. The abutment must also withstand earth pressure loads from the adjacent compacted embankment fill.

Significance: ***Significance Rating 3***

Depending on the mechanism, the consequences of abutment failure will vary from noticeable settlements at deck level to partial collapse of the end span.

Details:

Where rock or firm material occurred close to the surface, a common form of abutment in timber bridges was the concrete gravity type wall as shown in Figure 14.1. Though essentially mass concrete, there is generally some reinforcing in the bearing shelf area. Handhold recesses for the girder hold down bolts were often incorporated.

Another form of concrete abutment consisted of a conventional RC headstock supported on square RC driven piles or columns.

A cantilever type RC retaining wall was occasionally used for timber bridge jobs - Figure 14.1.

Failure Mechanism:

The method of failure of concrete abutments depends on the abutment type. For gravity retaining wall types the most common failure type observed has been settlement with possible rotation as a result of flood or stream flow scouring of the material below the footing. This leads to large settlement of the span end.

Another type of failure can be the loss of girder support due to significant spalling out of the support area.

For concrete headstocks on piles or column, there is the potential for bending and shear failure, as well as spalling as a result of reinforcement corrosion.

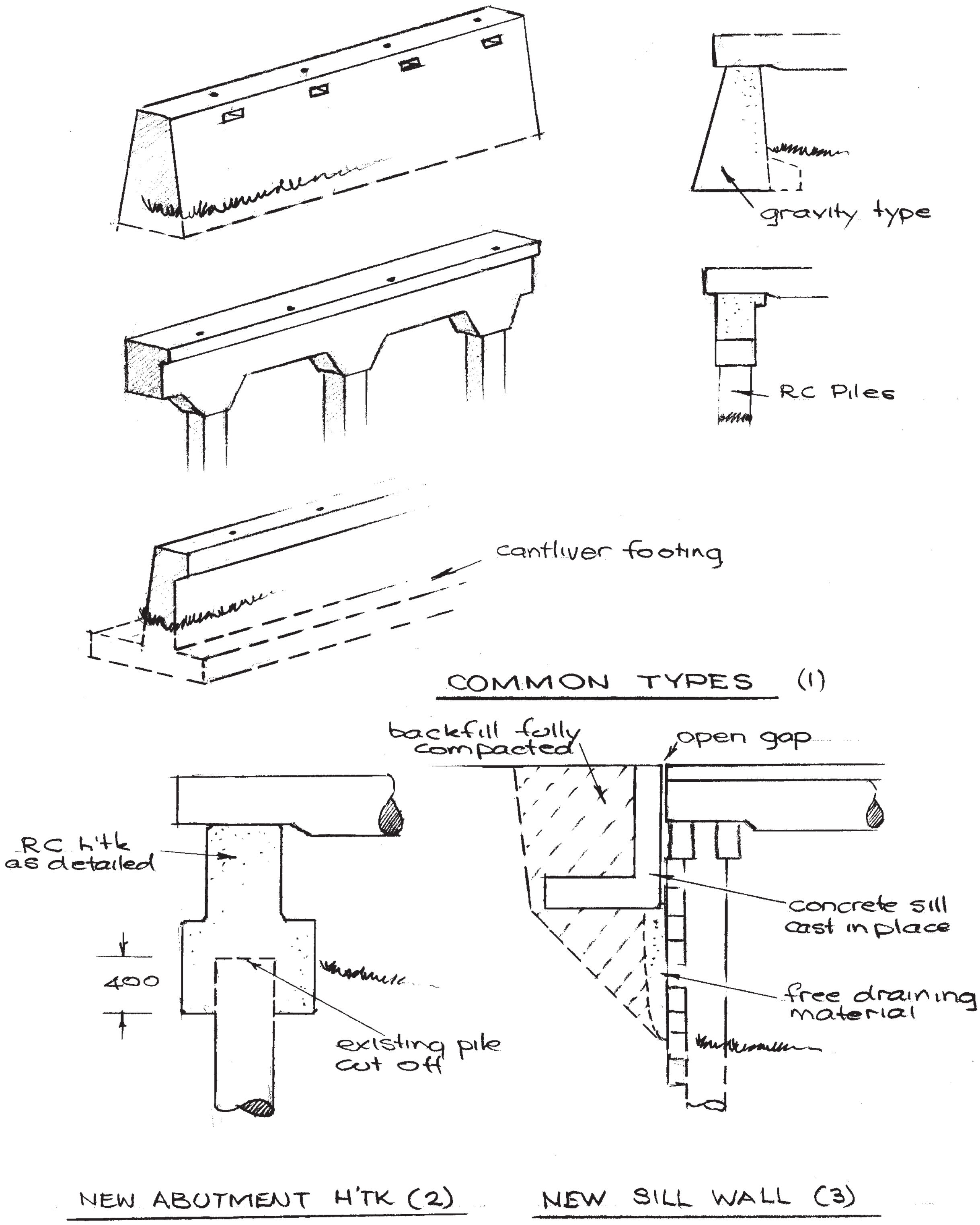


Figure 14.1 - Concrete Abutment

2

Maintenance Activities:

Refer to Part 3 Item 2.38 (50C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

Additional:

Substitution of a concrete abutment to replace existing timber headstocks may be achieved if the timber piles are in acceptable condition. Figure 14.1(2) shows the general concept. Contact Structures Division for proposal details if this concept is being considered.

Figure 14.1(3) shows a detail using a concrete sill to try and improve the durability of a timber abutment. The sill would be designed as a small retaining wall and separates the timber bridge components from the approaches by introducing an open deck joint. This provides both reduced moisture access to the bridge and provides a barrier to insect attack.

14.2 Masonry Abutment (50O)

Bridge Inspection Manual Component No. 50O

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
50O1 Repair mortar	M^2

Purpose:

The main function of an abutment is to transfer vertical and longitudinal loads on the bridge and span to the foundations. The abutment must also withstand earth pressure loads from the adjacent compacted embankment fill.

Significance: ***Significance Rating 3***

Depending on the mechanism, the consequences of abutment failure will vary from noticeable settlements at deck level to partial collapse of the end span.

Details:

Figure 14.2 shows typical details for rubble masonary abutments, which are gravity type retaining wall structures. A lightly reinforced cap was placed on top of the wall to provide a tie across the abutment and an even girder support area. This type of abutment was used where rock or firm material precluded the driving of piles.

Failure Mechanism:

The most common form of failure would be settlement and possible overturning rotations as a result of flood or streamflow scour of the supporting material. As well, there is the potential for collapse of the structure due to the breaking down of the concrete matrix holding the stones together.

These defects can lead to deck settlements as partial collapse of the end span.

Maintenance Activities:

Refer to Part 3 Item 2.39 (50O) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

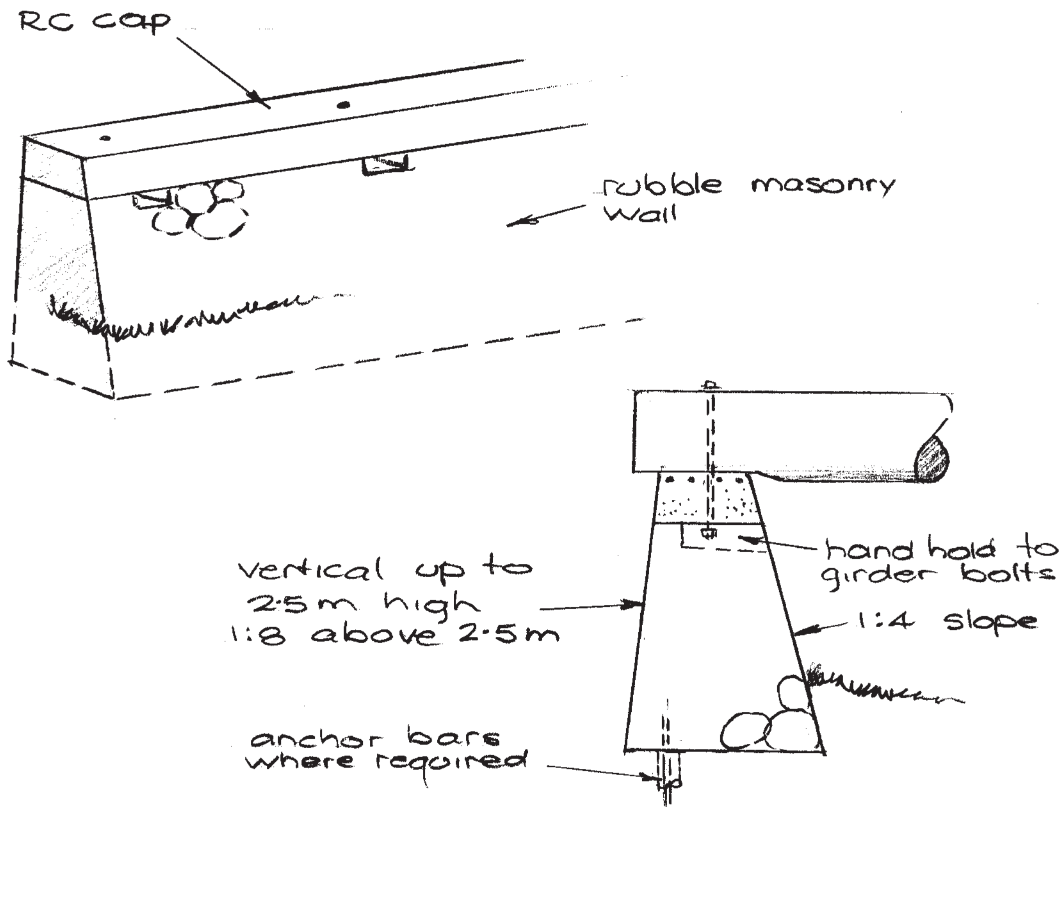


Figure 14.2 - Masonry Abutment

2

15.0 Abutment Sheeting / Infill

15.1 Timber Planks & Ballast Boards (52T)

Bridge Inspection Manual Component No. 52T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
52T1	Replace sheeting planks	M^2
52T2	Splice sheeting planks	M^2
52T3	Reposition sheeting	M^2

Purpose:

The function of backing slabs is to retain the compacted embankment fill behind piled abutments. They also provide protection against flood and stream flow scour of the supported soil.

Significance: ***Significance Rating 2***

Any failure of backing slabs will allow loss of retained fill material due to scour or soil slippage, resulting in settlement of the road approach. The resultant bump at the end of the bridge will cause higher dynamic vehicle loads on the bridge as well as effecting the safe operation of vehicles.

Details:

Timber backing slabs are not detailed on any timber bridge standard drawings, so it is assumed that these were substituted for the normal precast concrete slabs during construction or later maintenance operations.

Ballast boards are used to hold the compacted approach fill over the depth of the girders while coverboards provide sacrificial protection to the rear headstock member. Refer to Figure 15.1.

Failure Mechanism:

As a result of loss of bending capacity of timber slabs due to rotting or termite attack, earth pressure behind the slabs my cause collapse, allowing slumping out or scouring of the full material. As well, scouring at the base of the backing slabs may allow dropping down of the slabs and exposure of the fill material to further loss.

Maintenance Activities:

Refer to Part 3 Item 2.40 (52T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

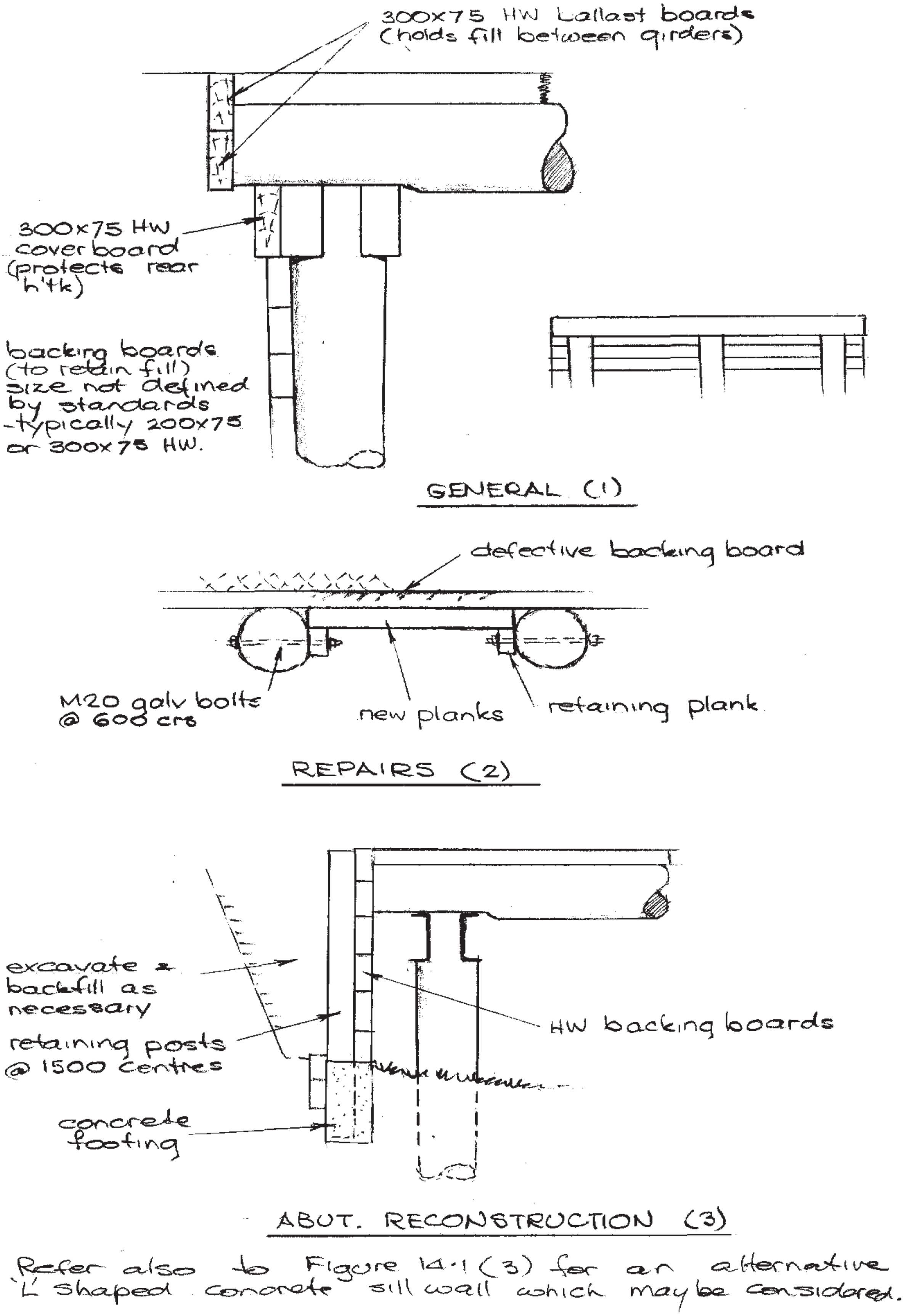


Figure 15.1 - Timber Backing Boards

Because of the high cost of fill excavation to replace backing boards, splicing in of sections as shown in Figure 15.1(2) may be considered.

Badly bulged existing planks may need to be removed to allow new sheeting to be placed hard against the existing boards. Provided the fill is dry, single boards may be removed one at a time without effecting fill stability. The new planks are placed in front of the existing planks and locked in place with retaining planks bolted through the piles.

Any voids behind the planks can be filled with a slurry mortar poured in from above.

15.2 Concrete Planks (52P)

Bridge Inspection Manual Component No. 52P

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
52P1 Replace concrete planks	M^2
52P2 Reposition concrete planks	M^2

Purpose:

The function of backing slabs is to retain the compacted embankment fill behind piled abutments. They also provide protection against flood and streamflow scour of the supported soil.

Significance: ***Significance Rating 2***

Any failure of backing slabs will allow loss of retained fill material due to scour or soil slippage, resulting in settlement of the road approach. The resulting bump at the end of the bridge will cause higher dynamic vehicle loads on the bridge as well as effecting the safe operation of vehicles.

Details:

Concrete backing slabs are the specified type of backing slabs on timber bridge drawings. They are reinforced slabs, conventionally cast on site and placed behind driven piles. Details of these slabs are shown in Figure 15.2.

Failure Mechanism:

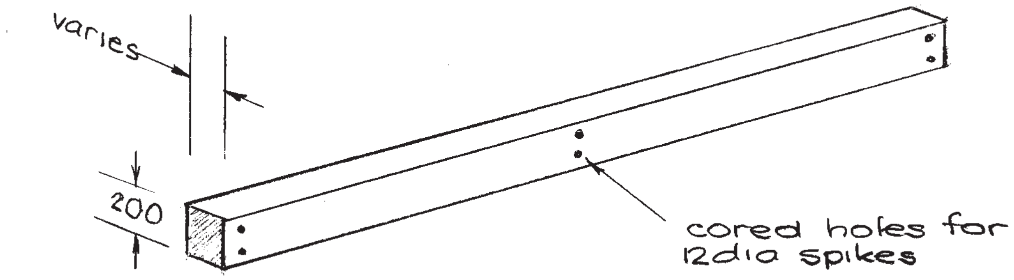
Loss of section caused by spalling of concrete resulting from reinforcement corrosion may cause slabs to fail in bending.

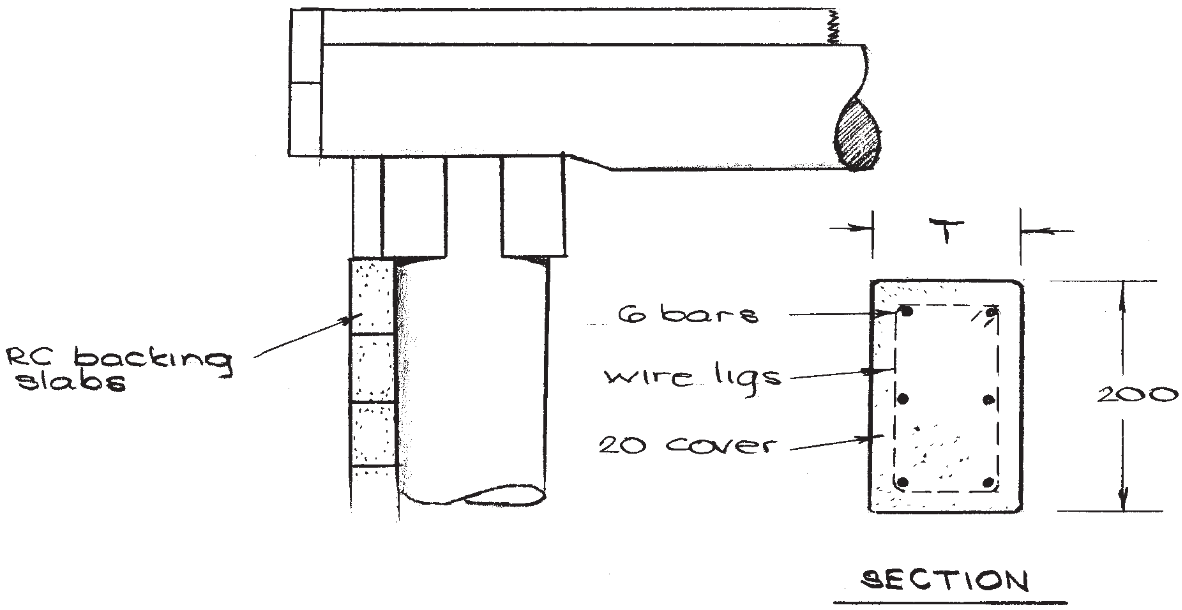
As well, scouring at the base of the backing slabs may allow dropping down of the slabs and exposure of the fill material to erosion loss.

Maintenance Activities:

Refer to Part 3 Item 2.41 (52P) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for description of applicable maintenance activities.





LOCATION	T	BAR SIZE
wing slabs to 1·8m depth	75 mm	6·5 mm-Y
" " " 3·0 " "	100	10 "
Abutment slabs to 1·8m depth	100	10 "
" " " 3·0 " "	125	10 "

Concrete 32MPa/10

Figure 15.2 - Concrete Backing Slabs

15.3 Concrete Infill (52C)

Bridge Inspection Manual Component No. 52C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
52C1 Seal gaps - concrete	Lump sum
52C2 Stabilise wall	Lump sum

Purpose:

The purpose of concrete infill walls is to help retain the embankment fill behind piled abutments and to prevent erosion of this material due to streamflow.

Significance: ***Significance Rating 2***

Any failure of the wall will allow erosion or slumping out of the fill materials, leading to a cavity behind the abutment with associated settlement of the road surface. Such depressions lead to an increase in dynamic vehicle loads on the bridge.

Details:

These infills walls were cast in-situ as gravity sections and were of mass concrete construction. Ideally there was a separation material against the piles to allow independent movement of the wall and so prevent the transfer of earth pressure loads to the piles.

Figure 15.3 shows typical details.

Failure Mechanism:

Settlement and / or rotation leading to gaps between headstocks and walls is generally caused by inadequate founding materials, resulting in softening when wet, with or without scour action. Proper consideration of soil capacity and hydraulic action needs to be given.

If stream flow undermines this type of block wall, it is possible for the wall to tilt out and in extreme cases it is possible for the wall to overturn. Such walls are subject to both static earth pressure loads and surcharge earth loads produced by vehicles.

Maintenance Activities:

Refer to Part 3 Item 2.42 (52C) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

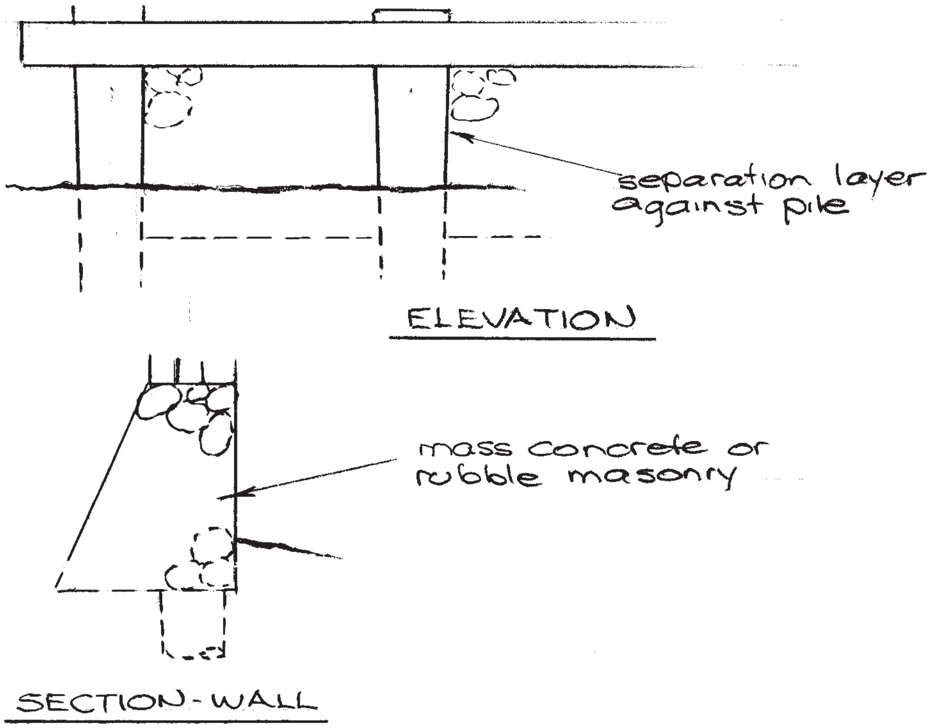


Figure 15.3 - Concrete / Masonry infill walls

15.4 Rock Fill (52O)

Bridge Inspection Manual Component No. 52O

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers		Units
52O1	Place additional rock fill	M^3
5202	Patch grouted surface	Lump sum

Purpose:

Rock fill was used in lieu of conventional abutment sheeting to provide scour protection to the compacted embankment fill behind piled abutments. The rock fill also performed the normal function of wing walls.

Details:

Figure 15.4 shows typical details for this component. This protection was formed by dumping rock to spill through between the abutment piles. Often the surface was hand packed and grouted to provide extra protection against scour.

2

Significance: ***Significance Rating 2***

Loss of the rock protection will lead to erosion of the embankment fill. Loss of material behind the abutment will result in road surface depression with consequent increase in dynamic traffic loads on the bridge.

Failure Mechanism:

The most common failure is settling of the rock spill as a result of undermining by flood scour. Cracking of the surface when grouted can also lead to loss of fill material due to erosion.

Maintenance Activities:

Refer to Part 3 Item 2.43 (52O-Rockfill) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

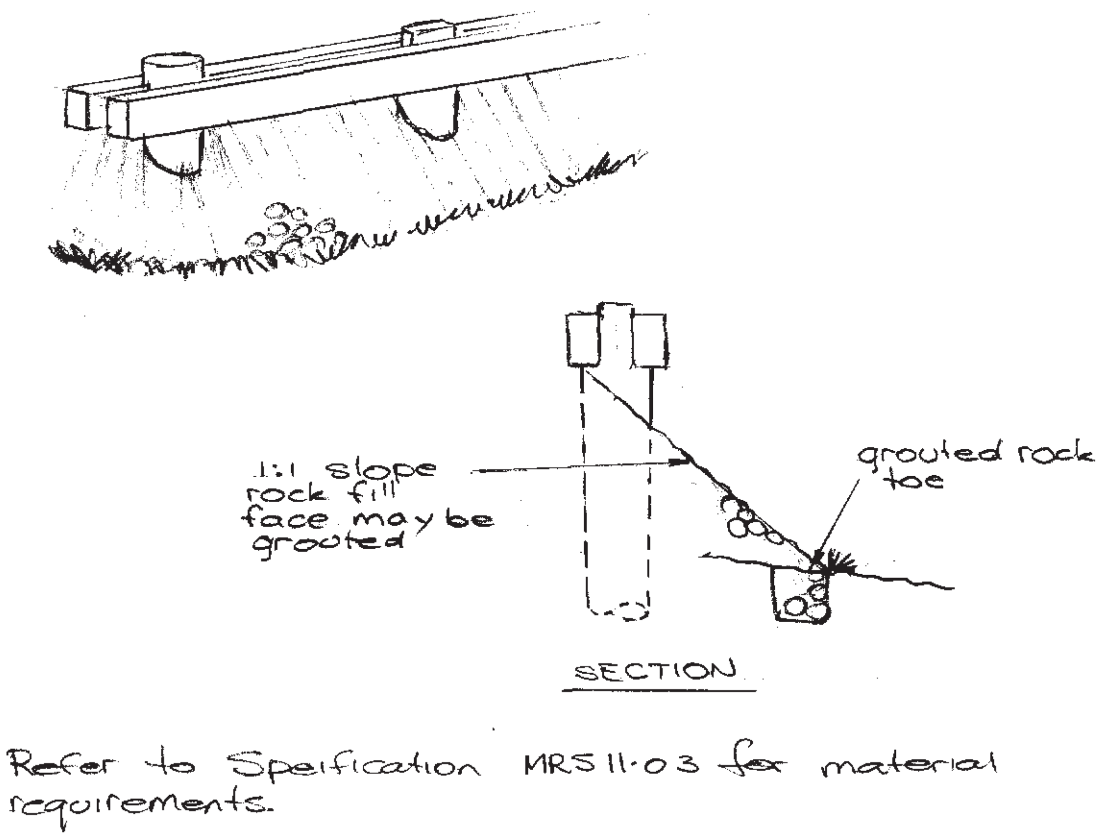


Figure 15.4 - Rock Fill Protection

15.5 Masonry Infill (52O)

Bridge Inspection Manual Component No. 520

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to Activities for Masonry Abutment	

Purpose:

As for concrete infill (Section 15.3)

Significance: ***Significance Rating 2***

As for concrete infill (Section 15.3)

Details:

This type of construction was an alternative to mass concrete and generally took the same form and dimensions - Figure 15.3.

Failure Mechanism:

As for concrete infill (Section 15.3)

Maintenance Activities:

Refer to Part 3 Item 2.44 (52O - masonry) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

15.6 Timber Sill Abutment (52T)

Bridge Inspection Manual Component No. 52T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
52T4 Replace abutment log	Each

Purpose:

The main function of an abutment is to transfer vertical and longitudinal loads on bridge end spans to the foundations. The abutment must also withstand earth pressure loads from the adjacent compacted embankment fill.

Significance: ***Significance Rating 3***

Depending on the mechanism, the consequences of abutment failure will vary from noticeable settlements at deck level to partial collapse of the end span.

Details:

This type of abutment consisted essentially of logs one above the other to form a wall and were generally seated on a concrete footing as shown in Figure 15.6. Abutments of this type were generally low, with vertical bolts used to hold the assembly together.

Failure Mechanism:

The expected mode of failure would be vertical settlement due to rotting of the logs and as a result of earth pressure loads, possible collapse.

Maintenance Activities:

Refer to Part 3 Item 2.45 (52T - Sill abutment) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

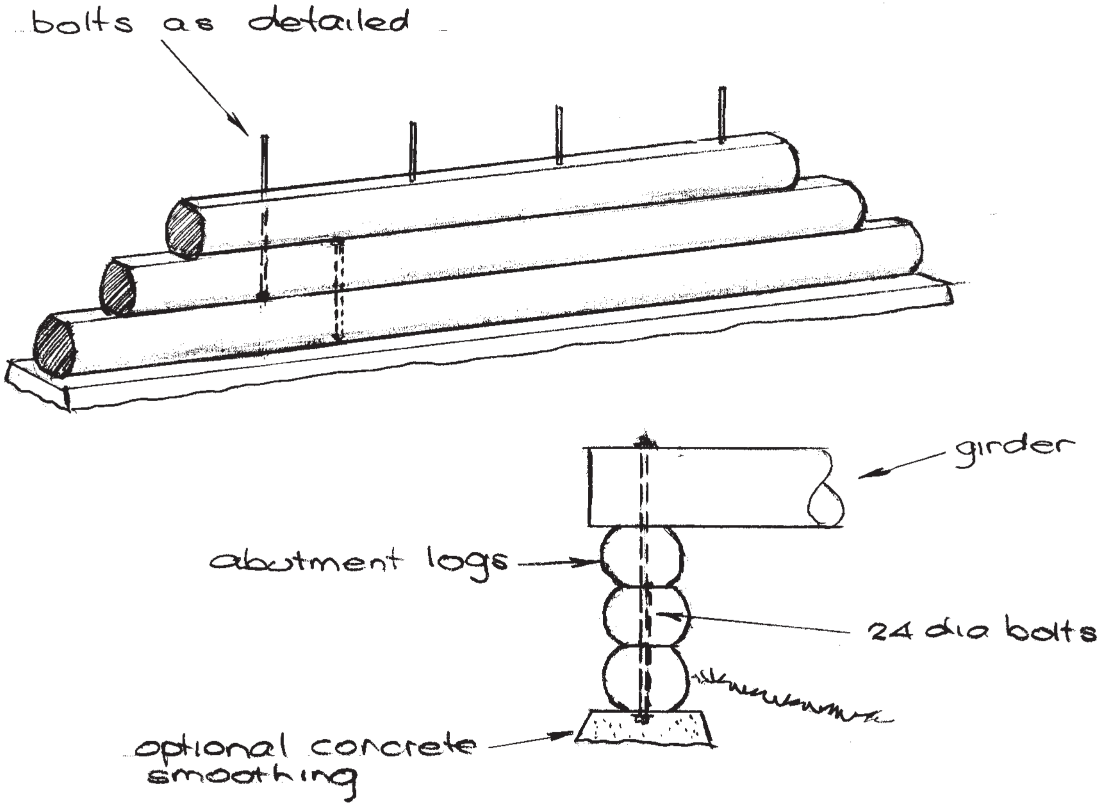


Figure 15.6 - Timber Sill Abutment

2

16.0 Wing Walls

16.1 Timber Plank Sheeting (51T)

Bridge Inspection Manual Component No. 51T

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to Activities for Abutment Sheeting	Timber Planks

Purpose:

The function of a wing is to provide protection to and terminate the road embankment at the sides of bridge abutments.

Significance: ***Significance Rating 3***

Wings are important because they help prevent scour of embankment fill as a result of steam flow or flood. Without such protection, it is possible for scouring to progress to a washout behind the abutment.

Details:

This type of wing consisted of timber backing slabs, spanning across driven wing piles, as shown Figure 16.1.

Failure Mode:

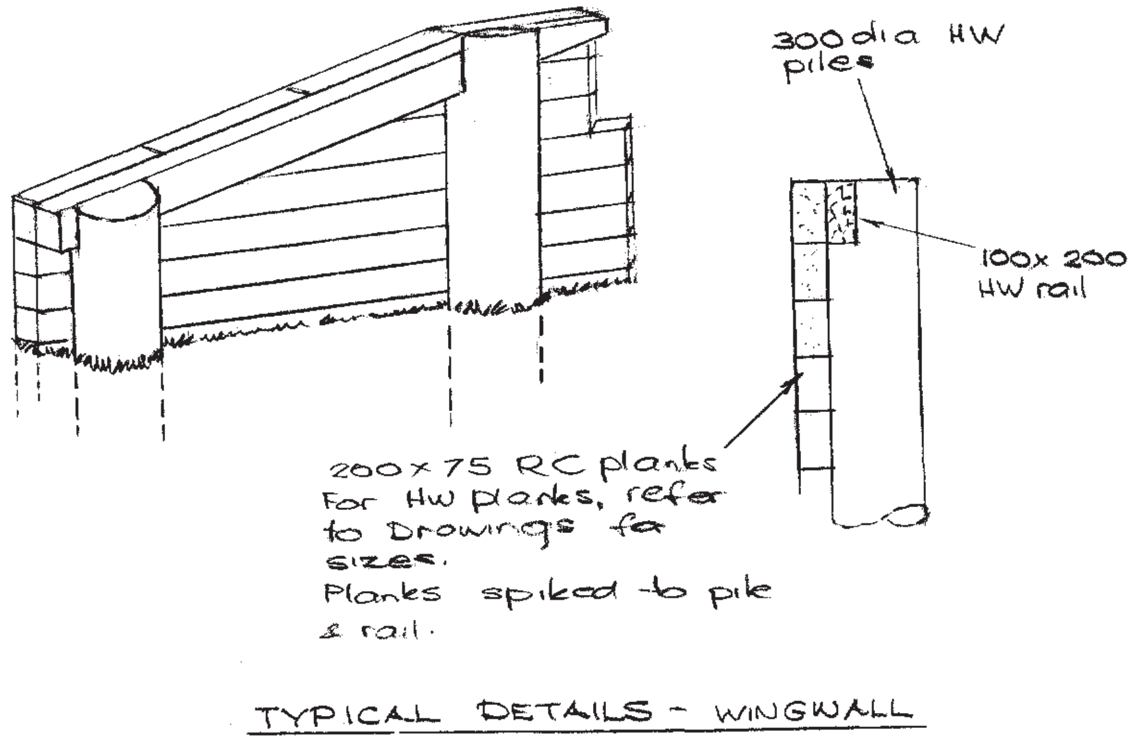
The most common failure mode is bending failure in the timber planks as a result of loss of section due to rotting. Similarly, failure of rotted piles may occur if they are unable to withstand the embankment earth pressure loads.

As well, scouring at the base of the wing may allow dropping down of the slabs and exposure of the fill material to erosion loss.

Maintenance Activities:

Refer to Part 3 Item 2.46 (51T) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.



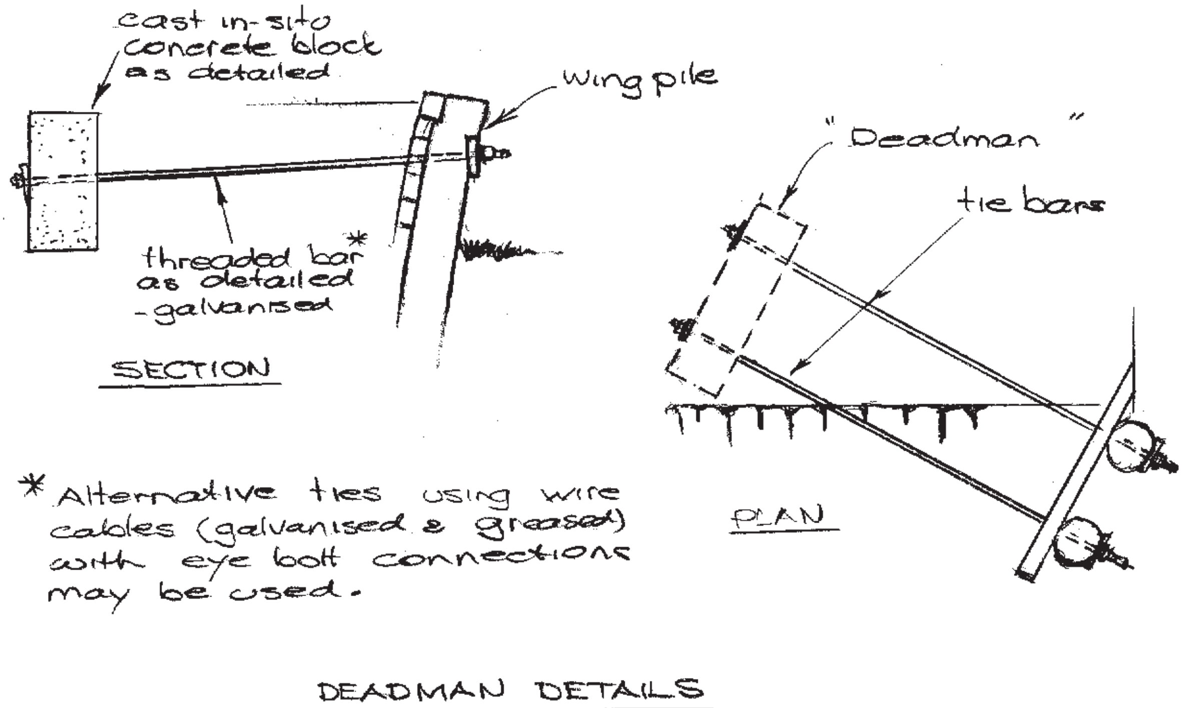


Figure 16.1 - Plank Wings

2

16.2 Concrete Plank Sheeting (51P)

Bridge Inspection Manual Component No. 51P

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to Activities for Abutment Sheeting - Concrete Planks	Concrete Planks

Purpose:

The function of a wing is to provide protection to and terminate the road embankment at the sides of bridge abutments.

Significance: ***Significance Rating 3***

Wings are important because they help prevent scour of embankment fill as a result of stream flow or flood. Without such protection, it is possible for scouring to progress to a washout behind the abutment.

Details:

This type of wing consisted of precast concrete backing slabs spanning across driven wing piles, as shown in Figure 16.1.

Failure Mode:

Loss of section caused by spalling of concrete as a result of reinforcement corrosion may cause slabs to fail in bending.

As well, scouring at the base of the wing may allow dropping down of the slabs and exposure of the fill material to erosion loss.

Maintenance Activities:

Refer to Part 3 Item 2.47 (51P) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

16.3 Concrete Wing (51C)

Bridge Inspection Manual Component No. 51C

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer to activities for concrete repair	

Purpose:

The function of a wing is to provide protection to and terminate the road embankment at the sides of bridge abutments.

Significance: ***Significance Rating 3***

Wings are important because they help prevent scour of embankment fill as a result of stream flow or flood. Without such protection, it is possible for scouring to progress to a washout behind the abutment.

Details:

These wings were cast in-situ as gravity sections and were of mass concrete construction. Figure 16.3 shows typical details.

Failure Mode:

If streamflow undermines this type of block wall, it is possible for the wall to tilt out under the action of earth pressure, with overturning an extreme possibility.

Maintenance Activities:

Refer to Part 3 Item 2.48 (51C) for recommended maintenance practices applicable to the various expected deterioration states for the component.

Refer to Part 4 for a description of applicable maintenance activities.

2

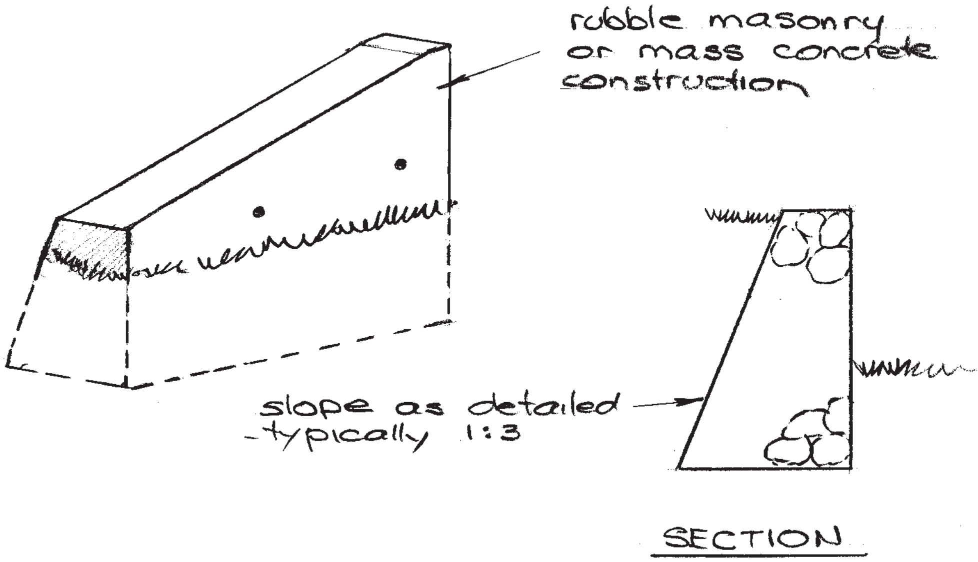


Figure 16.3 - Concrete / Masonry Wing

16.4 Masonry Wing (51O)

Bridge Inspection Manual Component No. 51O

Refer to BIM Appendix D for a description of the four condition states applicable to this component.

Maintenance Activity Numbers	Units
Refer activities for Masonry repair	

Purpose:

As for concrete Wings (16.3).

Significance: ***Significance Rating 3***

As for concrete wings (16.3).

Details:

This type of construction was an alternative to mass concrete and generally took the same form and dimensions - Figure 16.3

Failure Mechanism:

As for concrete wings (16.3).

Maintenance Activities:

Refer to Part 3 Item 2.49 (51O) for recommended maintenance practices applicable to the various expected deterioration states for this component.

Refer to Part 4 for a description of applicable maintenance activities.

17.0 Miscellaneous

17.1 Bolts

Maintenance Activity Numbers	Units
120S1 Tighten existing bolts	Lump sum
120S2 Replace or install bolts	Each
120S3 Replace anchor bolts	Each
120S4 Install large size washers	Each
120S8 Supply new bolts	kg

Details:

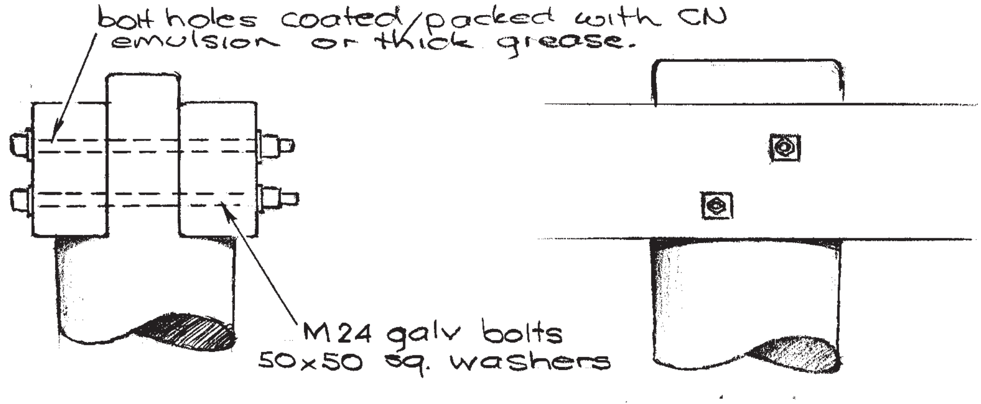
Bolt sizes and spacings shall be as shown in Figures 17.1(a) - (d).

All new bolts supplied shall be galvanised. Wherever possible, existing bolts should be re-used, after application of protective coating as required.

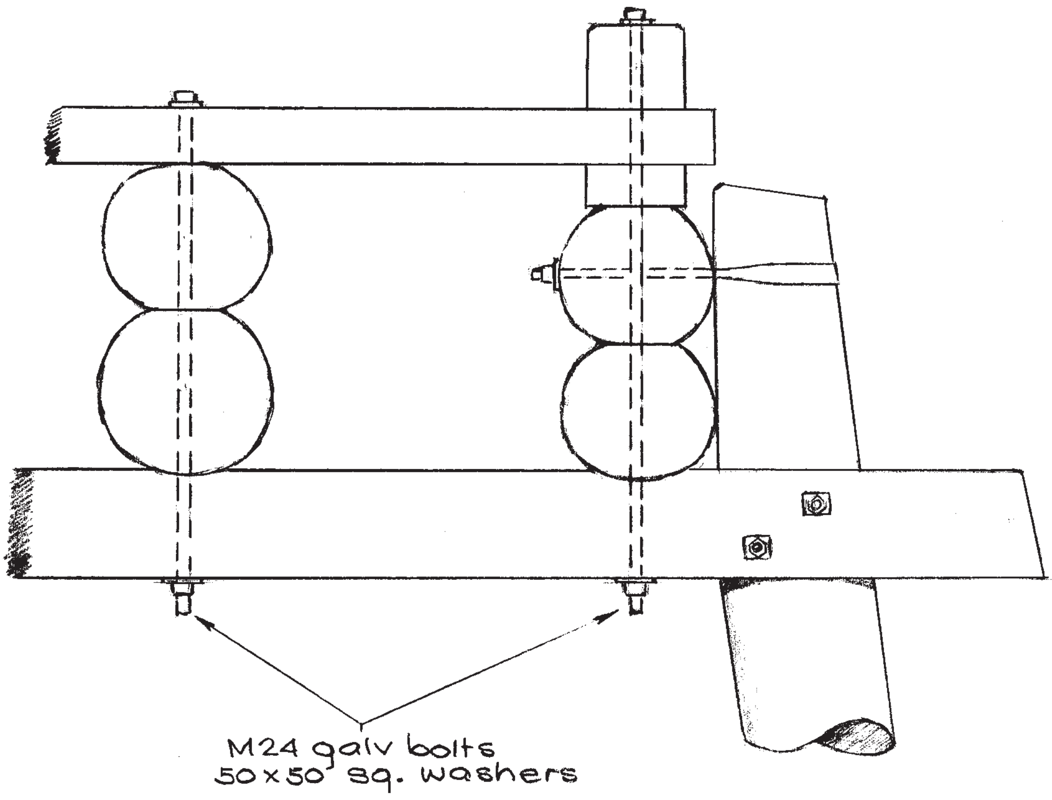
All bolts should be coated with grease before insertion in bolt holes in order to provide further protection to timber components.

Bolts may require packing with steel washers and tightened to refusal. Care must be exercised to prevent over tightening, causing crushing below washers.

Refer to Part 4 for a description of applicable maintenance activities.



HEADSTOCK / PILE BOLTS



GIRDER / HEADSTOCK BOLTS

Bolts shall be Grade 4·6 to AS/NZS 1111.
Nuts Grade 5 to AS/NZS 1112 & washers for Grade 4·6 bolts to AS/NZS 1237.

All bolts & nuts to be hot dip galvanised to AS 1214 and washers to be hot dip galvanised to AS/NZS 4680 unless noted otherwise.

Apply grease to bolts before insertion.

Figure 17.1(a) - Bolts (1)

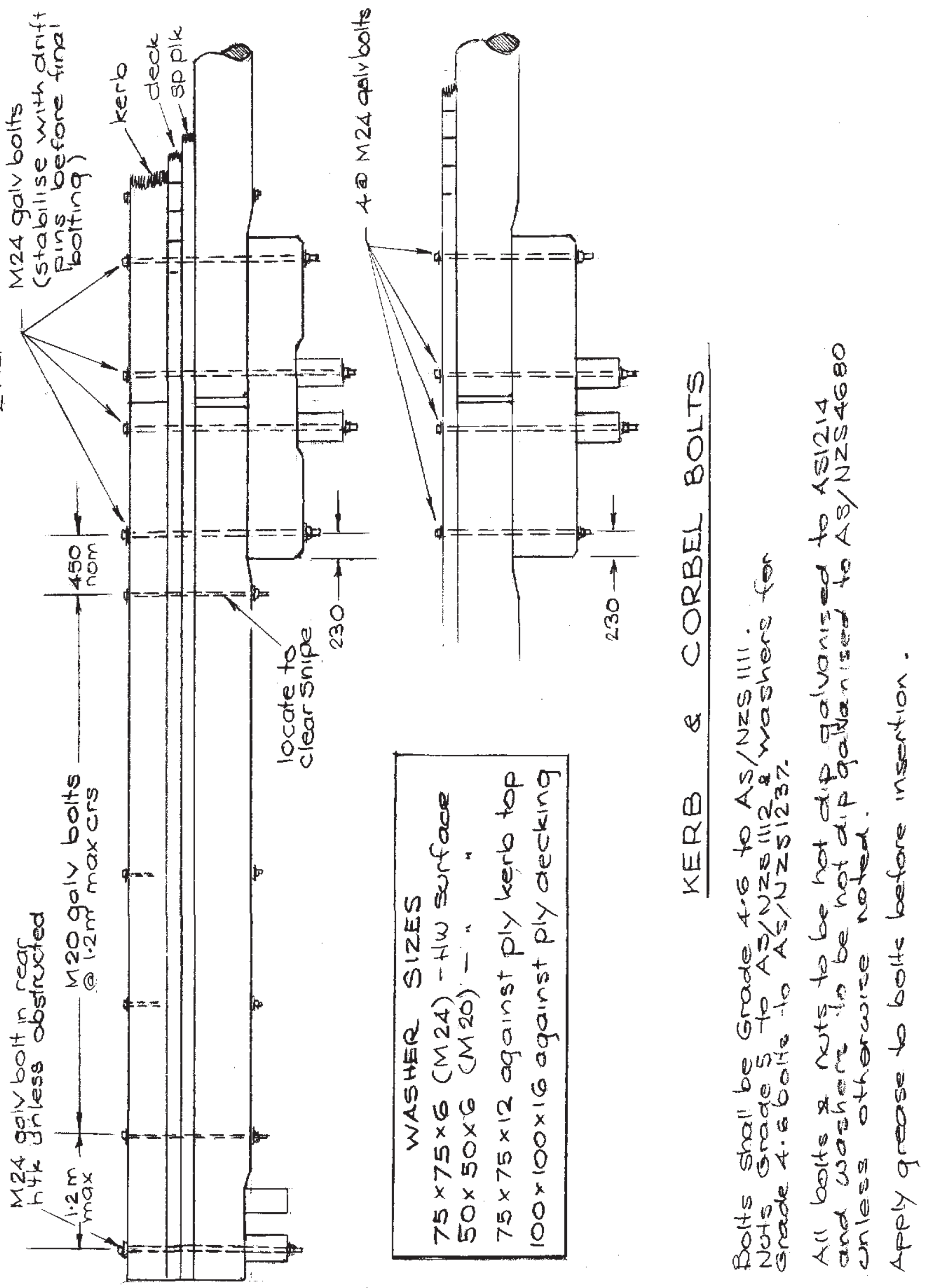


Figure 17.1(b) - Bolts (2)

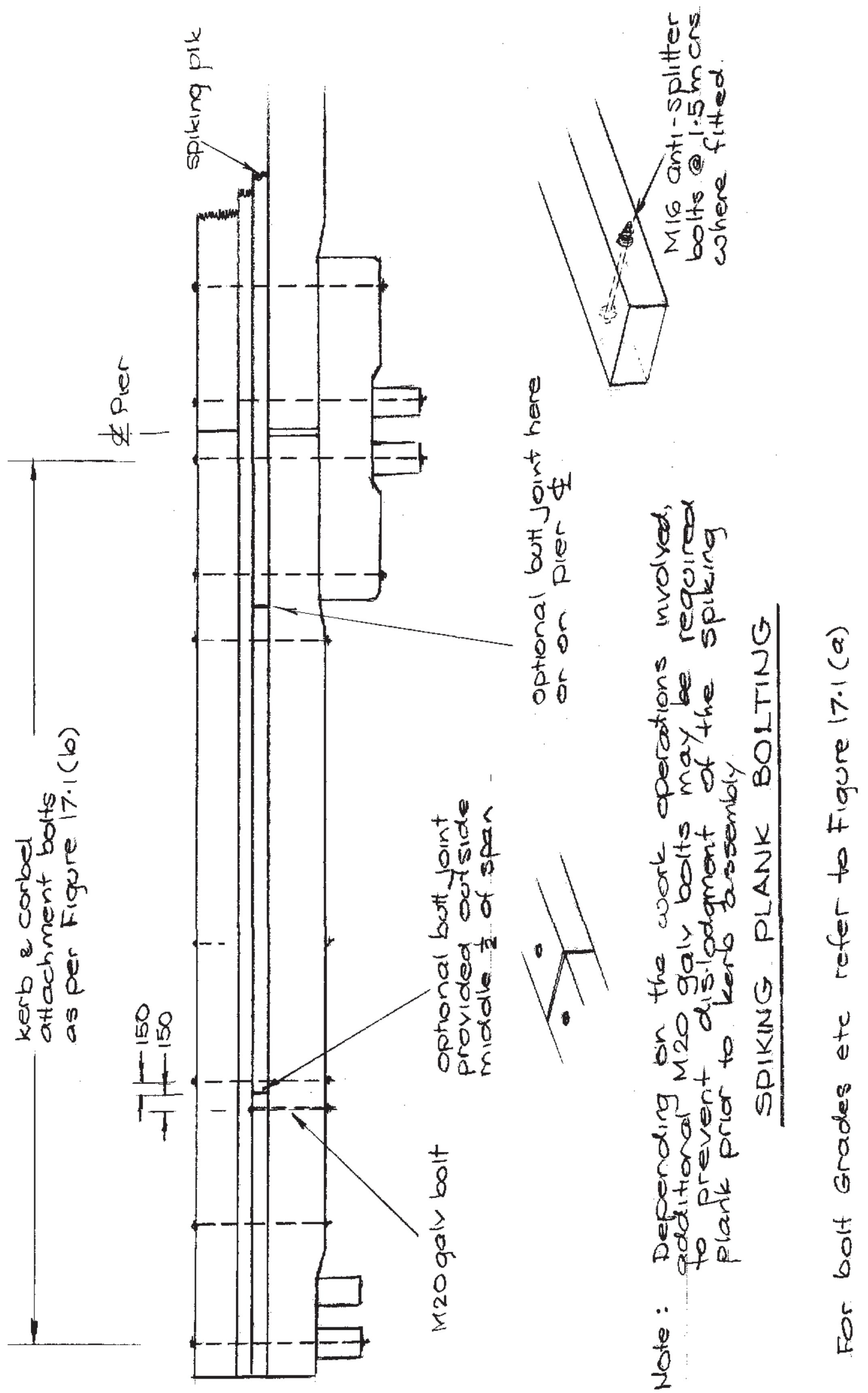
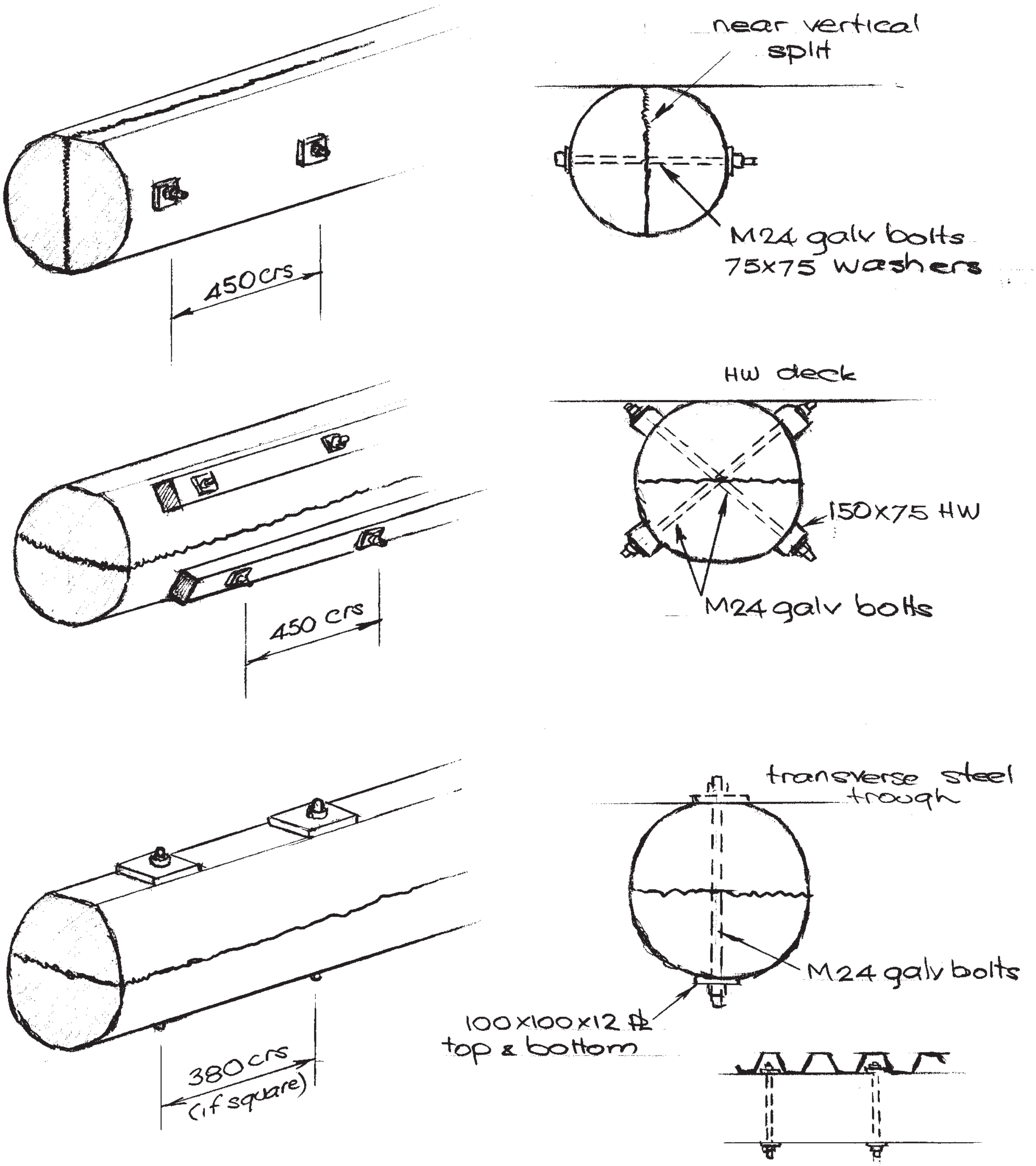


Figure 17.1(c) - Bolts (3)



For bolt Grades, refer to Figure 17.1 (a)

ANTI- SPLITTING BOLTS

CORBELS & GIRDERS

Use for cracks of 10mm or > width or as directed.

Figure 17.1(d) - Bolts (4)

2

17.2 Running Planks

Maintenance Activity Numbers	Units
29T3 Replace & retighten running planks	M

Purpose:

Hardwood timber running planks were used, generally in conjunction with distributor planks to improve decking performance. They provided enhanced distribution of wheel loads to deck planks and would span individual deteriorated planks.

General:

Placement of new running planks is not generally recommended today because of the increased potential for rotting of adjacent decking due to moisture trapped between these members. In addition, ends of running planks are prone to deterioration around spikes resulting in looseness. Consideration may be given to removal of these members and replacement with AC. In general, distributors could be retained, but would probably require a new set of attachment bolts.

Refer to Part 4 for a description of applicable/maintenance activities

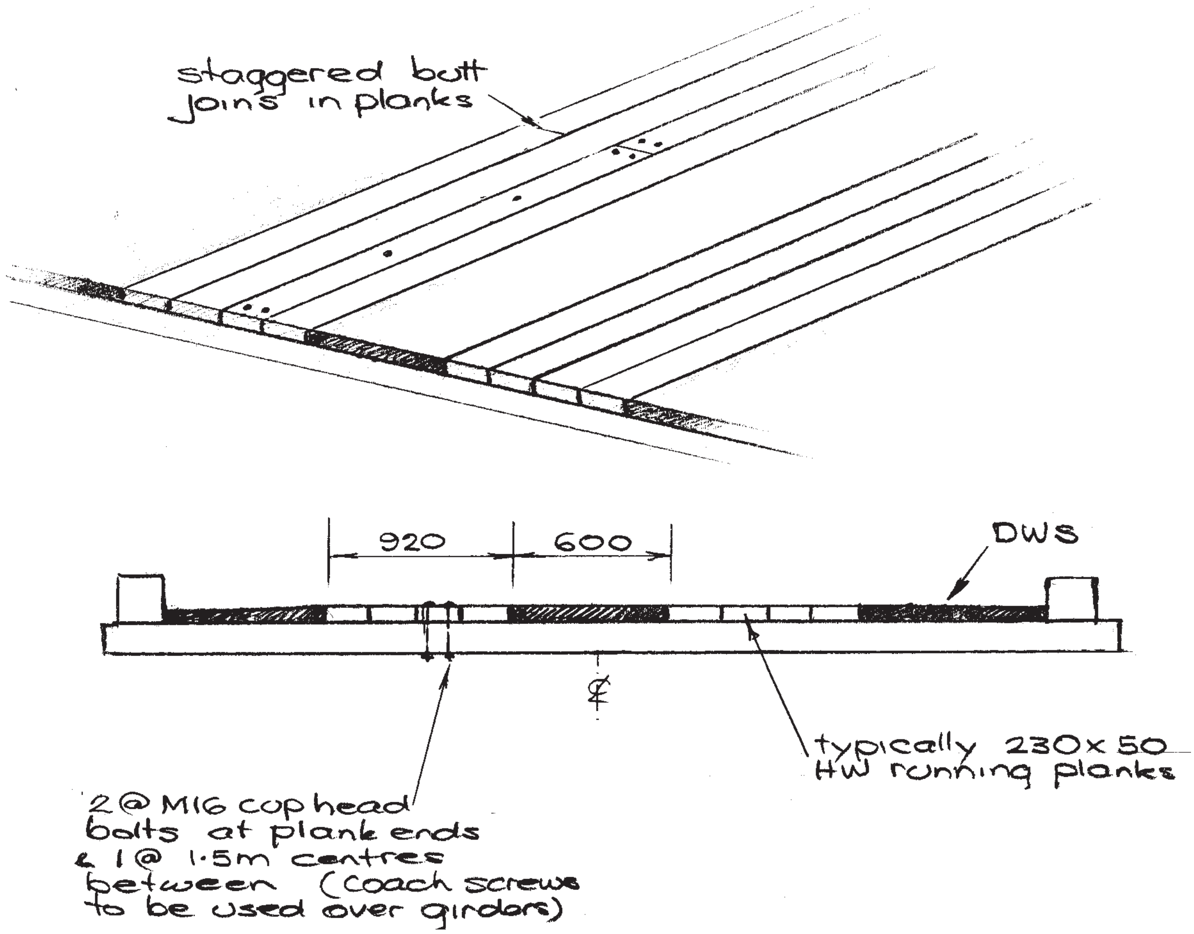


Figure 17.2 - Running Planks

17.3 Distributors

Maintenance Activity Numbers	Units
120T1 Install distributor planks (HW)	M
120T2 Replace & retighten distributor planks (HW)	M
130S3 Install distributors (steel)	M
130S4 Replace distributors (steel	M

Purpose:

Timber or steel distributors are used to improve distribution of wheel loads to decking. Hardwood distributors were generally placed under hardwood decks (often in conjunction with running planks) as a maintenance addition to also improve general tightness of the deck. Alternatively, steel members would be suitable. The general use of distributors is beneficial to the deck system and is recommended.

Distributors are also considered essential under ply decks to reduce differential deflection of the sheet edges under traffic wheels and so reduce break up of the AC wearing surface. Steel distributors are generally detailed for this purpose though some use of hardwood was initially made.

Steel angle distributors are an essential part of PSC decking in order to spread wheel loads between planks.

Details:

Figure 17.3(a) shows the traditional use of hardwood distributors under hardwood decks, with fastener spacings as typically used. For steel distributors similar spacings are appropriate.

Supply of hardwood distributors shall be to the requirements of MRS 11.87.

Figure 5.2(b) shows details suitable for ply decks.

Distributors shall be lapped as required by the drawings.

Refer to Part 4 for a description of Maintenance Activities applicable.

2

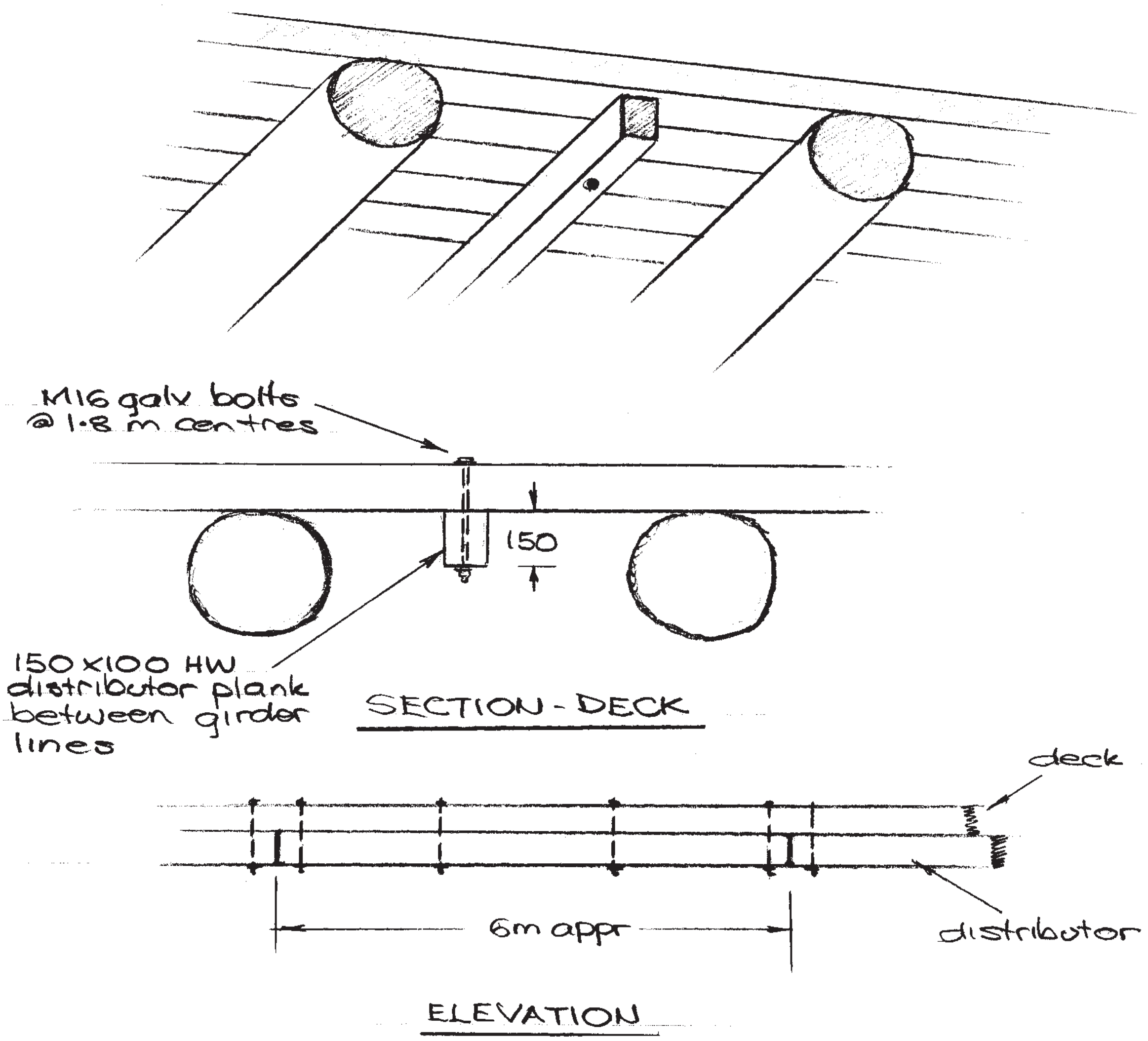


Figure 17.3 - Distributors - HW Decks

17.4 3mm Deck Plate

Maintenance Activity Numbers	Units
100M7 Lay 3mm galvanised steel plate decking	M^2

Purpose:

Thin galvanised steel plate has been laid over deteriorated timber decks in order to extend their life. The plate is 3mm thick and is screwed to the decking with a close grid of screws. The plate helps wheel loads span across gaps or weak deck planks.

Details:

Figure 17.4 shows the general details which have been used. Reference 12 gives details of testing and evaluation of this system on a timber bridge.

Coach bolts or screws shall be used to attach the steel plate securely to the timber decking. In order to effectively transfer wheel loads, no more than three isolated defective deck planks or two adjacent defective planks are allowed in any metre length of sheeted decking. If this cannot be achieved, some replacement of deck planks will be necessary.

Note that the use of this system is not actually compatible with general strategies for maintenance as given in 2.1.1 Part 1 because of the retention of deterioration components. The top of deteriorated decking is covered by the steel plate so the decking condition can only be determined from below and the ends. Some Districts claim success with this system as it allows an extended life for decking, but material costs will be high.

Refer to Part 4 for a description of maintenance activities applicable.

Refer to Appendix D(16) for a Supplementary Specification which may be used for the placement of 3mm deck plate.

Reference

12. Infratech Systems and Services. (1998). Performance of a Deteriorated and Rehabilitated Timber Bridge Deck.

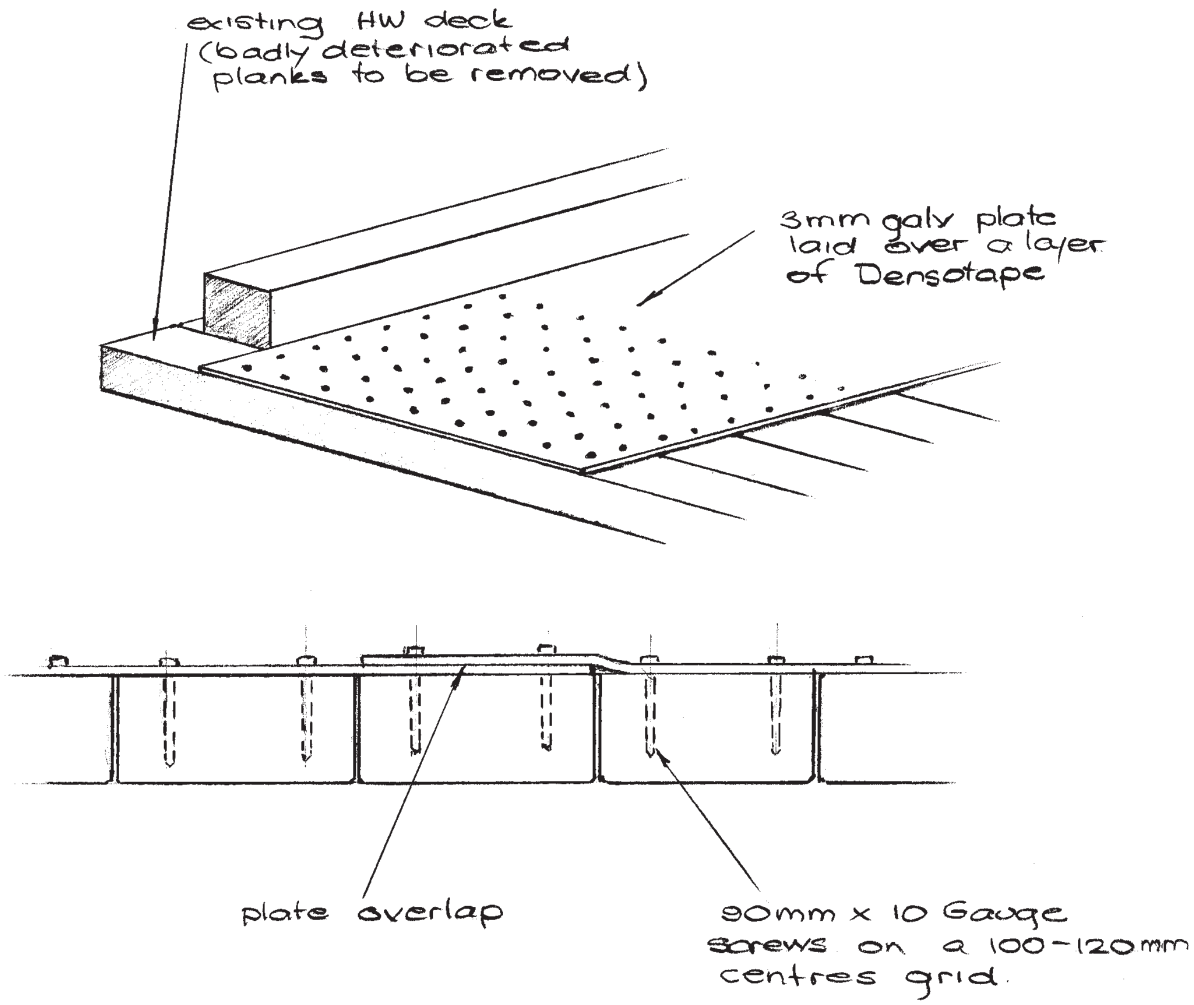


Figure 17.4 - 3mm Plate

2

17.5 Channel Tie - Downs

Maintenance Activity Numbers	Units
130S1 Install channel tie-downs	M
130S2 Replace channel tie-downs	M

Purpose:

Longitudinally placed channels are used to help tie down various types of decking; both during original placement and as a rectification procedure. Typically they are today used for steel trough decks and may be used on ply decks. They have also been used to help tighten HW timber decks.

Details:

Figure 17.5 shows typical usage for this component. The channel should be galvanised and bolted over the girders as shown in Figure 17.5.

Because of partial girder continuity induced by corbel action, channel members may be taken continuously across our locations.

Refer to Part 4 for a description of maintenance activities applicable.

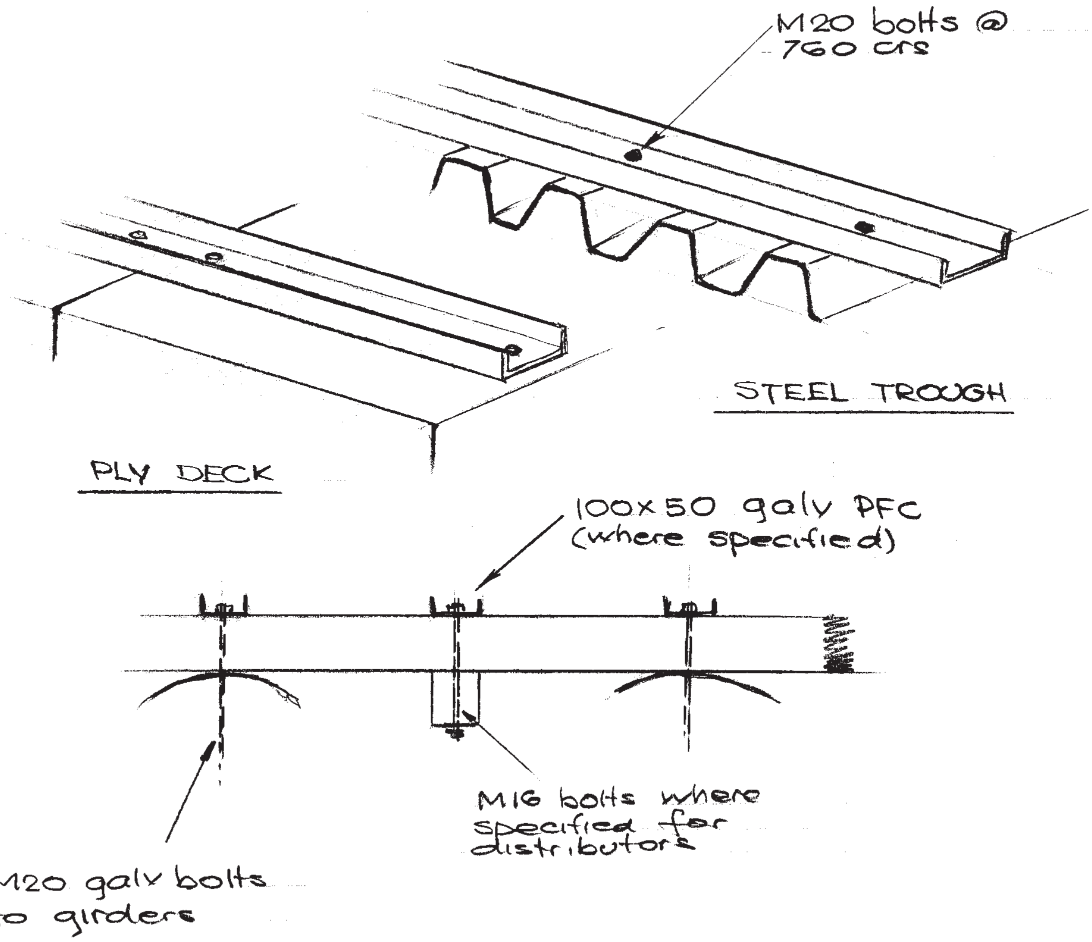


Figure 17.5 - Channel Tie-Downs

17.6 Tingling

Maintenance Activity Numbers	Units
100M8 Lay Tingling	M

Purpose:

Tingling is the placement of cover strips (metal generally) over excessive gaps between hardwood deck planks prior to the application of bituminous wearing surface. This is to prevent the dropping of the DWS through the gaps.

Details:

Figure 17.6 shows the general concept.

The tingling should be securely fixed to the decking with coach bolts, screws or clouts so as not to vibrate loose.

Refer to Part 4 for a description of maintenance activities applicable.

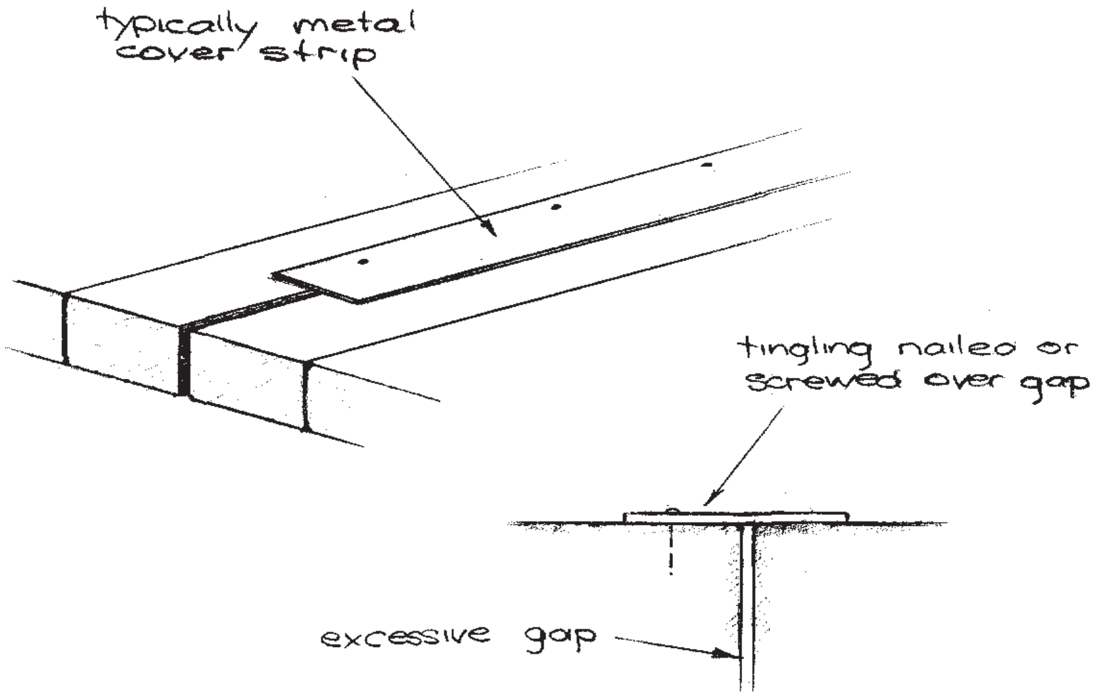


Figure 17.6 - Tingling

17.7 Preservative Treatments

Maintenance Activity Numbers	Units
100T1 Apply chemical preservative to timber	Lump sum
100T2 Apply preservative grease to timber	Lump sum
100T5 Apply end sealant	Lump sum
100T7 Place bituminous felt	Lump sum

Purpose:

Preservative treatments are applied to timber components in order to slow down the process of degradation from both biological attack and weathering.

General:

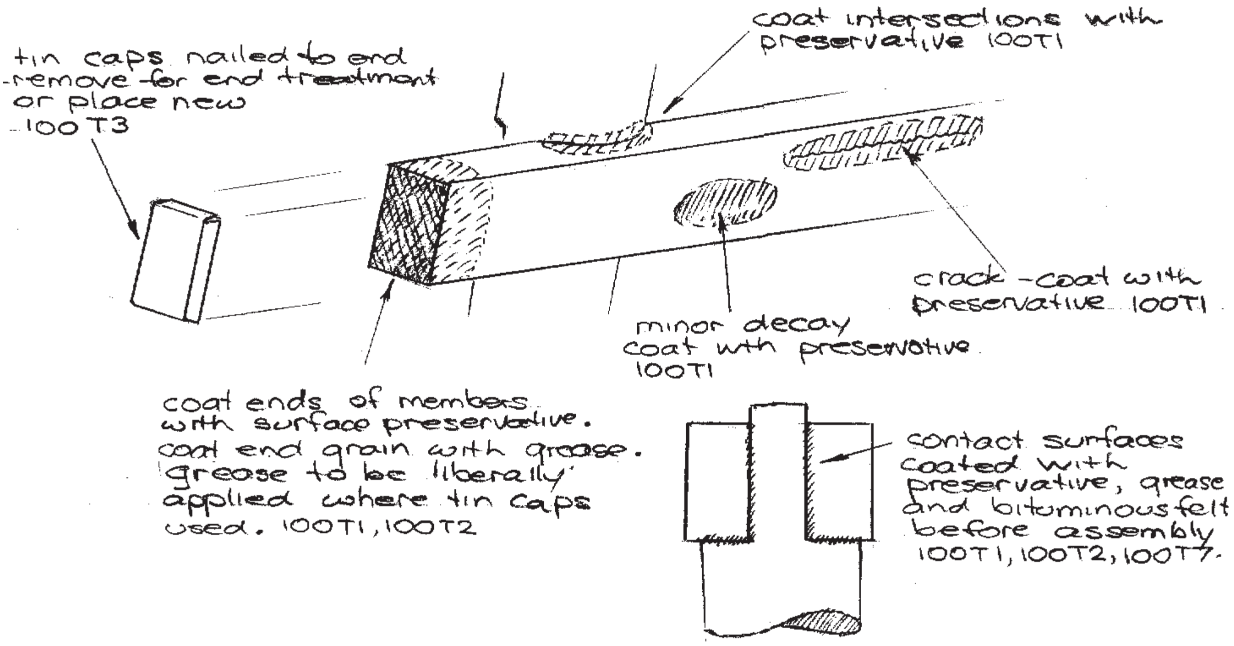
Timber rotting is caused by fungii living in or on the component and consuming part of the structure of the timber. This type of deterioration is generally controlled by the application of surface treatments which may be sprayed or painted on. Figure 17.7 shows lists and applications of generally used and proven chemical preservatives.

Baron rods which are placed in drilled holes are also included as a chemical preservative - refer Figure 7.1(b) Part 1.

Envelope treatment of sawn timber girders may also be considered as a means of extending girder life - refer Section 8.1.

Because rot fungii require water or a high moisture content to survive, a strategy to limit water collection is beneficial. The use of grease and a layer of bitumen impregnated compressible material at contact surfaces between timber components is recommended in order to reduce the potential for water pockets to be trapped between surfaces. Figure 17.7 lists recommended materials for this process.

Refer to Part 4 for a description of applicable maintenance activities.



APPROVED PROPRIETARY PRODUCTS

SURFACE PRESERVATIVES - during construction & maintenance			100T1
* CN Timber Oil	- Koppers	- liquid, general use	
CN Emulsion	- Koppers	- paste, vertical faces, ends	
CNB Emulsion	- "	" " "	
* Borocol 400RH	-	- liquid, general use	
Petroleum jelly (hot)		- end grain (over preservative)	
* on exposed faces, an overlay of grease is also to be applied.			

Diffusing preservatives in the form of solid boron rods placed in drilled holes may also be covered by the above Activity Item. A typical example is:-
Impel Rod - solid, general use in high risk areas

Figure 17.7 (a) - Preservatives & Sealants (1)

2

PRESERVATIVE GREASE	100T2
• Denso Grease - Denso Australia • other types of thick grease will provide some protection	

BITUMINOUS FELT	100T7
• • • * Denso Tape - Denso Australia * Bitac Strip * these products provide the same function.	

EDGE SEALANT - PLY	100T5
CN Emulsion - Koppers • for ply deck during construction, the approved deck bitumen emulsion may be used on the end faces. • for ply kerbs, a paint system as covered under Activity 100T4 will provide adequate protection.	

MOISTURE BARRIER	- after log felling & prior to job - refer MRS 11.87
Mobil-Cer M	- Mobil Oil Co
Anchorseal	- UC Coatings Corp.
EndSeal	- Newkem Aust.
Wax Emulsion Timber Sealer	- Pacific Petroleum Products

NOTE - Details of alternative products may be submitted to BAM for approval & inclusion in above lists.

Figure 17.7 (b) - Preservatives & Sealants (2)

17.8 Termite Poisoning

Maintenance Activity Numbers	Units
110T1 Drill & inject termicide poison into timber	Lump sum
110T2 Poison termite nest or trails	Lump sum

Purpose:

Anti-termite poisoning is carried out on

(a) New girders, corbels and piles as a guard against attack.

(b) Infested members in order to kill the termites and stop further damage.

General:

Poisoning is an on-going procedure at recommended intervals of 4 years. However, once termite presence is detected, treatment should be carried out as soon as practical in order to limit damage.

A list of approved termicides is given in Table 7.2(a) (Part 1). Where another chemical is proposed, details including NRS registration proof shall be submitted to BAM for approval.

Poisoning will be carried out by drilling holes into the heart of the member, injecting the liquid poison and plugging the hole with a removable plug. Figure 17.8 shows the required locations for poison applications and a list of approved proprietary products.

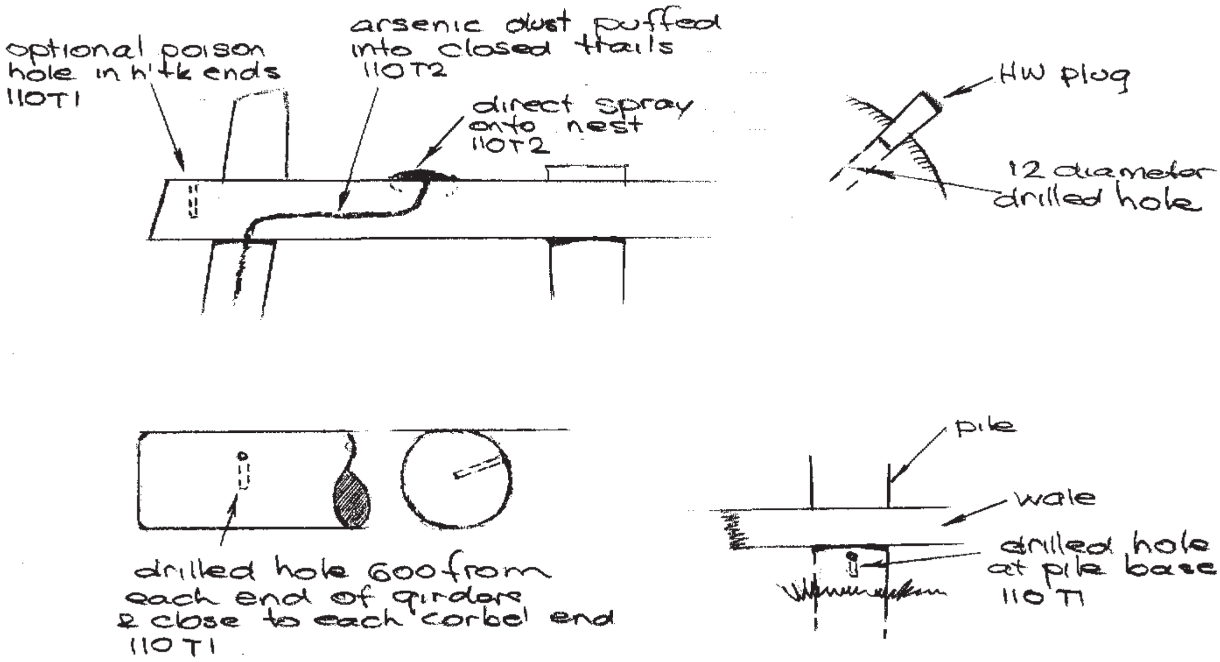
For future reference, the date, month and year that the structure was poisoned should be clearly marked at the abutment 1 headstock.

Some improvement in effectiveness is expected if chemical use is rotated.

Covered termite trails may be treated with arsenic trioxide dust applied by a hand puffer as noted in Section 7.2(Part 1).

Refer to Part 4 for a description of applicable maintenance activities.

Refer to Appendix D(19) for a Supplementary Specification which may be used for the poisoning of termites.



APPROVED PROPRIETARY PRODUCTS		
• Dursban	- Dow Chemicals	- chlorpyrifos, liquid spray & injection
• Pigeons Pest Controller 500		" "
• Arsenic Trioxide		- powder, dusting
• Bi- flex		

Refer to Table 7.2(a)(Part 1) for a list of Australian approved termicide chemicals.
Details of alternative proprietary products may be submitted to BAM for approval & inclusion in above list.

Figure 17.8 - Termite Poisoning

17.9 Deck Recambering

Maintenance Activity Numbers	Units
100M1 Recamber girders	Lump sum

Purpose:

Because hardwood decking is not physically connected to internal girders, tightness of the decking is developed by jacking up the internal girders with respect to the outer girders. The process is called "cambering" and the resultant reduction in differential movement between girder and decking helps reduce wear and rattling.

Details:

Standard DMR timber bridge drawings specify girders to be placed such that a small amount of upward curvature equivalent to a 16mm camber occurs in timber decking. Because of creep in timber under strain, the effectiveness of this procedure reduces with time. From time to time, a recambering of girders is required to re-establish deck tightness.

From earlier analysis carried out, it is recommended that a jacking of a centre girder be limited to 25mm at re-cambering (about 1% cross fall). Although it is possible for hardwood decking to be cambered by 50mm or more, very large forces are developed in the outer girders bolts and hold-down bolts on outer sill piles. In addition larger bending and shear forces occur in headstocks because of the increased load applied by the inner girders.

Before a recambering operation is to take place, all replacement of unsound timber components shall be carried out, and all hold down bolts as specified in Figures 17.1(a)-(d) shall be in place. Ideally, headstock condition should be at least Condition State 2.

Internal girders and corbels shall be jacked up, ensuring tight contact with the underside of the decking. Metal shims as shown in Figure 17.9 shall be placed between the headstock top and the corbels / girders. Under no circumstances are shims to be placed between corbels and girders.

If the total depth of shims will exceed 100mm, larger girder / corbel members should be used.

Refer to Part 4 for a description of this Maintenance Activity.

Refer to Appendix D (20) for a Supplementary Specification which may be used for deck recambering.

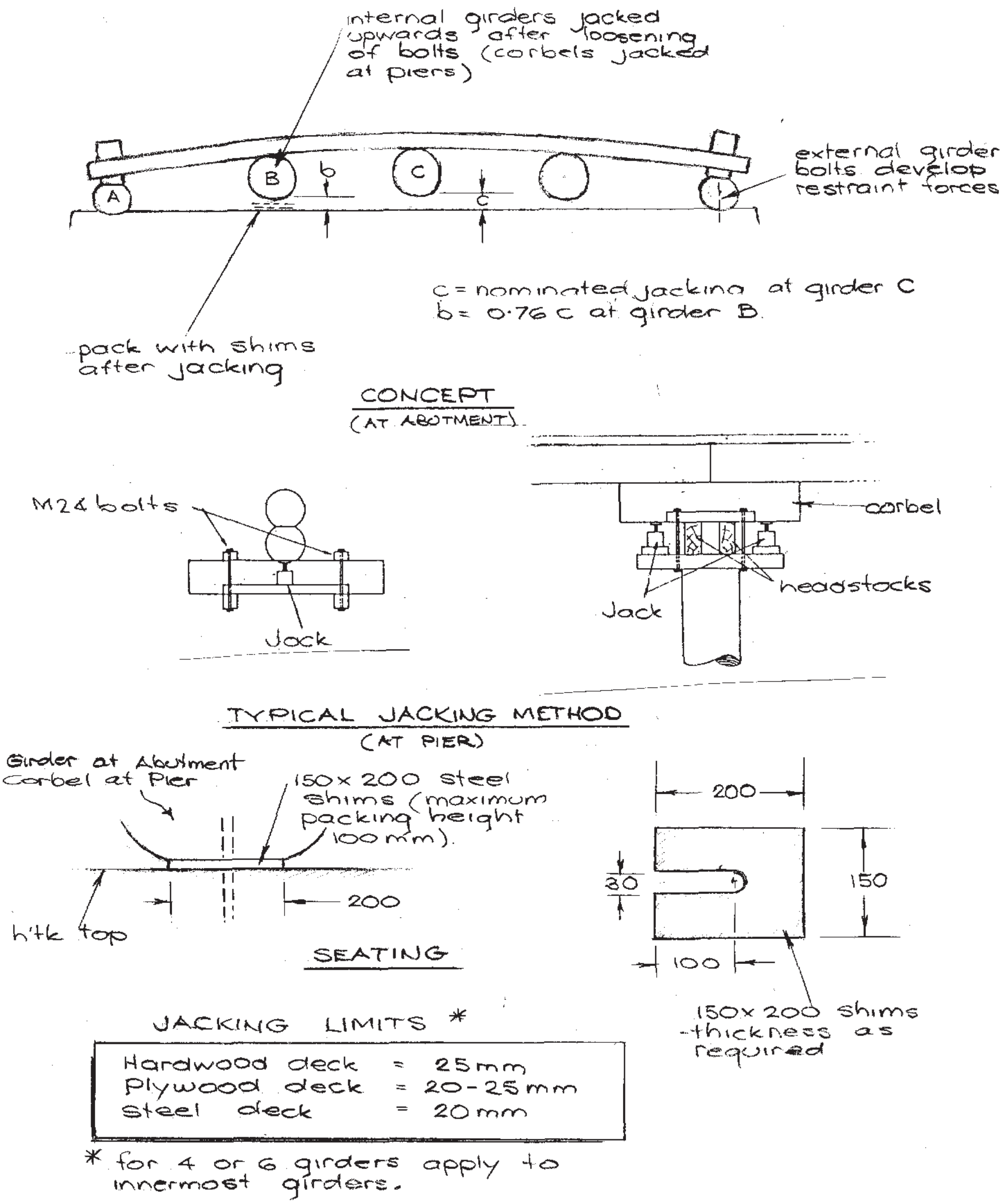


Figure 17.9 - Deck Recambering

17.10 Painting

Maintenance Activity Numbers	Units
100T4 Paint or repaint timber	Lump sum
100S1 Spot clean and paint steelwork	
100S2 Clean & paint bolts, nuts & washers	Lump sum
100S3 Clean & paint steelwork	Lump sum
100S4 Clean & paint stressing bars	Each

Purpose:

Painting of timber surfaces such as handrails and kerbs is generally carried out to provide delineation of the roadway.

Painting of metal surfaces is used to provide protection against corrosion. The majority of metal components such as bolts, piles or headstocks are generally specified to be galvanised.

General:

On new timber surfaces, painting will generally provide increased protection from fungal attack and weathering. However, it is not recommended on cracked members because of the potential for sealing and holding of water within a member.

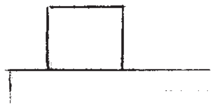
Steel headstocks and piles have often been placed without protection, particularly in dry areas if service life is to be brief. Where surfaces are painted and are showing corrosion, however, spot painting or repainting should be carried out. Figure 17.10 gives details of paint types.

Stressing bars in stress-laminated decks cannot be galvanised because of potential hydrogen embrittlement and are supplied with a paint protection. It is important these bars are kept free of corrosion by painting as noted in Figure 17.10.

Refer to Part 4 for a description of maintenance activities applicable.

2

TIMBER KERBS



Exposed faces to be painted white.

- Refer to specification MRS 11·14 Clause 14·4·2 for recommended paint details.

STRESSING BARS (stress-Laminated Timber)

- Paint with a grey inorganic zinc silicate coating

STEEL SECTIONS (non galvanised)

(1) MICACEOUS IRON OXIDE OVER RED LEAD (existing)

- Refer to MRS 11·85 for preparation & repainting including red lead removal & disposal requirements.

(2) ALL OTHER COATINGS

- Submit details of proposed preparation & paint system to Structures Division for approval.

For new steel surfaces, the provisions of Draft MRS 11·88 may be applied.

MINOR REPAIRS

- Where a surface coating is damaged, a cold galvanising product should be used. Submit details to Structures Division for preparation of an approved products list.

Figure 17.10 - Painting

17.11 Propping

Maintenance Activity Numbers	Units
100M9 Emergency propping	Lump sum
100M10 Place / reinstate relieving props	Lump sum

Purpose:

Propping (or tomming) is used to:-

(a) provide emergency support to allow continued bridge operation until repairs are carried out.

(b) Provide medium term relief to deteriorating substructure pending reconstruction.

(c) Provide temporary support during various maintenance operations to remove load from components.

(d) Allow passage of heavy overload permit vehicles where alternative arrangements are not possible (at cost).

General:

Emergency propping is associated with failed or partially failed members and is of a temporary nature.

Typical locations would be below failed steel decking, headstocks or girders.

Relieving props would be used adjacent to log abutments or silled piles where settlements are occuring due to sill deterioration . Propping of the superstructure will reduce load to the defective components and provide extra time before repairs are required.

Figure 17.11(a) & (b) show various prop arrangements.

Figure 17.11(b) provides details of typical propping required for overload passage placed at the span centreline. In all cases, BAM will provide acceptable details for this procedure. Figure 17.11(c) shows typical temporary support / jacking procedures for various maintenance works.

Refer to Part 4 for a description of maintenance activities that are applicable. Note that general jacking and propping used for load reduction or support during general maintenance operations are covered in the particular Activity item.

Reference shall also be made to the current Australian Standard for falsework and also to Workplace, Health and Safety requirements.

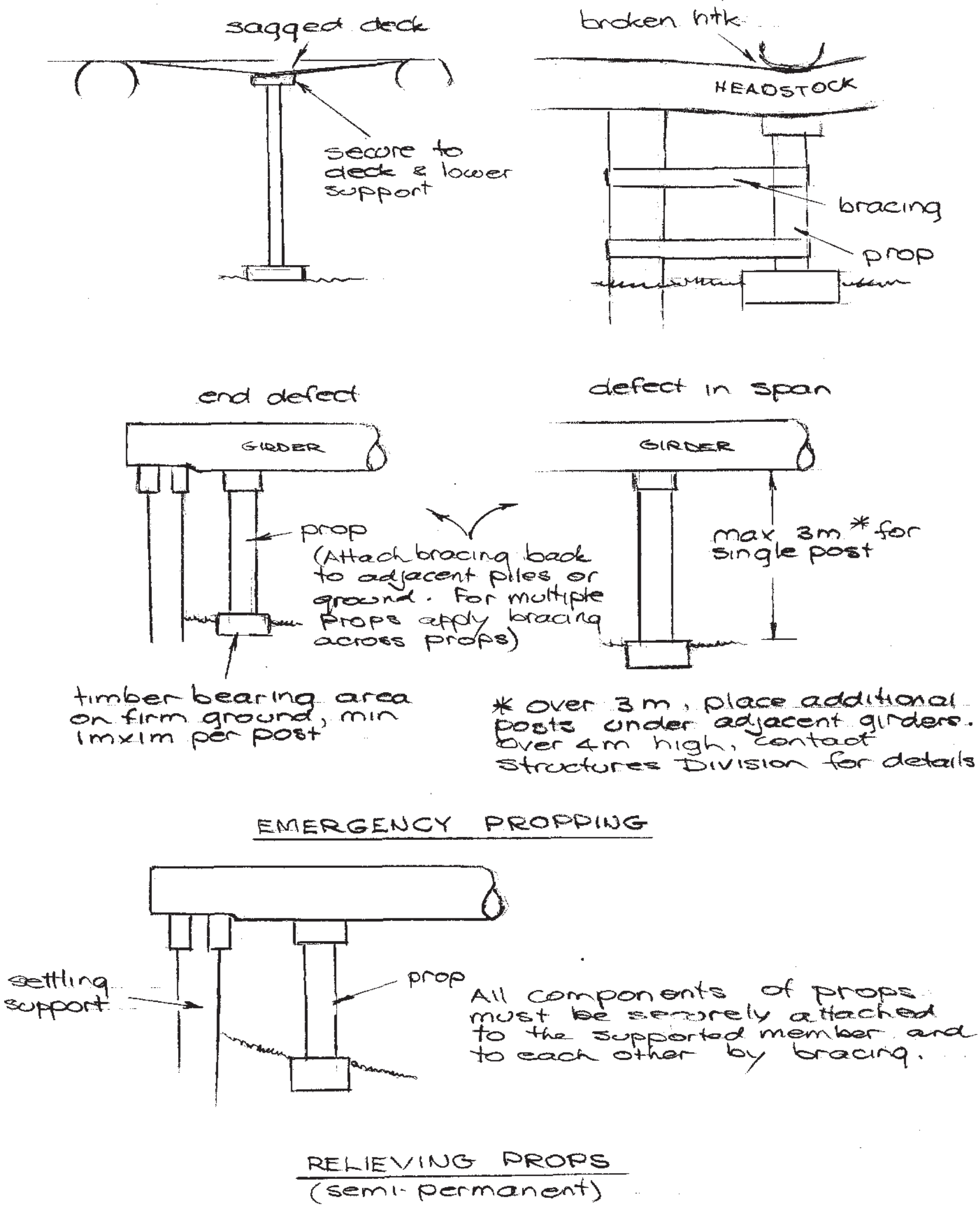
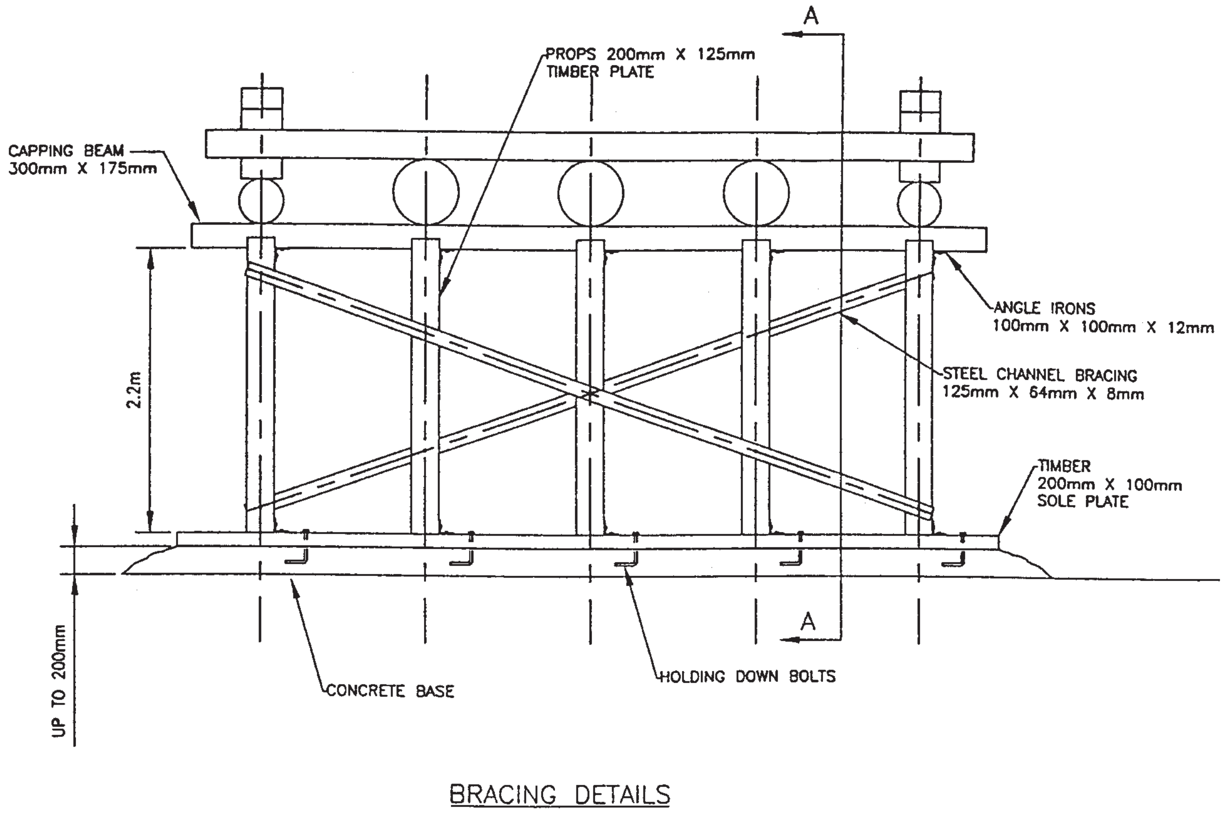


Figure 17.11(a) - Propping 1

2



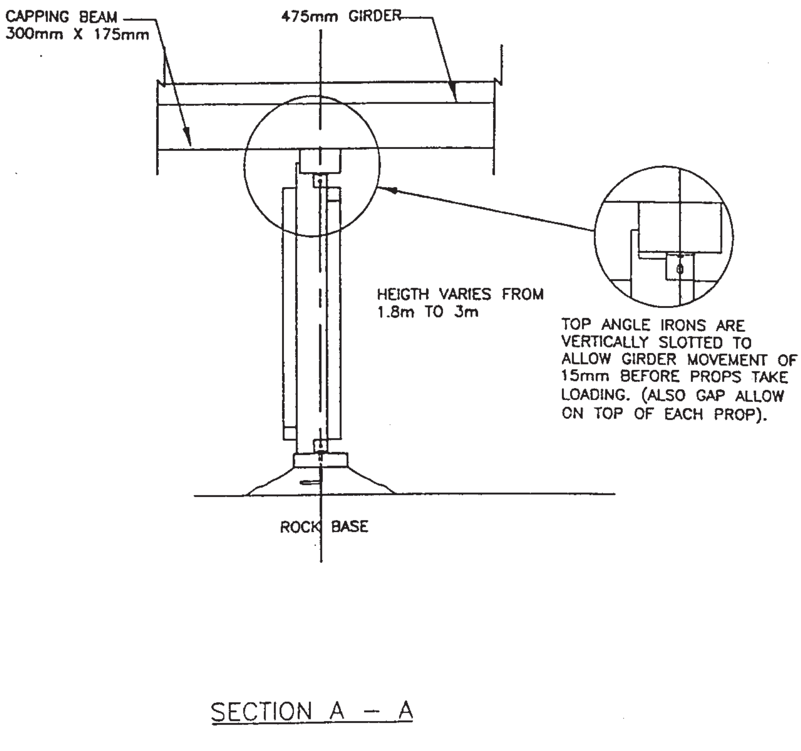


Figure 17.11(b) - Propping 2

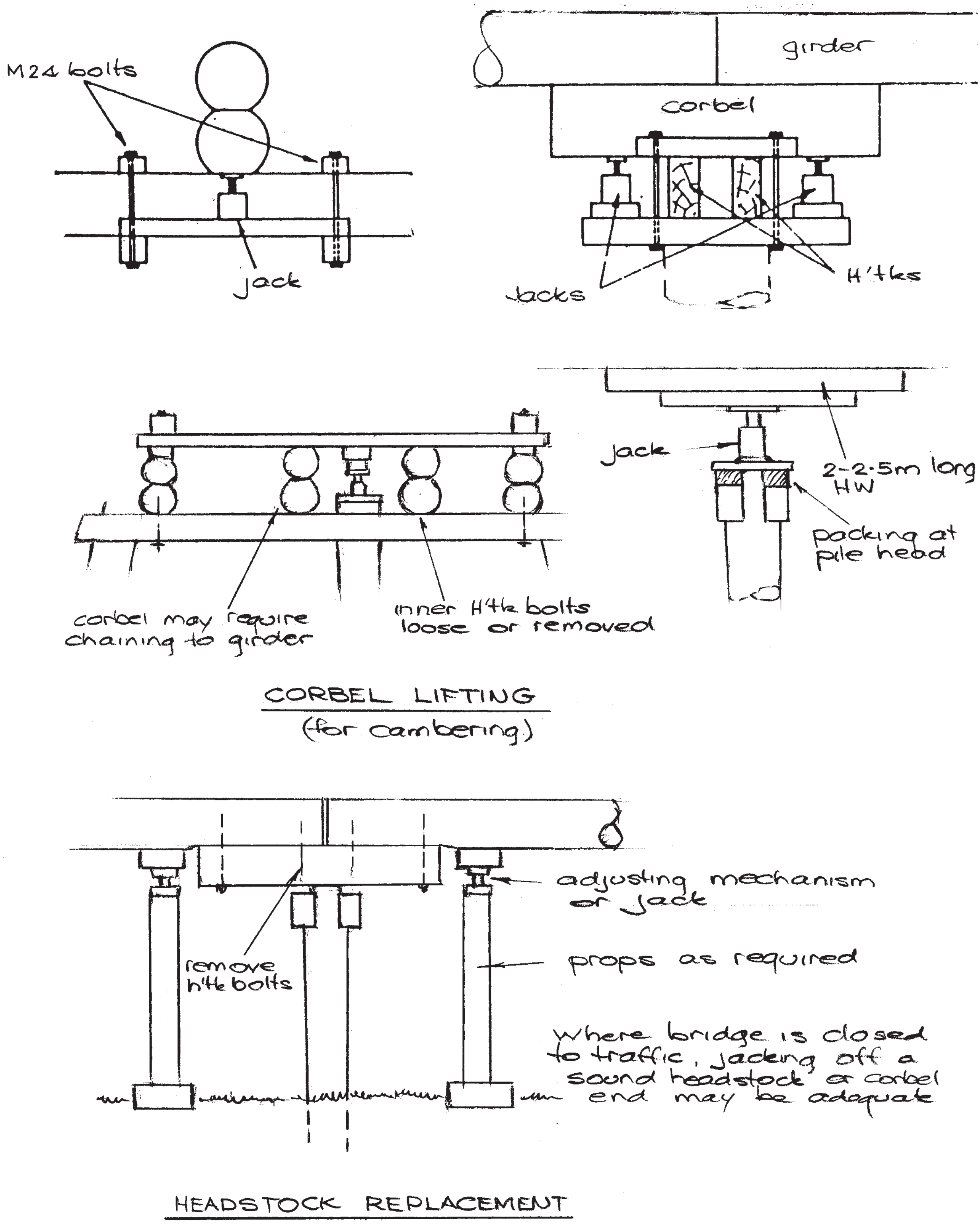


Figure 17.11(c) - General Propping