BRIDGES 15

DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

Manual No. 6

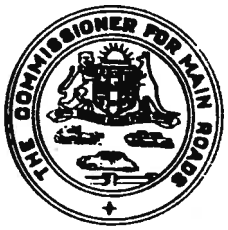
BRIDGE MAINTENANCE

Methods to be followed in the Inspection, Testing and Maintenance of Bridges

Prepared for the use of Department of Main Roads bridge maintenance foremen and recommended as a guide to Municipal and Shire Councils

Costing

ISSUED 1962



DEPARTMENT OF MAIN ROADS
NEW SOUTH WALES

Manual No. 6

BRIDGE MAINTENANCE

Instructions for
Bridge Maintenance Foremen

ISSUED 1962

CONTENTS

CONTENTS (Continued)

List of Figures

List of Drawings and Forms at back of Manual

Truss span—"Allan"—70 feet	Diagram	M.R.	No. A. 3727
Truss span—"Allan"—90 feet	"	"	" A. 3728
Truss span—"Allan"—110 feet 3 inches	"	"	" A. 3729
Truss span—"McDonald"—75 feet	"	"	" A. 3730
Truss span—"McDonald"—90 feet	"	"	" A. 3731
Typical diagram for test boring timber beam bridges	"	"	" A. 3741
Replacing timber girder under bolted timber deck without lifting deck		Sketch	"A"
Truss chord support during replacement		"	"B"
Support of truss span during chord repairs		"	"C"
" " " " " " "		"	"D"
Support of truss span using Bailey trusses		"	"E"
Timber truss, type "B"—Permanent undertrussing	Drawing		B.26A
" " " "A"—Permanent undertrussing	"		12B, 113D
" " " "B"—Permanent undertrussing	"		B.47A
Standard Pile Splice	"		A.1227
R.S.J. Bridges with timber decks—zinc protection sheet	"		A.3560
R.S.J. bridges with concrete decks—zinc protection sheet	"		A.3561
Lock washers	"		A.4633
Longitudinal sheeting for timber bridge decks	"		A.5576
Provision for traffic	M.R. Form		No. 121
General arrangement and location of temporary signs	Drawing		A.1323
Details of temporary signs	"		A.1325
Extermination of termites	M.R. Form		No. 326
Arrangement of bolting planks	Drawing		A.1886
Standard running planks	"		A.1216
Specification for timber beam bridge	M.R. Form		No. 164

Add the following as a new paragraph after the existing two paragraphs.

"The Department is required to comply with the Scaffolding and Lifts Act No. 38 of 1912 and the Regulations made under that Act. Regulation No. 73 (19) of the Act states that suitable rescue equipment of an approved type shall be provided and kept ready for the prompt rescue of any person liable to fall with risk of drowning into water on or adjacent to a site where work is being carried out. In these circumstances, the Department is required to provide the following approved type of rescue equipment which shall be maintained in an effective condition for the duration of the project, on each floating vessel (pile driving rig, floating crane, dredge, barge, punt, etc.) or wharf or bridge construction or repair, including any piers, bents, or cofferdams in connection with such bridge or wharf:-

(a) A substantial timber or metal "slide" ladder, constructed as prescribed in Regulation 142(2), (3) and (4) or Regulation 142(8) if of metal. Such ladder shall rise 3 feet 6 inches above the deck of the vessel, wharf, or landing of a bridge or pier, and extend below the surface of the water at least 3 feet. It shall be securely fixed as prescribed in Regulation 80(6) and landing platforms as prescribed in Regulation 80(13) be provided where the vertical distance exceeds 20 feet.

(b) A lifebuoy (or lifebuoys at intervals not exceeding 100 feet on wharf or bridge works) fitted with rope loops and to which a lifeline at least 50 feet long, of fibre rope a minimum size of 1¼ inches circumference, is securely attached.

(c) Where such building work is carried on in the hours of darkness, a self-releasing and igniting red flare shall also be so attached to the lifebuoys that when thrown or released the flare ignites on contact with the water.

(d) A resuscitation instructional notice of approved type, exhibited near the lifebuoys or in the workmen's change sheds, or deckhouse of any floating vessel in a situation accessible to all workmen. The person actually in charge of the work at the immediate site of the operation or some other responsible person at the immediate site shall possess a sound knowledge of resuscitation procedure and rescue equipment.

(e) A rowboat tender complete with oars, rowlocks permanently attached, and a boathook shall be moored to the floating vessel, wharf, bridge pier, or cofferdam and be readily accessible at all times.

The boat should be kept where it is accessible as possible to the actual site of the work. On long bridges it may be necessary to have a temporary ladder attached to the pier nearest to the actual work site, and have the boat moored at this pier so that it can be used immediately if it is required.

Where such rowboat may be used for conveyance of men or equipment requiring absence from the vessel or site for more than 15 minutes, a second similarly equipped rowboat shall be provided and be available at the site or vessel.

(f) In tidal or swift flowing waters where the current is in excess of 5 knots, consideration should be given to the installation of a buoyed safety line securely anchored to both banks across the stream not more than 200 feet below the site of the work, and on tidal waters, on both upstream and downstream sides of the work. Such line shall be buoyed by air tight drums or timber planks so that the safety line remains buoyant at the surface of the water. However, the line or lines should not be installed if this would create a danger to the occupants of small craft, such as speed boats, especially at dusk or other times of decreased visibility. In navigable waters it may be impracticable to provide this equipment unless some means of making openings for vessels is possible.

(g) Where dredge discharge pipes are used as walkways, they shall be provided with a flat surface walkway at least 12 inches wide, securely anchored to the pipeline. A guardrail or taut lineline 3 feet 6 inches high shall be provided on one side, secured to staunchions at centres not exceeding 8 feet. The lifeline shall be a minimum size of ⅝ inches diameter wire rope kept taut in an approved manner.

Divisional Engineers are to give consideration to the extent to which Regulation No. 73(19) applies to installations and operations in their Divisions, and to arrange for the provision of approved rescue equipment required under the Regulation.

BRIDGE MAINTENANCE.

1. SCOPE OF BRIDGE MAINTENANCE BY DEPARTMENT OF MAIN ROADS.

The Department is responsible for the maintenance of all bridges on Main Roads maintained by the Department (as opposed to Main Roads maintained by Councils), together with certain other bridges, at one time called "National Works", for which the State has assumed full responsibility. The Divisional Engineer will instruct the bridge maintenance foreman as to the bridges with which he is concerned.

2. PROVISION FOR TRAFFIC AND SAFE WORKING.

When bridge repair work is in progress, arrangements for the provision of barriers, lamps, warning signs, etc., where required are to be made in the manner set out on M.R. Form No. 121 and standard drawings A.1323 and A.1325, copies of which are attached. This information is also set out in the booklet, "Provision for Traffic, etc., at Works in Progress" issued to all foremen. The bridge maintenance foreman at all times is to ensure that adequate provision has been made for the safety of traffic at any bridge under repair and at any bridge which is damaged or weakened in such a way as to require special caution to be exercised by traffic. He is also to take all action necessary to ensure the safety of workmen.

The bridge maintenance foreman will be responsible for seeing that all staging and rigging is in accordance with the Department of Labour and Industry's regulations on these matters. Safe working methods are to be observed at all times to keep to a minimum the chance of accidents occurring. It is particularly desirable that foremen should study for and obtain (by examination) a Scaffolder's Certificate from the Department of Labour and Industry.

3. REGULAR INSPECTION.

The bridge maintenance foreman is to examine closely every bridge with which he is concerned (*see* Section 1) at least once each year and furnish the Divisional Engineer with a report on its condition. The report is to indicate, also, whether more detailed examination of the structure is desirable, and to describe or list the repairs or replacements considered by the foreman to be necessary. All timber members will be struck with a hammer with the object of sounding for "drummy" wood. Where there is any doubt in the foreman's mind as to the soundness of any timber member, it is to be test-bored in the manner described later (*see* Section 7), and the results of borings are to be included in the foreman's report. Particular attention is to be given to signs of white ants which should be immediately treated as set out in Section 4 (ii) a.

During the annual inspection, those minor repairs should be undertaken for which equipment and material are on hand. In all cases, bolts in timber bridges are to be tightened and accumulations of dirt on any structural part of any type of bridge (steel, concrete or timber) are to be removed. The foreman shall also ensure that water cannot lie on the deck of any part of the structure. In the case of a painted bridge where the paint is in generally good order, but where a small amount of patch painting is required, the patches concerned are to be cleaned and painted during the annual inspection. The condition of the paintwork is to be described in the foreman's report, and where a total repaint is not required, an estimate of the area requiring repainting is to be given.

Expansion arrangements (if any), are to be inspected to see if free movement is taking place with changes of temperature. In all cases, expansion arrangements are to be cleaned, and points requiring lubrication are to be oiled or greased.

Concrete bridges are to be carefully examined for cracks or signs of spalling of the concrete, on the deck, underside of beams or slabs, and on the surface of piers and abutments.

Timber truss bridges are to be measured for camber of the lower truss chord. Particulars of correct camber will be supplied by the Divisional Engineer.

Special attention should be given to the lower chord joints of timber trusses of the Allan (Howe) type (*see* Truss Type "C"). Several failures have occurred in these and

AMENDMENT TO

MANUAL NO. 6 - BRIDGE MAINTENANCE

Amendment No. 1 - September, 1966

Page 2 - Section 3 - Regular Inspection

Add the following to the end of Section 3.

When an employee of the Department is engaged in diving using one of the Department's sets of diving equipment, Regulation No. 99 (1) to (27) of the Scaffolding and Lifts Act, 1912, as amended, is to be observed except that the table on the amended D.M.R. Form No. 535 is to be used to determine air decompression times in place of Table II of the Seventh Schedule of the Regulation.

The above Regulation also covers compressed air work in general.

In connection with the care and use of Departmental diving equipment, the following requirements are to be observed:-

(1) Each diving set is to consist of air pump, helmet and corselet, diving dress (rubber suit), woollens (frock), air hose, boots, weights and life line.

(2) Each set is to be kept intact, with suitable cases for packing and transport and is to be accompanied by a book "Record of Dive", D.M.R. Form No. 534. Copies of D.M.R. Form No. 535 "Diving Regulations" are to be pasted inside the book covers and also in the pump case and packing cases. These are to be maintained in a legible condition.

(3) Details of each day of diving are to be entered in the "Record of Dive" book, from which no pages are to be removed. The diving set and the book are to be made available for inspection by the Department of Labour and Industry Inspector at any time.

(4) A Divisional Office which has on issue a diving set is responsible for the proper storage of the set when not in use, as laid down in Regulation 99 (12) (f) of the Scaffolding and Lifts Act.

(5) At all times the diving set is to be treated with the greatest care to avoid damage by cutting or abrasion or by careless or dirty storage. Human lives depend on the condition of this equipment.

any signs of weakness should be reported so that consideration can be given to strengthening with wire rope ties or under-trussing to prevent parting of the chord.

Where a line diagram or other diagram of the bridge is required by the foreman, on which to mark parts referred to in his report, he is to obtain it from the Divisional Engineer before the bridge is inspected.

All bridges with substructure in permanent water deep enough to warrant the employment of a diver, are to be examined not less frequently than once in three years, in normal circumstances. After a flood, where the occurrence of scouring is indicated by soundings, a diver should make a special inspection, if the circumstances warrant it. Diving work is carried out usually by a contract diver who works under the direction of the Divisional Engineer. Programmes of proposed under water inspection should be prepared well in advance (at least six months) so that the Divisions' requirements can be correlated and a suitable itinerary prepared. Reports of under water inspections will be handed by the diver to the Divisional Engineer who should forward them with any necessary comment and recommendations to Head Office as soon as practicable.

4. ROUTINE MAINTENANCE.

(i) General (all bridges).

The bridge maintenance foreman is to obtain from the Divisional Engineer a list of those bridges which have caretakers under contract, together with notes on the duties for which the caretakers are responsible. The foreman is to draw the attention of the Divisional Engineer to any works which caretakers have failed to perform under the terms of their contracts. In an emergency, affecting public safety or safety of the bridge, where the caretaker fails to perform an urgent work for which he is responsible, the foreman is to have the work performed and report the matter to the Divisional Engineer.

(*a*) *Debris*—Any debris accumulated around the piers, at the abutments, or on the banks adjacent to the bridge is to be cleaned well away from the structure, and preferably burned in order that it will not harbour white ants. Any dirt found lying on the deck or any part of the structure is to be removed, as it holds moisture and causes decay or corrosion. In the case of timber bridges, moisture also encourages white ants.

(*b*) *Scuppers*—Scuppers are to be kept clean so that drainage of the deck is effective.

(*c*) *Damage by flood or traffic accident*—Any such damage is to be immediately made safe for traffic according to the foreman's judgment, and the nature of the damage and circumstances reported to the Divisional Engineer as an urgent matter, and to obtain further instructions.

(*d*) *Reports to Divisional Engineer*—All defects observed by the foreman at any time in bridges, whether timber, concrete, or steel, other than of a minor nature, are to be immediately reported to the Divisional Engineer.

(ii) Timber Bridges.

(*a*) *White ants* are to be treated in accordance with M.R. Form No. 326. Treatment is to be carried out whenever white ants are seen during the annual inspection. After treatment and eradication, any holes left in the timber that could allow water to collect should be filled, preferably with a tar mixture.

(*b*) *De-sapping*—When sapwood on piles and girders commences to decay and shell off, it is to be removed down to sound timber and the new surface coated with creosote.

(*c*) *All ironwork* is to be inspected and tightened where necessary. Particular care is to be taken to see that the bolts in the deck bolting-down system are tight, and that kerbs are seating firmly on the decking. Where the top tightening system of bolting, as shown on drawing A.4633, is in use, the countersunk holes in the deck are to be cleaned of dirt or other debris before the head of the bolt is gripped with a box spanner for tightening. Any lock washers under the deck which have lost their grip are to be replaced, so that tightening from the top may be effective. The circular washer shown on drawing A.4633 may be omitted.

(*d*) *Kerbs and handrails* are to be repainted white whenever the old paint loses its brightness.

(*e*) *Deck planks* which show signs of failure due to any defect are to be replaced immediately, using new planks from stock in hand. In the absence of stock, sound salvaged planks are to be used and the shortage of new planks immediately reported to the Divisional Engineer.

(*f*) *Girders* which fail or show signs of failure are to be tommed and the matter immediately reported to the Divisional Engineer.

Page 3 - Clause 5(iii) USE OF BAILEY BRIDGE EQUIPMENT

Delete the existing clause.

Substitute:-

(iii) USE OF BAILEY BRIDGE EQUIPMENT

The Department's Emergency Bridging Equipment includes a significant amount of Bailey Bridging.

Bailey Bridging is usually erected either as a complete bridge or as support trusses for a structurally deficient existing bridge.

The description of basic Bailey components and the various types of construction are dealt with in Chapter 16 of Volume 1 of the Training Manual for Bridge Design Engineers and also in Chapter 27 of Volume 4 of the Training Manual for Bridge Foremen. The "Bailey Uniflote" handbook is also available in the library.

Regular inspection and maintenance of Bailey Bridging in use is essential and the following requirements are to be observed.

(a) Inspections

FREQUENCY

Bailey Bridging erected as a complete bridge is to be inspected every three months. All other Bailey Bridging in use (e.g., as support trusses etc.) is to be inspected at least every six months.

REPORTS

Inspection reports are to be prepared using M.R. Form 1130 as an aid and two copies of the report are to be forwarded promptly to Head Office, (one copy for these papers and one copy marked for the relevant bridge general file) with Divisional comment and advice of the action required and taken.

MAIN POINTS

All the equipment is to be carefully inspected and the report is to also include specifically the following main points -

Tightness of fasteners - all bracing bolts, chord bolts, riband bolts, transom clamps and swaybraces are to be maintained fully tight.

Stability of Supports - examine base plates for signs of any uneven settlement, examine the packing under the end transoms and end ramps in case it is working loose.

Lubrication - waterproofing etc. - check that grease is applied around all pins to prevent water lodging in the joints. All exposed bolts, threads and end post bearings are to be greased and kept free from corrosion.

Carriageway - check the decking for evenness and tightness, running planks require regular checking and attention.

Truss Panels - some common defects are -

(i) bent vertical or diagonal members;

(ii) general distortion

(iii) torn transom seating

(iv) burred or oversize pinholes

(v) cracks in or near welds

(vi) local bending or buckling of chord members, this is sometimes due to incorrect packing or handling.

Panel Pins - common defects are -

(i) missing safety pins

(ii) burred tapered ends.

Endposts - common defects are -

(i) loss of pin and chain

(ii) fracture or cracking of weld at the jacking step

(iii) wear of link at the jacking step.

Corrosion Protection - all steel members are to be checked for rusting and the general condition of paintwork.

Laternal Displacement - lateral bracing is to be provided but this is usually impracticable with single support trusses. Lateral displacement is a common defect with single truss assemblies.

(b) Replacement

Bailey Bridging which is subjected to heavy loading is vulnerable to the development of fatigue cracks in certain members. Consideration is to be given to the replacement of Bailey Bridging assemblies which have been in continuous erected service for five years. The replaced assembly is to be forwarded direct to Central Workshop for inspection, check testing (including test loading of panels) and necessary maintenance and renovation.

Fatigue cracks may occur in and around welds, particularly in the truss panels. They usually first appear around the sway brace slots at positions of maximum stress in the tension chords.

General distortion of the panels may occur usually as a result of overloading or incorrect handling.

General repainting is usually necessary after five years continuous service and also particularly if the equipment has been erected and dismantled frequently.

(iii) Steel Bridges.

(*a*) Any loose bolts are to be tightened.

(*b*) Any fault, want of painting, or other matter, which in the opinion of the foreman, requires early attention is to be reported to the Divisional Engineer. Particular care should be taken to note any corrosion between plates, or elsewhere, and also any pockets in the steelwork which do not drain freely.

In movable span bridges the condition of steel lifting ropes and the rope fittings should be examined, and also the manner in which a lift span seats when it is closed. The condition of counterweight arrangements and the correctness of balance should be noted. Abutments should be examined to detect whether any movement has occurred.

(iv) Concrete Bridges.

Any fault, movement or weakness of piers or abutments, or other matter which, in the opinion of the foreman, requires attention is to be reported to the Divisional Engineer.

5. SPECIAL REPAIR WORKS.

(i) General.

(*a*) *Programme of repair work*—Following the test boring of timber bridges, or the special inspection of any bridge, a programme of repair work will be prepared by the Divisional Engineer, who will order the necessary materials for the work and issue detailed instructions to the foreman as to the work to be carried out and as to when such work is to be undertaken. The Divisional Engineer will give particulars of timber and other materials being supplied, and a list of cost headings to be used. The cost headings will conform to M.R. Forms Nos. 449A or 449B, with such other cost headings as may be required for each particular job.

(*b*) *Method of carrying out repairs*—The method to be followed will be as arranged with the foreman by the engineer supervising the work. In no case are truss repairs to be commenced until approval has been obtained to the method to be adopted. (*See* Sections 9, 10, 11 and 12 relating to methods of repair of timber truss bridges.)

(*c*) *Fortnightly reports*—At the end of each pay period a brief written report is to be submitted setting out the stage the works have reached, a description of work proposed to be carried out during the following period, and particulars of any unforeseen defects being encountered or other matter which may be of value or interest to the engineer supervising the work.

(ii) Timber Bridges.

(*a*) *Stacking of timber*—Timber received on site is to be stacked clear of the ground with adequate and even support, and with sufficient separation to allow the free circulation of air. Stacking is to be done with particular care when delay in its use is anticipated, and in such cases, the ends are to be coated with petroleum jelly.

(*b*) *Deck fixing by the bolting plank method*—In all cases, unless otherwise directed by the Divisional Engineer, the fixing of a new deck to a timber bridge is to be by the bolting plank method. This arrangement is shown on standard drawing No. A.1886, as revised September, 1948.

(*c*) *Running planks*, will sometimes be specified by the Divisional Engineer. Running planks are to be laid in accordance with standard Drawing No. A.1216. To prevent the development of slippery conditions, running planks are to be given a flush seal.

(*d*) *Timber truss bridges—workmanship*—Timber pieces for the replacement of truss members are to be free from any fault and air dried for at least twelve months prior to cutting and placing in position.

In preparing a new member for insertion in the truss the length is to be determined by measuring on the truss with a lath or steel tape. The new member is to be cut "full" or longer than the determined length by $\frac{1}{8}$ inch to ensure a "driving" fit and to allow for initial crushing of the end fibres. Where the shape of a cut is other than square, it is to be scribed from the truss on to a template and transferred to the new member.

(*e*) *Disposal of old timber*—Old timber removed from bridges will be utilised for repairs to other Departmental bridges, disposed of to the Council in whose area the bridge is situated, or sold to the highest bidder. When the works are nearing completion, the foreman is to submit a list of old timber on hand with a brief description of its condition and recommendations with regard to its suitability for use on other bridges. Instructions will then be issued from Divisional Office with regard to the disposal of the timber. In no case is old timber to be disposed of without authority from the Divisional Office.

6. INSPECTION OF NEW TIMBER BRIDGES.

New timber bridges are to be inspected at least once every three months for the first year from the date of opening to traffic. Thereafter, inspections are to be made every six months for a period of two years and after high floods. Points to be reported upon to the Divisional Engineer are:—

(i) Timber shrinkage which the foreman has not been able to compensate for by tightening bolts;

(ii) Loss of camber in trusses;

(iii) Warping of deck surface or grade;

(iv) Subsidence of piers;

(v) Movement of abutments;

(vi) Faulty timbers;

(vii) Presence of decay or white ants.

Matters that would receive attention during an "Annual Inspection" are also to be attended to. (*See* Section 3.)

7. TESTING OF TIMBER BRIDGES BY BORING.

(i) General.

The test boring of timber bridges must be carried out, and recorded, in a uniform manner in order that the Engineer in the field, and the Divisional and Bridge Engineers shall be in no doubt as to the extent and location of decay and weakness in any bridge member.

The Divisional Engineer will provide the foreman with diagrams of the bridge. The diagrams comprise an expanded drawing in which each member is shown separately, but in correct relation to its neighbours, the size to which each member is drawn being sufficient for clear marking with a pencil in figures 3/16 inch high. Sample sheets are attached—A.3727, A.3728, A.3729 (2), A.3730, A.3731, A.3741.

The diagram shall be filled in to show abutments A and B pier members and span numbers, which should agree with the plans of the bridge (if any exist). The directions "from" or "to" nearest towns and of the stream flow shall also be filled in.

(ii) Boring.

Borings may be made with ½ inch auger, but it will be found that two augers are better for deep timber sections. For instance, half depth can be bored with a 9/16th inch auger and the remainder with a ½ inch or 7/16th inch auger.

Borings are to be made where any unsound timber is apparent and at points where decay usually occurs, such as near the ends, near the top of girders, and at points where damp is retained, due regard being given to borings previously taken to avoid unnecessary repetition.

Girders should always be bored vertically in the first instance at three points, namely, at the ends and at the centre of the span. If this testing causes doubt as to the condition of the girder, it should be bored at other points. Vertical boring from underneath girders is preferable as the hole so made will drain.

At any point where the vertical boring of a girder reveals pipe or decay in excess of one-third of the total depth, the girder is to be bored horizontally through the centre at that point.

Decay generally occurs in the centre at the top of piles where wales and braces join piles and slightly below ground level where rot may be from the outside as well as at the heart. A boring should, therefore, be taken where there is any doubt at the locations referred to.

On heavily trafficked bridges decking usually requires replacement due to wear. The thickness of the planks should therefore be measured in such cases. Decay in decking generally occurs under the kerbs or on the underside of the decking over the girders. In the former case the hammering of the ends of the decking will usually disclose decay and, in the latter case, decay can generally be detected by boring from the top of the deck.

Kerbs frequently have heart centres and, in such cases, it may be necessary to bore in order to determine the extent of decay.

Decay in trusses most frequently occurs where moisture can lodge, such as between chocks and chord flitches and at the lower ends of compression members. Careful sounding and boring are particularly necessary on trusses.

(iii) Recording of test boring.

Australian hardwoods generally decay and then pipe in the heartwood and this is the form of decay which will be in greatest evidence.

As mentioned previously, any record of test boring should leave no doubt as to the

condition of the timber member concerned. The extent and location of sound timber must be known, and also the extent and location of decay or pipe. The full dimension of the member also requires to be known.

The method of recording the results from every test hole is, therefore, to be as follows:—

(*a*) Where the timber is sound throughout, this will be recorded by the letter "S". Where rot or decay is present it will be denoted by the letter "R". A pipe will be denoted by the letter "P".

(*b*) In all other cases three figures will be used, viz.: in a girder 4,8 "R" or 8 "P", 5, will indicate 4 inches sound, 8 inches rot or pipe respectively and 5 inches sound. If decay commenced on top of a girder, three figures will still be used, 0, 9R, 8, will indicate no sound timber, 9 inches rot and 8 inches sound timber. In both these cases the overall dimension of the timber is 17 inches as indicated by the sum of the figures.

(*c*) The figures will be prefixed by a letter or letters. If the boring was vertical downwards the letter "D" will be used.

If the boring was vertical upwards the letters "UP" will be used.

If the boring was horizontal the letter "H" will be used.

To sum up, markings will be one of the following types:—

"S"—means sound throughout.

"D48R5"—means 4 inches sound on top, then 8 inches rot and 5 inches sound on bottom.

"D09R8" means 9 inches rot from the top with 8 inches sound on bottom.

"UP58R3" means 5 inches sound on bottom, 8 inches rot in centre and 3 inches sound on top, as might be in a top chord.

"H65RorP7" means 6 inches sound wall, 5 inches rot or pipe heart and 7 inches sound wall, as in the horizontal boring of a girder.

(*d*) The markings as described above should be made on the bridge diagram in a careful legible manner alongside a dot in a circle which latter is to indicate the point on the timber where the boring was made.

(iv) Schedule of Defective Timbers and Other Information.

The person actually testing the bridge should write a report to accompany his record of borings as marked on the bridge diagram. This report is to be made under the following headings:—

(*a*) Overall length of decking pieces;

(*b*) Thickness of decking;

(*c*) Abutment A—dimensions of defective timbers (width thickness, or diameter, and length);

(*d*) Pier 1—as in (*c*),including corbels;

(*e*) Pier 2, etc., as in (*d*);

(*f*) Abutment B—as in (*c*);

(*g*) Span 1—length and diameter at centre (or dimension) of defective girders;

(*h*) Span 2, etc.—as in (*g*);

(*i*) Estimate of new bolts required—diameter and length.

(v) Report to be in duplicate.

The boring record on bridge diagram and accompanying report are to be supplied to the Divisional Engineer in duplicate, so that one copy may be forwarded by him to the Bridge Engineer.

(vi) Ordering of Timber.

When timber is requisitioned for bridge repair work, consideration is to be given to economy in rail freight. The sizes of the commonly used rail trucks and the capacities and minimum amounts to qualify for the various rates (M-Miscellaneous rate is cheapest) are shown below:—

Type	Length	Width	Height	Capacity	Minimum quantities to qualify		
				Tons	M	M+5%	A
G	40' 0"	8' 9"	4' 3"	40	30	16	Any
K	21' 11¾"	9' 0"	4' 1½"	25	15	10	smaller
S	17' 8½"	8' 8¾"	3' 0"	15	12	8	quantity

Small quantities of timber which exceed the truck lengths given above can be carried in the trucks projecting over one end ("tailing"). Very long pieces of timber require the use of table-top trucks. For particulars of both these matters the local Station-master should be consulted.

8. REPAIR OF TIMBER BEAM BRIDGES.

(i) General.

Before commencing repairs the foreman shall carefully inspect all timber proposed to be used in the work to see that it conforms to specifications (M.R. Form No. 140, amended as necessary to suit the particular job). Timber not conforming to specification is to be set aside and is not to be used unless directed by the Engineer, even although it may have been previously inspected, passed and stamped by an Inspector of the Forestry Commission.

Careful measurements are to be made by the foreman or bridge carpenter of timbers being replaced, before they are removed from a bridge, and the new timbers are to be marked and cut to the same dimensions so that they will fit neatly into the structure.

The surfaces of all new timbers are to be treated with wood preserving oil or creosote, tar, petroleum jelly, or paint as specified in M.R. Form No. 164. Particular attention is to be paid to the application of wood preserving oil or creosote on surfaces in contact (e.g. seatings of girders on corbels, etc.). Bolts are to be red leaded and nuts and washers painted.

Two or three inches thick planks for longitudinal sheeting should be given one coat of creosote and stacked for drying for at least three months (if practicable) before placing. Where delay is expected in placing other sawn or hewn timbers, these are to be given one coat of creosote (except on ends) prior to stacking. The ends of the timber should be coated with petroleum jelly.

(ii) Replacement of Girders.

Where traffic cannot be detoured, or accommodated on portion of the bridge deck with access to the girders obtained by lifting and sliding over the deck planks, individual girders can be replaced without the necessity for removing or lifting the deck (except for minor lifting). One method is briefly as follows (*see* sketch "A")

Remove transverse bolting down members (cross pieces).

Remove the bolts through girders and corbels. To do this the deck planks above the bolts have to be lifted. If the bolts cannot be drifted out they can be cut between the girder and the corbels. Sometimes it is easier to do this than to lift the deck and drift the bolts out. Erect temporary corbels on wedges on capwales alongside existing corbels on one side of the girder to be replaced. By means of jacks push girders across on to temporary corbels. Using the wedges, lift the girders and temporary corbels so that the deck is raised slightly. Haul girder under bridge into a position longitudinally with the bridge, but sufficiently skewed to permit it to be initially lifted without fouling the wales.

Fix eye bolts with eye down in decking on the side of the old girder towards which it has been moved, and at distances from the piers to bring them beyond the line of the ends of the corbels. Fix special pulleys under the decking opposite each eye bolt on the opposite sides of the girder to be removed and well clear of the position of the new girder when in place.

Fasten wire ropes to eye bolts, then down under the ends of the new girder on the ground through the special pulleys referred to in the previous paragraph, down to snatch blocks at the foot of piles and thence to hand winches.

Using winches tighten both ropes and raise girder. In doing this it is necessary to clear the wales and braces. This can be done by raising one end slightly higher than the other, and then swinging or barring to allow the other end to pass the wale or brace.

When the girder is up near the level of the top of the capwales, pull the lower end back under the capwales sufficiently to allow the high end to pass the capwales on the other pier, then lift the high end until it can be passed over the top of the wales, then pull the high end forward sufficiently to clear the capwale and raise the low end. With both ends of the girder above the level of the capwales, it can then easily be pulled one way or the other to place it in the right position.

Continue raising until the top face of the girder is flush with the underside of the deck, and jack across on top of the corbels. The slope of the rope assists this latter operation. Remove wedges from under temporary corbel and lower old girder using the same ropes that lifted the new one. Bolt the new girder by lifting individual deck planks as required.

Re-fasten cross pieces and tighten up decking.

(iii) Redecking.

The practice of replacing broken planks with new ones leads to the situation of having isolated new planks at various parts of the deck. As these generally stand up above the worn planks rough riding conditions are thereby created with consequent accelerated deterioration of the deck planks. To avoid this, when isolated planks are to be replaced, the new planks should be grouped at the end of the deck, the sound old planks thus displaced being used for the repair work. Some difficulty may be experienced because of different deck plank widths, but this can be overcome, even if it means replacing two or three planks when only one has been broken.

Re-decking must be carried out with a minimum of inconvenience to traffic. Normally, therefore, planks should be removed and re-placed singly, as far as practicable.

(iv) Longitudinal Sheeting.

Longitudinal sheeting of transverse timber decks is to be carried out in accordance with D.M.R. Standard Drawing A.5576 attached herein. The bituminous surface (either flush seal or premix) is to be placed as soon as practicable after laying the sheeting.

(v) Longitudinal Decking.

Longitudinal decks of timber bridges are to be given a flush seal (similar to the treatment of longitudinal sheeting) to avoid the development of slippery conditions. General maintenance of this type of deck will consist of keeping the bolts tight and replacing defective planks as for transverse decking.

(vi) Other Repairs.

Corbels should be replaced by methods similar to girders.

Before replacing capwales, the weight of the corbels should be taken by tomming and wedging or jacking.

Piles are to be driven in terms of the timber bridge specification, M.R. Form 164. Where old piles are to be spliced, the splicing is to be done in accordance with Standard Drawing A.1227, unless otherwise directed by the Engineer.

Piles for bridges over salt water are to be of Turpentine and should be protected with concrete armour, the space between the timber pile and the pile armour being filled with sand.

When any repairs are being carried out on a bridge, the foreman is to see that all bolts in the structure are tightened up.

A general guide in carrying out maintenance on timber bridges is M.R. Form 164—Specification for Timber Beam Bridge, which is attached at the back of this Manual.

9. SCREWING UP AND REPAIR OF TIMBER TRUSS BRIDGES.

(i) Scope.

The following instructions apply to:—

1*st* (*Truss A*). The old form of "McDonald" truss constructed prior to 1886, having single principals, and single suspension bolts passing through the chords. Spans 60 to 100 feet.

2*nd* (*Truss B*). "McDonald". The double principal truss with double suspension bolts at haunches (not passing through the chords, but through links resting on the chords) and with wedges at feet of braces; in use after 1886. Spans 65, 75 and 90 feet.

3*rd* (*Truss C*). "Allan". The truss of "Howe" type introduced in 1894 having open top and bottom chords, double principals, braces parallel to principals—no wedges at feet of braces, and cross girders only at suspension bolts. Spans 70 and 90 feet.

4*th* (*Truss D*). "de Burgh". Introduced in 1899. Composite truss, with timber vertical struts and timber upper chord, steel lower chord, and wrought iron diagonal tie-rods.

5*th* (*Truss E*). "Allan". Introduced in 1904. Composite truss, with timber upper chord and diagonal struts, steel lower chord, and wrought iron vertical tie-rods.

(ii) General.

The requirements of clause 8 (*a*) of this Manual apply equally to timbers in truss bridges.

All bolts in the piers are to be kept screwed up, additional washers being used if necessary. If the timber in any portion of the bridge has shrunk so much as to render 1½ in. of washers necessary, the bolt is to be removed and replaced by a shorter bolt, the old bolt being kept for use elsewhere. The unsightly practice of using wooden packing pieces as washers is not to be adopted except as an emergency measure. Where the struts in piers have shrunk so as to cease to butt at the ends, hardwood or iron wedges in pairs are to be driven from opposite sides, so as to bring the strut into operation again.

The suspension bolts in the older trusses being lighter than those now in use, and not having so good a bearing on the chords and principals, may be unequal to the task of restoring the camber to the truss. In screwing up, therefore, shores should be placed under the chord, which can then be wedged up while the suspension bolt is tightened. If the bolts are damaged they are to be replaced by new bolts 25 per cent. heavier.

If the height from the bed of the river is so considerable as to make shoring a troublesome and expensive operation, a chain may be passed round the chords set up with union screws or a pair of bolts used similar to the haunch bolts in the "B" type of truss,

so as to relieve the suspension rod while it is being tightened. Shoring is preferred. In the older designs of truss bridges no iron wedges were used at the foot of diagonal members. In screwing up, hardwood wedges or iron plates are to be used to fill the space left by shrinkage.

The method of screwing up certain of these types of timber truss bridges is shown in the clauses which follow.

(iii) Truss Type "A".

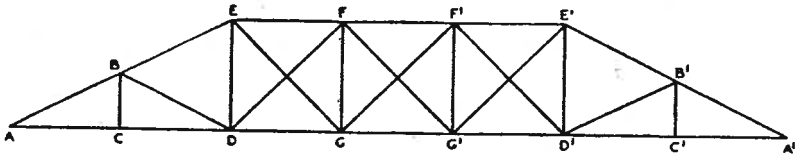


FIG. 1

At the junction (*see* Figure 1) E or E^1 of the top chord EE^1 and principals AE and A^1E^1, the shoulder shoes are in most cases fitted with wrought-iron washer plates, through which the suspension bolts pass. As the timber in top chord shrinks from under them these plates become bent, in some cases breaking the cast-iron shoulder shoe. The surface of the washer plate being no longer level, nor at right angles to the suspension bolt, the plate acts as a washer on the cant, and bends the suspension bolt under the nut, tending to break it off. The weight should be taken off the suspension bolt either by shoring or by using a temporary suspension (as described above). The bent washer plate should then be cut through with a cold set where it joins the shoulder shoe. This will permit it to drop on to the top chord where it will lie level. The cutting should be carefully done, a heavy hammer being held at offside of plate to lessen the jar during operation. The nuts at the ends of the suspension bolts below the bottom chord should then be slackened off an inch or two, and those above tightened until the upper nuts are filled with new thread from below. It may be found necessary to drift the bolt up with a heavy hammer from below, but generally, screwing at top will be found sufficient. All bolts in butting blocks, chords, cross girders, etc., should be kept screwed up; but the suspension bolts and the iron wedges at ends of struts should not be touched unless a loss of camber is observed.

In every other respect the operation of restoring camber is similar to that detailed below for the "B" type of truss.

In the event of iron wedges becoming loose they should be lightly driven by the man in charge; but the operation of restoring the camber to the truss should not be undertaken without the express approval of the Divisional Engineer.

(iv) Truss Type "B".

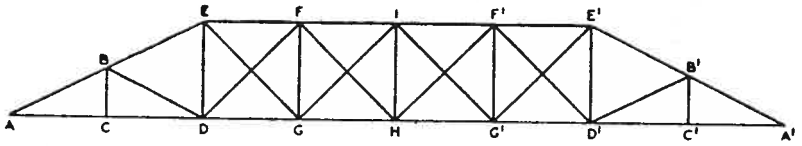


FIG. 2

Figure 2 represents a 90-ft. truss; but the following instructions are also applicable to 75 and 65 feet trusses.

The camber in each truss should be 2 in. in the 90 feet, 1¾ in. in the 75 feet, and 1½ in. in the 65 feet truss when first erected, and the chords should never be allowed to approach a straight line.

Having ascertained that the point D is low, the bolts connecting the tee iron stiffener (which runs from end of cross girder at D to top chord at E) should be removed, as it is evident that the bottom chord cannot be taken up so long as those bolts remain in. The wedges at the feet of the members BD, DF should be examined and, if not already loose, may be loosened with a hammer; the suspension bolt DE should then be tightened until slightly more than the necessary camber is obtained at point D.

If the point D^1 is low, the same operation is gone through with the suspension D^1E^1, and the members B^1D^1, D^1F^1.

The correct level having been thus obtained at points D and D^1, the wedges at the feet of members DF, D^1F^1 should be driven up solid until any sag in the top chord at point F and F^1 is removed.

Levels should now be taken at points G and G^1. If the point G^1 is low, the wedges at the feet of members G^1E^1, G^1I must be loosened, and the suspension bolt G^1F^1 tightened until the necessary camber is obtained at point G^1. In the same way if point G is low, the wedges at the feet of members GE, GI must be loosened and the suspension bolt GF tightened until the necessary camber is obtained at point G.

The above operations with regard to points G and G^1 should, if both points are low, be performed simultaneously.

The wedges at the feet of members G^1I, GI should now be driven up solid, until any sag in the top chord at point I is removed.

If the point H is found to be still low, the wedges at the feet of members, HF, HF^1 should be loosened and the suspension rod HI tightened until the necessary camber is obtained at point H.

The wedges at the feet of members GE, G^1E^1 should now be driven up solid; then those at the feet of members HF, HF^1 and then those at the feet of members DB, D^1B^1.

There should now be no sag in the top chord, and not more than ½ in. camber between the points E and E^1.

A line should be stretched along the principals AE, A^1E^1 and the struts DB, D^1B^1 should be wedged up until the principals have an upwards camber of ¼ in.

Levels should now be taken at points C and C^1 and the correct height obtained at those points by tightening the suspension bolts CB, C^1B^1.

A final observation may now be taken of the levels of the various points along the chord; and if the camber is correct the locknuts of suspension bolts may be finally tightened, and the bolts in butting blocks looked to, and the operation is complete.

No staging is required to support the truss during the operation.

(v) Truss Type "C".

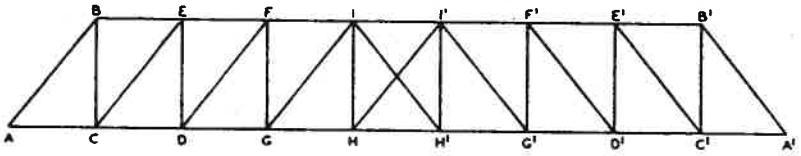


FIG. 3

The main points of difference between this truss and Trusses A and B are the double chords separated only by packing pieces at intervals, the absence of wedges at feet of braces, the fact that the braces are parallel and that there are no cross girders resting upon the chords excepting where suspension bolts occur.

The absence of wedges at foot of braces in the type now under consideration makes the task of screwing up much easier.

The camber at each point of truss is shown on drawing of bridges, and is to be obtained from the Divisional Engineer before screwing up.

Levels having been taken at each cross girder on lower chord A to A^1 (*see* Fig. 3), the camber is restored by screwing up the bolts BC, B^1C^1 until the points C and C^1 are at correct level, then the bolts ED, E^1D^1 and so on, approaching the centre of the truss. In every respect the process is the same as detailed already for B Type Trusses with the exception of there being no wedges to deal with.

(vi) Truss Type "D".

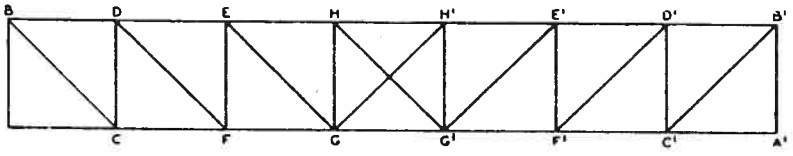


FIG 4

(vii) Truss Type "E".

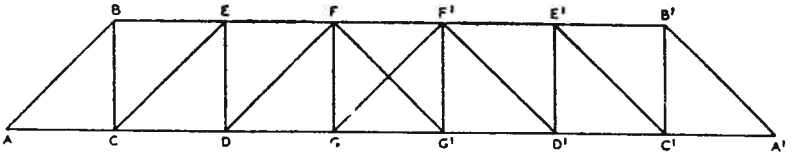


FIG. 5

In types D and E the method of restoring camber is the same as for Truss C, the tie-rods at the haunches being the first to screw up, working thence towards the centre.

In cases where more than one suspension rod is used at each panel point, care should be exercised to have each rod take its share of the load.

10. METHODS OF SUPPORTING TIMBER TRUSSES DURING REPLACEMENT OF MEMBERS.

(i) Choice of Methods.

During replacement of truss members, it is necessary to have support under the lower chord at various positions. The most convenient and economical of the methods of support described hereunder are to be used, or other suitable methods approved by the engineer.

(ii) Underpinning.

Where practicable, "shoring" or "tomming" from the ground is the easiest method of supporting trusses when replacing top chords and principals. In its simplest form, it consists of one or more toms supporting crossheads under the lower chord, the necessary adjustment of height being obtained by means of fox wedges at the base. The toms can be erected on driven or silled foundations as occasion demands. Replacement girders or similar members can frequently be used as crossheads; if such are not available, bush timber can often be obtained.

In some cases vertical toms cannot be used on account of a water crossing or too great a clearance above ground. Diagonal struts from the bases of the piers may sometimes be employed, but care should be taken in this case to check the stability of the piers. Such struts should generally not be taken from the piers above ground line unless the piers are of very substantial design or are provided with adequate lateral support.

(iii) Wire Rope Tie.

This method may be used when replacing lower chord flitches, and consists, essentially, of taking the tension in the chord by a wire rope tie. It is effected by passing two wire ropes 2⅝ in. circumference around the butting blocks of the truss, or the cap-sills, and connecting with turnbuckles which are then adjusted to take the tension necessary to allow the removal and replacement of the defective chord member. Sketch "B" shows one method of attaching the ropes.

(iv) Wire Rope Support.

A typical arrangement of this method is shown in sketch "C". It is an alternative to underpinning, and is specially useful over water, or where the truss is high above ground.

The anchorages should be placed at suitable distances from the hardwood posts at or below ground level. In pile piers, where the piles have been spliced, the anchorage bearers should be placed below the splice. Struts should be inserted between the bearers and the bridge to prevent their being pulled upward. For effective use of the turnbuckles, the free ends of the wire rope should be pulled back by tackle or hand winch before securing with wire cramps.

(v) Temporary Undertrussing.

This is similar to the "Wire Rope Tie" method, and a typical arrangement is shown in sketch "D" for McDonald type trusses. Care should be taken that the trussing blocks on the bottom chord are so placed as to permit the removal and replacement of the defective chord section.

(vi) Additional Temporary Truss.

In this method, the load of the bridge is temporarily transferred to a temporary truss erected alongside the truss to be repaired. Sketch "E" shows how a Bailey truss was used at Jindabyne during repairs to the lower chord of a McDonald truss. In this case the cross girders were hung from the Bailey truss to take their load off the lower chord of the bridge truss and the top chord and bracing was propped off the cross girders. There was no interruption to traffic during the period of the repairs.

(vii) Precautions to be Taken in All Cases.

When a truss is temporarily supported during repairs, traffic should be confined to the side of the span remote from the truss under support, and its speed should be reduced to walking pace. Because of this, and for general safety, the time of temporary support should be reduced to a minimum. This can be facilitated by doing all possible work on replacement members before releasing the existing members.

Old ferry ropes are suitable for use where wire ropes are indicated. Such rope is usually 2¾ inches circumference of 6 x 7 galvanised steel wire. One turn will safely carry a live load of four to five tons. Should heavier vehicles commonly use the bridge under repair, a second rope should be provided.

It is essential that wire ropes slip round all supports freely. Accordingly, bearers should be shaped, grooved and well greased. Vibrating the ropes also assists them to slip.

Theoretical determination of the stress in a rope, from observations of sag and vibrations, is not reliable owing to give in timbers and like factors. If slipping of the ropes on all bearers has been made as free as possible, tightening of the tensioning turnbuckles, or nuts, to the capacity of an average man using a spanner with a 2-ft. purchase, will stress the ropes to their safe load.

11. REPLACEMENT OF MEMBERS OF TIMBER TRUSSES.

Where the chord members of a truss are made up of two or more flitches, replacements can often be made, one flitch at a time, without temporary external support for the truss. However, unduly heavy live loads cannot be allowed on the bridge during the time of repairs, and in any case, moving loads must be restricted to a walking pace on the side of the bridge remote from the truss under repair.

When all flitches in one section of a chord are in very bad order, or the chord is in one piece, support for the truss during replacement is necessary.

Where the whole length of a flitch is in bad condition and has to be replaced it will probably be impracticable to obtain new flitches long enough to retain the existing joint arrangement and extra joints will be required. The maximum length obtainable without undue difficulty can be assumed as 30 ft. As the new arrangement of joints will depend on the location and extent of deterioration in the existing timber, a sketch should be prepared of the proposed arrangement and forwarded to Head Office for checking well in advance of the commencement of the repair work.

The replacement of diagonal members does not necessitate external support for the truss.

Various methods of support which have been successfully used are described in Section 10.

Whenever repairs have been made on a truss, proper tightening up is to be carried out and camber restored as detailed in Section 9.

The following describes the precautions which need be observed in carrying out replacement of members and other repairs to timber trusses.

Truss Type "A"—(McDonald Truss, Early Type).

(i) *To remove principal*—Solid Member AE or A^1E^1.

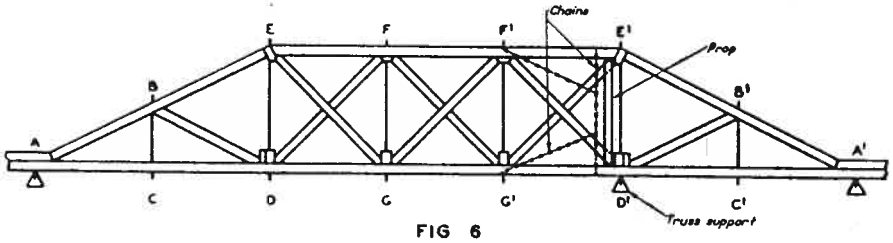


FIG 6

(*a*) Place prop between top and bottom chords near panel point D^1.

(*b*) Tie together top and bottom chords with chain and union.

(*c*) Tie diagonals E^1G^1 and D^1F^1 to top and bottom chords respectively with chains so that "free" ends cannot slip.

(*d*) Support truss under panel point D^1.

(*e*) Place prop between top chord and kerb on opposite side of bridge.

(*f*) Remove and replace principal A^1E^1.

(*g*) Dismantle in order (*e*), (*c*), (*b*), (*a*) and (*d*).

(ii) *To splice portion of principal.*

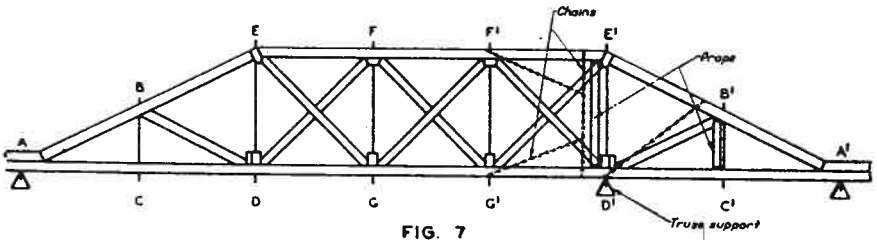


FIG. 7

(*a*), (*b*), (*c*), (*d*) and (*e*) as above.

(*f*) Prop solid portion from lower chord.

(*g*) Remove and replace defective part.

(*h*) Dismantle (*f*), (*e*), (*c*), (*b*), (*a*) and (*d*).

(iii) *To remove a diagonal*—For example, member FG^1.

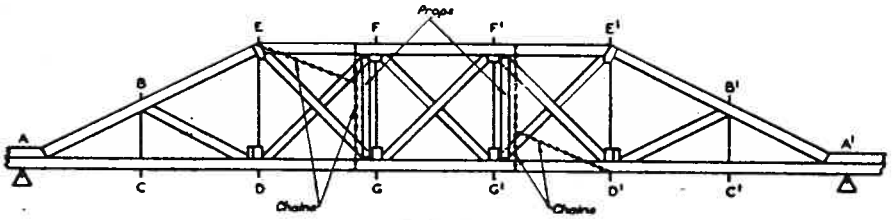


FIG. 8

(*a*) Place props between top and bottom chords at panel points G and G^1.

(*b*) Tie top and bottom chords together with chains and unions.

(*c*) Tie braces in adjacent panels, i.e., members DF and G^1E^1 to top and bottom chords respectively, with chains to prevent slip.

(*d*) Remove and replace diagonal.

(*e*) Dismantle (*c*), (*b*), (*a*).

(iv) *To remove top chord.*

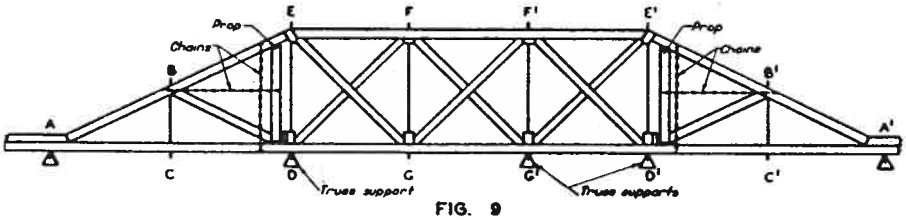


FIG. 9

(*a*) Place props between tops of principals and lower chord at panel points D and D^1 and securely tie with chains and union screws to ends of truss, say panel points B and B^1.

(*b*) Tie tops of principals to lower chord with chains and unions.

(*c*) Support bottom chord at panel points D and D^1 and alternate ones.

(*d*) Place props between tops of principals and kerb on opposite side of bridge.

(*e*) Tie tops of principals across bridge.

(*f*) Brace all diagonals to maintain alignment.

(*g*) Remove and replace top chord.

(*h*) Dismantle in order (*f*), (*e*), (*d*), (*b*), (*a*) and (*c*).

(v) *To remove outside flitch in lower chord*—For example flitch in panel CG^1.

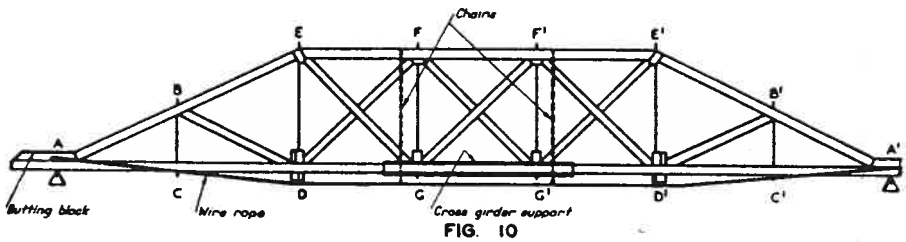


FIG. 10

(*a*) Support cross girders and deck by chains from top chord over faulty section.

(*b*) Tie bottom ends of principals around butting blocks with wire rope and union to take tension off lower chord.

(*c*) Remove and replace flitch.

(*d*) Dismantle (*a*) and (*b*).

(vi) *To remove inside flitch of lower chord.*

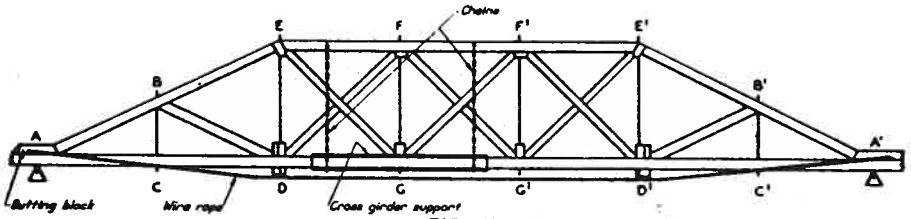


FIG. 11

(*a*) Tie ends of truss with wire rope and unions to take tension out of lower chord.

(*b*) Replace bearing plate at lower end of double suspension rods by separate plates having gap between them sufficient for the defective flitch to drop through. Tie suspension rods together immediately above lower chord to prevent their spreading.

(*c*) Remove deck load from faulty part of chord by placing girder under cross girder and supporting from top chord by chains and unions.

(*d*) Loosen and drive splicing bolts in lower chord from faulty flitch but not free from other flitches. Wedge flitches apart, drop out faulty flitch and replace, using new splicing bolts and plugging up old holes.

(*e*) Replace original bearing plates under suspension bolts.

(*f*) Dismantle (*c*), (*a*).

(vii) *To remove a cross girder*—for example, girder at G.

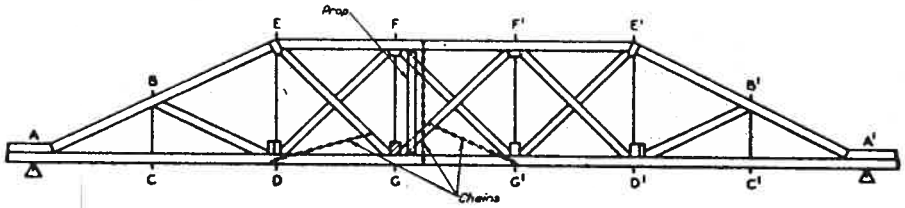


FIG. 12

(*a*) Place prop between top and bottom chords near panel point G.

(*b*) Tie top and bottom chords together with chain and union near same panel point.

(*c*) Tie diagonals butting against girder (i.e., EG and GF^1) to lower chord.

(*d*) Take out suspension rod.

(*e*) Remove and replace cross girder.

(*f*) Replace suspension rod.

(*g*) Dismantle in order (*c*), (*b*) and (*a*).

(viii) *To remove butting block.*

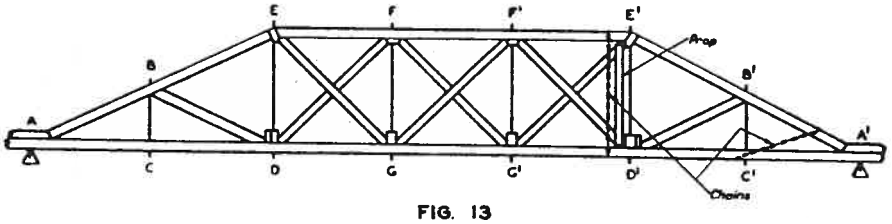


FIG. 13

(*a*) Place prop between top and bottom chords at panel point D.

(*b*) Tie top and bottom chords together with chain and union.

(*c*) Tie principal to lower chord with chain and union to prevent slip of "free" end.

(*d*) Remove and replace faulty portion of butting block.

(*e*) Dismantle in order (*c*), (*b*), (*a*).

Truss Type "B" (McDonald Truss, Late Type).

Repairs are carried out as for Type A Truss except when replacing section only at bottom of a principal.

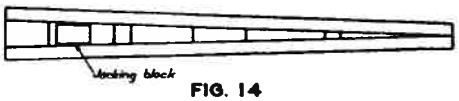


FIG. 14

(*a*) Remove lower spacing block between flitches and bolt a new piece of timber in between to sound portion leaving room for jack between lower end and butting block.
(*b*) Jack up end of truss to free timber from butting block.
(*c*) Cut off faulty portions of members and replace with new timber.
(*d*) Release jack, remove central temporary piece and replace original spacing block.

Truss Type "C"—Allan Truss (Howe Type).

(i) *To remove principal*—for example, member A^1B^1.

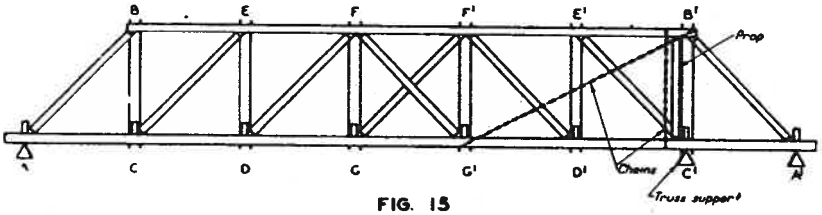


FIG. 15

(*a*) Place prop between top and bottom chords at C^1B^1.
(*b*) Tie top and bottom chords together with chain and union at C^1B^1.
(*c*) Tie top chord (at B^1) back with chain and union to lower chord.
(*d*) Support truss under low chord at C^1.
(*e*) Place prop from top chord to kerb on opposite side of bridge.
(*f*) Tie top chords across bridge.
(*g*) Remove and replace principal.
(*h*) Dismantle (*f*), (*e*), (*c*), (*b*), (*a*) and (*d*).

(ii) *To splice portion of principal*—

Lower end.

(*a*) Remove spacing blocks between flitches and bolt a long piece of new timber to flitches above faulty section.
(*b*) Jack up truss to free ends of flitches from butting blocks.
(*c*) Cut off faulty sections, one side at a time and splice on new pieces.
(*d*) Release jack and remove temporary spacer.
(*e*) Replace spacing blocks to original design.

Top end—Proceed similarly to jacking between new timber and top chord.

(iii) *To remove whole of top chord.*

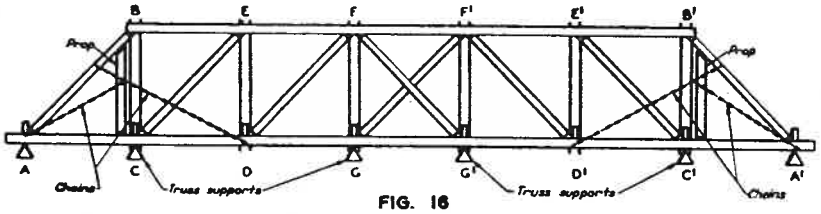


FIG. 16

(*a*) Support truss under lower chord at first and last panel points (i.e., C and C^1) and every alternate intervening panel point. The stiffness of the lower chord will hold the intervening panel points.
(*b*) Place props between tops of principals and lower chord, and tie props to butting blocks.
(*c*) Tie principals to lower chord.
(*d*) Place props between tops of principals and kerbs on opposite side of deck, or against check blocks attached to deck.
(*e*) Tie tops of principals across bridge to prevent overturning.
(*f*) Brace diagonals longitudinally to maintain alignment.
(*g*) Remove and replace chord.
(*h*) Dismantle (*f*), (*e*), (*d*), (*c*), (*b*) and (*a*).

(iv) *To remove part of one flitch of top chord.*

(*a*) If life is only to be extended five to six years, unstress flitch by placing new timber alongside and bolting to sound part of old timber.
If a short length only is to be removed from otherwise sound truss proceed as in (*a*), then—

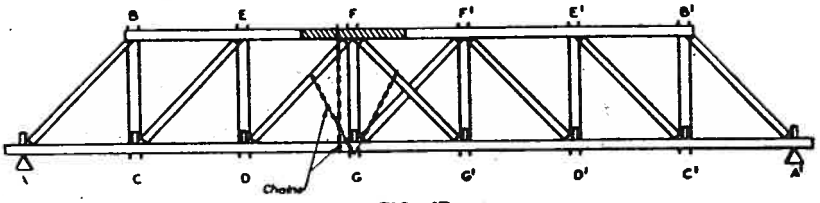


FIG. 17

(*b*) Tie together top and bottom chords with chains and unions, using wooden blocks to give clearance to slide in new piece.
(*c*) Tie back diagonals to top and bottom chords.
(*d*) Remove suspension rods.
(*e*) Remove and replace faulty timber.
(*f*) Replace suspension rods and dismantle (*c*), (*b*), (*a*).

(v) *To remove a diagonal*—for example, member DF.

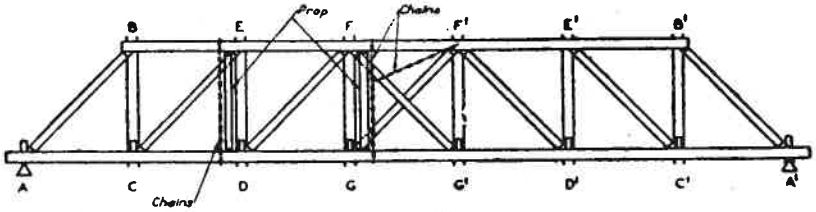


FIG. 18

(*a*) Place props between top and bottom chords at adjacent panel points (i.e., DE, FG).
(*b*) Tie top and bottom chords together with chains and unions at same points.
(*c*) Tie diagonals in adjacent panel (FG^1) to top chord.
(*d*) Remove and replace diagonal.
(*e*) Dismantle (*c*), (*b*), (*a*).

(vi) *To remove flitch from lower chord.*

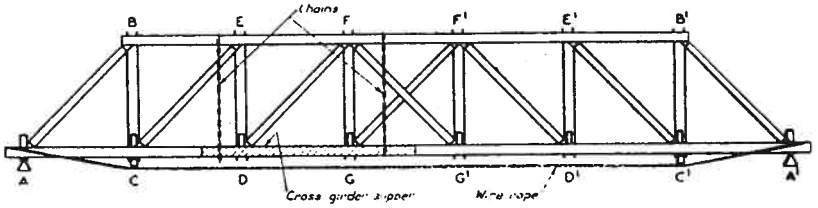


FIG. 19

(*a*) Tie ends of truss with wire rope and unions to take tension out of lower chord.
(*b*) Remove deck load from faulty section of chord by placing a girder under the cross girders and supporting by chains and unions from top chord.
(*c*) Remove and replace flitch.
(*d*) Dismantle (*b*), (*a*).

(vii) *To remove butting block.*

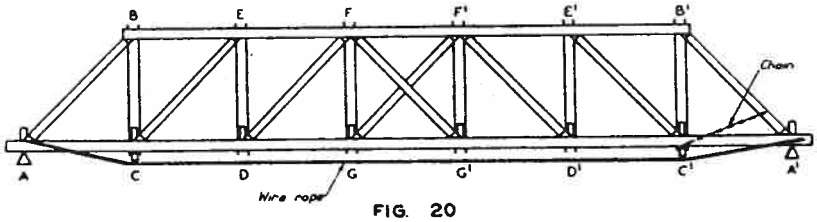


FIG. 20

(*a*) Tie bottom ends of principals at each end of truss with wire rope and unions to take weight off butting block.
(*b*) Tie principal to lower chord at first panel point.
(*c*) Support stringers by fixing additional cross girder on lower chord.
(*d*) Remove cross girder on butting block.
(*e*) Replace faulty butting block and original cross girder.
(*f*) Dismantle (*c*), (*b*), (*a*).

(viii) *To remove a cross girder.*

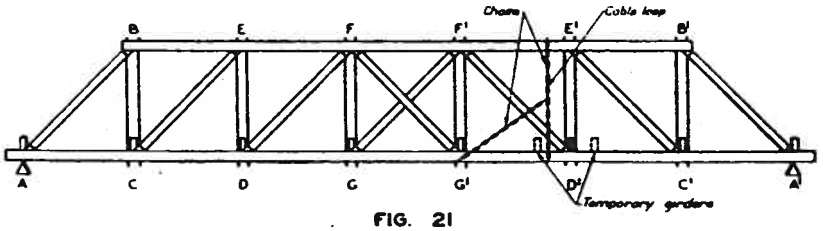


FIG. 21

(*a*) Suspend lower chord, near cross girder, from top chord with chains.
(*b*) Fix two temporary girders on lower chord to support stringers carrying deck. Arrange with jacks so that deck can be lifted slightly.
(*c*) Tie diagonal butting against cross girder to lower chord.
(*d*) Remove one suspension rod; take out and replace cross girder and replace rod.
(*e*) Dismantle (*c*), (*b*), (*a*).

Truss Type "D"—de Burgh Truss (Pratt Type) (Through Truss only).

(i) *To remove whole of top chord.*

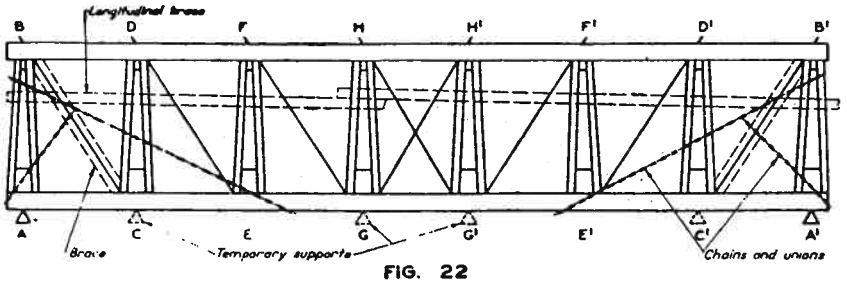


FIG. 22

(*a*) Support truss under lower chord at first and last panel points (i.e. C and C^1) and every alternate intervening panel point. The stiffness of the lower chord will hold the intervening panel points.
(*b*) Brace top of end verticals from foot of adjacent verticals and tie brace back to ends of truss at A and A^1.
(*c*) Tie end verticals to lower chord at E and E^1.
(*d*) Place props between tops of end verticals and kerbs on opposite side of deck or against deck blocks attached to deck.
(*e*) Tie tops of end verticals across bridge or to check blocks to prevent overturning.
(*f*) Brace verticals longitudinally to maintain alignment.
(*g*) Remove and replace chord doing each flitch in turn between splices. Tee iron braces should also be removed and replaced in turn to help maintain alignment.
(*h*) Dismantle (*f*), (*e*), (*d*), (*c*), (*b*) and (*a*).

(ii) *To remove part or whole of one flitch of top chord.*

Where a complete flitch is to be removed support truss at lower chord panel points under length of flitch to be removed.
Where a short length is to be removed proceed as follows:—

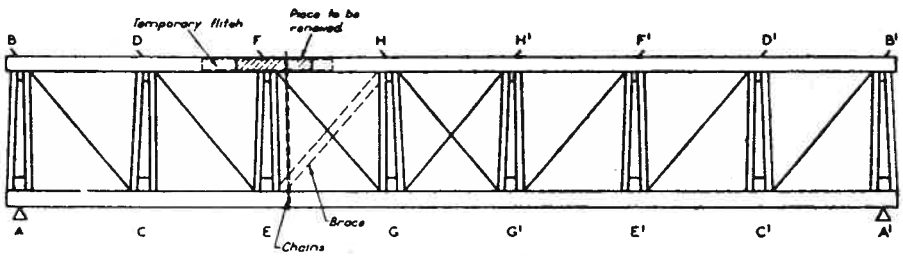


FIG. 23

(*a*) Place temporary timber flitch alongside portion of flitch to be removed and bolt to sound timber beyond. (Where this is not possible, e.g., for portion of flitch commencing from B or B^1 support truss at lower chord panel points under portion of flitch to be removed.)
(*b*) Tie top and bottom chords together with chains and unions using timber blocks to give clearance to slide in new piece.
(*c*) Where necessary to slacken off diagonals to remove portion of flitch, brace panels in opposite direction to diagonals.
(*d*) Remove and replace faulty section of flitch.
(*e*) Dismantle (*c*), (*b*) and (*a*).

(iii) *To remove end vertical (one or both sections)*—for example, member A^1B^1.

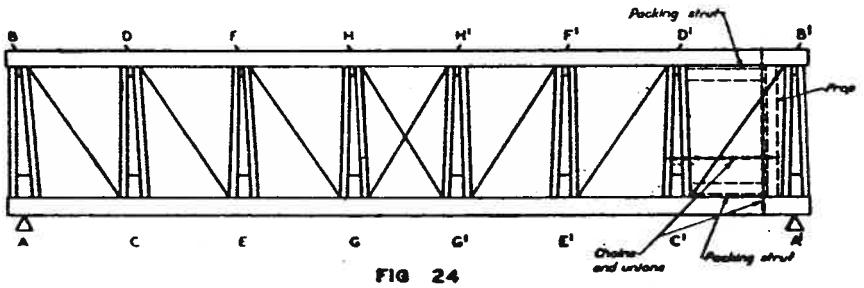


FIG 24

(*a*) Place prop between top and bottom chords at A^1B^1.

(*b*) Tie prop back at the top and the bottom against struts to next vertical C^1D^1 to prevent movement.

(*c*) Tie top and bottom chords together with chain and union at A^1B^1.

(*d*) Remove and replace end verticals.

(*e*) Dismantle (*c*), (*b*) and (*a*).

(iv) *To remove intermediate vertical*—for example, member G^1H^1.

Where only one section requires replacement proceed similarly to (iii) placing temporary prop as close as practicable to section to be replaced. Tie prop back against struts to adjacent vertical and tie chords together.

Where both sections require replacement do each one in turn as above or place props on each side of vertical tying props back against struts to adjacent verticals. Tie chords together at each prop.

(v) *To remove a cross girder.*

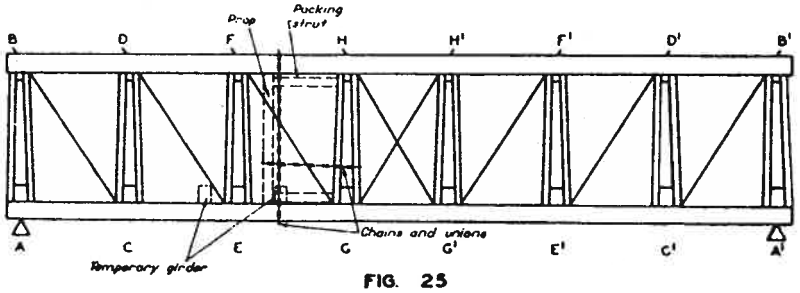


FIG. 25

(*a*) Fix prop near side of vertical to be removed to permit removal of cross girder, packing and tying prop back to adjacent vertical as in (iii).

(*b*) Tie top and bottom chords together with chains and unions.

(*c*) Fix two temporary girders across bottom chords to support stringers carrying deck. Arrange with jacks so that deck can be lifted slightly.

(*d*) Remove one side of vertical, cutting rivets to remove one gusset plate to lower chord where there are two such plates.

(*e*) Remove and replace cross girder; replace vertical and gusset plate using bolts.

(*f*) Dismantle (*c*), (*b*) and (*a*).

Truss Type "E"—Allan Truss (Howe Type) with Steel Lower Chord.

This truss differs from TRUSS TYPE "C" in that it has a steel lower chord; otherwise repair of it is the same as in TRUSS TYPE "C".

12. STRENGTHENING LOWER CHORD BY PERMANENT UNDERTRUSSING.

Timber trusses are sometimes undertrussed with cables as a permanent measure where strengthening of the lower chord is required, but it is not desired to carry out extensive repairs, for example, when the bridge is due for early renewal.

Drawings of three such trusses are shown, as typical examples:—

(*a*) Plan B26A—using cables and mild steel welded saddles.

(*b*) Plan 12B.113D—using cables and cast iron saddles.

(*c*) Plan B47A—using mild steel rods and timber bearers.

The method as used in (*c*) is cheapest in first cost and in maintenance, and should be generally adopted, unless materials for methods (*a*) or (*b*) are available from some other bridge.

AMENDMENT TO MANUAL NO. 6

BRIDGE MAINTENANCE

Papers 69M.841 December 1977

PAGE 18 - CLAUSE 14(i)

INSERT the following paragraph:-

Particular attention shall be paid to the provision of adequate protection for personnel engaged in abrasive blast cleaning processes, viz.:-

(1) The operation shall not cause a nuisance to other employees or persons in the vicinity.

(2) The operator and those working with him shall wear approved type hoods supplied with air, under pressure, which has been suitably filtered to eliminate all impurities, dust, mist, oil, vapours, gases, odours and irritating ingredients and fitted with a device to trap all condensation.

(3) The control of the air supply shall be a manual control device that will continue to supply a minimum of 0.085 cubic metres (three cubic feet) per minute in the fully "closed" position. The source of air supply shall be adequate to supply 0.17 cubic metres (six cubic feet) per minute to each protective hood.

(4) The air supply temperature shall be maintained between 15°C to 20°C and the humidity maintained between 20% and 85%.

(5) The air intake shall be so constructed and sited to avoid all forms of contamination, particularly fumes from the compressor and other plant or stationary engines.

(6) The compressor shall be well maintained and shall not be allowed to run hot as harmful substances can be produced by the decomposition of lubrication oils.

(7) The air supply hose shall be of rubber, plastic, a combination of both, or other suitable materials. It shall contain braided reinforcement and shall be flexible and non-kinking.

(8) All regulating and filtering devices shall be maintained in a clean and hygienic condition by daily cleaning when in constant use. After storage all component parts shall be checked for faults. Any faulty part and/or parts showing signs of wear, perishing or damage shall be replaced immediately.

(9) The examination of regulating and filtering devices shall be carried out by the supplier or other competent persons.

(10) All persons required to wear the protective hoods shall be fully informed of the importance of conscientiously wearing the device while in close proximity to sandblasting operations.

(11) All persons engaged in activities other than sandblasting shall be kept at a distance of at least 18 metres (60 ft.) on the downwind side of blasting operations.

The protective equipment shall be regularly inspected by the Plant Foreman at intervals not greater than six (6) months and necessary repairs or replacement of worn parts undertaken. Equipment in constant use shall be inspected at more frequent intervals.

13. STEEL BRIDGES—ARREST OF CORROSION.

Small areas of corrosion appear on steel bridges, mainly where the surface is moist for a large proportion of the time, common reasons being:—

(*a*) Moisture condensation on under surfaces.

(*b*) Undrained pockets in which water can lie.

(*c*) Pockets and ledges which collect dirt which in turn retains moisture.

In the case of (*a*) rivet heads are particularly susceptible. In cases (*b*) and (*c*) the lapped steel inter-faces and the inter-faces between rivet heads and the steel member are particularly vulnerable to corrosion.

All pockets or traps susceptible to corrosion are to be thoroughly cleaned of rust, scale or perished paint so that the steel is bright, and then filled with "Sand mastic".

"Sand mastic" should be prepared and used in dry weather conditions as follows:—

(i) mix 5 parts boiled linseed oil with 1 part copal varnish;

(ii) add dry freshwater sand to the oil until the mixture becomes tacky; press out surplus oil with hessian bags. (The sand may be fine or coarse depending on the finish desired but obviously should be fine where a normal painting finish is required);

(iii) dry thoroughly and prime the area to be filled with a light coat of 10 parts boiled linseed oil to 1 part varnish;

(iv) pack and tamp the mastic into position driving out all trapped air bubbles; and

(v) allow the freshly placed filling to dry for 12 months before painting.

Inter-faces of steel members which show signs of corrosion are to be cleaned out, if possible, by a hack saw blade or similar means, and caulked with lead wool. An oil with penetrating and cleaning properties may aid in loosening the rust.

All areas susceptible to corrosion are to be thoroughly cleaned of rust, scale, or perished paint so that the steel is bright. A thick coat of red lead in linseed oil (weighing not less than 30 lb. per gallon) is to be applied immediately after cleaning, by thorough brushing in, and then smoothing out evenly. The subsequent coats of paint (intermediate and finishing) may be applied in the normal course of a general repaint of the bridge, but they should not be delayed more than three months.

Many areas susceptible to corrosion are difficult to clean by ordinary methods such as scraping, while it is impossible to clean some by use of mechanical chipping or descaling hammers. Flame-cleaning using any oxy-acetylene flame, is effective in removing thick rust and scale, a nozzle producing a round tip flame being used for areas around rivet heads and in awkward corners, and a tee head nozzle producing a flame about 4 inches wide being used for flat surfaces. A steel wire brush used in conjunction with the flame accelerates the work. It is not possible, however, to complete thorough cleaning in this way, as the products of combustion always remain and require to be cleaned away.

The most thorough method of cleaning steel in erected bridges is by sand or grit blasting. The process is expensive and is only to be employed after careful consideration as to costs. Generally, the whole of a steel structure will not be sand-blasted, but, the protection afforded by good priming and painting over a sand-blasted steel surface often warrants the expense of sand-blasting areas especially susceptible to corrosion, and should always be considered as a means to cleaning steel in such locations.

To arrest deterioration where timber planking rests on steel joists, all such bridges as they are redecked shall be provided with a zinc protection sheet—as shown on Drawing A.3560.

When a concrete deck is placed on rolled steel joist girders, a zinc protection sheet is to be placed over the rolled steel joist to avoid the deleterious effects of moisture. This protecting sheet will be regarded as part of the joist and the concrete deck will still project under the level of the top of the joist where this is required to prevent movement of the concrete on top of the girders—see Drawing A.3561.

14. STEEL & TIMBER BRIDGES—PAINTING PRACTICE.

(i) General requirements and surface preparation.

On steel surfaces the presence of rust or the crazing of paint indicates that the existing paint has failed and complete cleaning to steel is required. Areas so affected are to be stripped, by the most efficient means available, to bright dry steel and the rust inhibitive priming coat is to be applied immediately. Particular care is to be given to the joints between two surfaces or two members, as, for example, at a junction of an angle with floor plates, and at similar locations. As a general rule such corners should be thoroughly chipped at regular intervals, according to the degree of exposure. The use of a filling material such as a heavy application of red lead is often desirable, but the most satisfactory procedure is to caulk the joints with lead wool.

Damage to the steel by the use of sharp-edged chipping tools is to be avoided.

On steel surfaces where the surface coats have failed and the existing priming coat is in good condition, all loose paint and dirt shall be removed by methods which do not damage the priming coat, prior to the application of the cover coats.

On steel or timber surfaces where frequent repainting is adopted for reasons of appearance and/or visibility, little, if any, surface preparation is required, other than the removal of surface powder from the paint, casual dirt or grease if the underlying paint is in good condition. Grease should be removed by washing down, if practicable, with a weak solution of washing soda.

Timber surfaces, on which the paint has failed completely, should be cleaned up as much as possible by wire brushing or similar means and a priming coat of "pink primer" applied. If the timber surface is very absorptive by reason of cracks and open surface, a second coat of pink primer may be required. The priming coat should be followed by one coat of intermediate and one coat of finishing grey micaceous iron oxide paint in the case of truss timbers, or white paint for the kerbs and handrails of timber bridges.

(ii) Supply of Paint.

All paint required for steel bridges is to be obtained from the Sydney Harbour Bridge Maintenance Organisation by requisition. The primer used is red lead in linseed oil and the grey intermediate and finishing coats consist of a micaceous iron oxide pigment in an alkyd vehicle. The paints will be supplied ready mixed.

The primer used for timber bridges is "pink primer" which consists of a mixture of red lead and white lead in linseed oil. This will be supplied ready mixed.

White paint for kerbs and handrails of timber bridges will be supplied ready mixed on requisition.

The ready mixed paint should not be requisitioned too far in advance of the work, and while in stock awaiting use should be turned over weekly.

Where the substructure of a bridge consists of steel cylinders, advantage should be taken of low river levels to paint the cylinders where this is required. The type of paint to be used is still the subject of investigation and the requisition should state clearly that the paint is for this purpose so that a suitable type may be supplied. Surfaces to be painted are to be thoroughly cleaned of all silt and other debris by chipping and wire brushing, and the surface is not to be painted unless thoroughly dry.

(iii) Priming coat, application.

The application of the priming coat is to be made by brushing, immediately following the cleaning of the steel and with the surface of the steel dry.

Spraying of lead paints is not permitted.

Where any area to be painted shows signs of tar or other stain, a coat of knotting varnish (chiefly shellac in spirits) should be applied and allowed to dry prior to painting. This will prevent the stain from penetrating through the paint. The finished paint film shall be smooth and uniform in thickness, including that at all corners and rivet heads. The rate of application should be 600 plus or minus 100 square feet per gallon.

(iv) Intermediate and finishing coats, application.

Paint should be applied only to dry surfaces. Where surfaces are damp or suspected of dampness, painting should be deferred.

The bulk of the Department's maintenance painting is carried out by brushing. The finished paint film shall be smooth and uniform in thickness, including all corners and rivet heads.

A thick paint film, provided it is properly brushed into tack to the surface, affords better economy as a protective covering than a thin paint film. The use of thin paints and the common practice of many painters to brush out as much as possible, results in a thin film and coverage which sometimes exceeds 1,000 square feet per gallon of paint. This is uneconomical and brush painting is to be carried out by vigorous brushing in, followed by light smoothing in the one direction without thinning the coat by excessive brushing out.

Where suitable plant is available, and the areas to be covered are sufficiently large, spray painting may be used for intermediate and finishing coats, *except for lead paints* or where droppings will affect traffic. The paint formulae have then to be selected to suit the plant employed. No coat shall be applied until the preceding coat is thoroughly dry. The interval between coats will vary according to atmospheric conditions and in no case should be less than forty-eight hours.

(v) Brushes.

The bristle should possess the following qualities:—

Elasticity sufficient to provide flexibility. *Fineness* sufficient to provide good paint-holding capacity in all positions and ability to spread the paint evenly without leaving brushmarks. *Durability*, i.e., to give reasonable wear under working conditions.

The best bristles are the boar bristles imported from China and Manchuria and known as the Tiensin and Manchurian bristle. A good quality paint brush should give at least twenty (20) days' service.

The bristle should be set in vulcanite encased in a metal shield and fixed into the handle in such a manner as to hold the bristle in position during the life of the brush.

The undermentioned sizes are recommended for various types of steel construction:

	Length Inches	Width Inches	Thickness Inches
For use on plane surfaces	3¼	3½	¾
For use on lacing bars, angle bars and rivet heads, etc.	3	2 to 3	¾

For use in crevices and fine work—A round bristle brush or flitch 1 in. diameter x 2½ in. to 3 in. long.

After the brush has worn half an inch, it should not be used for intermediate or finishing coats.

Brushes used from day to day on work in which there is no change in the specification or colour of the paint applied, should have all free paint removed by brushing on a clean dry surface and kept overnight in water sufficient to immerse the bristles only. Brushes taken into store after use or when a change in specification or colour is made, should be thoroughly cleaned in turpentine and dried out.

(vi) Confined Spaces.

Where it is necessary to work in confined spaces, lead paint is not to be used. Should it be necessary to chip or scrape old lead paint in confined spaces respirators are to be used. When the circulation of air is insufficient, fumes from aromatic thinners, such as turpentine, may produce nausea and headaches, and consequently in confined spaces these substances should not be used.

15. REPAIR OF CONCRETE BRIDGES.

(i) Expansion Joints.

Particular attention should be given to the watertightness of (closed) expansion joints. These are generally formed with a rubber hose inserted in the expansion gap with a bituminous filler. The hose should be examined to see whether it is perished and the bituminous filler should be brought up to the level of the roadway if required.

(ii) Expansion Bearings.

These are to be examined to see whether they are free to move with changes in temperature and the adjacent concrete should be closely examined for cracking or spalling caused by failure of the bearings to act properly.

(iii) Use of Epoxy Resin.

This material has been found extremely useful as an adhesive for bolted joints of steel bridges, for strengthening timber bridges, in the repair of cracked or spalled concrete and for providing a non-skid surface on steel grid bridge decks. As many different kinds of resin are available, each repair proposal should be submitted to Head Office for advice regarding a suitable type.

The following general information regarding the use of this material is given:—

(1) The surface of the materials to be bonded should be cleaned with a solvent (such as trichlorethylene) to remove dirt and oil. Steel should be sandblasted or ground to bright metal with a rough finish to form a key for the resin.

(2) The "pot life" of the mixed resin is very short (30 minutes to 1 hour) so that only limited quantities should be mixed.

(3) Curing takes place without pressure but the thickness of the joint should not exceed 0.1 to 0.2 millimetres if practicable. If thicker joints are required, a pasty type of adhesive is necessary and some means arranged to retain the resin in position until cured.

(4) The resin can be used (i) in film form for bonding (ii) in film form with sand or grit added to make a seal coat (iii) in mortar form with sand or other material where the holes are to be filled. The mixture can be trowelled into place.

(5) Epoxy resin is an irritant and may cause dermatitis. Gloves should be worn and the resin, if spilt on the hands, should be washed off with soap and water *not* with solvent.

16. EQUIPMENT.

THE STANDARD EQUIPMENT SUPPLIED TO A BRIDGE MAINTENANCE GANG IS AS FOLLOWS:—

Item.	Quantity.
Adzes	2
Anvil, 56 lb.	1
Augers, screw and bullnose	supply

Item.	Quantity.
Axe, Broad	1
Axes, 4½ lb.	2
Block, single for 2 in. wire rope	2
Block, double for 2 in. wire rope	2
Block, treble for 2 in. wire rope	2
Block, snatch for 2 in. wire rope	2
Block, single for 2½ in. hemp	4
Block, double for 2½ in. hemp	3
Block, snatch for 2½ in. hemp	2
Bolts, nuts and washers	assorted
Box, tool	1
Brace, ratchet and drilling post	1
Chains, ½ in. x 6 ft. with nip link at one end	2
Chains, ½ in. x 8 ft. with nip link at one end	2
Chains, ⅝ in. x 6 ft. with nip link at one end	2
Chains, ⅝ in. x 8 ft. with nip link at one end	2
Chest, ambulance	1
Chisels, cold, 1 in. x 8 in.	1
Chisels, cold, ¾ in. x 6 in.	2
Chisels, round nose, ¾ in. x 6 in.	2
Cramps, carpenters', 5 ft.	2
Cramps, carpenters', 3 ft.	2
Crowbars, 1¼ in. x 5 ft., pointed one end, claw at other	2
Crowbars, 1¼ in. x 6 ft., pointed one end, chisel at other	2
Cutters, bolt — capacity up to ¾ in.	1 pair
Drift, steel, ¾ in. x 12 in. long	1
Drift, steel, 1 in. x 12 in. long	1
Drift, steel, ¾ in. x 24 in. long	1
Drift, steel, 1 in. x 24 in. long	1
Drift, steel, ¾ in. x 36 in. long	1
Drift, steel, 1 in. x 36 in. long	1
Drill, petrol-driven	1
Drills, twist — ⅝ in.	1
Drills, twist — ¾ in.	1
Drills, twist — ⅞ in.	1
Drills, twist — 1 in.	1
Files, flat, bastard, 10 in.	2
Files, flat, second-cut, 12 in.	2
Files, mill saw (fine) 8 in.	2
Forge, with blower	1
Grindstone	1
Hacksaw, 12 in., with blades	1
Hacksaw, 15 in., with blades	1
Hammer, sledge, 7 lb.	1
Hammer, sledge, 10 lb.	2
Hammer, sledge, 14 lb.	1
Hammer, gympie, 3 lb.	3
Hemp rope, 2½ in. (for staying wire rope)	400 ft.
Hemp rope, 1½ in.	200 ft.
Hand winch — capacity 1 ton off barrel	1
Hooks, cant	2
Hooks, deck, ⅝ in. x 3 ft. long, with round handle and hooked end	4
Jacks, ratchet type, 10 ton capacity	2
Jacks, rack and pinion, 4 ton capacity	2
Jacks, traversing, 20 ton capacity	1
Jigger braces	3
Ladder, extension	1
Ladder, 15 ft.	1
Ladder, 20 ft.	1
Lamp, blow — 1 pint capacity	1
Picks, muck	2
Picks, rock	1
Pipes, 1½ in. x 5 ft.	2
Planks, staging assorted	quantity
Punches, steel spike, 6 in.	2
Saw, crosscut, 5 ft.	1
Saw, crosscut, 6 ft.	1
Shackles (screwed) — ⅝ in.	2
Shackles (screwed) — ¾ in.	2
Shackles (screwed) — ⅞ in.	2
Shovels, round mouthed, short handled	2

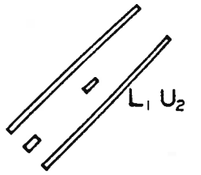
Item.	Quantity.
Spanners — ⅜ in.	2
Spanners — ½ in.	2
Spanners — ¾ in.	4
Spanners — ⅞ in.	4
Spanners — 1 in.	4
Spanners — 1¼ in.	2
Spanner, Clyburn, 18 in.	1
Spanner, Clyburn, 24 in.	1
Square, steel, 24 in.	1
Stocks and dies, Whitworth, ¼ in. - 1½ in.	1 set
Strops, 12 ft. long of 3¾ in. circ. wire rope, with thimble each end	2
Tools, blacksmiths'	1 set
Trestles, carpenters'	2
Trolleys, timber, with 8 in. rubber wheels	2
Truck, motor, 2½ - 4 tons capacity with power take-off	1
Turnbuckles, 1½ in. x 5 ft.	2
Turnbuckles, 1 in. x 4 ft.	2
Vice bench, 5 in.	1
Vice leg, 6 in.	1
Wedges, steel, 20 in. x 6 in. x 1½ in. to ½ in.	6
Wire rope, 1½ in.	200 ft.
Wire rope, 2 in.	200 ft.
Wrench, Stillson, 14 in.	1
Wrench, Stillson, 24 in.	1
Plant as under is kept in a central location, on call when required but not forming part of the usual equipment:—	
Grinder and brush, portable (petrol driven)	1
Jacks, hydraulic, 50 tons	2
Pile-driving machine, 35 ft. with 35 cwt. monkey, tripper, etc.	1
Pile-driving machine, portable, 30 ft., on wheels, with 35 cwt. monkey, tripper, etc.	1
Pile rings — 14 in. dia. 2½ in. x 1 in.	2
Torch, oxy-acetylene	1
Welding plant, portable (for Metropolitan, Newcastle and Grafton Divisions)	1
Winch for pile-driving machine (if steam, with boiler)	1
Winch hand	1

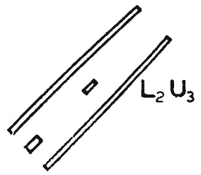
FOR A BRIDGE TESTING GANG THE FOLLOWING ARE SUPPLIED:—

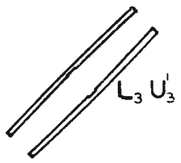
Augers, screw, ½ in.	2
Bits, auger, ⅜ in.	2
Bits, auger, ½ in.	2
Blocks, single, for hemp rope, 2½ in.	3
Blocks, snatch, for hemp rope, 2½ in.	1
Bolts, nuts and washers	supply
Braces, carpenters', ratchet	2
Crowbars, 4 ft. x 1¼ in.	1
Crowbars, 5 ft. x 1¼ in.	1
Jacks, Wallaby, 2 ton capacity	2
Ladder, 15 ft.	1
Ladder, extension	1
Motor truck, 30 cwt. capacity	1
Planks, staging	quantity
Respirators and blowers, white ant	2
Rope, manilla, 2½ in.	200 ft.
Rope, manilla, 1½ in.	100 ft.
Rope, manilla, 2 in.	100 ft.
Saw, cross-cut, 4 ft.	1
Spanners, Clyburn, 24 in.	1
Spanners, single-ended, Whit. ⅜ in.	2
Spanners, single-ended, Whit. ½ in.	2
Spanners, single-ended, Whit. ¾ in.	2
Spanners, single-ended, Whit. ⅞ in.	2
Spanners, single-ended, Whit. 1 in.	1
Spanners, single-ended, Whit. 1¼ in.	1
Tackle, handy-billy with double and treble blocks for 1½ in. circ. hemp rope	1
Wedges, steel, 20 in. x 6 in. x 1 in. to ½ in.	2

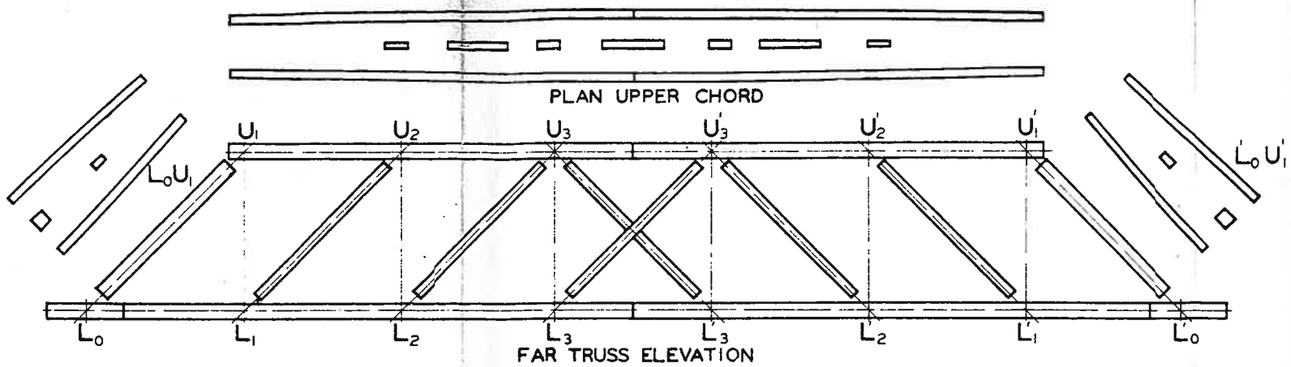
INVINCIBLE PRESS

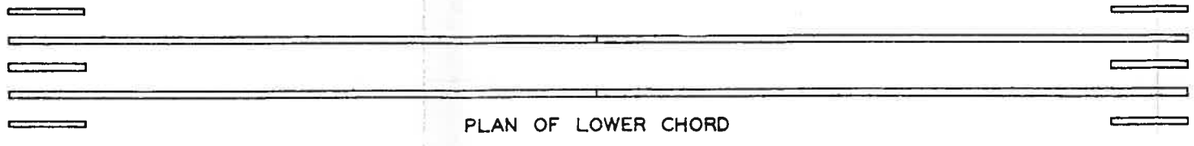
M.R. DIAGRAM Nº A3727

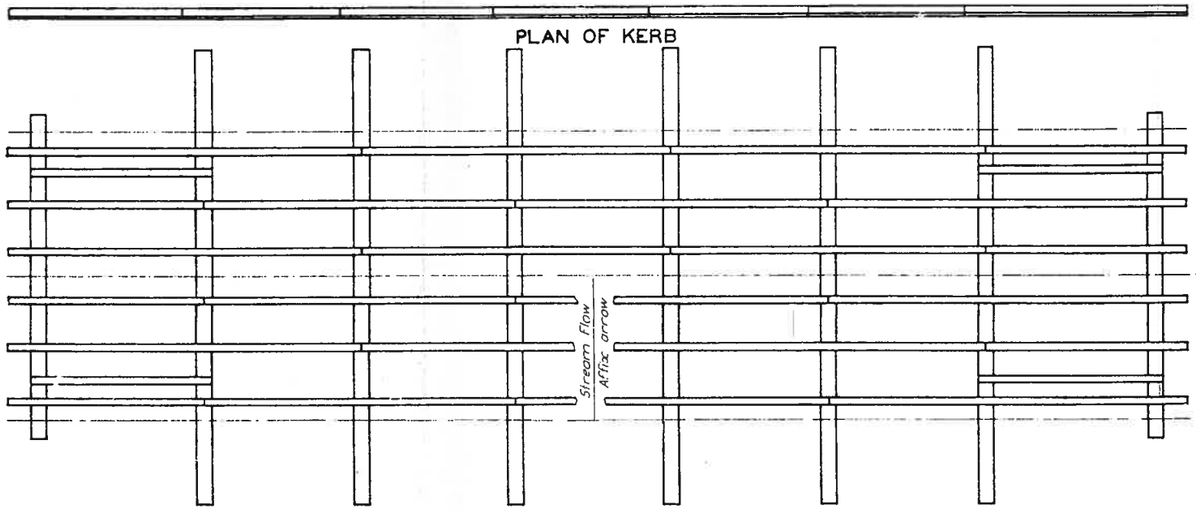








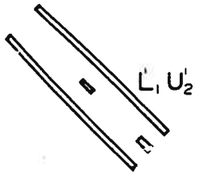


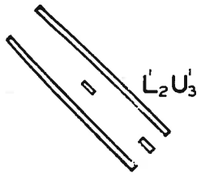


FROM
Insert place name

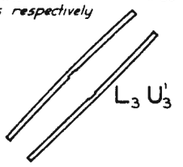
Views above or below this line refer to far or near truss respectively

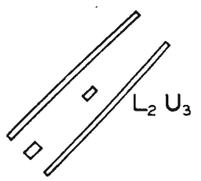
TO
Insert place name

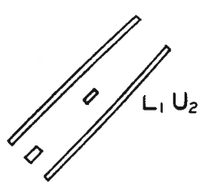


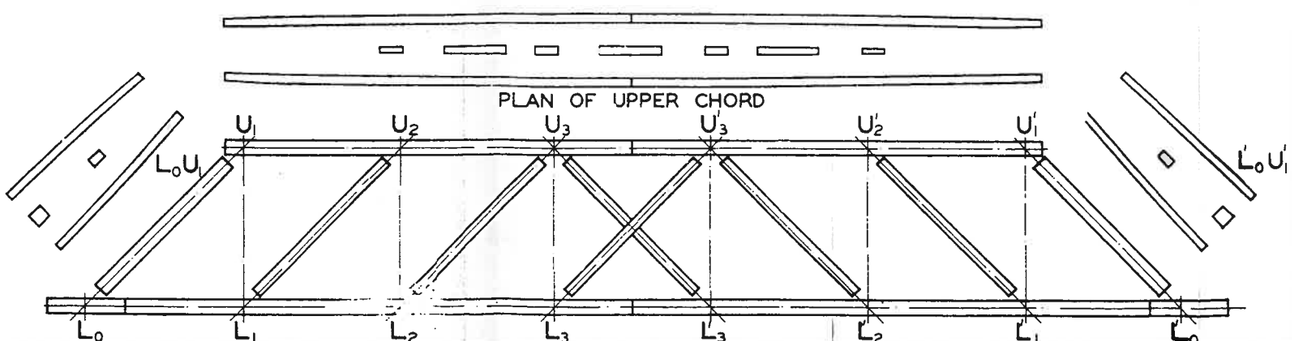


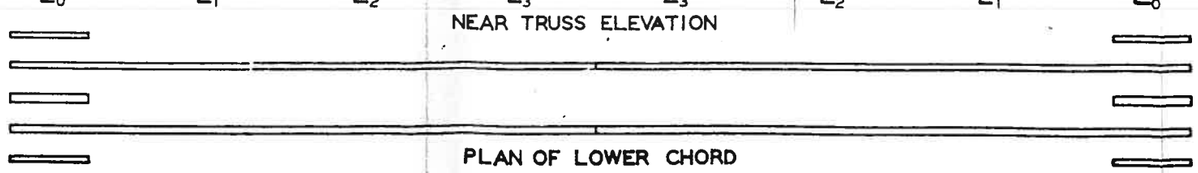
Where decking is to be renewed the number of planks their lengths and approximate positions are to be noted hereunder

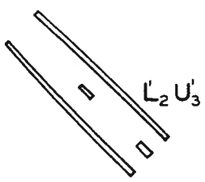


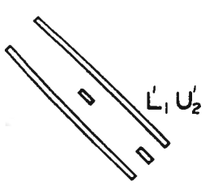








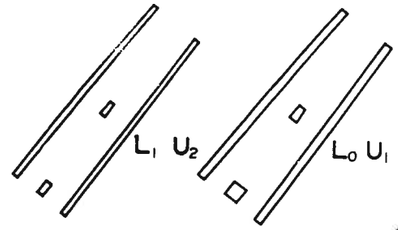


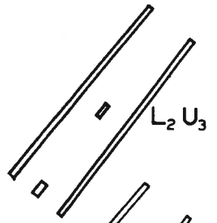


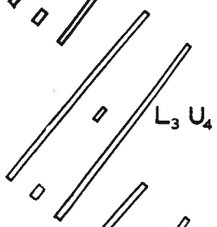
A3727

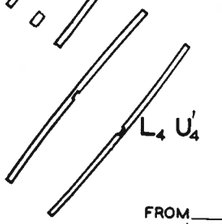
70-FT. ALLAN TRUSS SPAN	
SHIRE OR MUNICIPALTY }	ROAD Nº
BRIDGE OVER	
TRUSS SPAN Nº	FROM END
BRIDGE FOREMAN	DATE
DIVISIONAL ENGINEER	DATE

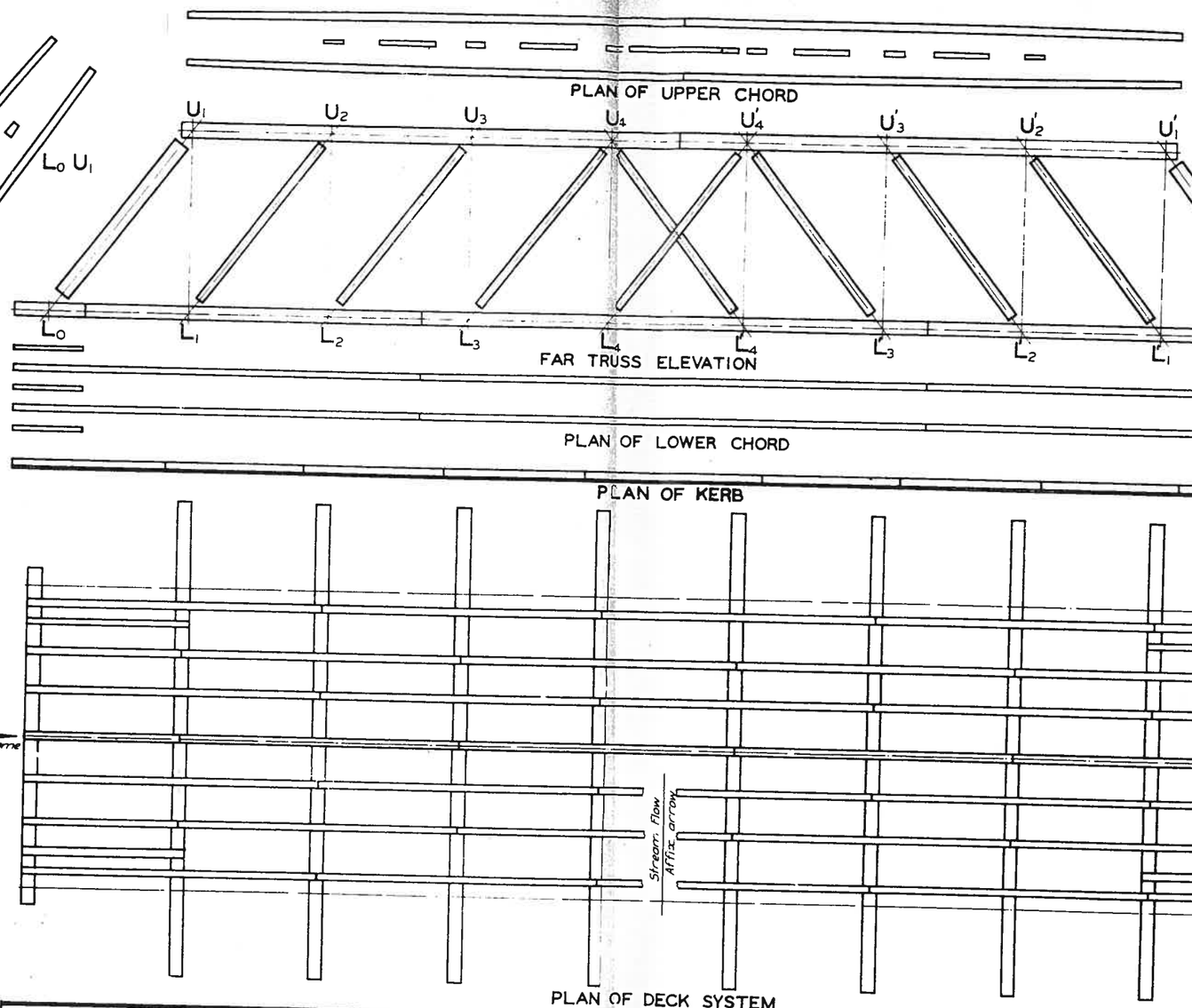
M. R. DIAGRAM N°A3728

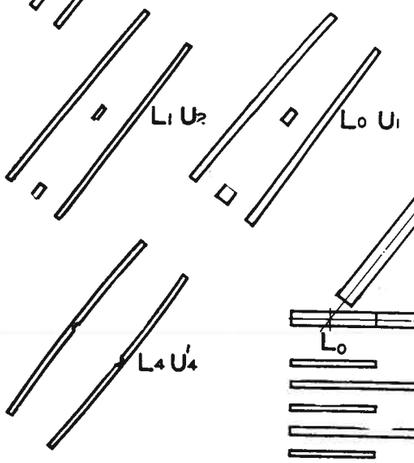


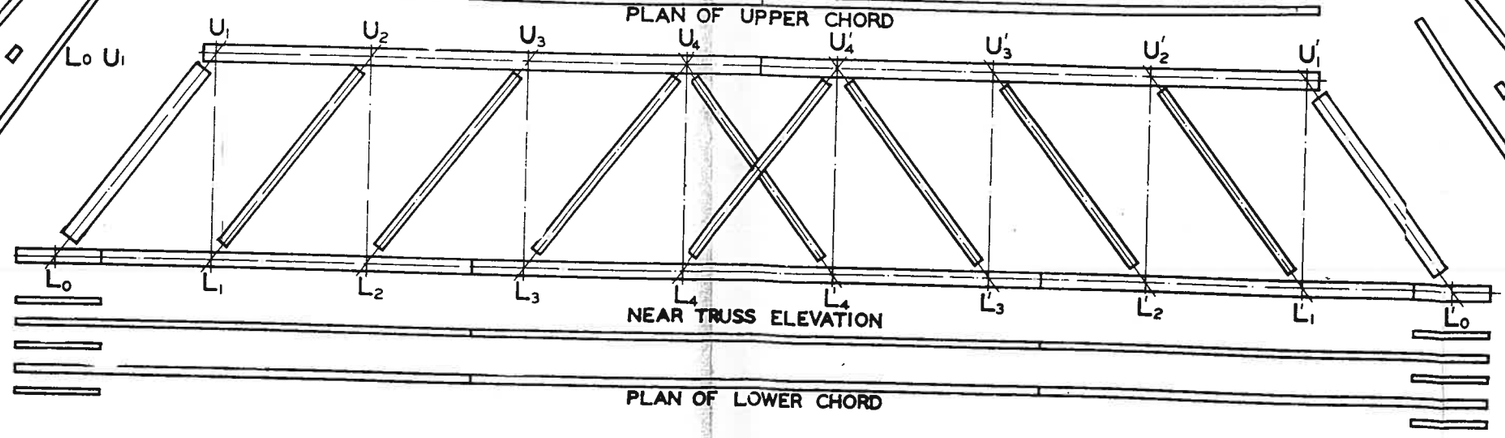


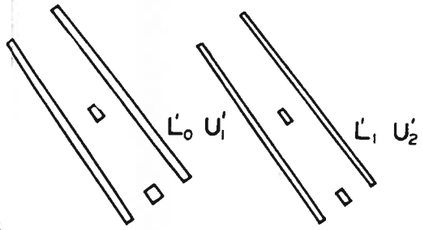


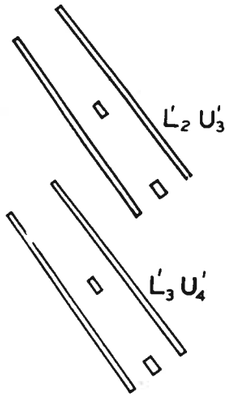


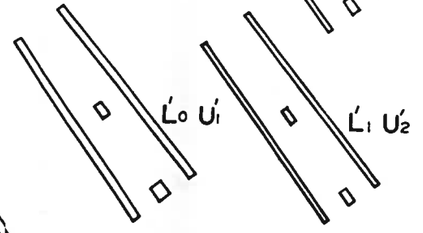












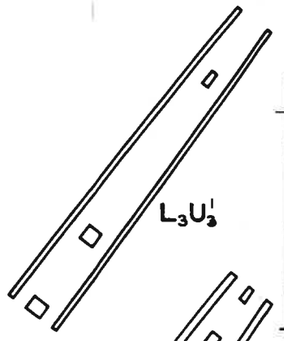
TO
Insert place name

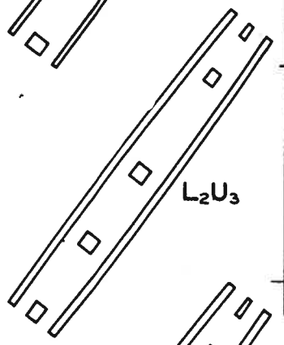
Views above or below this line refer to far or near truss respectively

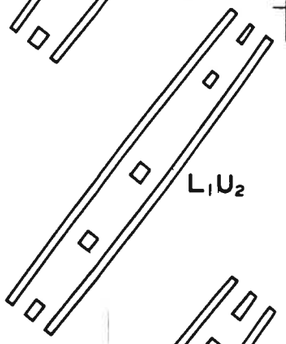
Where decking is to be removed the number of planks their lengths and approximate positions are to be noted hereunder

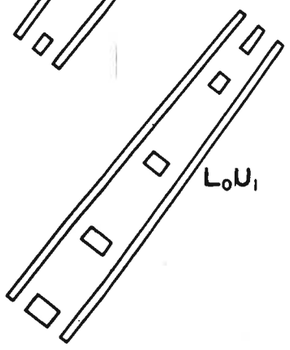
90-FT. ALLAN TRUSS SPAN	
SHIRE OR MUNICIPALITY	ROAD N°.
BRIDGE OVER	
TRUSS SPAN N°.	FROM END
BRIDGE FOREMAN	DATE
DIVISIONAL ENGINEER	DATE

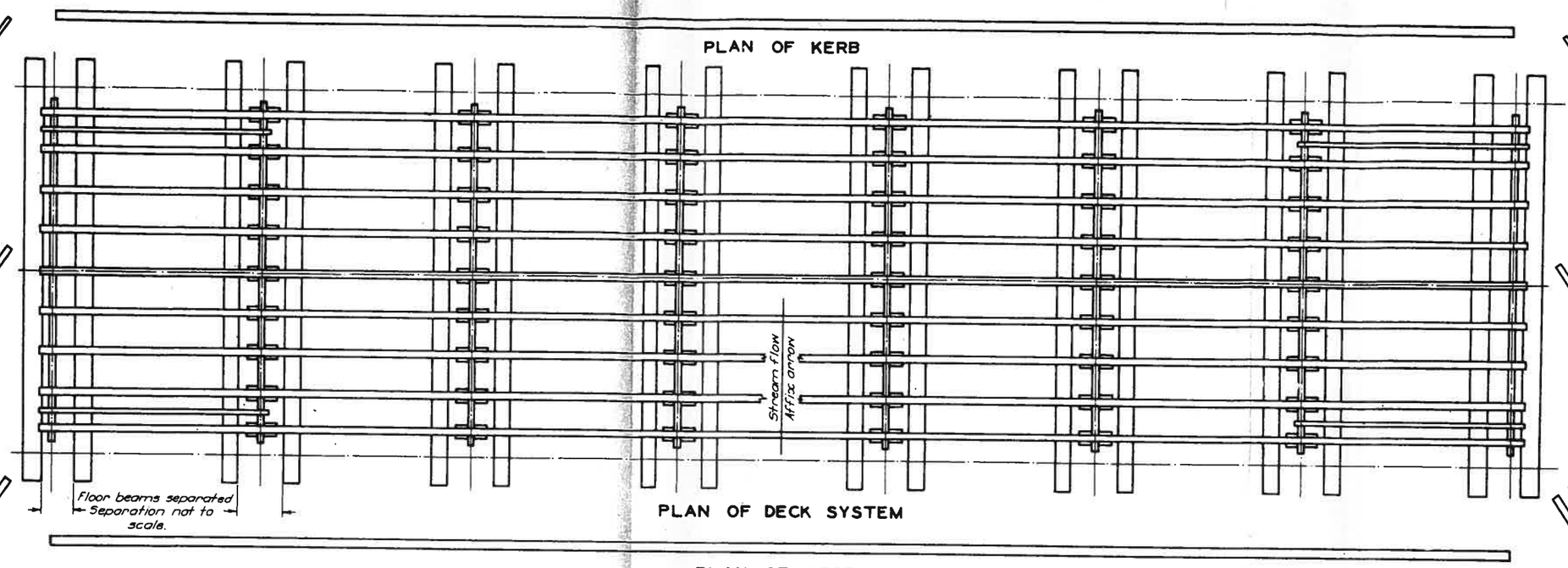
Issued 19-6-52

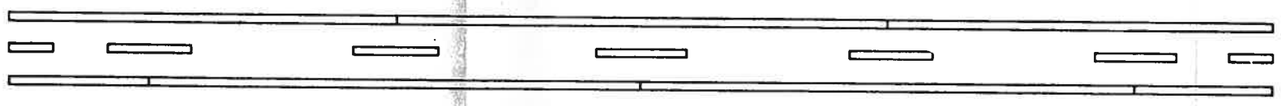


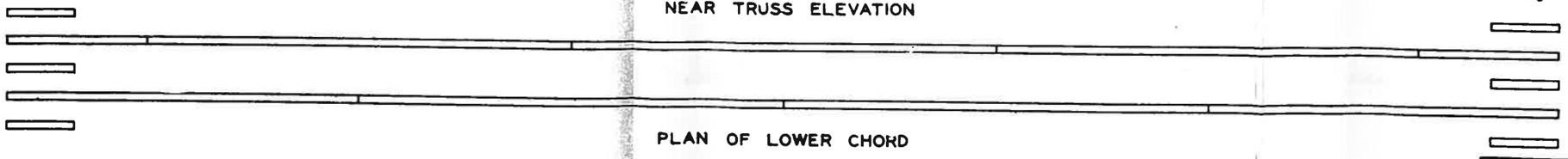


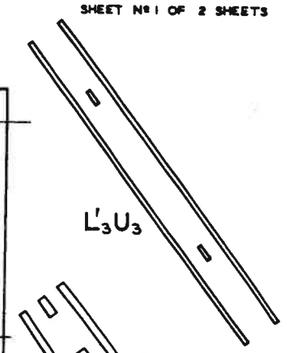


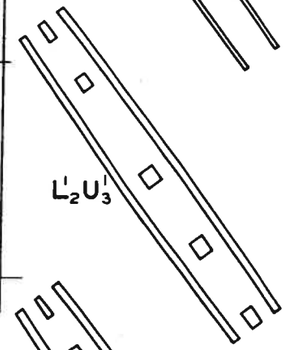


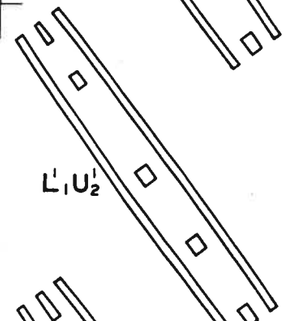


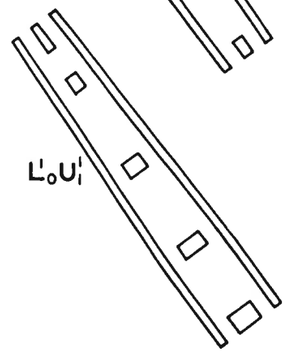












A3729

Where decking is to be reserved, the number of planks, their lengths and approximate positions are to be noted alongside this note.

Views on this sheet refer to near truss. For far truss and upper lateral struts, see sheet Nº 2.

24-6-52

110'-3" ALLAN TRUSS SPAN

SHIRE OR MUNICIPALITY } ..... ROAD Nº .....

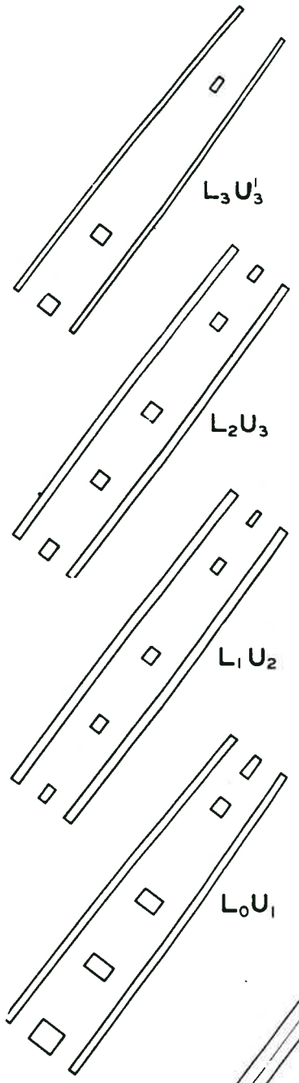
BRIDGE OVER .....

TRUSS SPAN Nº ___ FROM ..... END

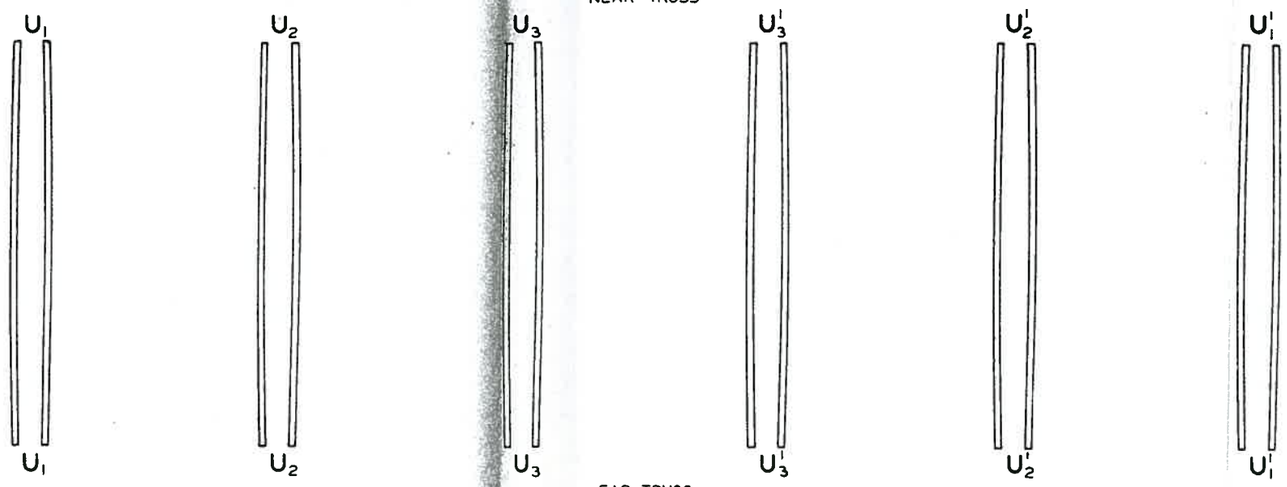
BRIDGE FOREMAN ..... DATE .....

DIVISIONAL ENGINEER ..... DATE .....

M.R. DIAGRAM Nº A3729
SHEET Nº2 OF 2 SHEETS

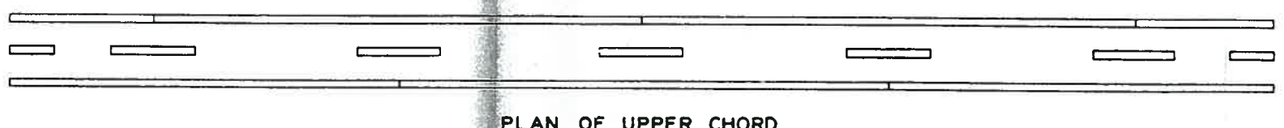


NEAR TRUSS

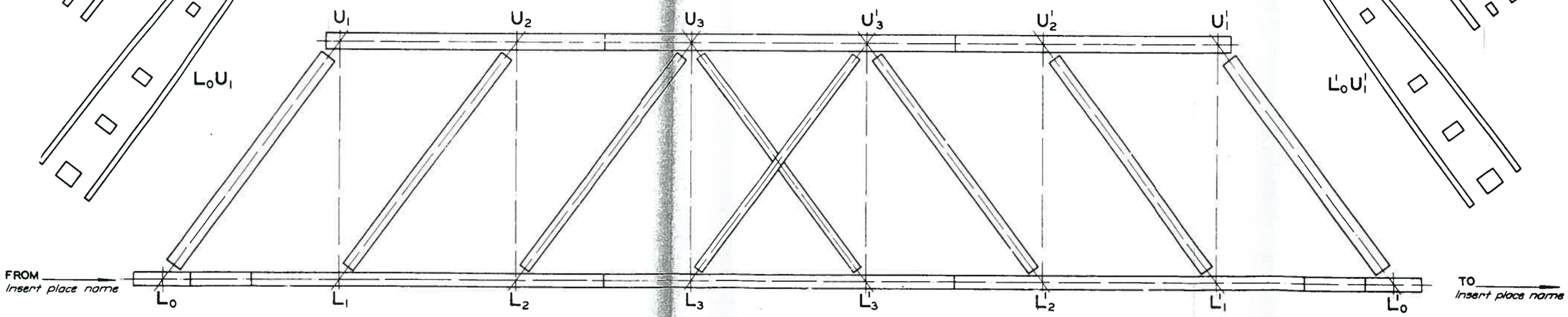


FAR TRUSS

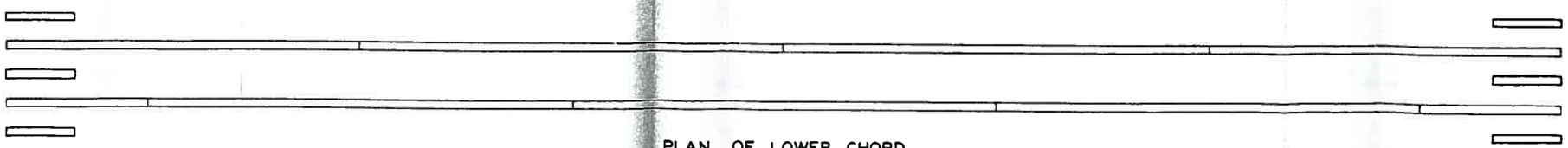
UPPER LATERAL STRUTS



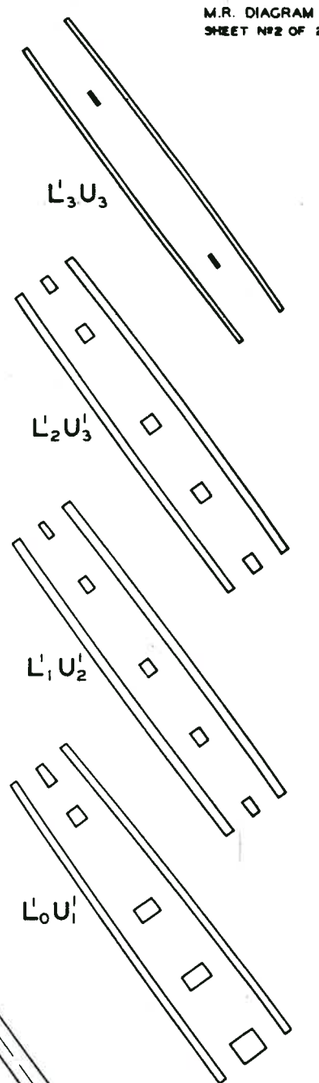
PLAN OF UPPER CHORD



FAR TRUSS ELEVATION



PLAN OF LOWER CHORD

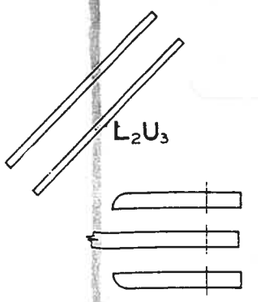


Views on this sheet refer to far truss. For near truss and deck system refer to sheet Nº 1.

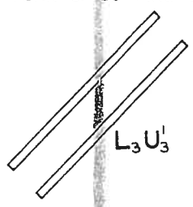
24-6-32

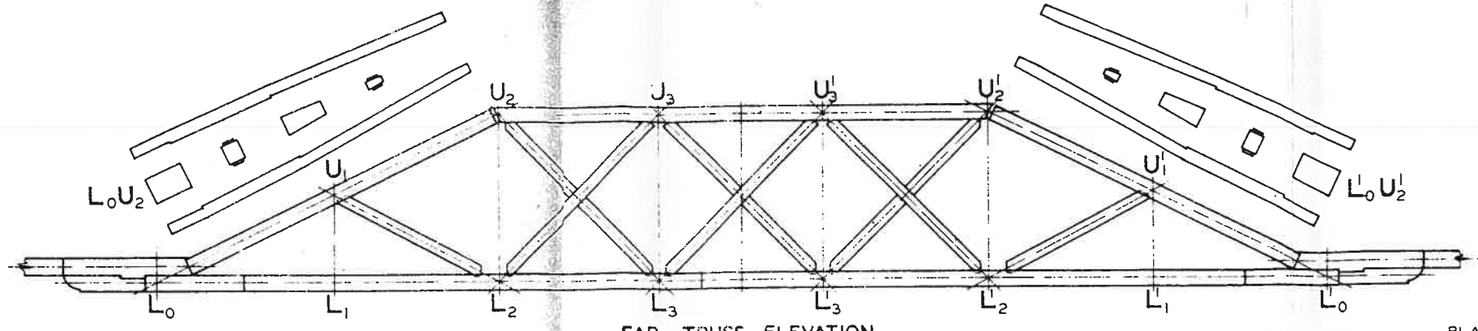
110'-3" ALLAN TRUSS SPAN	
SHIRE OR MUNICIPALITY }	ROAD Nº
BRIDGE OVER	
TRUSS SPAN Nº	FROM END
BRIDGE FOREMAN	DATE
DIVISIONAL ENGINEER	DATE

M.R. DIAGRAM Nº A3730

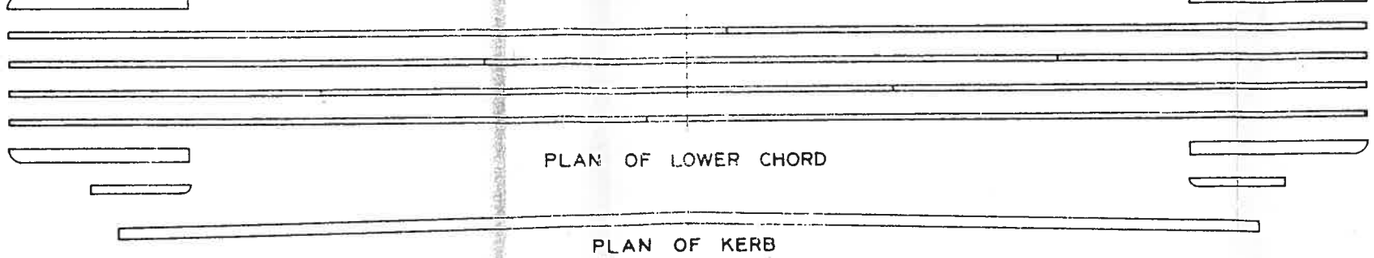


PLAN OF BUTTING BLOCKS AT L_0

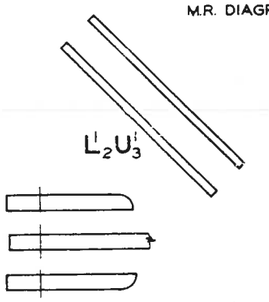




FAR TRUSS ELEVATION



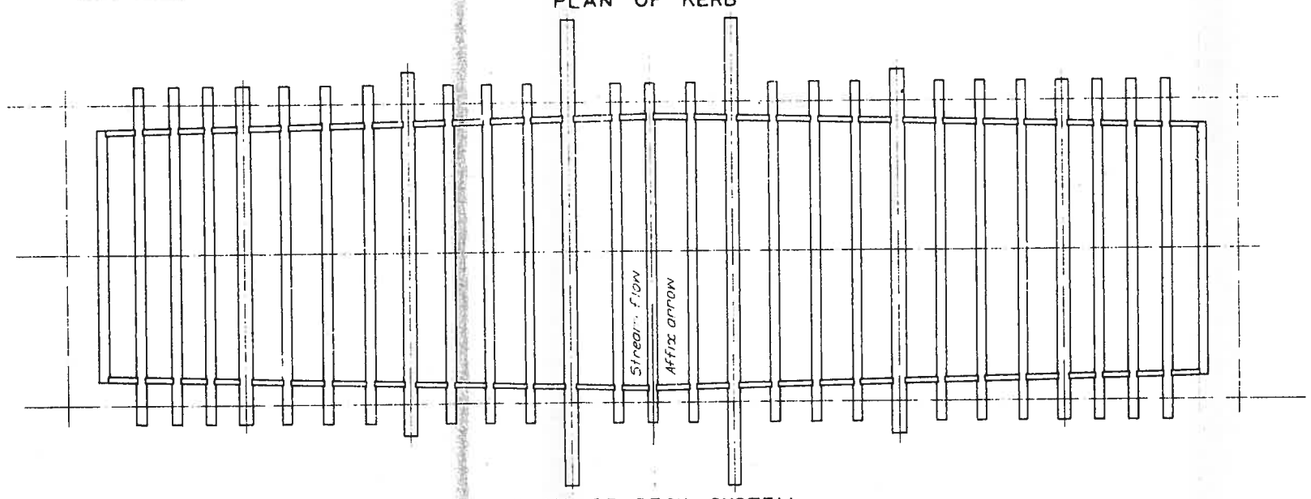
PLAN OF LOWER CHORD



PLAN OF BUTTING BLOCKS AT L_0'

Where decking is to be removed, the number of planks, their lengths and approximate position are to be noted hereunder

PLAN OF KERB



PLAN OF DECK SYSTEM

PLAN OF KERB

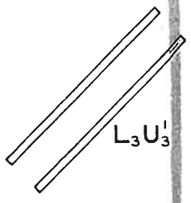
FROM

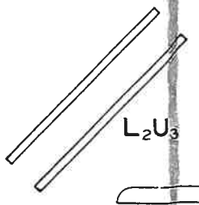
Insert place name

TO

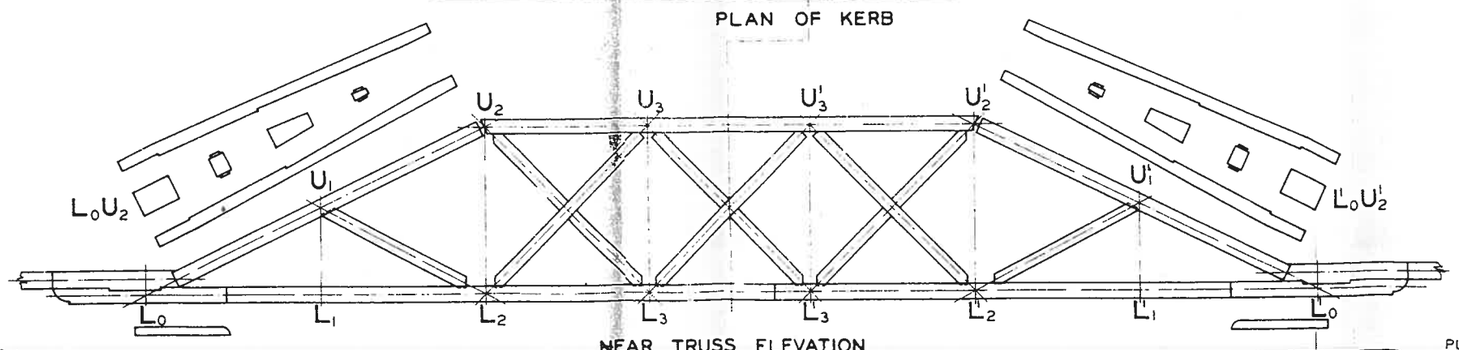
Insert place name

Views above or below this line refer to far or near truss respectively

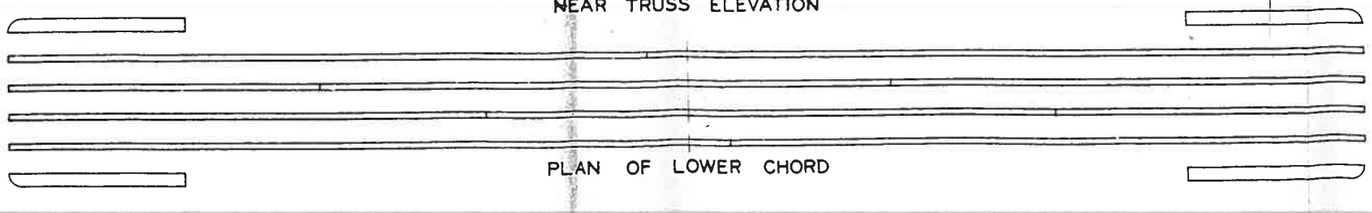




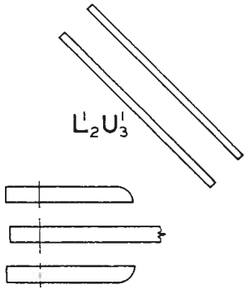
PLAN OF BUTTING BLOCKS AT L_0



NEAR TRUSS ELEVATION



PLAN OF LOWER CHORD



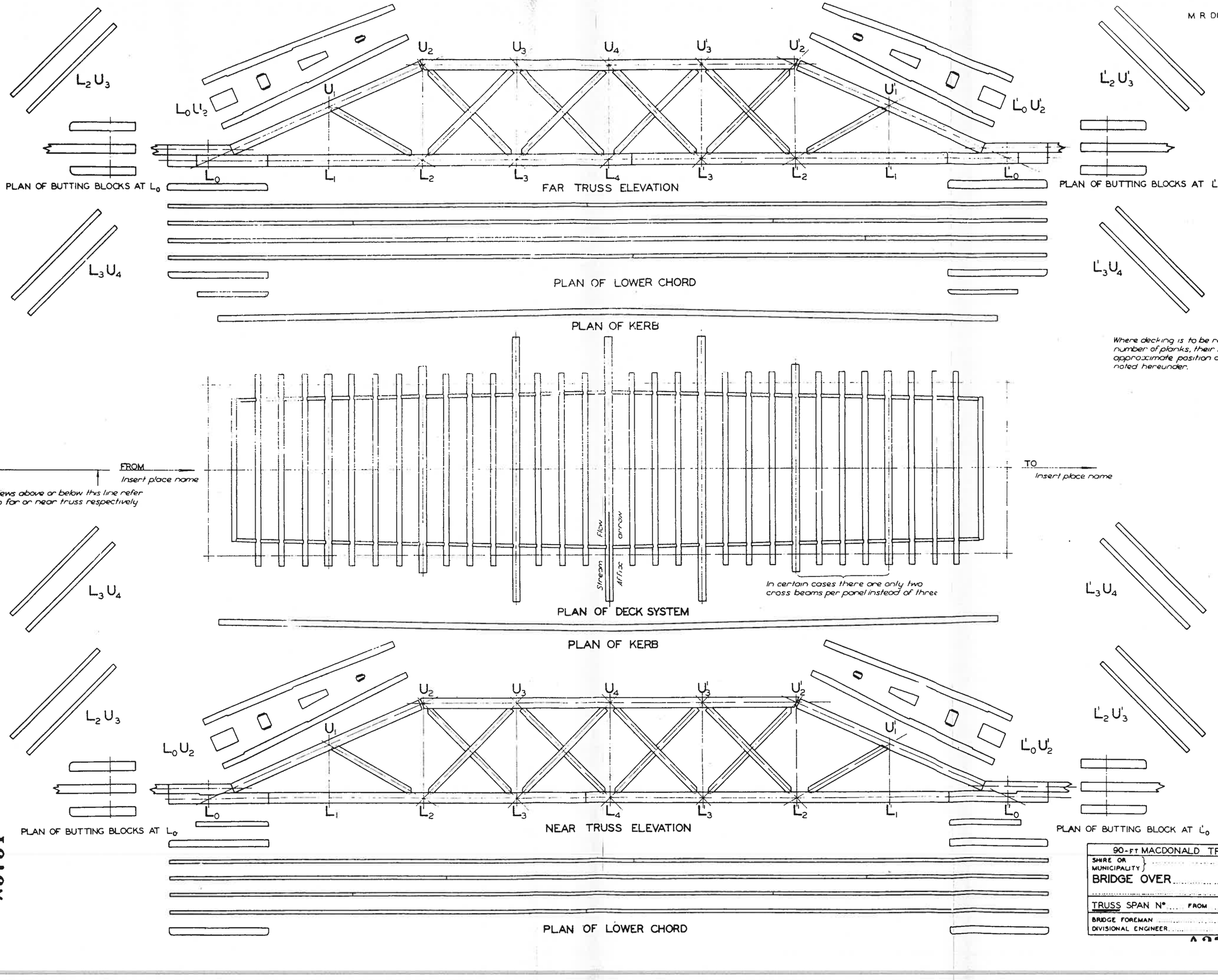
PLAN OF BUTTING BLOCKS AT L_0'

75-FT. MACDONALD TRUSS SPAN	
SHIRE OR MUNICIPALITY }	ROAD Nº
BRIDGE OVER	
TRUSS SPAN Nº	FROM TO END
BRIDGE FOREMAN	DATE
DIVISIONAL ENGINEER	DATE

A3730

A3730

M R DIAGRAM N° A3731



Where decking is to be renewed the number of planks, their lengths and approximate position are to be noted hereunder.

23·6·52

90-FT MACDONALD TRUSS SPAN

SHIRE OR MUNICIPALITY ..... ROAD N° .....

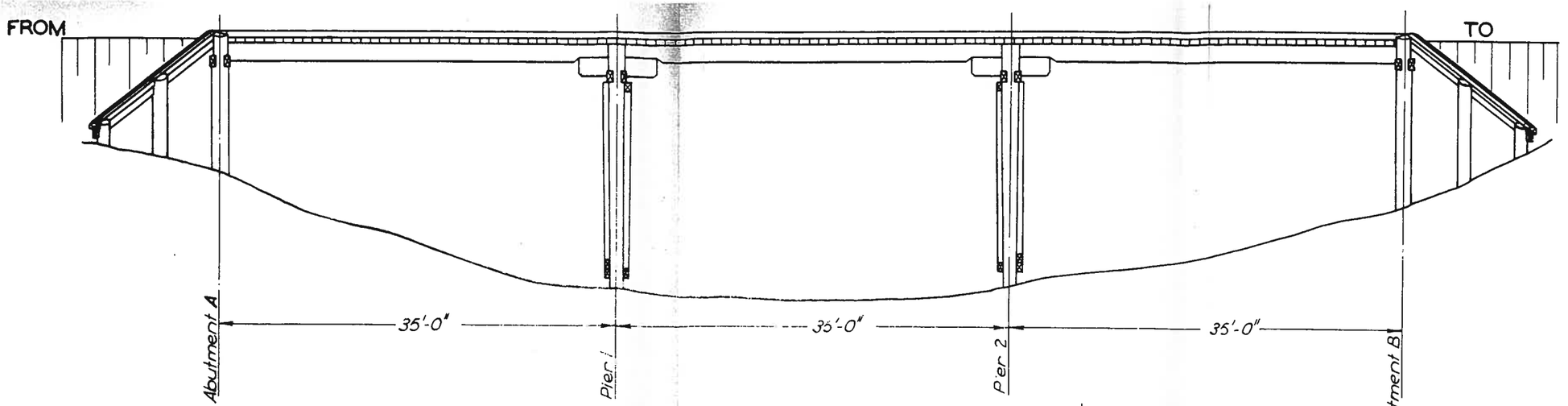
BRIDGE OVER .....

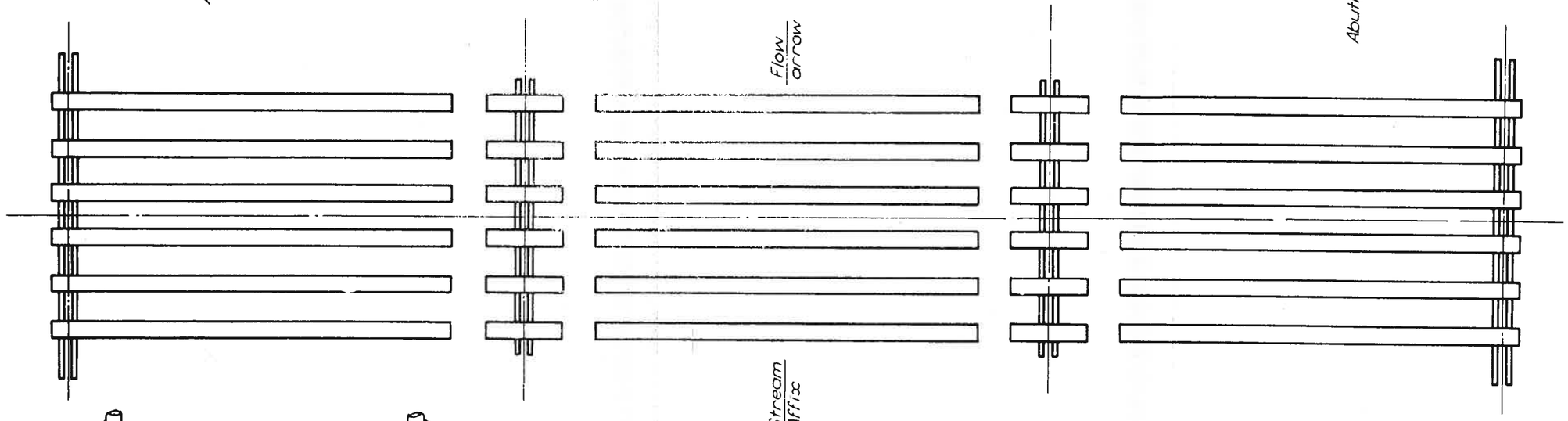
TRUSS SPAN N° ... FROM ..... END

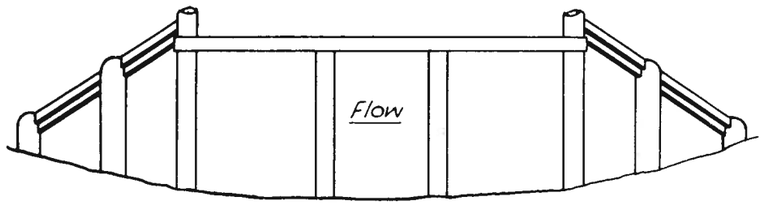
BRIDGE FOREMAN ..... DATE .....

DIVISIONAL ENGINEER ..... DATE .....

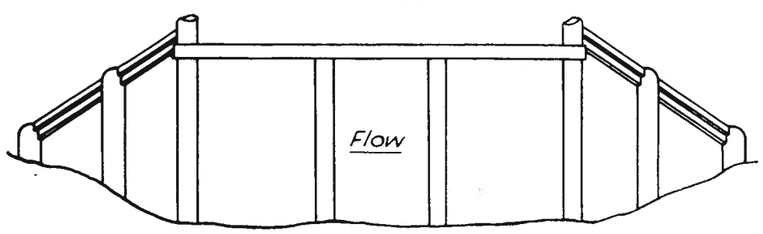
A3731



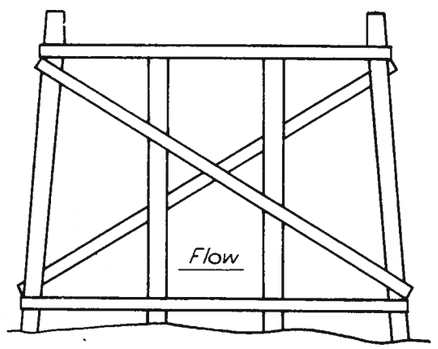




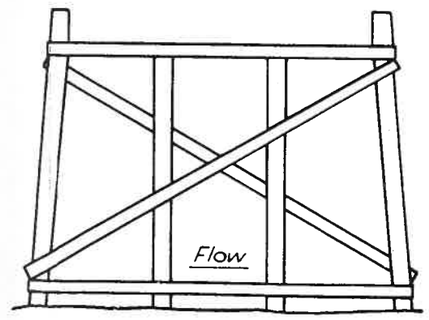
ABUTMENT A



ABUTMENT B



PIER 1

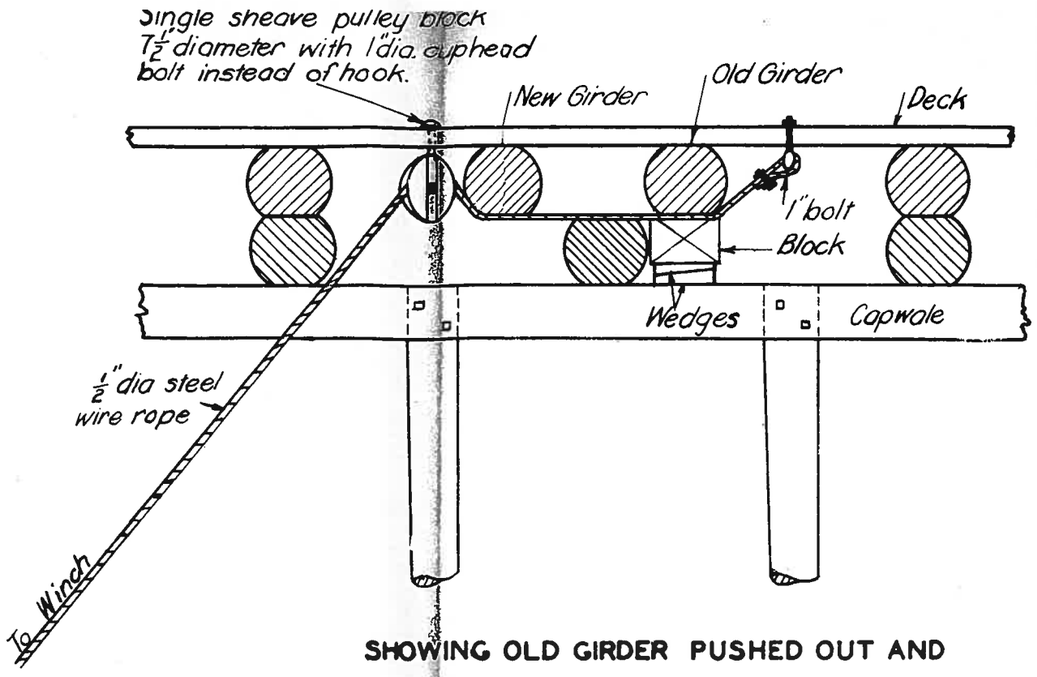


PIER 2

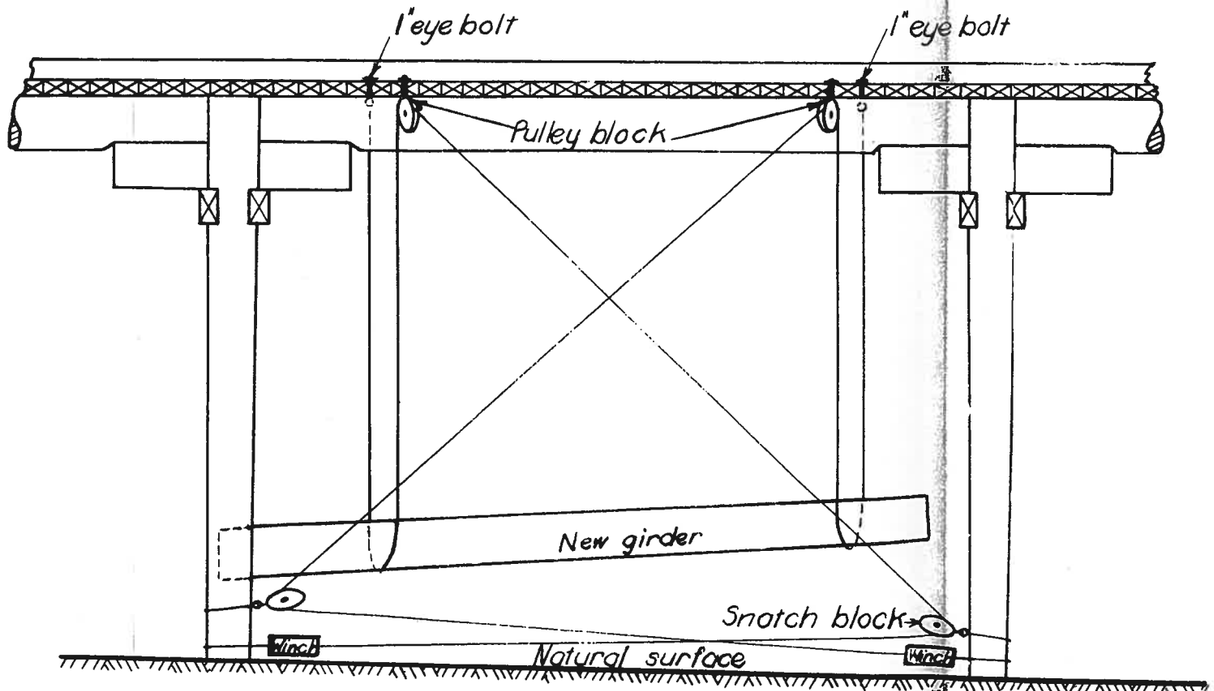
DECKING & SHEETING *Where decking or sheeting is to be renewed the number of planks, their lengths, thickness*

DEPARTMENT OF MAIN ROADS N. S. W.

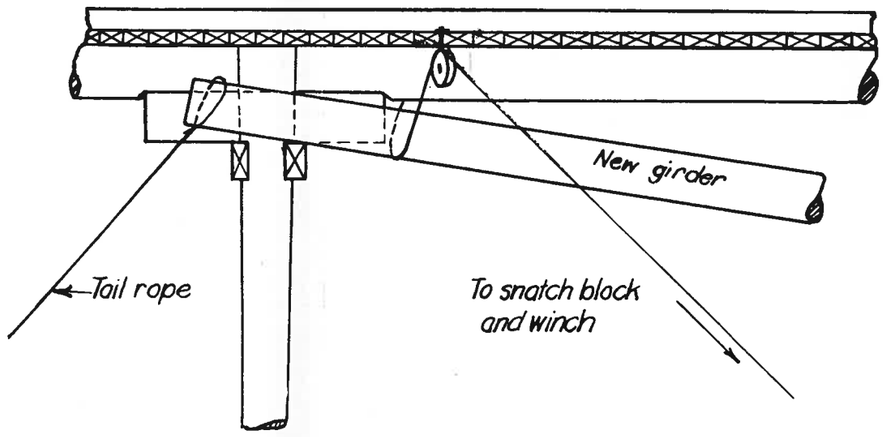
TYPICAL DIAGRAM FOR TEST BORING TIMBER BEAM BRIDGES



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



SHOWING METHOD OF LIFTING GIRDER



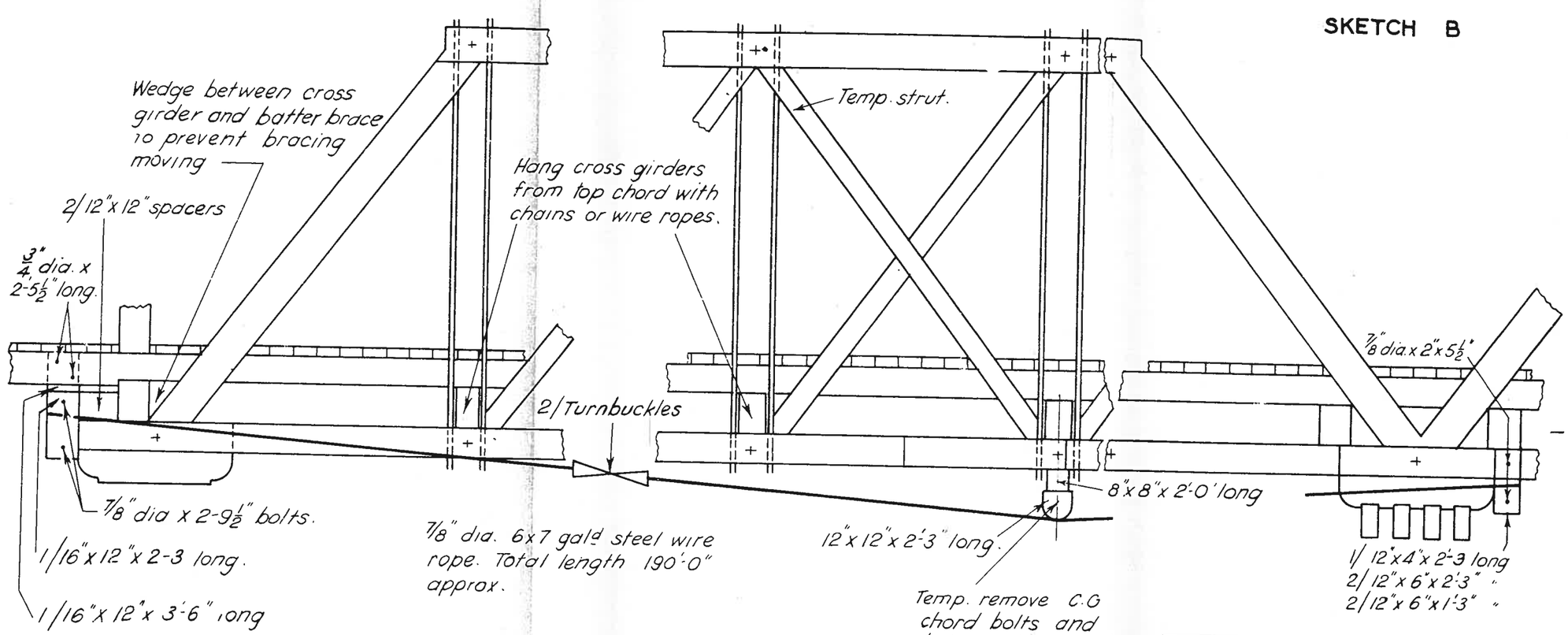
METHOD OF PASSING GIRDER OVER TOP OF CAPWALE

DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER BEAM BRIDGE MAINTENANCE

REPLACEMENT OF GIRDER

SKETCH B



Scale :- ¼ in = 1 ft

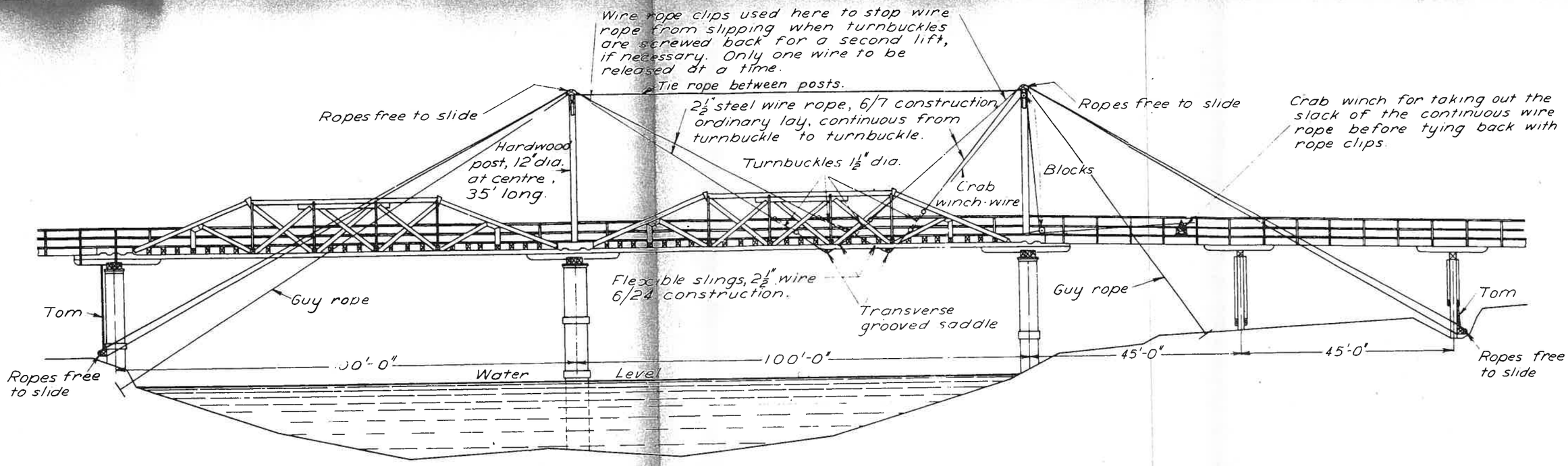
DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER TRUSS BRIDGE MAINTENANCE

WIRE ROPE TIE

FOR LOWER CHORD SUPPORT DURING MEMBER REPLACEMENT

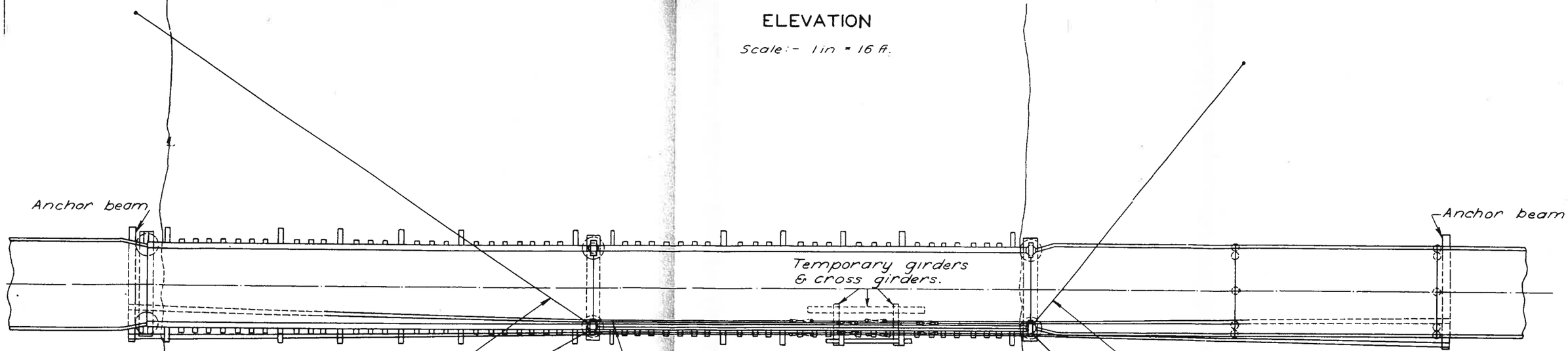
SKETCH C



ELEVATION

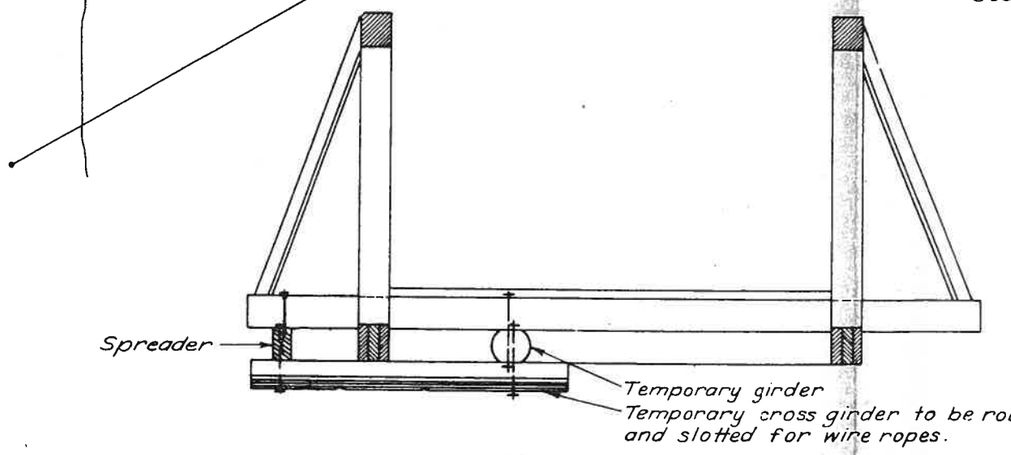
ELEVATION

Scale :- 1 in = 16 ft.



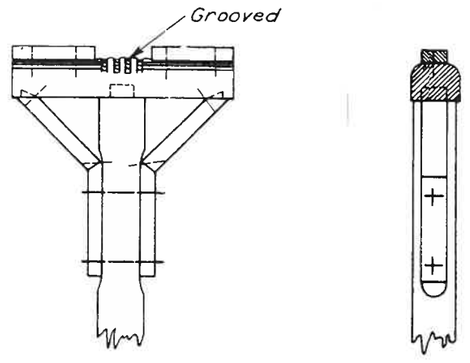
PLAN

Scale :- 1 in = 16 ft.



CROSS SECTION

Scale :- 1 in = 4 ft.



CROSS HEAD

Scale :- 1 in. = 2 ft.

REDUCED SCALE PRINT

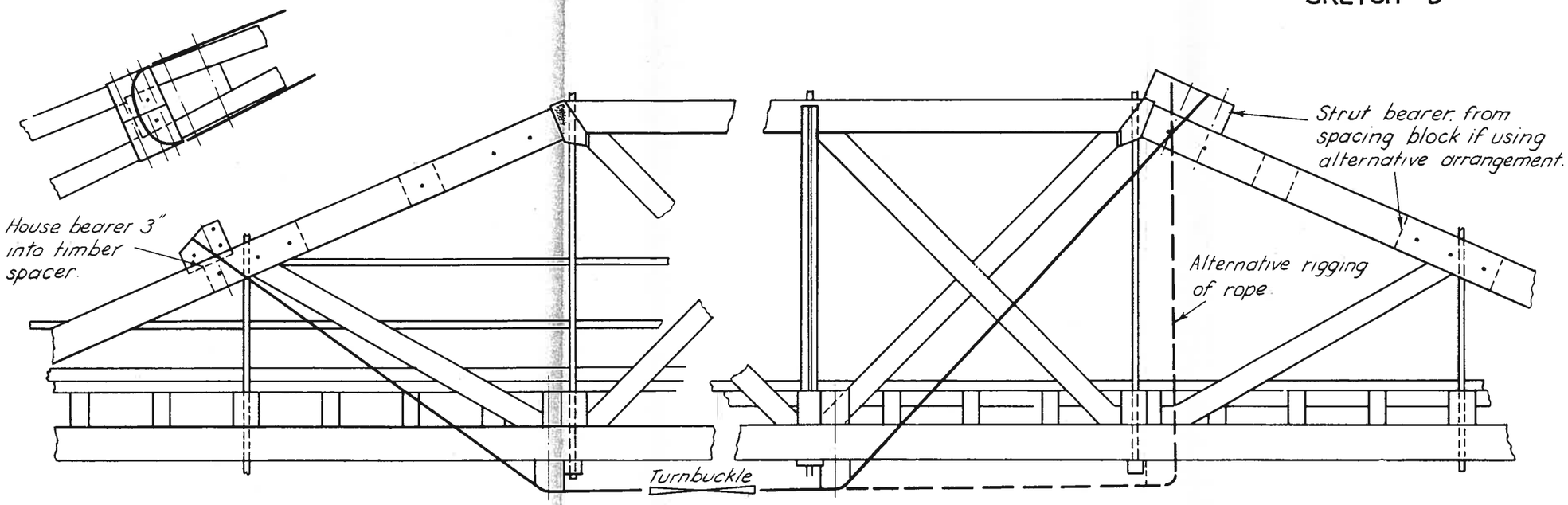
DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER TRUSS BRIDGE MAINTENANCE

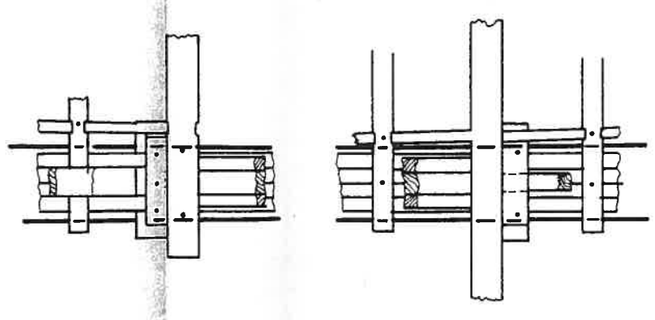
WIRE ROPE SUPPORT

DURING MEMBER REPLACEMENT

SKETCH D



Hardwood timber bearers to be shaped grooved and greased to assist slipping of wire rope. Rope to lie across grain of timber Live load for 1/2 3/4" circ. wire rope approx. 5 tons at slow speed. All bolts 7/8" dia.



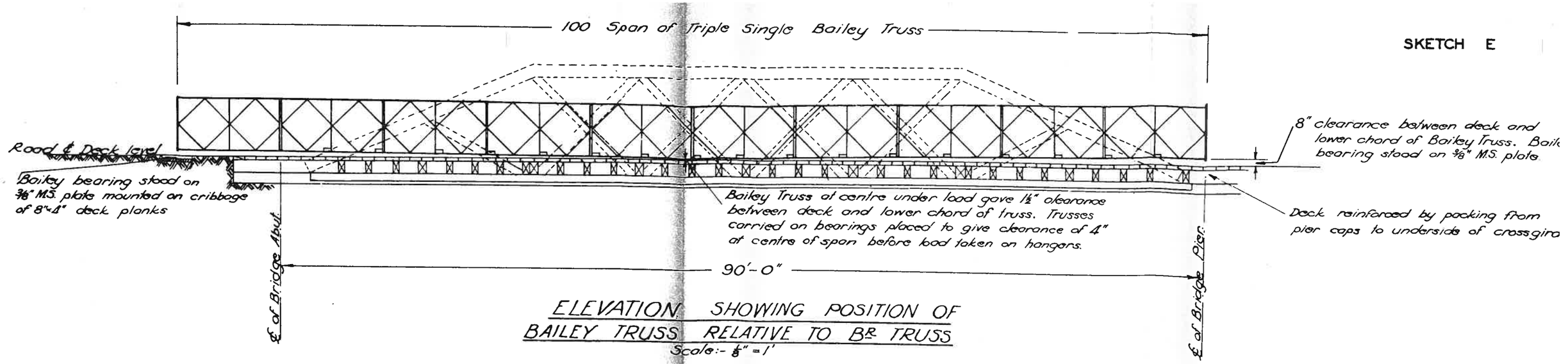
DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER TRUSS BRIDGE MAINTENANCE

TEMPORARY UNDERTRUSSING

DURING LOWER CHORD REPLACEMENT

SKETCH E



ELEVATION SHOWING POSITION OF BAILEY TRUSS RELATIVE TO Br TRUSS

Scale:- ⅛" = 1'

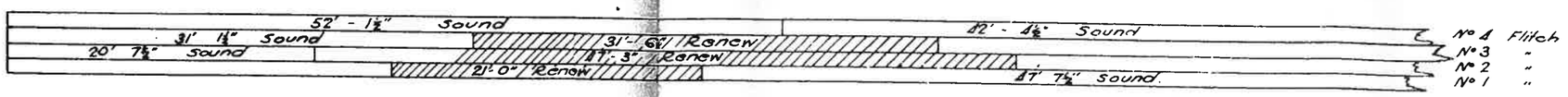
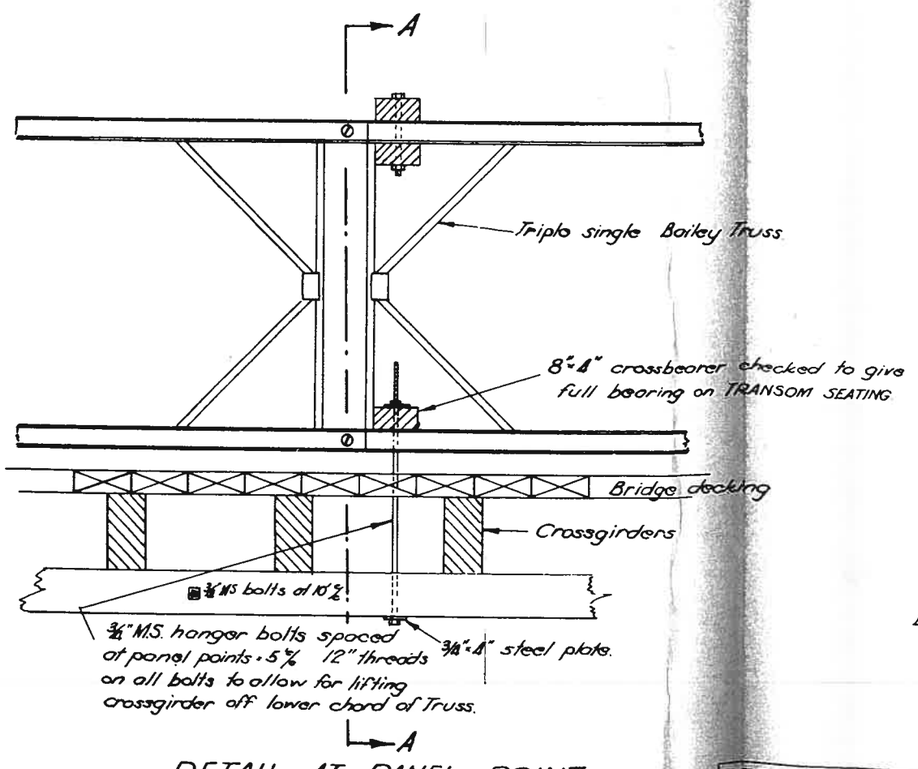
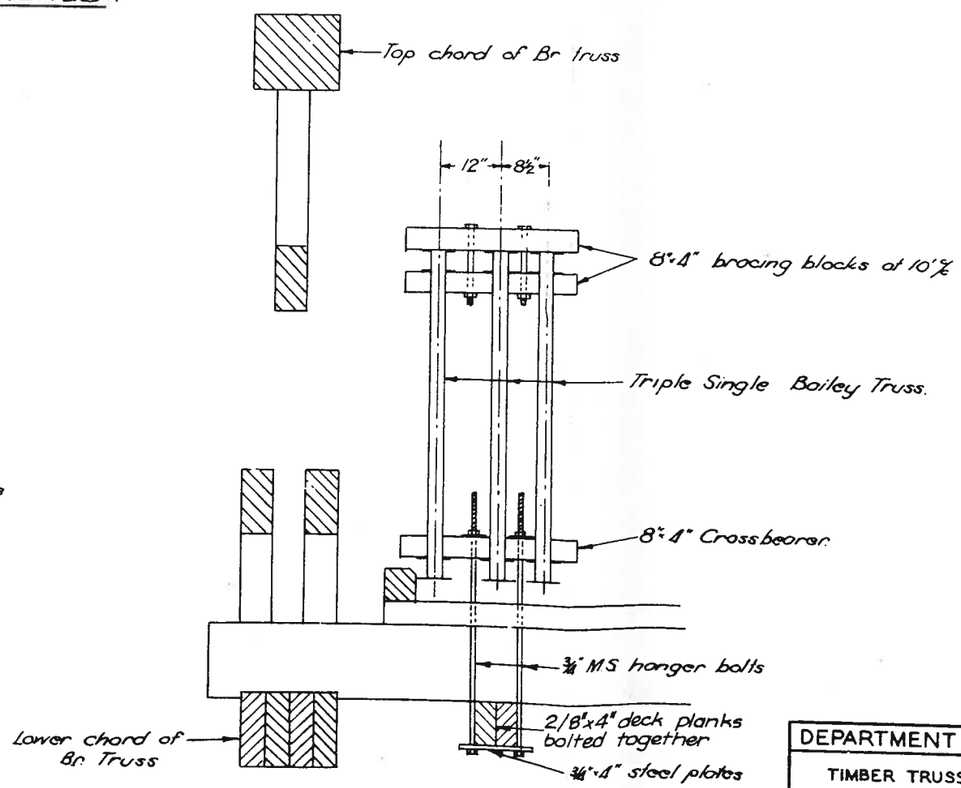


DIAGRAM SHOWING PORTIONS OF LOWER CHORD FLITCHES RENEWED.



DETAIL AT PANEL POINT

Scale:- ½" = 1'



SECTION AA.

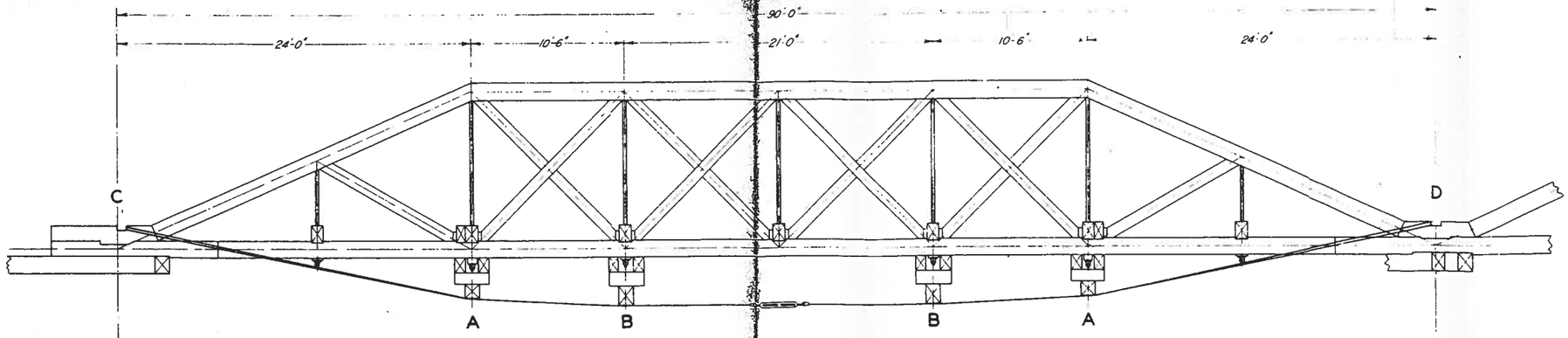
REDUCED SCALE PRINT

DEPARTMENT OF MAIN ROADS, N.S.

TIMBER TRUSS BRIDGE MAINTENANCE

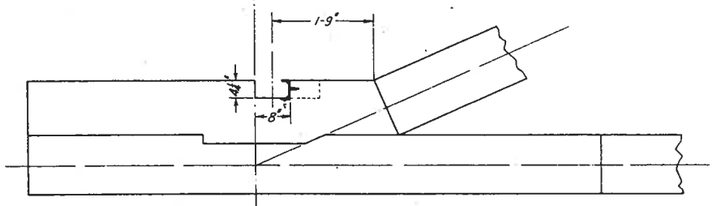
ADDITIONAL TEMPORARY TRUSS FOR SUPPORT DURING MEMBER REPLACEMENT

A 2973

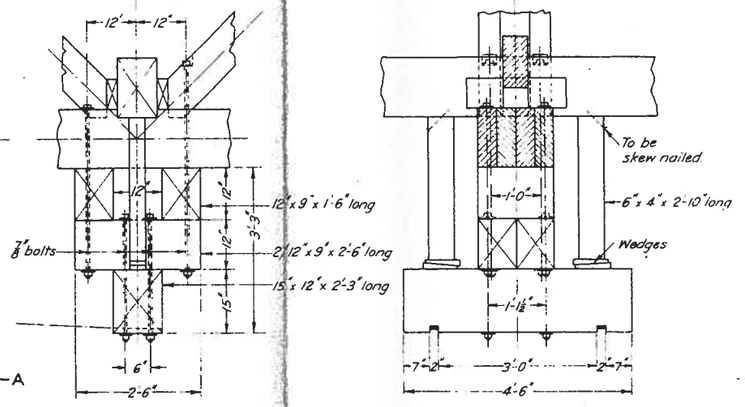


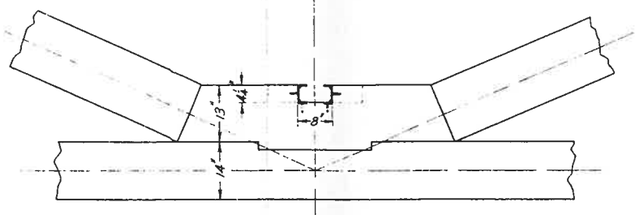
ELEVATION

Scale 1/4 in = 1ft

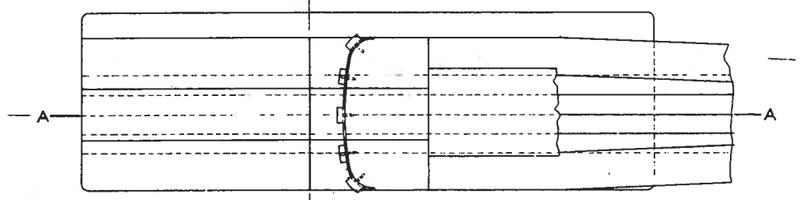


SECTION AA





SECTION BB



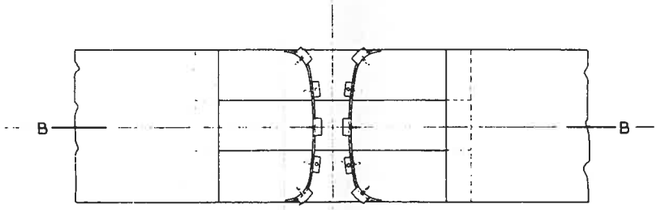
PLAN

POINT C

Scale: 3/4 in = 1ft

POINT B

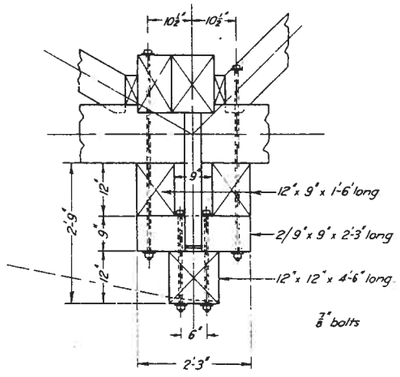
Scale: 3/4 in = 1ft

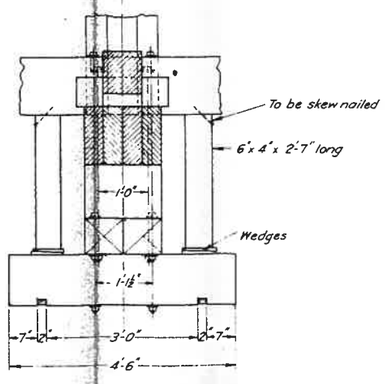


PLAN

POINT D

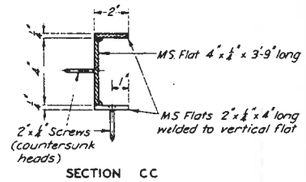
Scale: 3/4 in = 1ft



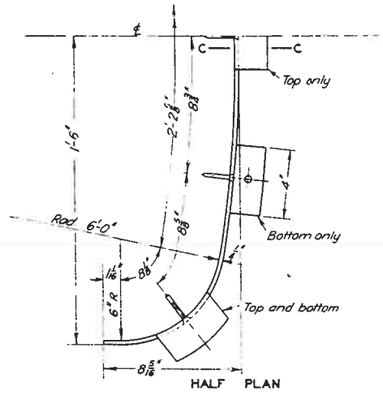


POINT A

Scale: 3/4 in = 1ft



SECTION CC

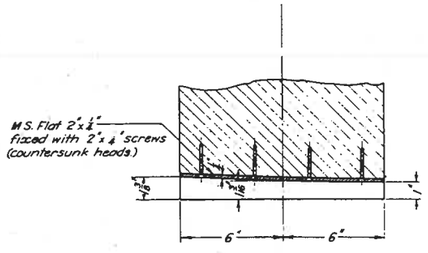


HALF PLAN

M.S. SADDLE 'C'

POINTS C & D

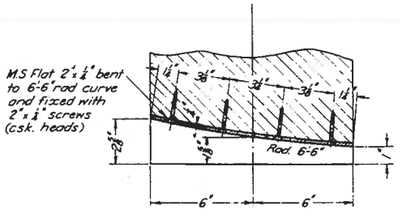
Scale 3 ins = 1ft



M.S. SADDLE 'B'

POINT B

Scale 3 ins = 1ft



M.S. SADDLE 'A'

POINT A

Scale 3 ins = 1ft

REDUCED SCALE PRINT

APPROVED

Bridge Engineer

Date 13-8-43

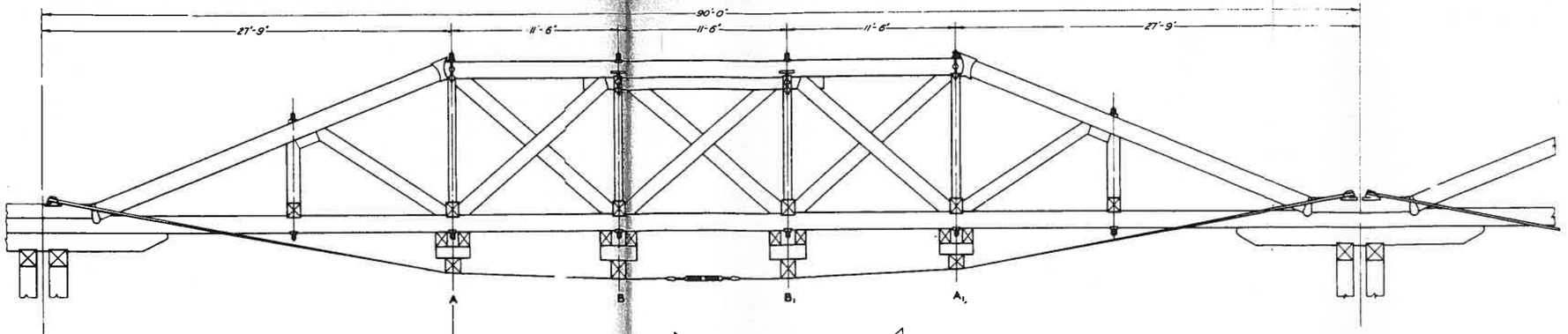
DEPARTMENT OF MAIN ROADS, N.S.W.

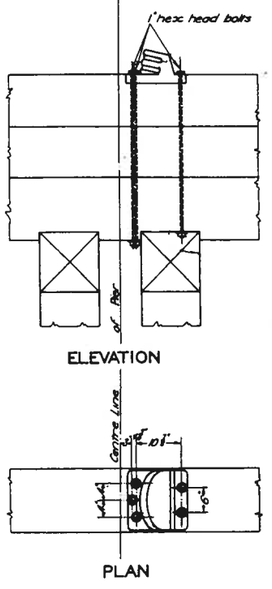
MAIN ROAD Nº 512 — MUNIC. OF LIVERPOOL

BRIDGE OVER GEORGE'S RIVER (HOLDSWORTHY BRIDGE)

UNDERTRUSSING

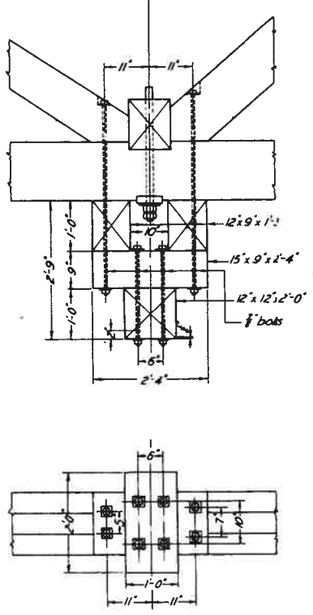
PREPARED	CHECKED	REGN Nº OF PLANS
DESIGN PARTLY ADAPTED FROM B 30 A		B26A
DRAWING		
SUPERVISION		
PASSED ASSISTANT BRIDGE ENGINEER		SHEET Nº 1 — Nº OF SHEETS 1



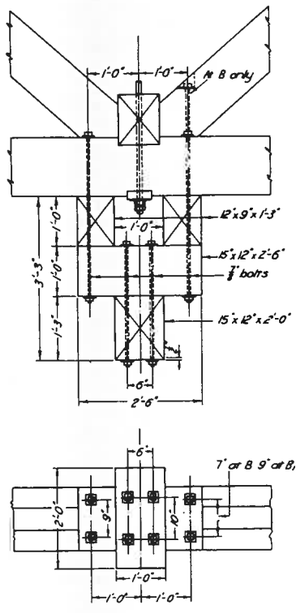


ELEVATION

PLAN

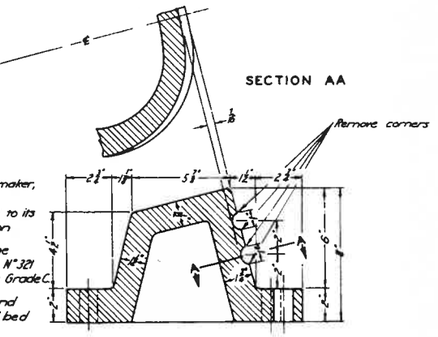


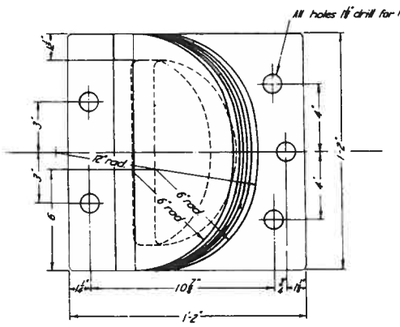
A & A1



B & B1

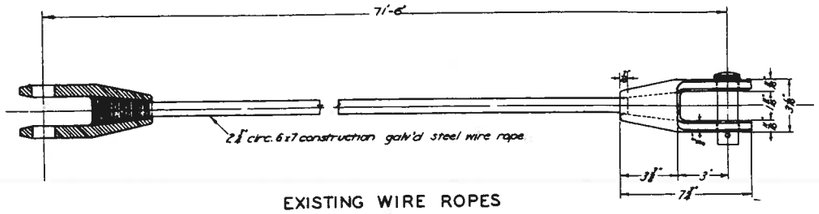
HARDWOOD BLOCKS
Scale ½ in. = 1ft.



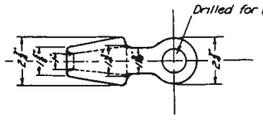


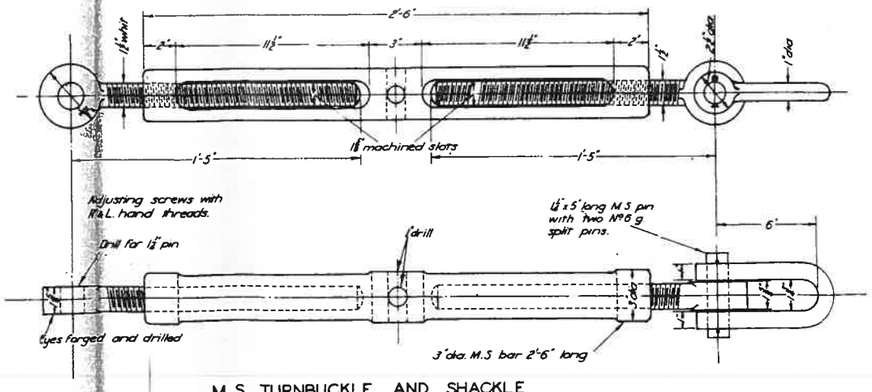
PLAN

CAST IRON SADDLE
8 Req'd
Scale 3 ins = 1ft



EXISTING WIRE ROPES
8 Available.





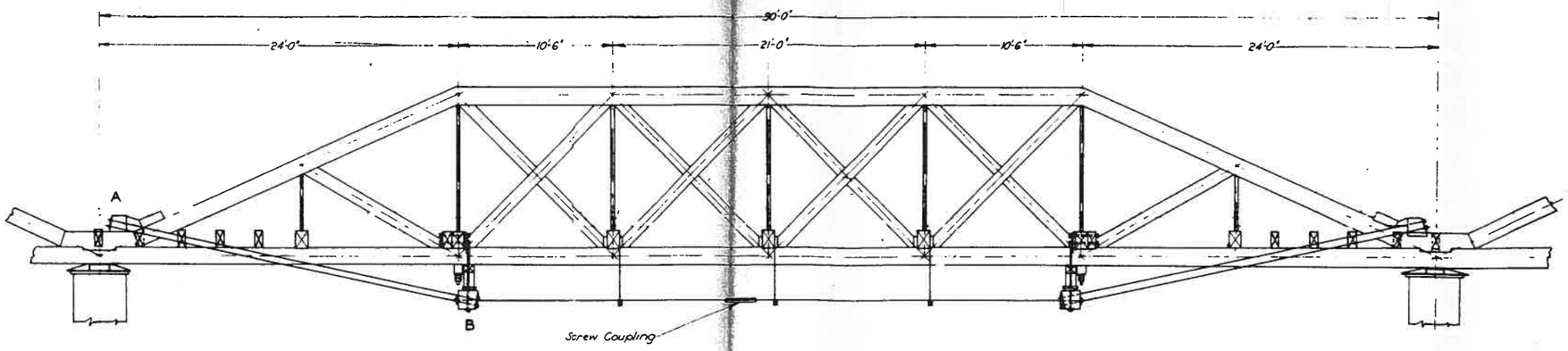
M.S. TURNBUCKLE AND SHACKLE
N° Required 24 Turnbuckles, 60 Shackles & pins
Scale - 3 ins. = 1ft.
Material to comply with Aust. Stand. Spec° N° A1 1931 for Structural Steel Class A

REDUCED SCALE PRINT

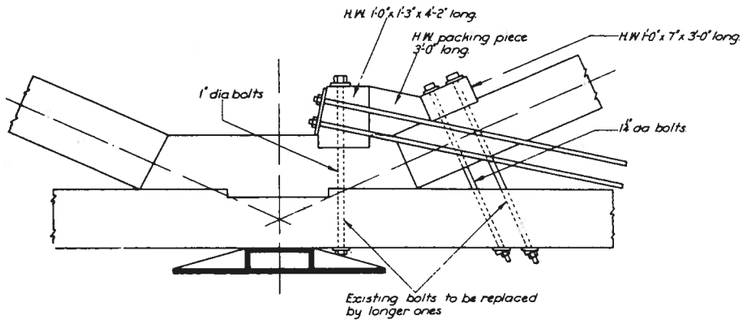
12 B113D

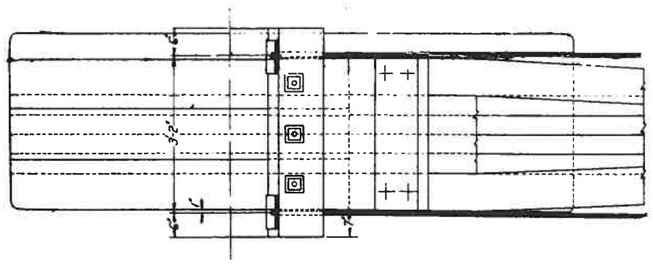
DEPARTMENT OF MAIN ROADS, N.S		
STATE HIGHWAY N°12		SHIRE OF SEVER
BRIDGE OVER MANN RIVER		
UNDERTRUSSING		
	PREPARED	CHECKED
DESIGN		
DRAWING		27/7/40
SUPERVISION Exd	Exd	29/7/40
PASSED B.E. Govt. 6/8/40		
ASSISTANT BRIDGE ENGINEER		
REG° N° OF PLANS	12 B11	
SHEET N° 1	N° OF SHEE	

APPROVED
Bridge Engineer
Date 6.8.40

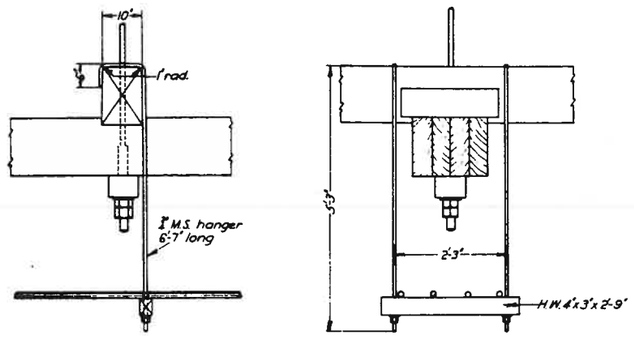


ELEVATION
Scale. ½ in. = 1 ft

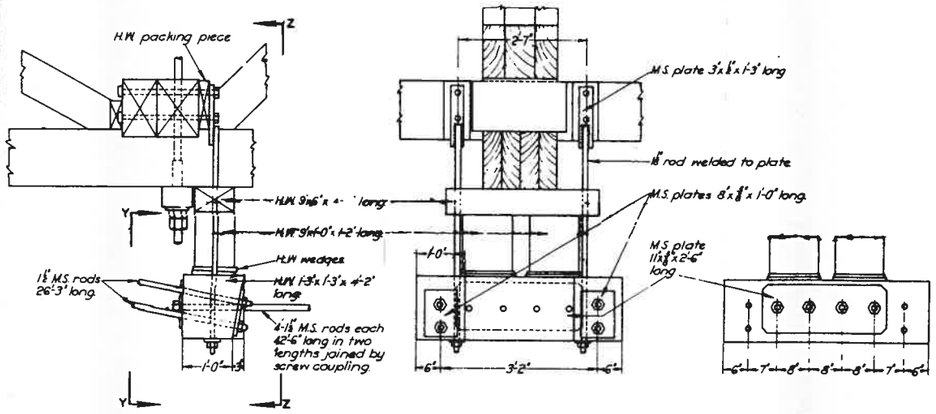




DETAIL AT POINT A
Scale ½ in = 1 ft



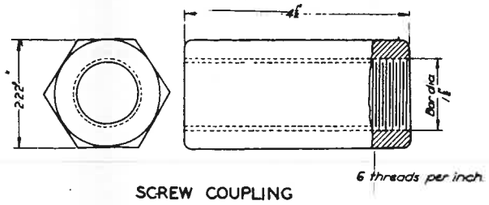
SUPPORT FOR M.S. RODS
Scale ½ in = 1 ft



SECTION ZZ

PART SECTION YY

DETAIL AT POINT B
Scale ½ in = 1 ft



SCREW COUPLING
8 Required

REDUCED SCALE PRINT

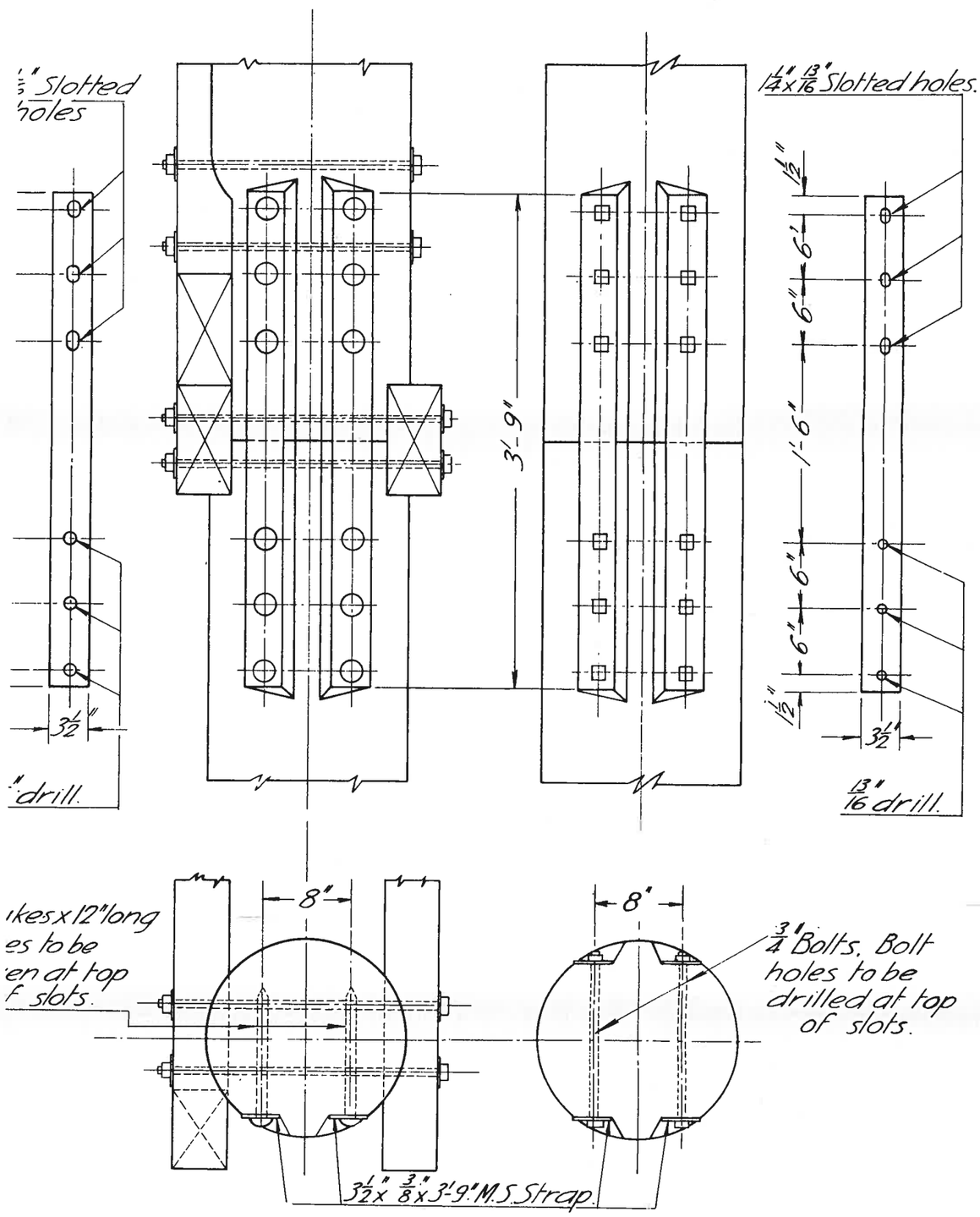
2-2-44

DEPARTMENT OF MAIN ROADS, N. S. W.	
MAIN ROAD No 278	SHIRE OF TUMBARUMBA
BRIDGE OVER MURRAY RIVER AT JINGELLIC	
UNDERTRUSSING	
DRAWN J. B. D. CHECKED A. L. 21/12/43 24-1-44	B47A

A.1227

STANDARD PILE SPLICE

Scale: 1in – 1 ft.



ABOVE GROUND BELOW GROUND

dge Engineer. Date 7-1-32

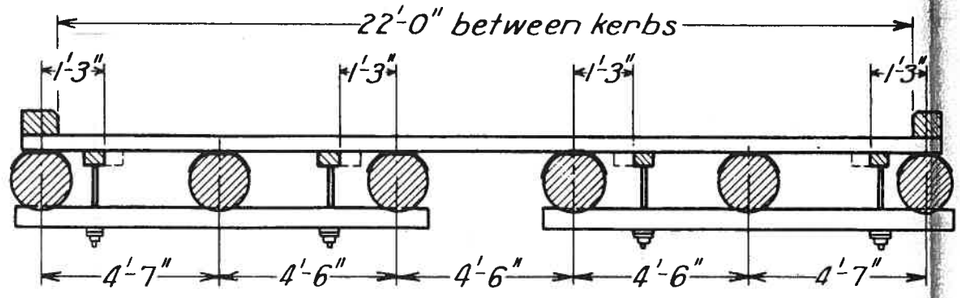
APPROVED on behalf of THE MAIN ROADS BOARD of N.S.W.

D. Craig.
Chief Engineer.

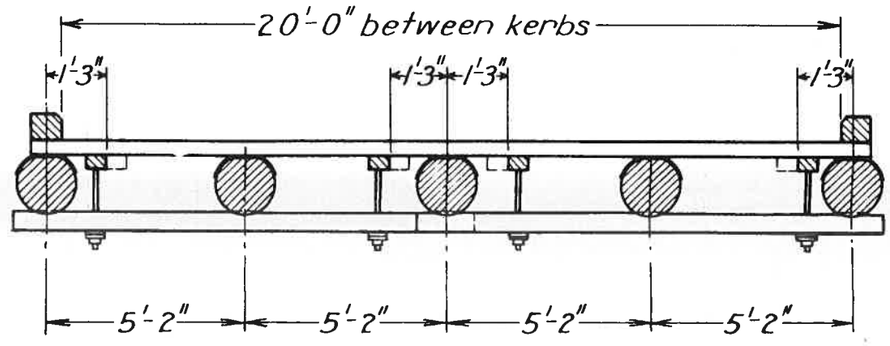
A.M.F.

A 1886

(Revised 1962)

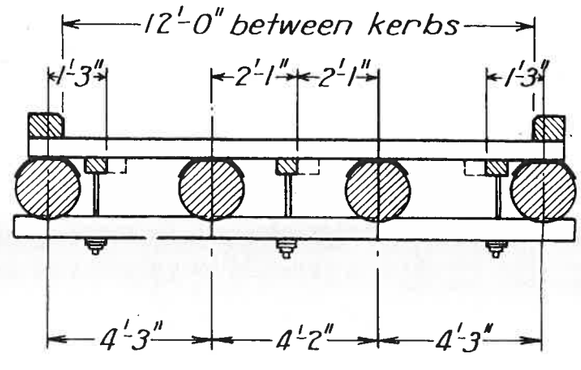


SIX GIRDER BRIDGE



Four rows of bolting planks continuous throughout bridge to be used.

FIVE GIRDER BRIDGE



FOUR GIRDER BRIDGE

N.B.-All bolting planks and cross pieces 6" x 4".

Scale : 1/4 in. = 1 ft.

Approved

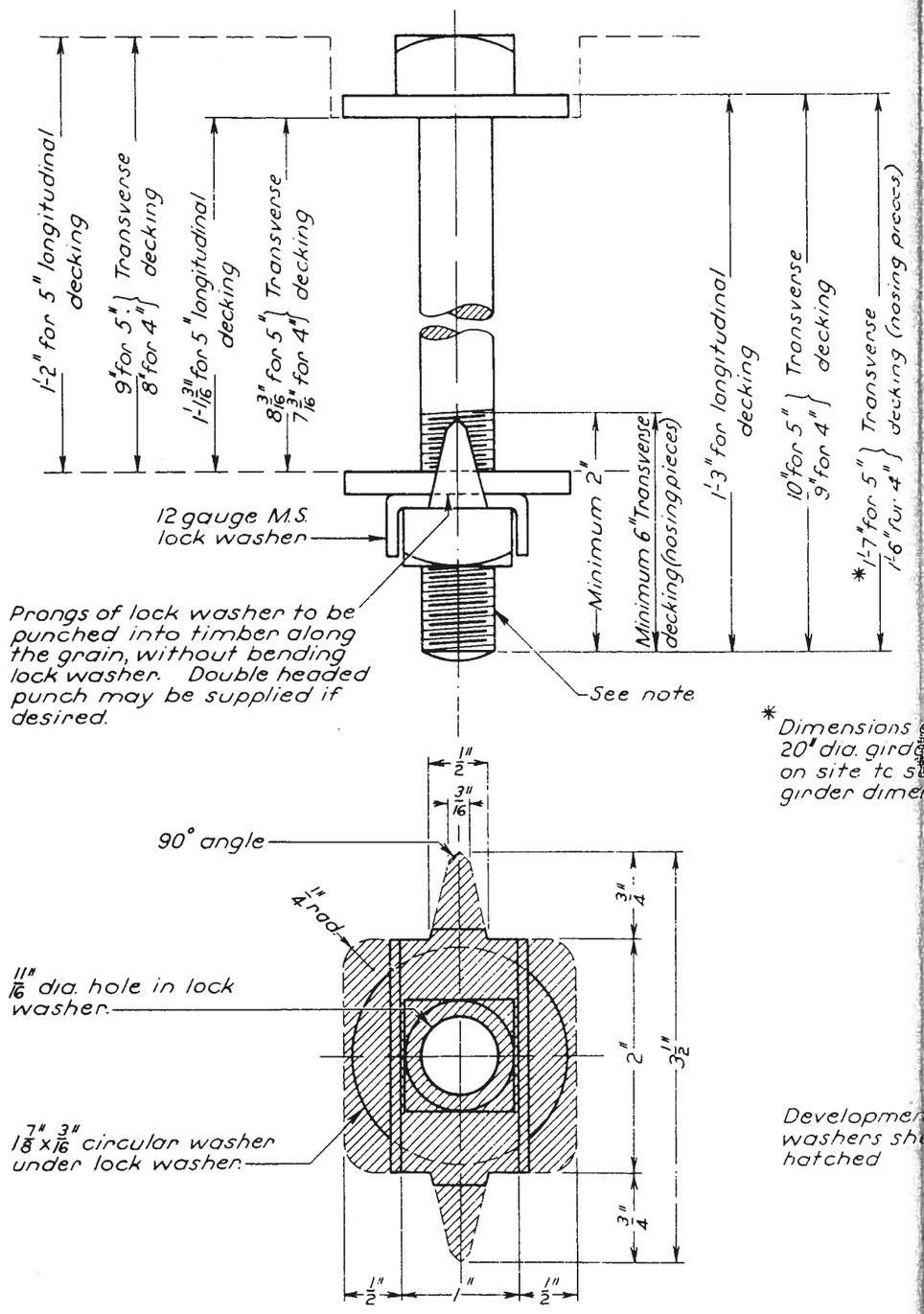
Bridge Engineer 24/4/48

DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER BEAM BRIDGES

Arrangement of Bolting Planks.

REGN Nº OF PLAN A 1886

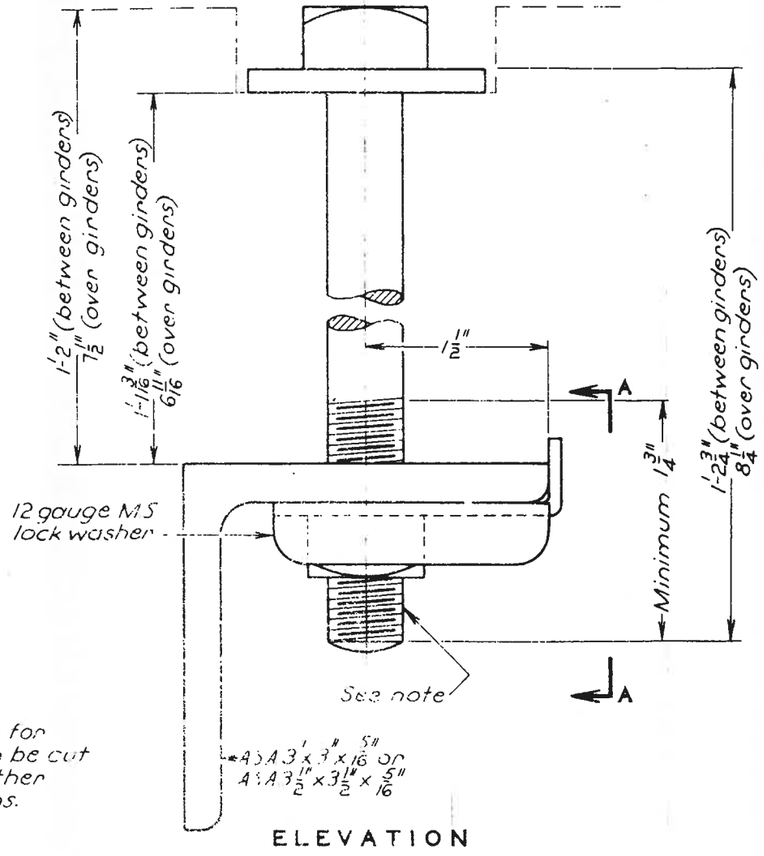


* Dimensions given for 20" dia. girder. To be cut on site to suit other girder dimensions.

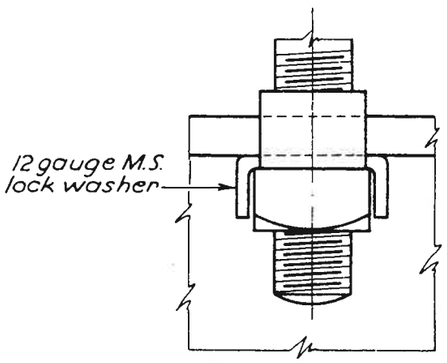
Development of lock washers shown cross hatched

MARK 1

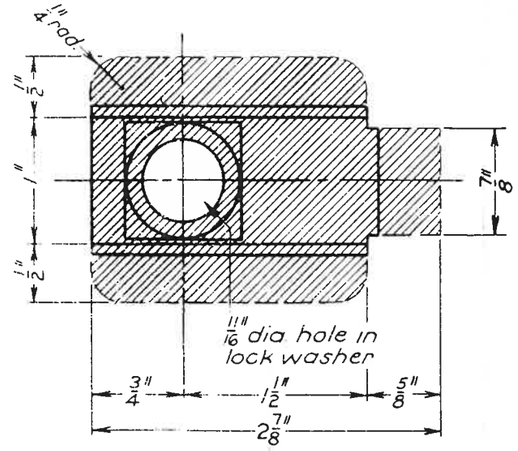
For transverse and longitudinal decking.



ELEVATION



VIEW AA



MARK 2

For use with steel angles (Longitudinal decking).

Note: Thread to be burred near nut (after fixing) by making vertical cut with cold chisel, but not so deep that bolt cannot be re-threaded.

Scale: Full size

REDUCED SCALE PRINT

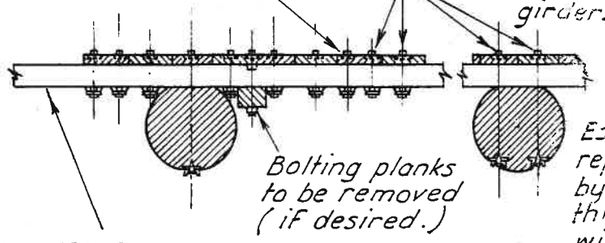
DEPARTMENT OF MAIN ROADS, N.S.W.

LOCK WASHERS
MARK 1 AND 2

For 5/8 in. dia bolt
For Timber Bridge Decks
(Longitudinal and Transverse Decking)

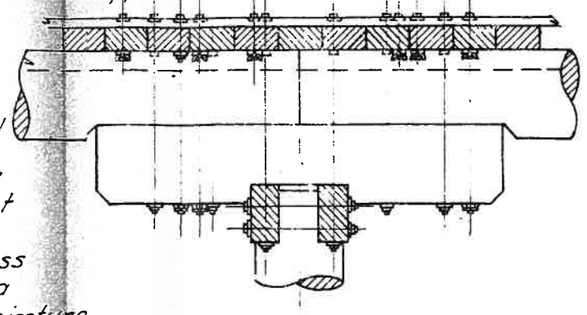
S. Schabuder 9.3.61
DESIGNING ENGINEER FOR BRIDGES

PJH

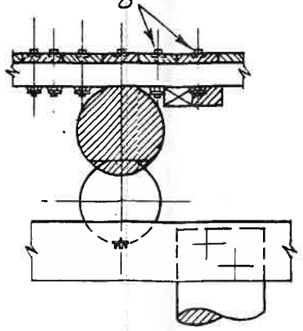


SECTION AA

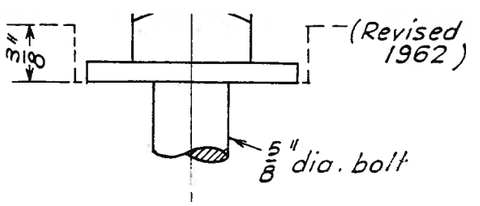
Existing planks to be replaced where necessary by planks of age and thickness comparable with those of adjacent planks. Significant difference in thickness to be corrected by a bitumen and sand mixture.



SECTION BB



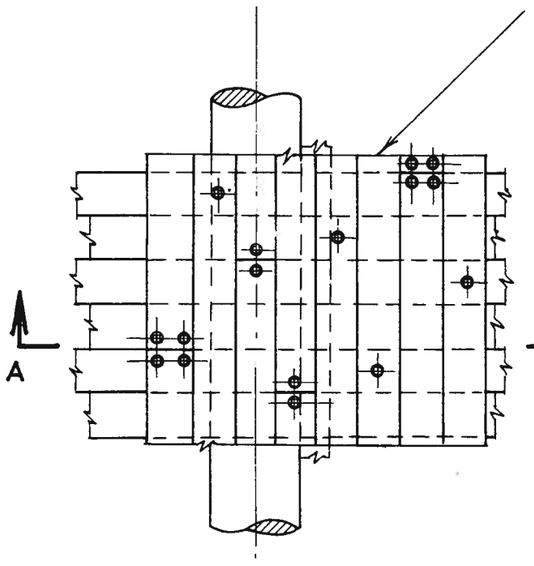
SECTION CC



COUNTERSINK DETAIL

(For detail of ⅝" dia. bolt with lock washer see A4633)

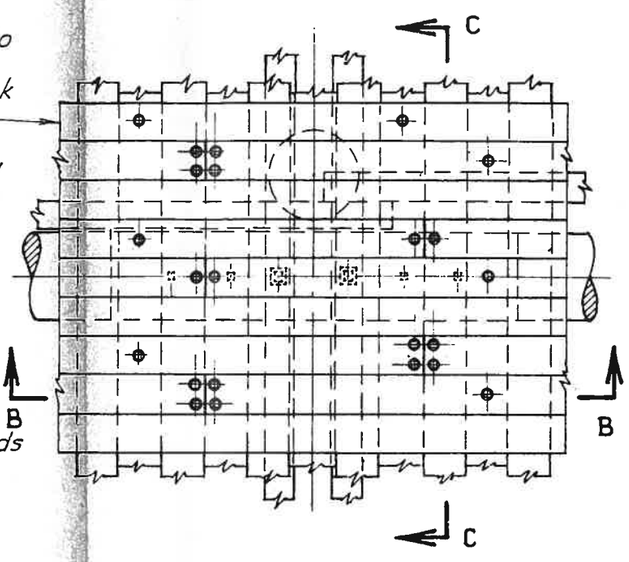
All bolts to be red lead painted before placing.



Sheeting bolted to deck every 5'-0" (max.)
Deck and sheeting bolted to girders every 5'-0" (max.)
Each transverse deck plank to be secured by at least 3 bolts. Min. length of planks 12'-0". Sheeting may extend underneath kerbs.
Joints to be kept clear of corbels if practicable.

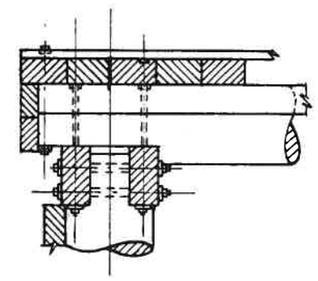
At joints over girders, ends secured by one bolt only. Other joints secured at ends by two bolts. Joints to be staggered and planks laid heart side down.

PLAN
BETWEEN PIERS

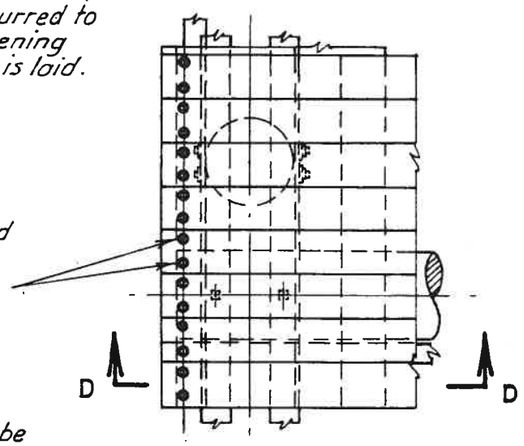


PLAN
AT PIERS

Cross pieces to be removed. Bolting planks to remain provided heads of bolts do not interfere with the laying of sheeting. All loose bolts which cannot be tightened, to be removed. All others to be thoroughly tightened & ends of thread well burred to prevent future slackening back before sheeting is laid.

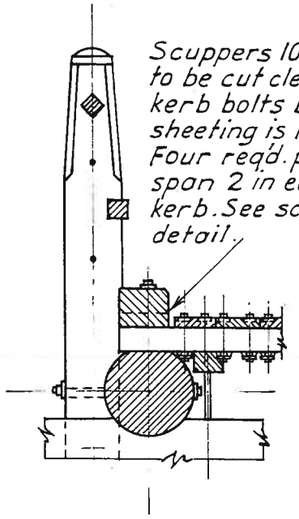


SECTION DD



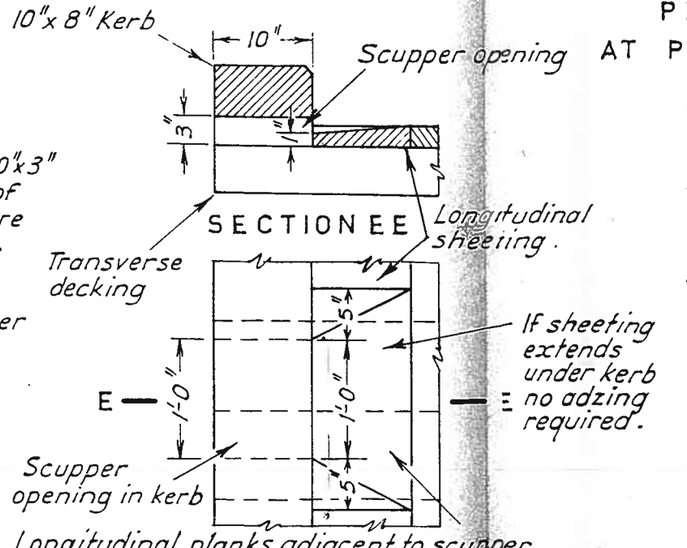
Sheeting to be secured at abutments by two ⅝" dia. bolts per plank

PLAN
AT ABUTMENT



Scuppers 10"x1'-0"x3" to be cut clear of kerb bolts before sheeting is laid. Four req'd. per span 2 in each kerb. See scupper detail.

DETAIL AT KERB



Longitudinal planks adjacent to scupper opening to be adzed as shown. Instead of scupper opening shown, a 3" gap may be cut at each kerb joint and adzing omitted.

SCUPPER DETAIL

NOTES

Widths of longitudinal planks will depend on the availability of timber, but shall in no case be less than 7" nor more than 10". Where planks of different widths are used together on any one bridge the lines of planks of any particular width shall extend for the full length being sheeted to prevent the formation of gaps between adjacent planks. Where planks are all of one width they shall be not less than 8" wide, & preferably 9" or 10"

When longitudinal sheeting has been completed a bituminous wearing surface shall be applied to prevent the development of slippery surface conditions. In locations where facilities exist for the application of a premixed course, the countersinking of the bolts may be omitted, the surface course being made thick enough to cover the bolt heads.

Scale: ⅜ in. = 1 ft. unless stated otherwise.
Scale: ¾ in = 1 ft

APPROVED
L. Laws
Dep. Chief Engineer

DEPARTMENT OF MAIN ROADS N.S.W.

LONGITUDINAL SHEETING FOR TIMBER BRIDGE DECKS

M.R. Form No. 121
(Revised January, 1975)

Department of Main Roads, N.S.W.

SPECIFICATION

FOR

CONTROL OF TRAFFIC

AT

ROAD AND BRIDGE WORKS

SPECIFICATION

FOR

CONTROL OF TRAFFIC AT ROAD AND BRIDGE WORKS

1. GENERAL:

Works being undertaken on roads and bridges require the provision of warning and control devices to inform drivers of hazards, to guide traffic safely past temporary obstructions, and to protect workmen.

Traffic control and guidance are achieved by signs, lights, barriers, flaps and cones, and other devices, which are placed in the vicinity of works generally in accordance with the diagrams in Appendix 1 of this Specification. The arrangement for barriers, trestles and lamps and details of cones, flaps and delineators are shown in Appendix 2 and details of the signs and other devices are contained in Appendix 3.

The diagrams in Appendix 1 to this Specification illustrate the more common examples of both works and emergency situations, and set out what shall be deemed the minimum requirements. The Contractor shall erect such additional signs, lights, barriers, flaps and cones of a nature generally conforming to those illustrated in the sketches as may be necessary, or as may be directed, to provide for the safety and convenience of traffic at the particular location. In this connection, the Contractor's attention is specially directed to his responsiblities for the protection and regulation of traffic under Clause 36(1) of the General Conditions of Contract.

2. MULTI-LANE ROADS:

On multi-lane roads in off-peak periods, not more than one traffic lane in each direction shall be closed, except as may be directed by the Engineer in writing. In peak periods it may be essential that all lanes serving the major direction of flow shall remain open. It will then be the responsibility of the Contractor to obtain from the Engineer written advice of the traffic arrangements to be adopted during the periods of major traffic flow.

A lane may only be closed with the approval of the Engineer. Under normal circumstances he would not permit the closing of a lane where the rate of flow exceeds 1,000 vehicles per hour per lane unless an additional lane is provided for this traffic or unless traffic can be diverted to other streets.

Where a suitable detour is unavailable, and the work is such that the closing of several lanes is essential, but would cause undue interference with traffic if the work were done during normal working hours, the Engineer may direct that the portions of the work concerned be done at weekends, or at night. The Contractor will not be entitled to any extra payment on this account.

3. ARRANGEMENT AND PLACEMENT OF TRAFFIC CONTROL DEVICES:

The arrangement and placement of the traffic control devices, referred to in Clause 1, are illustrated in Situation Diagrams A to Q inclusive in Appendix 1 of this Specification.

4. THE USE OF CONES AND FLAPS:

Details of cones and flaps are given in Appendix 2. They are used at approximately 12 m spacing for traffic control. The following shall apply:

(a) Where portion of the roadway is closed to traffic by the use of barriers and signs, but traffic retains the use of the remainder of the roadway, as illustrated in Diagrams B, G, H, J and M, flaps or cones shall be placed in a straight line, diagonally across the approach to the closed portion of the road, so as to guide traffic smoothly past the end of the barrier and signs closing the lane or lanes.

(b) Where traffic is allowed to pass on both sides of the closed portion of the roadway, as illustrated in Diagram J, an additional line of flaps or cones shall be placed from the point of commencement of the diagonal line of flaps or cones to the opposite end of the barrier closing the lane.

(c) Where part only of the road is to be closed to traffic for bituminous surfacing works, and traffic is to be allowed to use the remainder of the road, a line of cones, shall be used to separate the working area from adjacent traffic lanes. (See Diagrams B, G, H, J and M).

(d) At no time shall flaps or cones be used as a substitute for barriers and signs at either end of the work.

(e) Unless cones are spiked or otherwise firmly fixed in position, they shall be used only in daylight while the work is in progress, or in locations where there is a watchman in attendance who can reposition any of the cones which have been dislodged by traffic. Otherwise they shall be removed and flaps or barriers substituted as directed by the Engineer when work ceases at night. When directed by the Engineer, flaps shall be left in position at night.

5. DELINEATORS:

Delineators are illustrated in Appendix 2. Their use is generally confined to directing traffic into and along rural sidetracks as illustrated in Diagrams C and D. They are generally erected on star pickets at a maximum spacing of 30 m but closer on curves and as far as possible from the pavement edge (minimum 0.6 m, maximum 3 m).

The delineators may be replaced by lamps at salient points for emphasis or special traffic guidance.

6. BARRIERS:

Barrier Boards are used for the closing of lanes or roads, the protection of workmen and guidance of vehicular traffic. The main requirements are:-

(a) Barrier boards shall be constructed of timber or of other material, which shall be subject to the approval of the Department/Council. The barrier boards shall be of the design, dimensions and colour illustrated in Appendix 2.

(b) Trestles supporting barrier boards shall be neatly and stoutly constructed of sawn timber, or other material which shall be subject to the approval of the Department/Council and shall be painted yellow. Trestles shall serve as firm supports for the barrier boards, but the bases shall not protrude beyond the ends of the boards (See Appendix 2).

(c) Provision shall be made for the attachment of warning lamps to the trestles or barrier boards, by means of a bracket, where the barrier is to be left in position overnight. A suitable bracket is illustrated in Appendix 2.

(d) Where part-width of the road is to be closed to traffic and the closed strip is not required for actual working, additional barrier boards shall be erected across the closed portion of the road at approximately 30 m intervals. This arrangement is shown in Appendix 2.

(e) Where work other than bituminous surfacing is actually in progress on part only of the road, a line of barriers shall be erected between it and that portion of the carriageway which is to be available for traffic. This arrangement is shown in Appendix 2. Where bituminous surfacing is in progress, see Clause 4(c).

(f) Where an inner lane of a multi-lane carriageway is closed, and traffic is diverted on both sides of the closed lane, the barrier and sign arrangement shall be as in Diagram J.

7. TRAFFIC HAZARD WARNING LAMPS:

Traffic hazard warning lamps conforming to Australian Standard 1165 shall be kept in operation at all times during the hours of darkness, in conjunction with the traffic control devices which are to remain in position at night. The placement of lamps in relation to signs and barriers shall be as illustrated in the diagrams of Appendices 1 and 2. The notations indicating the types of amber lamp to be used are as follows:-

S/A - Steady Amber

F/A - Flashing Amber

Lamps may be single or double lens types. Double lens lamps shine to front and rear and are required where traffic may approach (and require warning) from both directions. Single lens lamps shine in one direction only.

8. FLAGMEN:

The designation 'Flagman' is used to describe an employee who controls traffic with a 'STOP/GO' bat (Sign T7-1 combined with Sign R6-7 or R6-8). Flagmen are to be employed to direct and warn traffic in the following instances:-

(a) Where sections of single lane width of pavement are being used by two-way traffic, as in Diagrams B, M and P.

(b) Where the whole road is closed to traffic during short periods, e.g., for bitumen spraying, or for blasting, as in Diagram E.

The sign T1-13 'FLAGMAN AHEAD', must be used when a flagman is on duty and must be removed when the flagman ceases his duties. This sign should precede the signs T1-6 DETOUR AHEAD, T1-7 SIDE TRACK AHEAD and T2-6C and T2-9 LANE CLOSED DRIVE SLOWLY.

A flagman must remain at the head of each traffic queue while it is halted. If there is the possibility of approaching vehicles colliding with the tail of the queue because of restricted sight distance, or of drivers queue jumping because they cannot see the flagman at the head of the queue, then an additional flagman shall be placed at the tail end of the queue. In any case, where in the opinion of the Engineer this additional flagman is deemed necessary, he shall be provided.

Where both ends of the work are not intervisible, the flagmen at each end should, if practicable, be provided with 2-way radio. Where radios are not available, an intermediate flagman, from whom both other flagmen shall take their cue, shall be stationed where he can see both extremities of the work (See Diagram B).

Single-lane working for two-way traffic will not be permitted at night, and will be permitted in daylight working hours only if traffic is controlled by flagmen.

At night, and in poor light; e.g., at dusk, each flagman shall carry a flashing amber lamp in addition to a reflectorized 'Stop/Go' bat.

Safety vests, of fluorescent orange material, suitably reflectorized for night working, shall be worn by flagmen.

The Department's flagmen shall also wear identifying armbands when on duty.

9. SIDETRACKS AND DETOURS:

The Contractor shall provide, at all times, a satisfactory running surface for traffic throughout the length of the work by using the existing road, by detour, or by sidetrack, in accordance with the Drawings or as otherwise directed by the Engineer.

Where traffic is diverted from the road using an adjacent road or street system, this shall be regarded as a 'Detour'. Where a temporary road is specially built for the purpose, generally in close proximity to the existing road, it shall be regarded as a 'Sidetrack'.

Unless the Engineer issues directions to the contrary, the detour or the sidetrack shall:-

(a) be of a general standard of alignment and grading in keeping with that of the existing road,

(b) have a lateral clearance of at least 1.2 m from any obstruction. In difficult situations, however, the Engineer may authorize a reduced clearance with an absolute minimum of 600 mm,

(c) be not less than 6.2 m wide if intended for two lanes of traffic and not less than 3.1 m wide if intended for single lane traffic,

(d) have a maximum gradient of 8%,

(e) have a pavement in keeping with the existing road; i.e., shall be sealed or gravelled if the existing road is sealed or gravelled, and shall be maintained to this standard for the duration of the work. Where the estimated duration of the work is less than a month, however, and the volume of traffic is low, the Engineer may authorize the use of a gravel surface in lieu of bitumen in rural areas. All gravel sidetracks shall be soundly constructed, and dust shall be kept down by regular watering to the satisfaction of the Engineer.

10. REGULATORY SIGNS:

A number of regulatory signs, viz., R2-3(L or R), R2-4, R2-6(L or R), R5-201, G9-13(L or R), G9-15, G9-16 and G9-201, for use as traffic control devices, may be required. The signs are generally self-explanatory, and typical uses are illustrated in Diagrams G, H, J, K and L.

Signs R2-3(R), R2-4, R2-6(L or R), R5-201 and G9-13(L or R) require Police approval for their erection.

11. DETAILS OF SIGNS:

Signs may be constructed of metal, timber or plastics. They shall be neatly and soundly constructed and resistant to rapid deterioration by weather and handling. Signs shall have sufficient rigidity so that when supported on the posts or trestles provided they shall not bend, sag or distort under wind or other loading. They shall remain clearly visible and legible at all times to the approaching driver. The dimensions, wording and colour of the signs, and the sizes of the letters thereon, shall be as detailed in Appendix 3. Details of each letter shall be as set out in A.S. No. E37, Road Signs Code.

Signs which are to be used for the warning and guidance of traffic at night shall be reflectorized as indicated. The reflective material used for all signs shall provide a high standard of reflectance and durability and shall be subject to the approval of the Department/Council.

Signs intended for daylight working only, e.g. T2-7 'WORKMEN', T1-4 'GRADER AHEAD' etc., shall carry a black legend on a yellow orange fluorescent vinyl background.

12. USE OF BLASTING SIGNS:

When blasting operations are being carried out, all traffic in each direction shall be stopped at a safe distance, but not less than 200 m from the site of blasting, as indicated in Diagram E. The signs and barriers to be displayed shall also be as indicated, and the Contractor shall ensure that these signs are displayed and that traffic is stopped. When it is safe for traffic to proceed, the T4-1 sign 'BLASTING - STOP - AWAIT SIGNAL' and the barriers shall be removed.

Where electric detonators are being used, the signs T4-2 and T4-3 shall be erected as illustrated in Diagram E. The signs shall be kept in position until all the electric detonators have been used in the blasting operations or have been removed from the site.

13. PLANT AND EQUIPMENT:

During the day, if working in a position adjacent to traffic, plant items having a projection beyond the normal width of the item (e.g., a grader blade) shall have a fluorescent red vinyl flag attached to the outer end of the projection.

At night, where traffic is permitted to use the whole or portion of the existing road, all plant items and similar obstructions shall be removed from the normal path of vehicles, to provide a lateral clearance of at least 6 m if practicable, with a minimum of 1.2 m.

Plant and equipment, if within 6 m of the edge of the pavement, detour or sidetrack, shall be lit at night by not less than two amber lamps suspended vertically from the point of the obstruction nearest to a traffic lane, and one amber lamp at each end of the obstruction on the side furthest away from the traffic lane.

14. MAINTENANCE OF TRAFFIC CONTROL DEVICES:

All traffic control devices shall be maintained in good order and in the correct positions day and night. They shall be neat and clean, and signs shall be clear and legible at all times. Sidetracks shall be maintained in good order at all times.

The Contractor may need to be contacted outside normal working hours to arrange for adjustments or maintenance. He shall therefore notify the Engineer and the local Police, in writing, of the names and addresses of, and means of communicating with, himself or his representatives.

15. DEFECTIVE TRAFFIC CONTROL DEVICES:

Where in the opinion of the Engineer the Contractor fails to provide and maintain adequate traffic control devices specified herein, the Engineer or Superintending Officer may have such items replaced or amended at the Contractor's expense and the cost of such replacement or amendment may be deducted from any moneys which may be or become due to the Contractor under this Contract.

APPENDIX NO. 1

SITUATION DIAGRAMS

Illustrating common examples of both works and emergency situations and setting out minimum requirements for the control of traffic.

TREATMENT AS FOR OTHER APPROACH

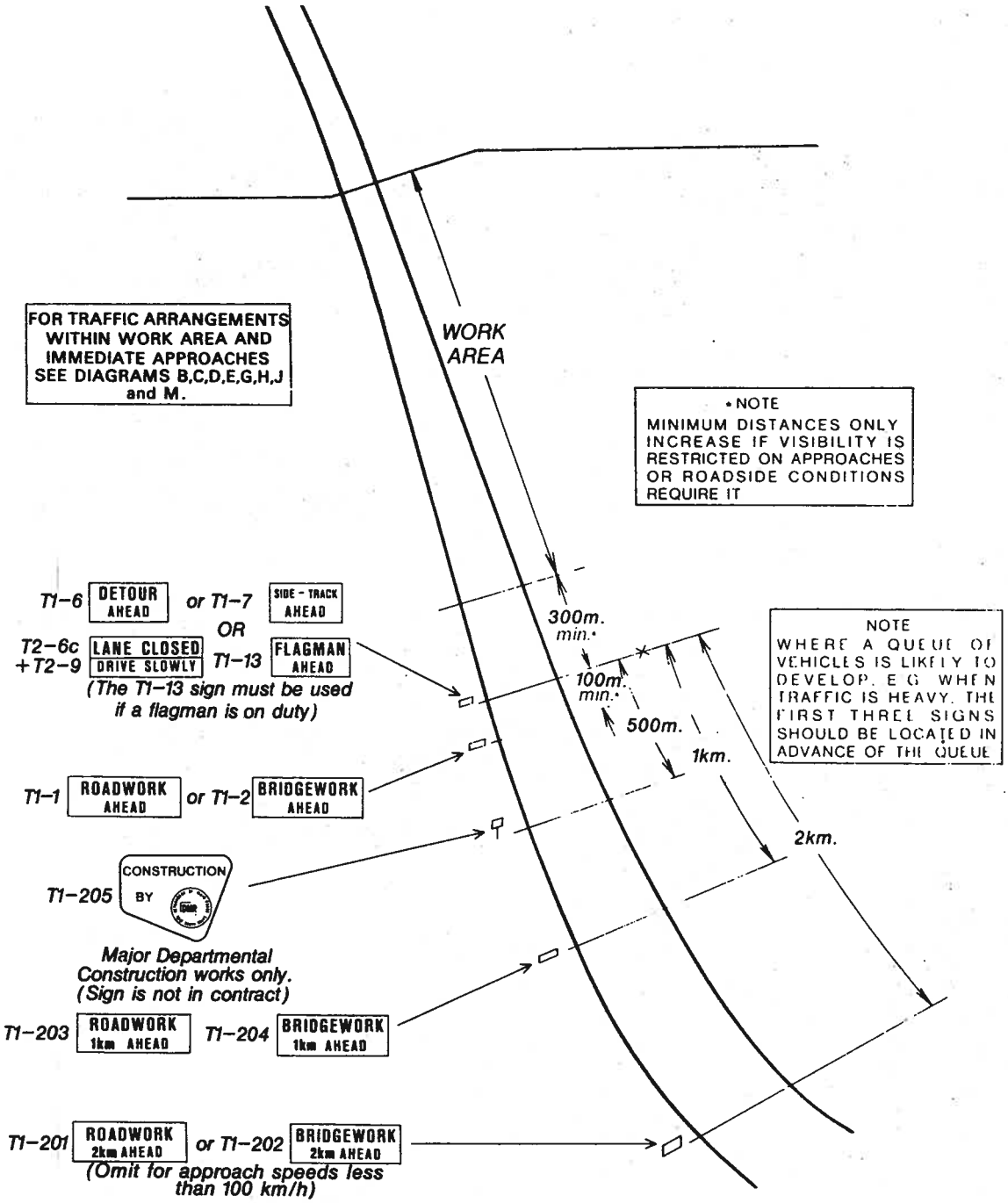


DIAGRAM A

WARNING SIGNS IN ADVANCE OF ROAD OR BRIDGE WORKS IN RURAL SITUATIONS.

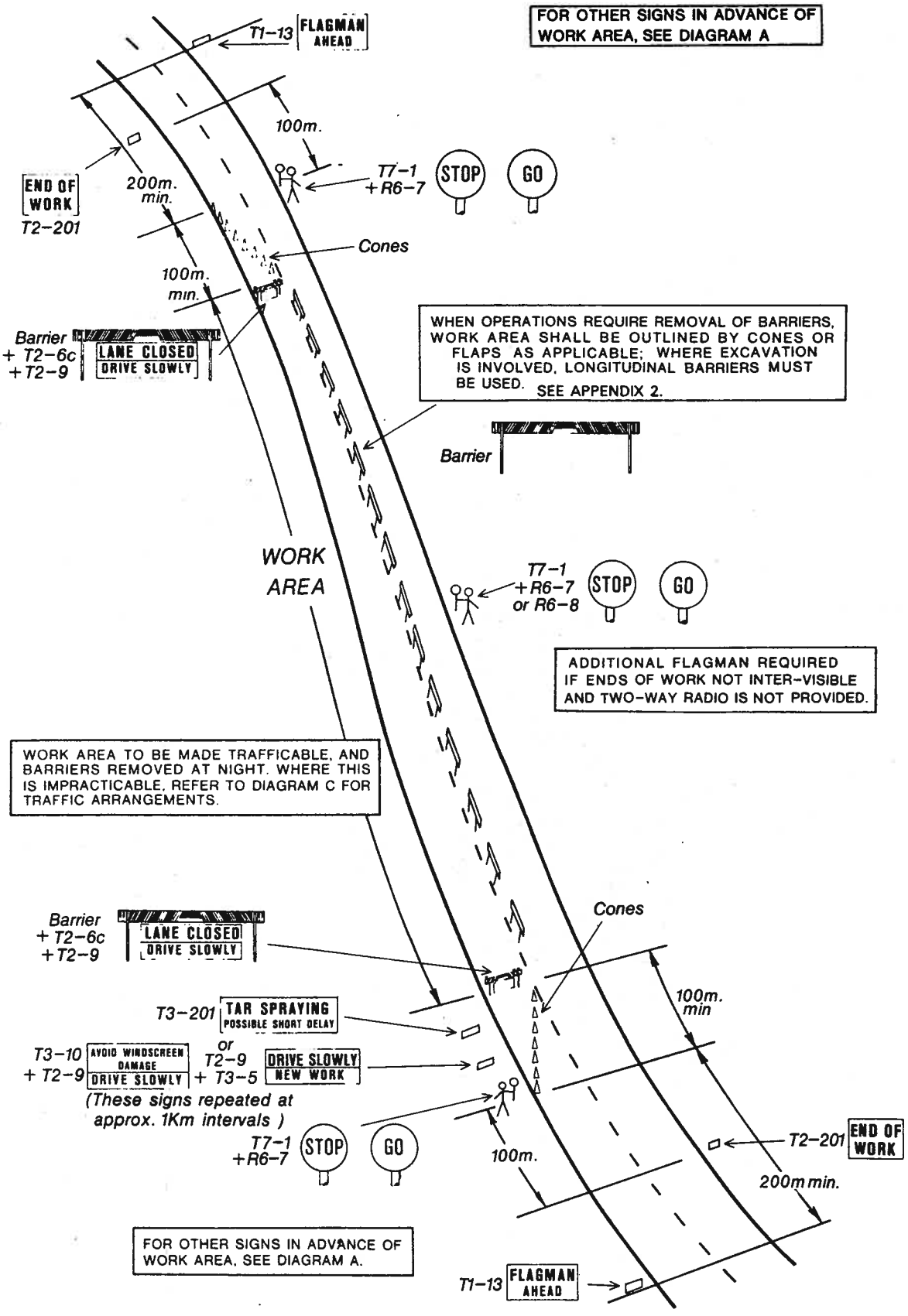


DIAGRAM B

TWO-LANE ROAD. ONE LANE CLOSED. SINGLE LANE USED FOR TRAFFIC IN BOTH DIRECTIONS UNDER FLAGMAN CONTROL. (NOT PERMITTED AT NIGHT)

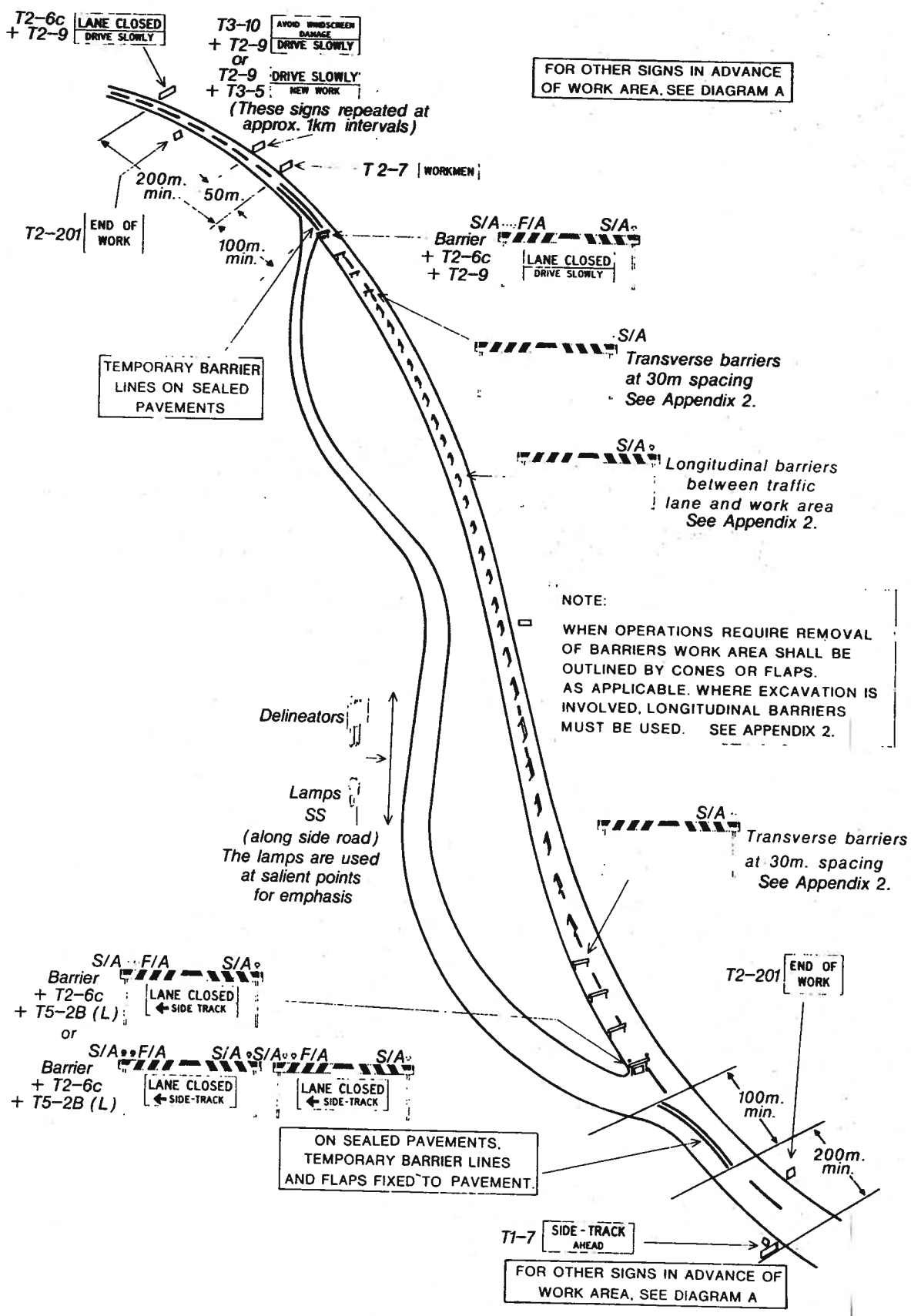


DIAGRAM C

RURAL ROAD, TWO-LANE OR MULTILANE

Closed to traffic in one direction; Sidetrack provided

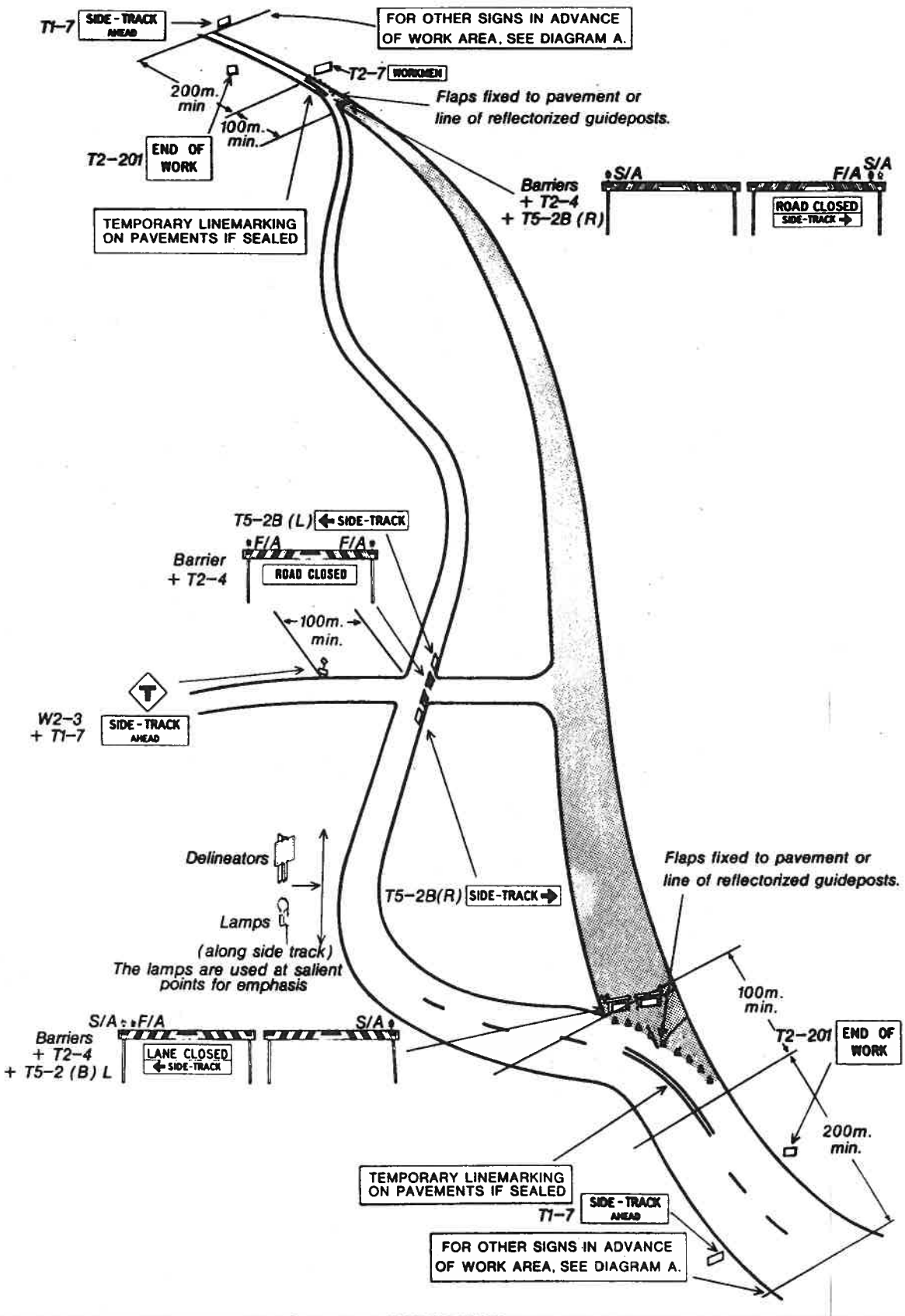


DIAGRAM D

RURAL ROADS, TWO-LANE OR MULTILANE

Closed to all traffic; Sidetrack provided

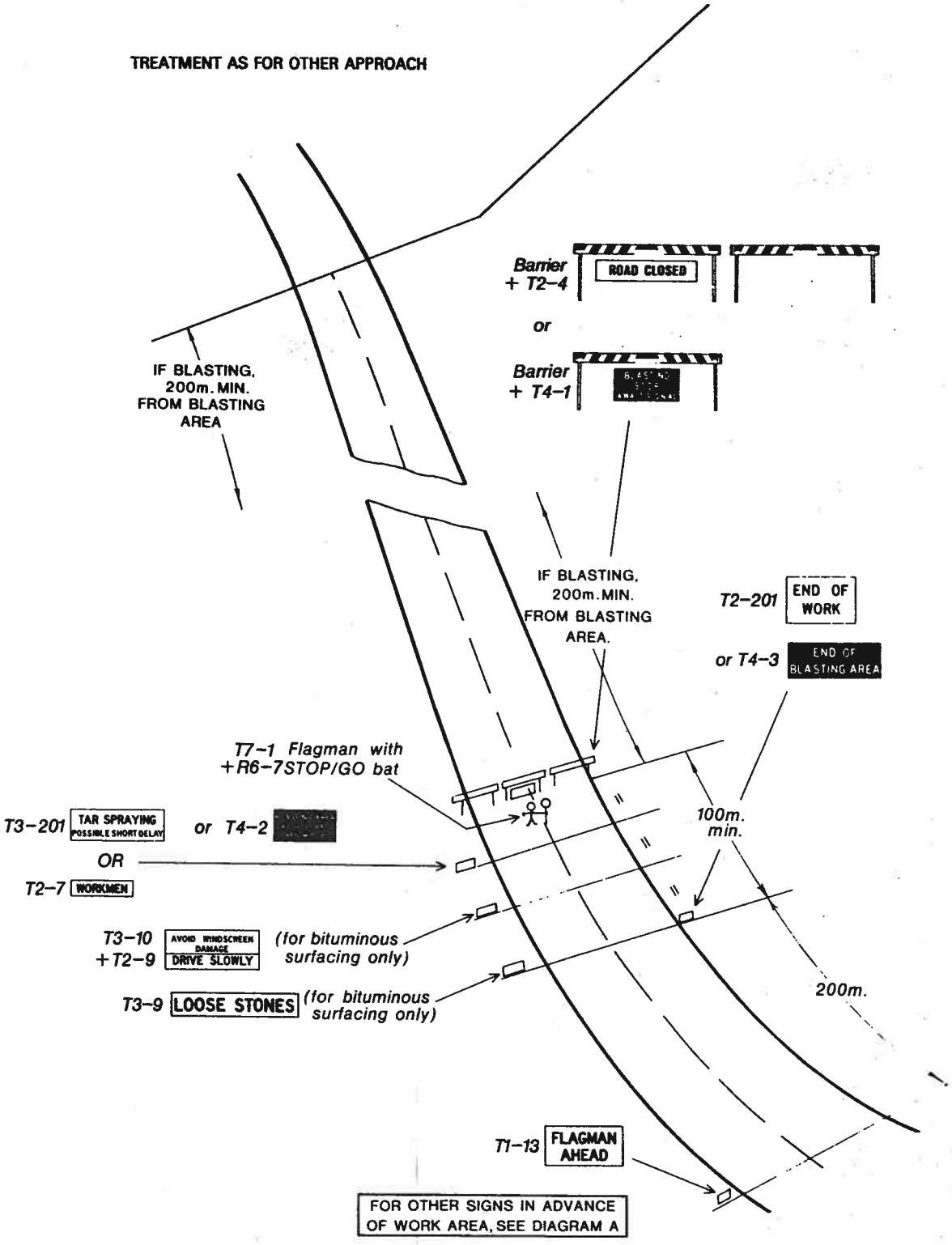


DIAGRAM E

RURAL ROADS, TWO-LANE OR MULTI-LANE

Road closed; All traffic temporarily halted, eg. for blasting or bituminous surfacing

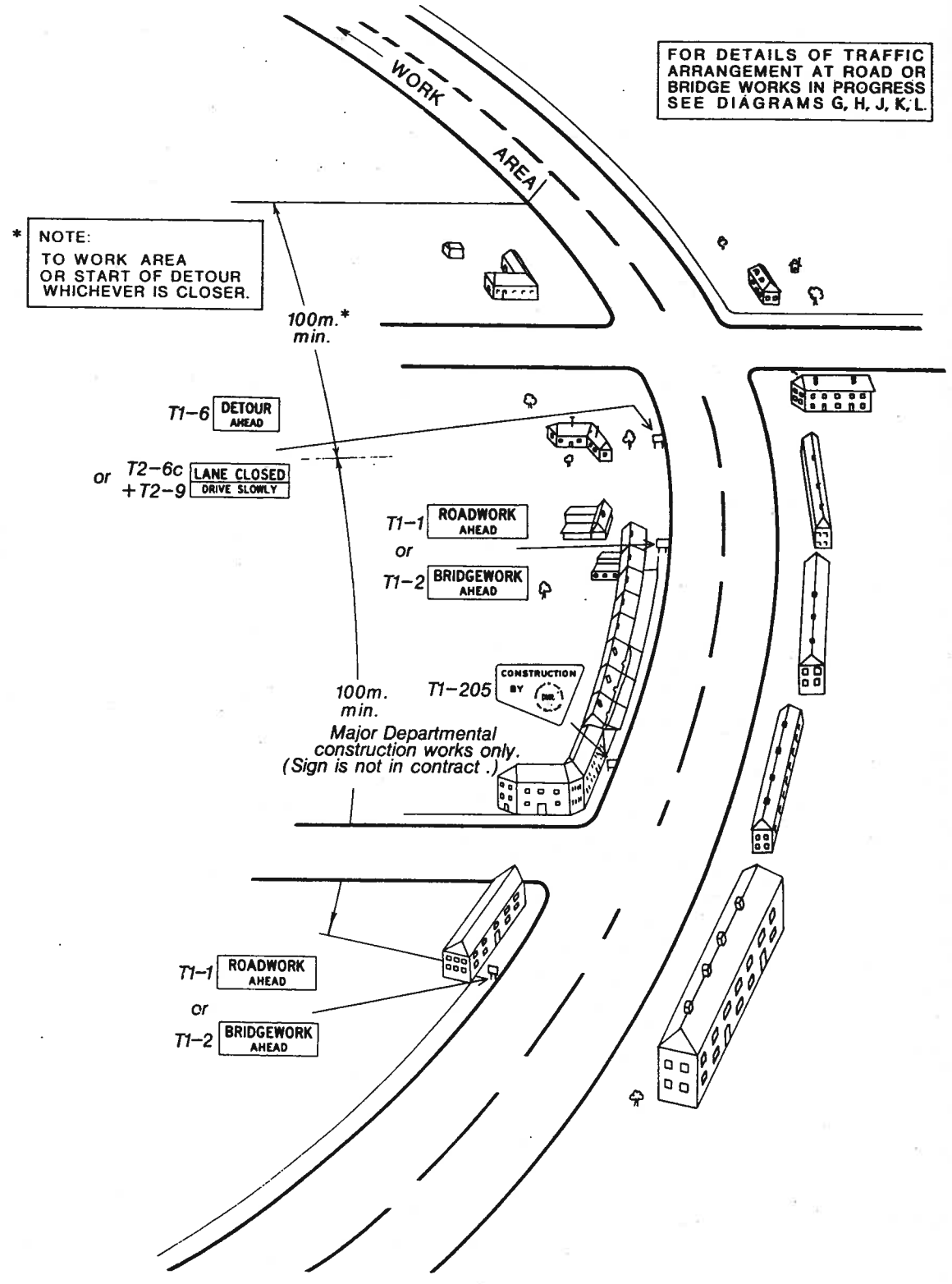


DIAGRAM F

WARNING SIGNS IN ADVANCE OF ROADWORKS OR BRIDGEWORKS IN URBAN SITUATIONS

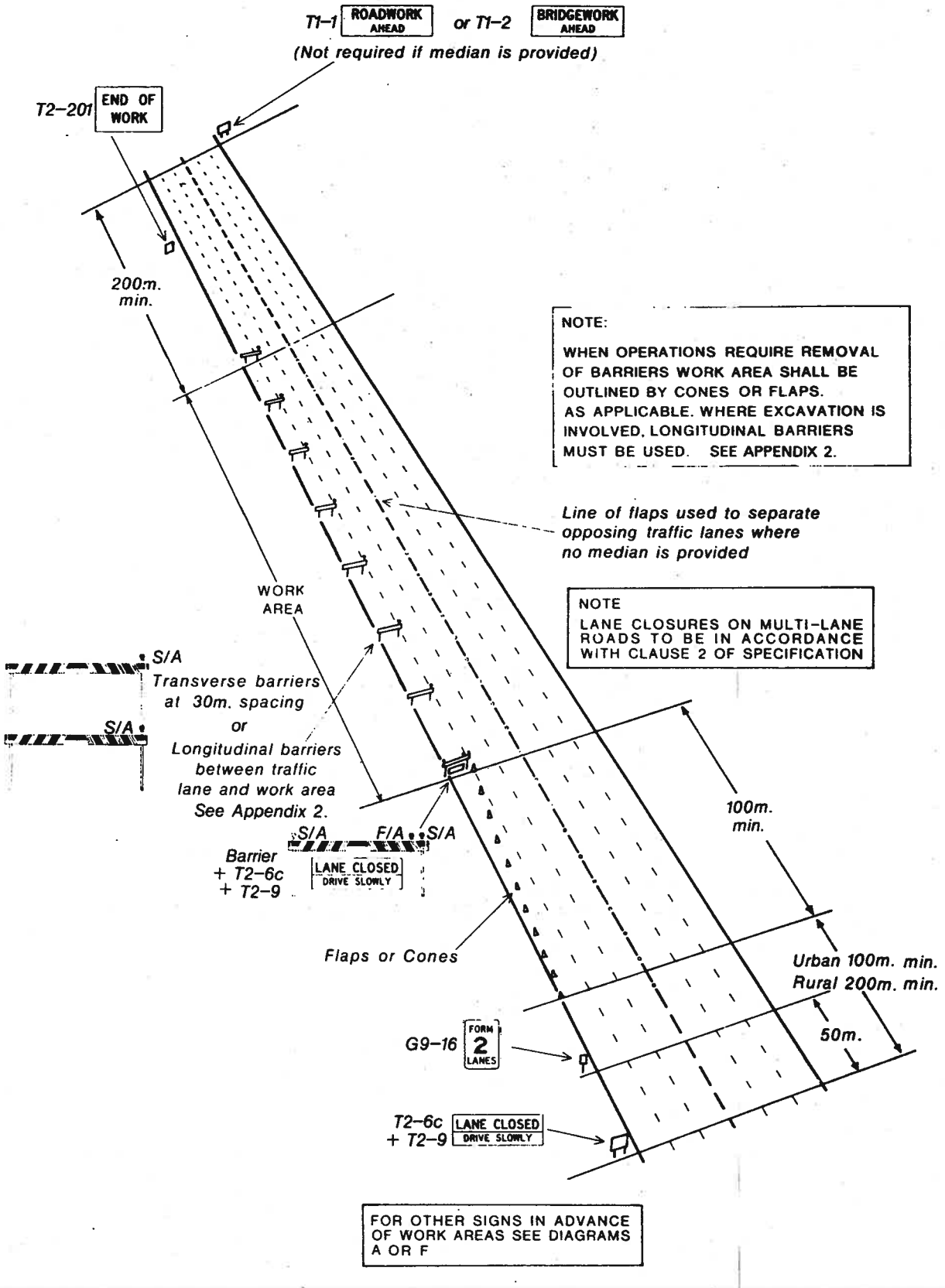


DIAGRAM G

MULTI-LANE ROADS
One lane closed, traffic diverted to right

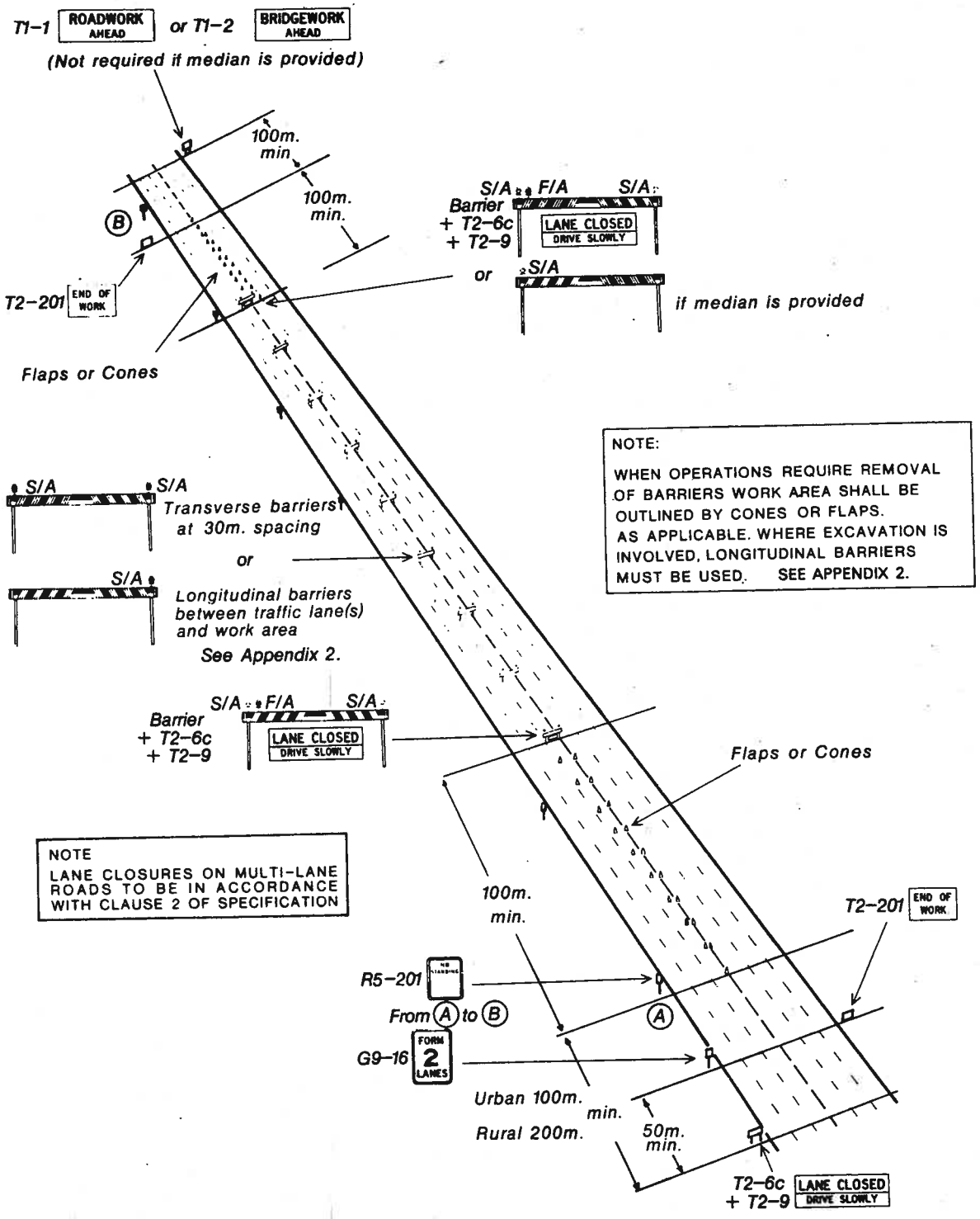


DIAGRAM H

MULTI-LANE ROADS

One lane closed, traffic diverted to left

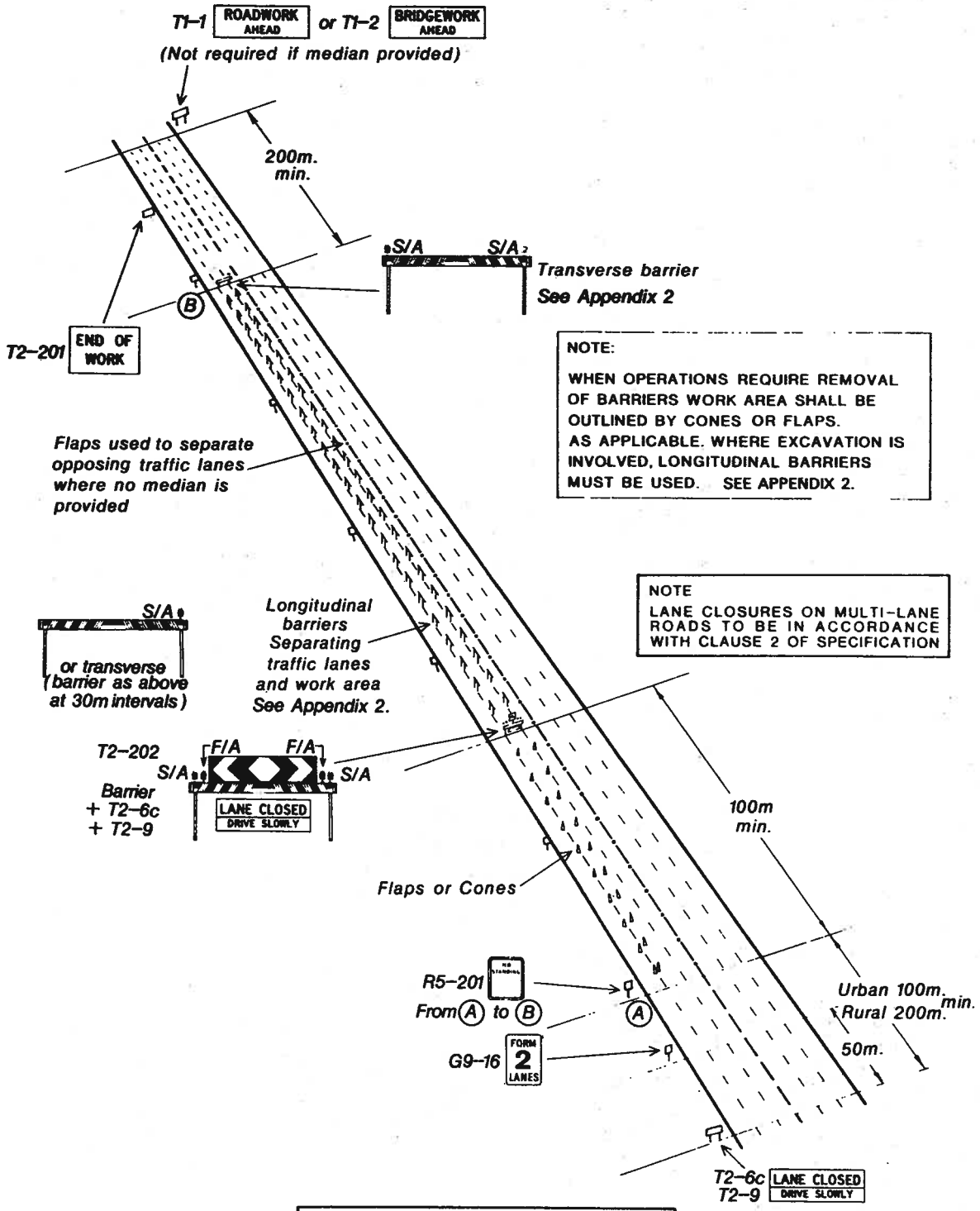


DIAGRAM J
MULTI-LANE ROADS
One lane closed, traffic diverted both sides

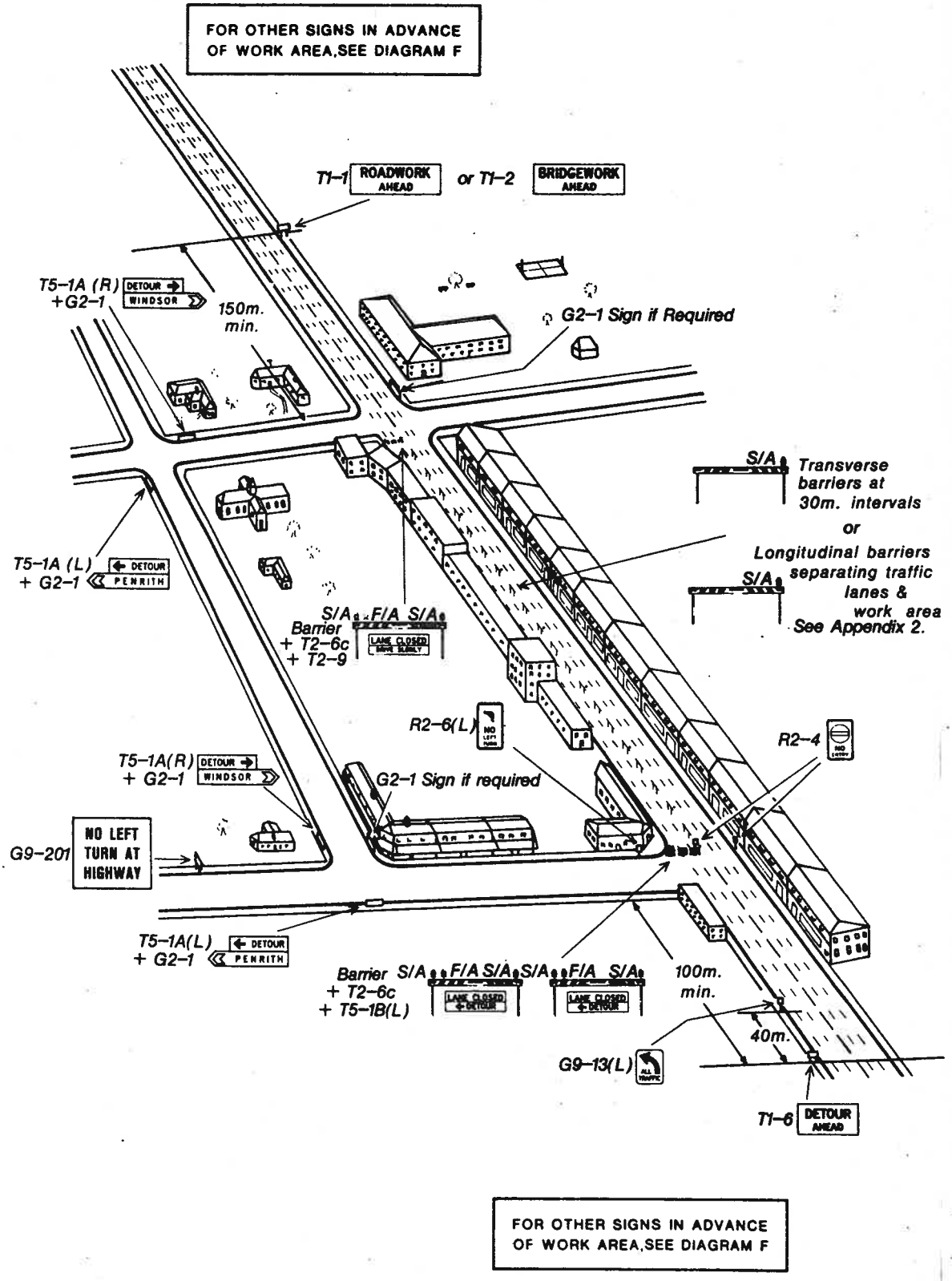


DIAGRAM K

URBAN SITUATIONS
TREATMENT OF DETOURS
Traffic in one direction detoured

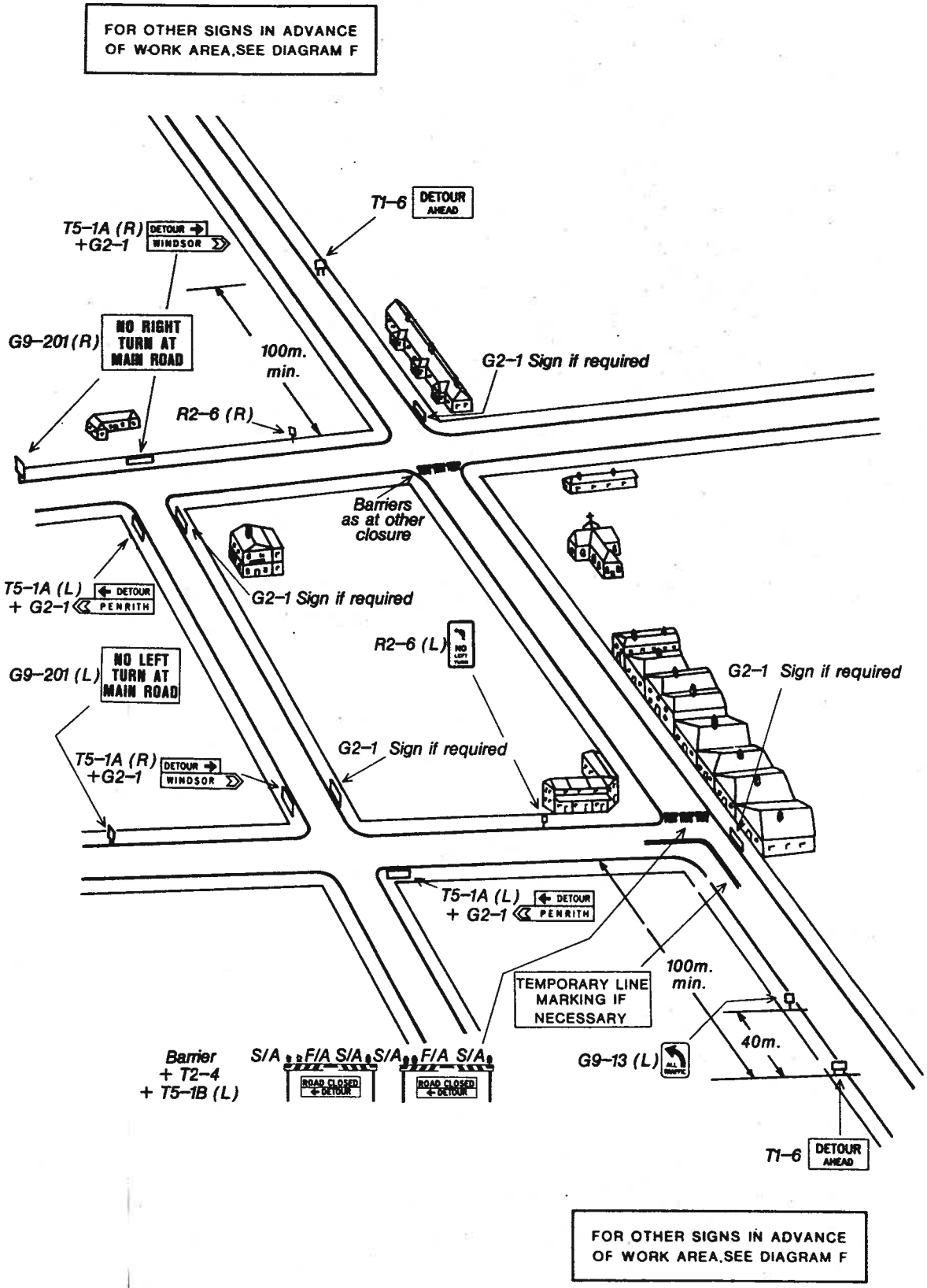
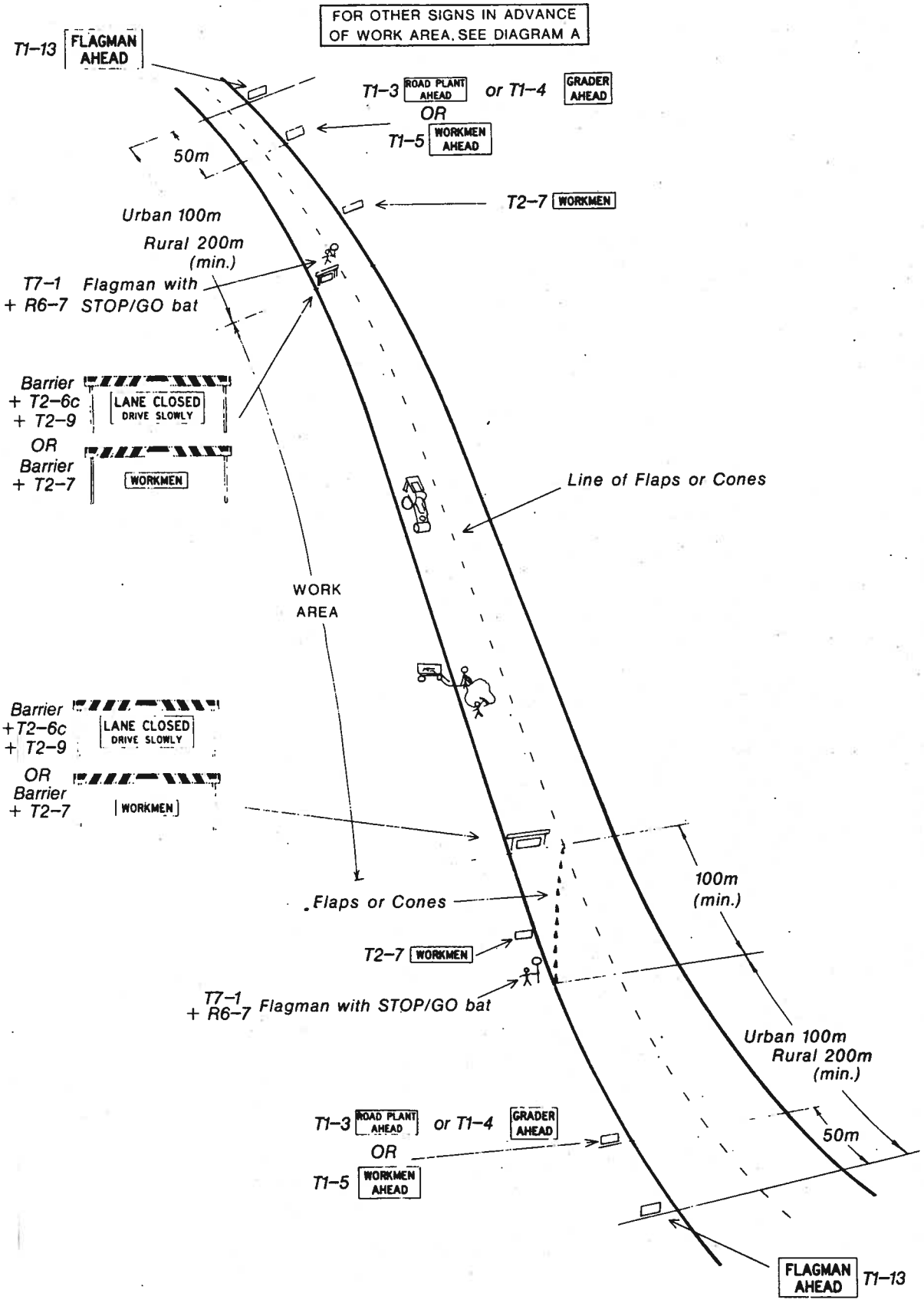


DIAGRAM L
URBAN SITUATIONS
TREATMENT ON DETOURS
All traffic detoured



— DIAGRAM M —

SHORT TERM OBSTRUCTIONS ON TWO-LANE ROADS

One lane closed. Single lane used for traffic in both directions under flagman control. Road must be restored for two-way operation overnight

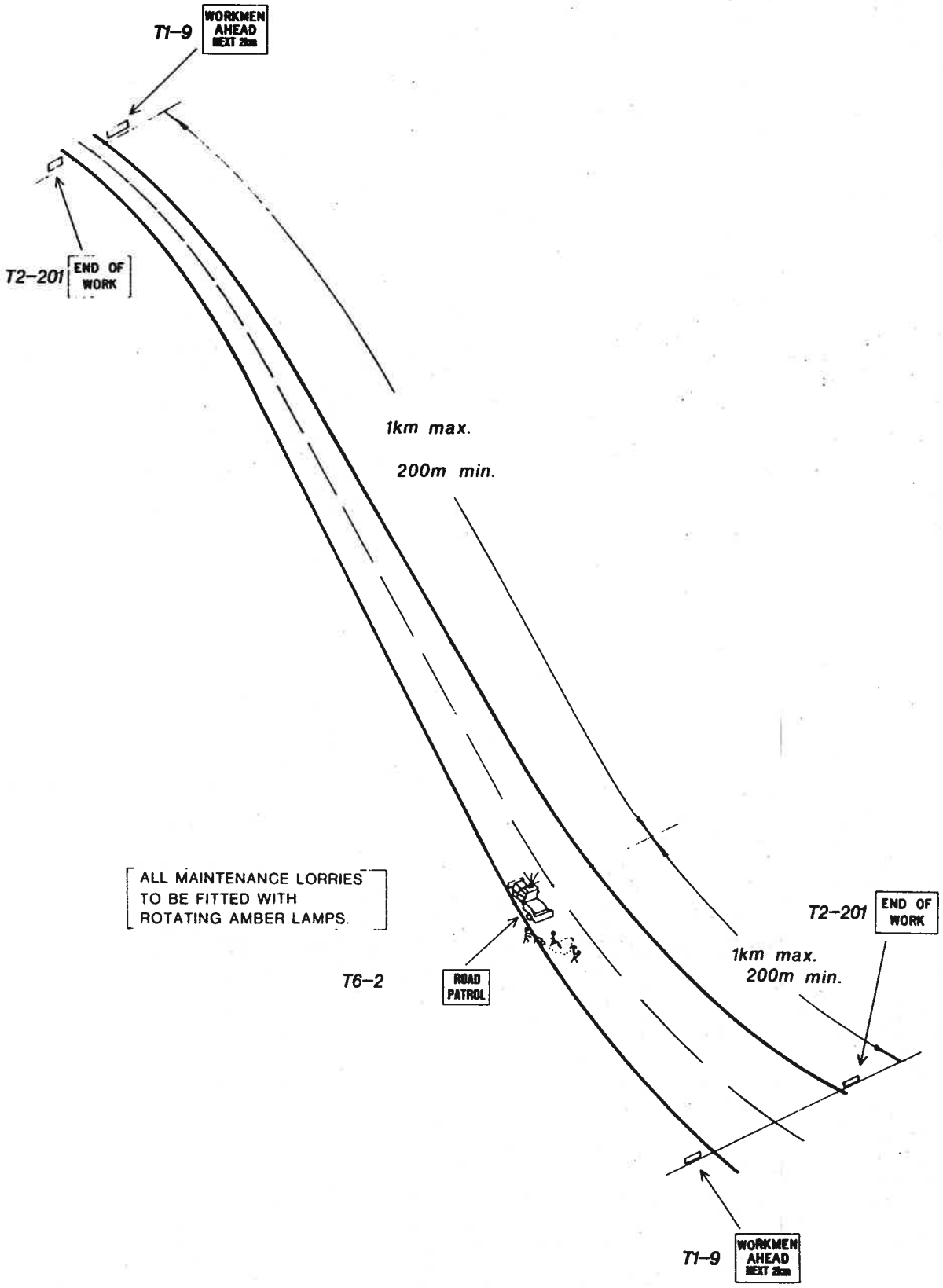


DIAGRAM N

SHORT TERM OBSTRUCTIONS ON TWO-LANE ROADS

Maintenance gang with vehicle

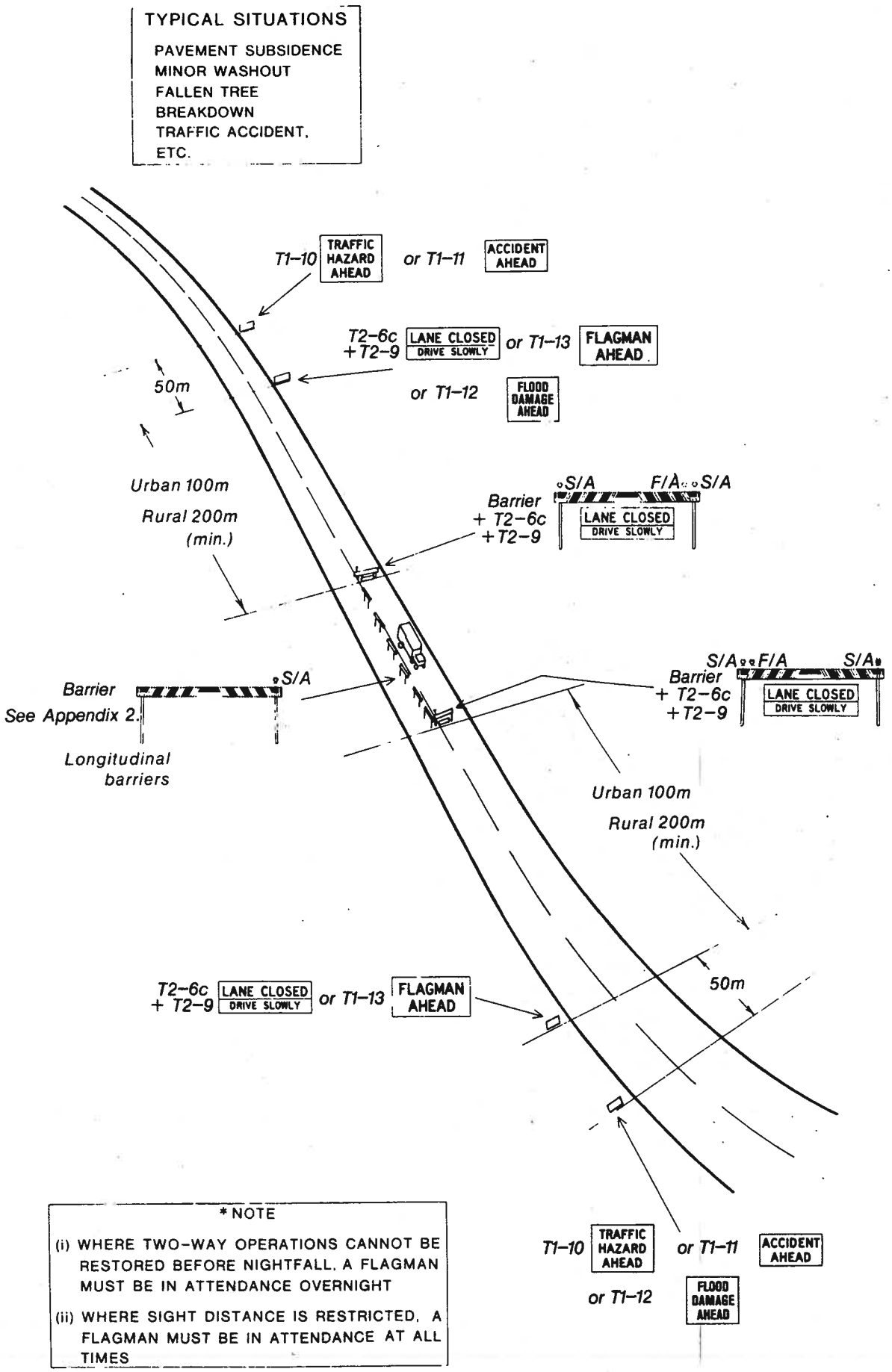
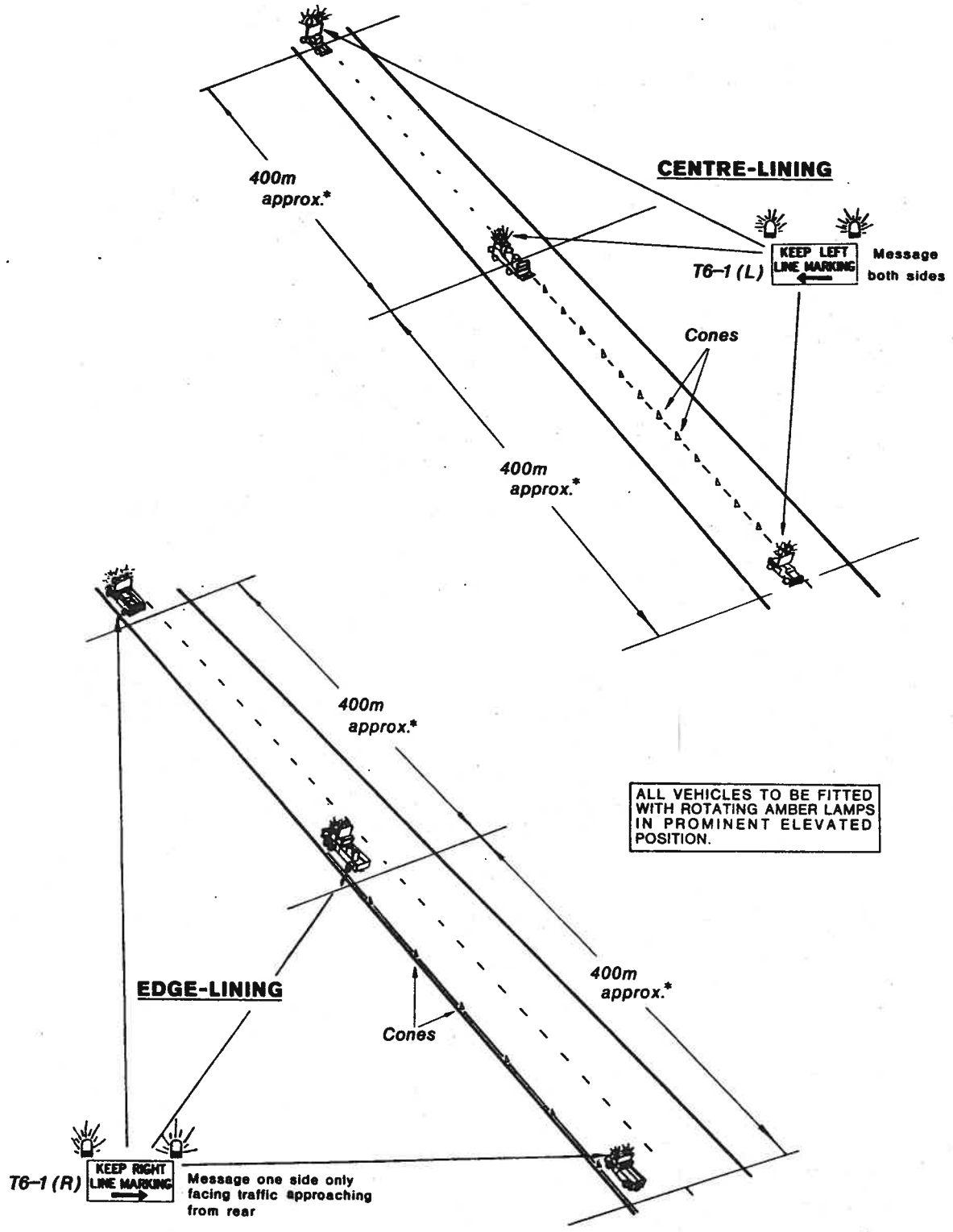


DIAGRAM P

EMERGENCY LANE CLOSURE ON TWO-LANE ROADS*



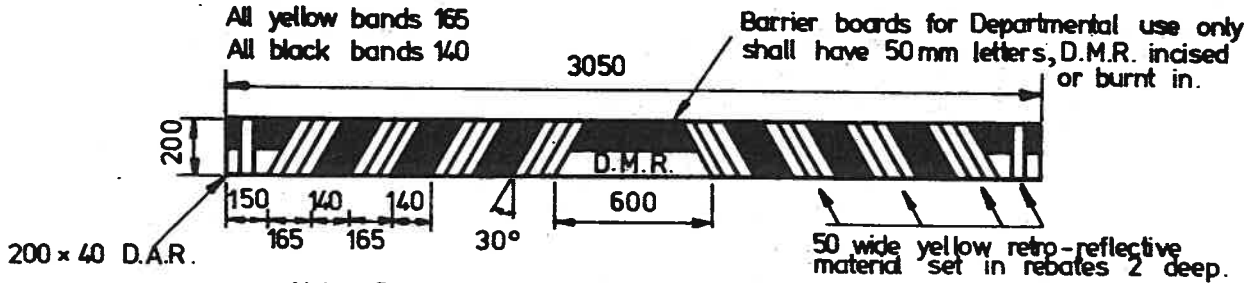
*RURAL CONDITIONS. IN URBAN AREAS, LESS DISTANCE MAY BE REQUIRED.

DIAGRAM Q

LINE MARKING

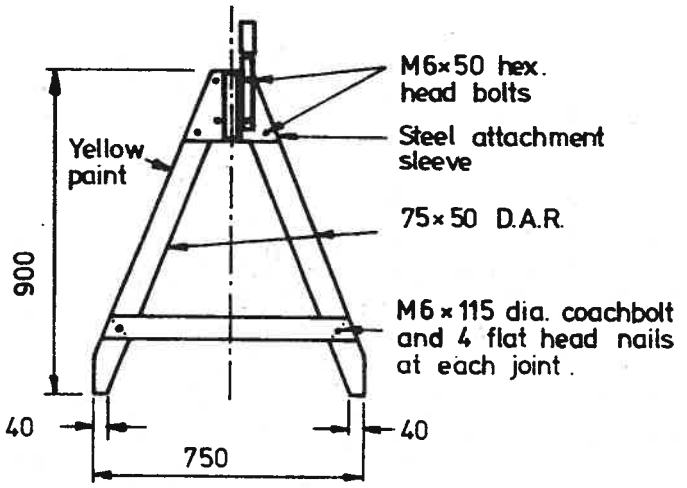
APPENDIX NO. 2

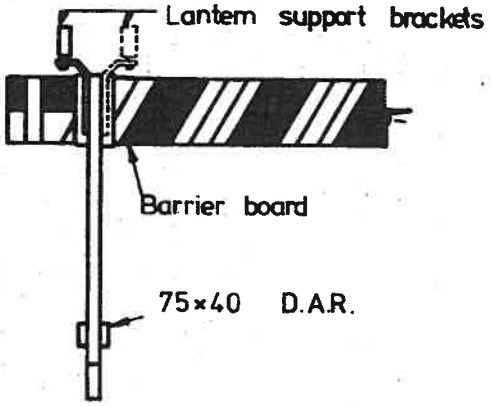
DETAILS OF
BARRIERS, TRESTLES, LAMPS
CONES, FLAPS, DELINEATORS



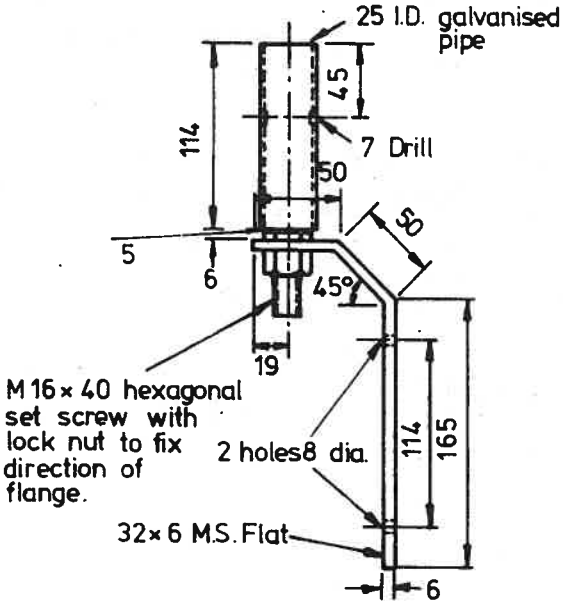
Note: Board to be painted and reflectorised on both sides as shown here.

STANDARD BARRIER BOARD

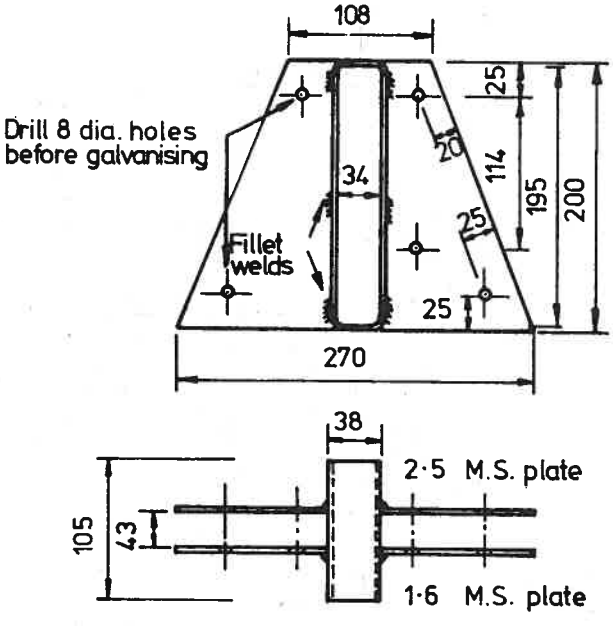




GENERAL ARRANGEMENT OF TRESTLE
2 required



LANTERN SUPPORT BRACKET



STEEL ATTACHMENT SLEEVE

SPECIFICATION

(1) Timber : All timber shall be No.2 clear dressed oregon

(2) Steel attachment sleeves and brackets shall be fabricated from black mild steel plate of the thicknesses shown and galvanised or oxo-sealed after fabrication.

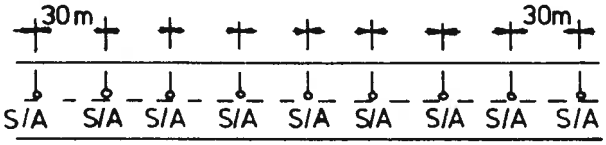
(3) Painting : All timber shall be primed with one coat of approved primer. Barrier boards and trestles shall be painted with approved finishing paint

All dimensions in millimetres unless otherwise shown

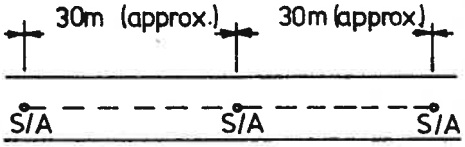
DETAILS OF BARRIER BOARDS AND TRESTLES

(See separate specifications of barrier boards and trestles.)

(a) Normal (transverse) position of barriers where lane is not required for working.



(b) Alternative (longitudinal) placing of barriers.



NOTE

The lamps used in (a) and (b) :

(1) are steady amber (S/A)

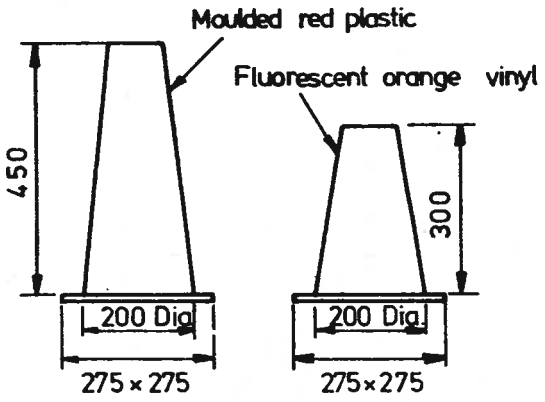
(2) may be single lens (shine one way only) or double lens (shine to front and rear ; required where traffic may approach from both directions.)

(3) should be erected at (approximately 30 m spacing approximate equivalent of three centre line or lane line markings.)

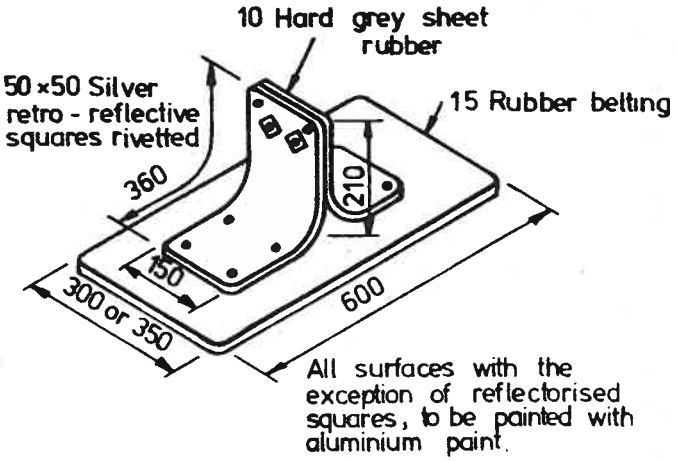
(4) shall be erected facing on-coming traffic adjacent to lanes available for traffic.

ARRANGEMENT OF BARRIERS AND LAMPS

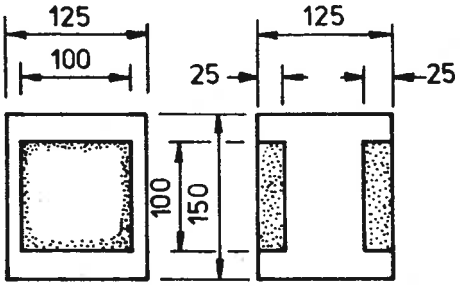
(When used alone, without signs)



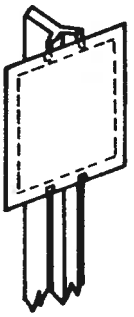
TYPICAL TRAFFIC GUIDANCE CONES



TYPICAL TRAFFIC GUIDANCE FLAPS



DELINEATOR for star pickets



150 x 125 delineators attached to star pickets

All dimensions in millimetres

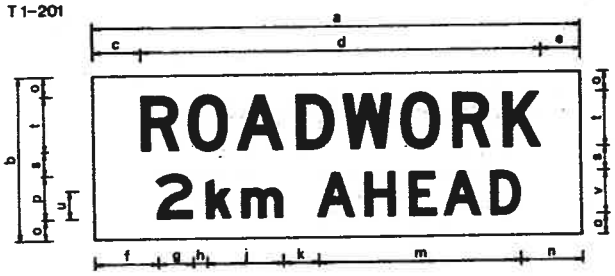
DETAILS OF CONES, FLAPS & DELINEATORS

APPENDIX NO. 3

DETAILS OF

SIGNS

T1-201



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-201 A	1800	600	175	1474	151	232	128	50	280	130

m	n	o	p	s	t	u	v
750	230	75	180 E	90	200 DM	105 LC	180 DM

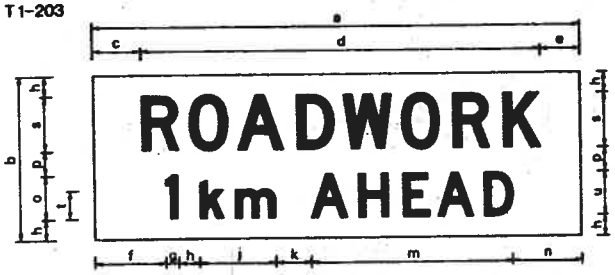
T1-202

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-202 A	1800	600	121	1582	97	280	128	50	280	130

m	n	o	p	s	t	u	v
694	258	75	180 E	90	200 DN	105 LC	180 DN

T1-203

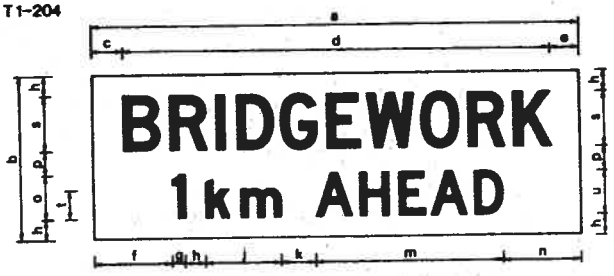


Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-203 A	1800	600	175	1474	151	280	48	75	280	130

m	n	o	p	s	t	u
750	257	180 E	90	200 DM	105 LC	180 DM

T1-204

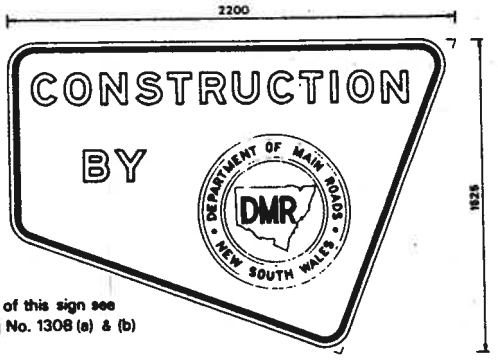


Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-204 A	1800	600	121	1582	97	288	48	75	280	130

m	n	o	p	s	t	u
694	285	180 E	90	200 DN	105 LC	180 DN

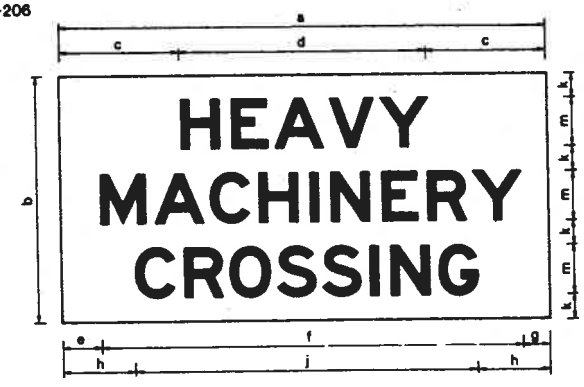
T1-205



For detail of this sign see
T.S. drawing No. 1308 (a) & (b)

Black and white reflectorised letters, black border coloured reflectorised emblem on white ground

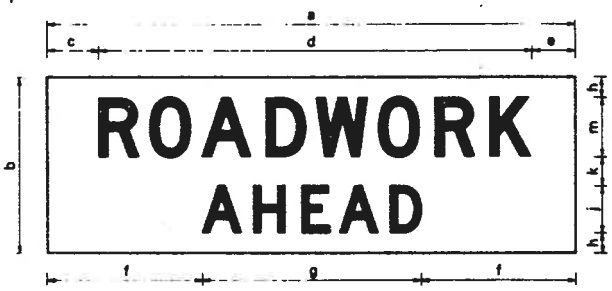
T1-206



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m
T1-206 A	1800	900	442	916	144	1556	100	267	1266	90	180 EN

T1-1



Black letters on yellow reflectorised ground

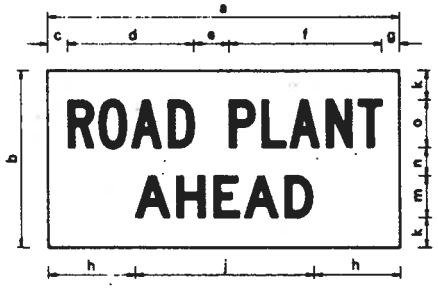
	a	b	c	d	e	f	g	h	j	k	m
T1-1A	1800	600	175	1474	151	525	750	70	160 DM	100	200 DM

T1-2

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m
T1-2A	1800	600	121	1582	97	553	694	70	160 DN	100	200 DN

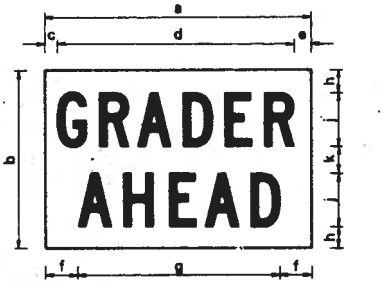
T 1-3



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o
T1-3A	1200	600	88	429	121	524	58	296	608	100	140 DN	100	160 CN
T1-3B	1800	600	110	634	183	779	94	478	844	75	180 DM	90	180 DM

T 1-4



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-4A	900	600	42	802	56	108	684	75	180 CM	90

T1-5

Black letters on fluorescent yellow–orange ground for day use
Black letters on yellow reflectorised ground for night use

	a	b	c	d	e	f	g	h	j	k	m
T1-5A	1200	600	66	1052	82	225	750	90	160 DM	100	160 DM
T1-5B	1800	750	101	1578	121	476	844	105	180 DM	120	240 DM

T1-6

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T1-6A	1200	600	84	1032	225	750	70	160 DM	100	200 DM
T1-6B	1800	900	177	1446	431	938	130	200 DM	160	280 DM

T 1–7

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o	p	s
T1–7A	1200	450	72	378	34	50	33	671	84	298	608	50	140 D N	70	22
T1–7B	1800	750	77	598	67	70	56	875	89	431	938	110	200 D M	130	30

T1–9

Black letters and numeral on fluorescent yellow–orange ground for day use
Black letters and numeral on yellow reflectorised ground for night use

	a	b	c	d	e	f	g	h	j
T1–9A	1200	900	68	1062	80	225	750	50	522

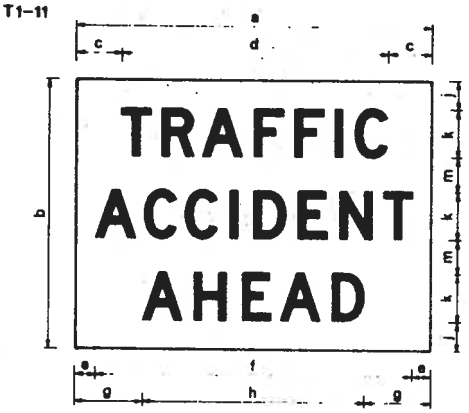
k	m	n	o	p	s	t	u
130	128	280	40	100	160 D M	110	105 L C

T1–10

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m
T1–10A	1200	900	151	898	149	902	225	750	95	160 D M	115

T1–11



Black letters on yellow reflectorised ground

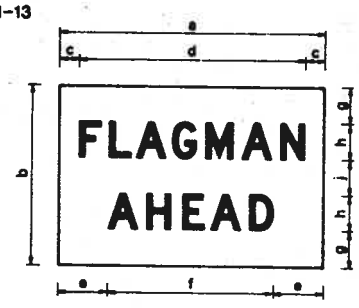
	a	b	c	d	e	f	g	h	j	k	m
T1–11A	1200	900	151	898	65	1070	225	750	95	160 D M	115

T1–12

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o
T1–12A	900	600	200	500	123	670	107	158	564	50	120 DM	70	120 D M
T1–12B	1200	900	213	774	94	1036	70	296	608	80	140 D N	100	200 D N

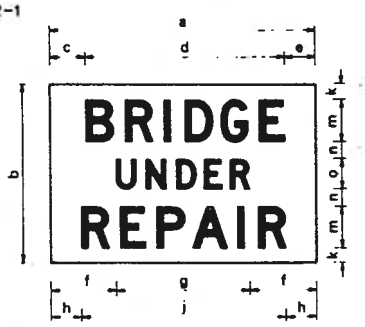
T1–13



Black letters on fluorescent yellow–orange ground for day use
Black letters on yellow reflectorised ground for night use

	a	b	c	d	e	f	g	h	j
T1–13A	900	600	61	768	168	564	120	120 DM	120
T1–13B	1500	750	110	1280	281	938	110	200 DM	130

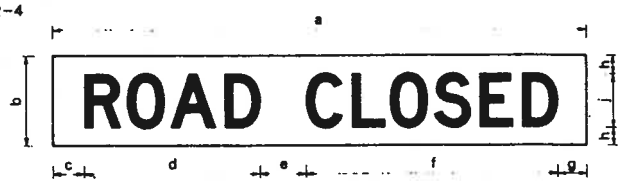
T2-1



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o
T2-1A	900	600	122	676	102	223	453	103	694	52	140 D M	56	100 D M
T2-1B	1200	900	130	964	106	282	636	104	992	80	200 D M	100	140 D M

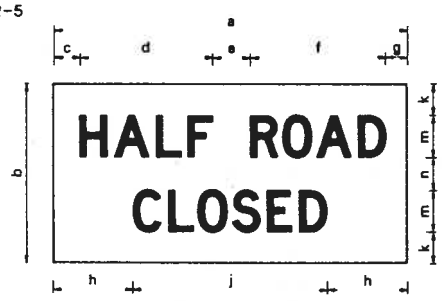
T2-4



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T2-4A	1800	300	103	596	153	848	100	60	180 D N

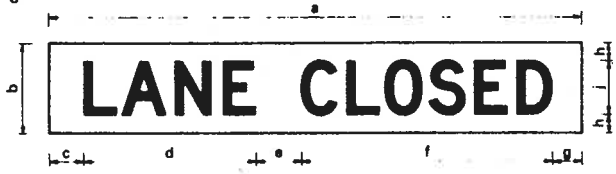
T2-5



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n
T2-5A	1200	600	87	453	126	463	71	270	660	105	140 D N	110
T2-5B	1800	750	183	647	181	662	147	428	944	110	200 D N	130

T2-6



Black letters on yellow reflectorised ground

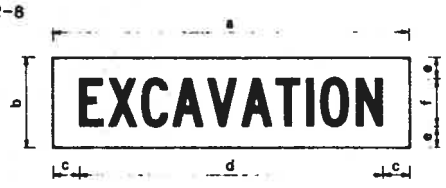
	a	b	c	d	e	f	g	h	j
T2-6C	1800	300	116	583	153	848	100	60	180 D N

T2-7

Black letters on fluorescent yellow-orange ground for day use
Black letters on yellow reflectorised ground for night use

	a	b	c	d	e	f	g
T2-7A	1200	300	49	1090	61	60	180 D N
T2-7B	1800	450	103	1578	119	105	240 D M

T2-8



Black letters on yellow reflectorised ground

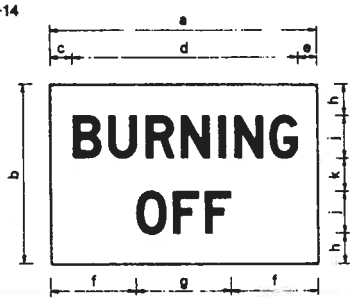
	a	b	c	d	e	f
T2-8A	1200	300	90	1020	70	160 C N

T2-9

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T2-9A	1800	300	66	641	152	897	42	60	180 D N

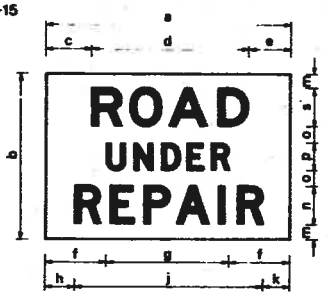
T2-14



Black letters on yellow ground

	a	b	c	d	e	f	g	h	j	k
T2-14A	900	600	76	780	64	291	318	105	140 D N	110

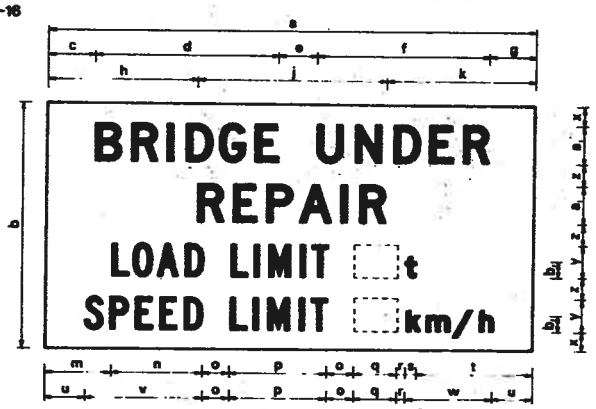
T2-15



	a	b	c	d	e	f	g	h	j	k	m	n	o	p	s
T2-15A	900	600	168	578	164	224	452	107	694	99	52	140 DM	58	100 DM	140 EM
T2-15B	1200	900	196	826	179	283	634	112	990	98	80	200 DM	100	140 DM	200 EM

Black letters on yellow reflectorised ground

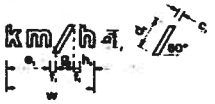
T2-16



	a	b	c	d	e	f	g	h	j	k
T2-16A	1800	900	176	675	143	635	171	556	694	550

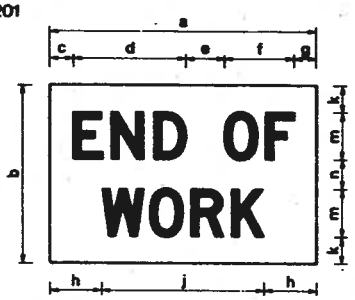
m	n	o	p	q	r	s	t	u	v	w
246	336	100	358	158	30	40	431	148	433	323

x	y	z	a.	b.	c.	d.	e.	f.	g.	h.
70	120 CM	80	140 DM	60 LC	15	120	190	25	62	51



Black letters and numerals on yellow reflectorised ground

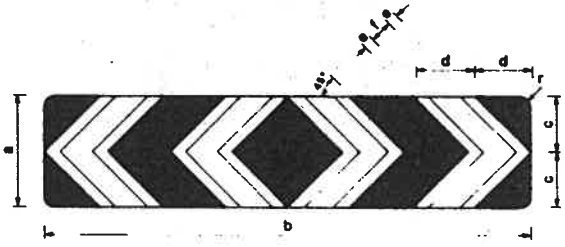
T2-201



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n
T2-201A	900	600	80	379	128	238	75	176	648	90	160 DN	100

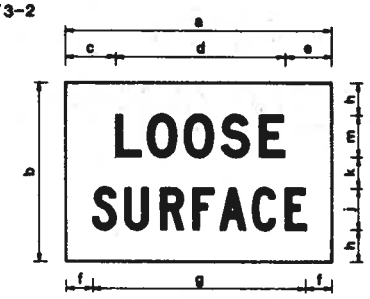
T2-202



White chevrons on black ground
White reflective material 75 mm wide to be centrally placed on white bands

	a	b	c	d	e	f	r
T2-202A	400	1600	200	143	34	75	40

T3-2



Black letters on yellow reflectorised ground

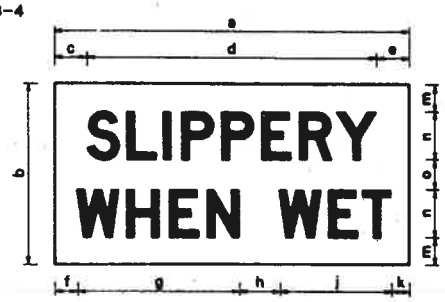
	a	b	c	d	e	f	g	h	j	k	m
T3-2A	900	600	168	574	158	89	722	107	140 CM	106	140 DM
T3-2B	1800	900	336	1152	312	151	1498	145	240 DM	130	240 EM

T3-3

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T3-3A	1200	600	69	1078	53	101	998	90	160 DM	100
T3-3B	1800	750	104	1616	80	151	1498	75	240 DM	120

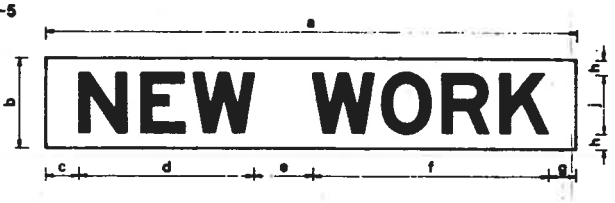
T3-4



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o
T3-4A	1200	600	113	980	107	72	547	135	382	64	80	160 DN	100
T3-4B	1800	900	177	1470	153	108	820	204	572	96	75	240 DN	120

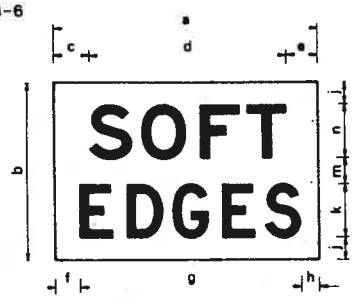
T3-5



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T3-5A	1800	300	112	595	199	802	92	60	200 EN

T3-6



Black letters on yellow reflectorised ground

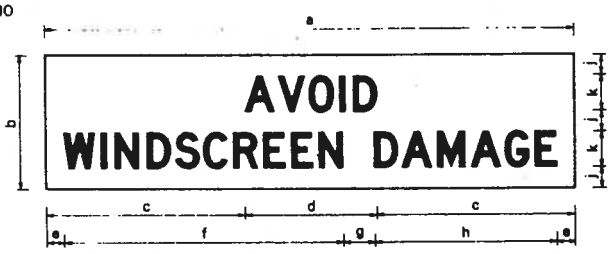
	a	b	c	d	e	f	g	h	j	k	m	n
T3-6A	900	600	118	674	108	82	752	66	75	180 DM	90	180 E M

T3-9

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T3-9A	1600	300	97	656	150	812	85	70	160 DM

T3-10



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k
T3-10A	1600	450	674	452	61	948	108	622	70	120 DN

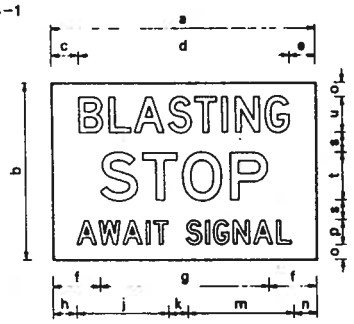
T3-201

Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T3-201A	1600	600	35	432	144	1145	44	130	590

k	m	n	o	p	s	t	u
80	395	83	398	124	100	120 C N	180 D N

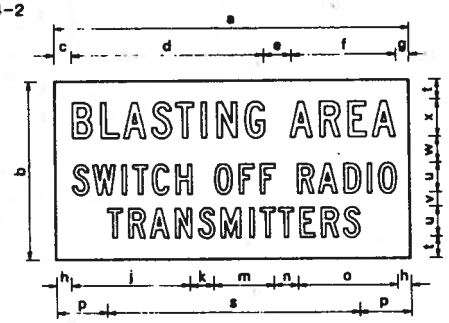
T4-1



White letters on red ground

	a	b	c	d	e	f	g	h	j	k	m	n	o	p	s	t	u
T4-1A	900	600	93	720	87	163	574	83	312	66	360	77	50	80 D N	70	160 E N	120 D N
T4-1B	1200	900	127	960	113	241	718	49	466	102	540	43	105	120 D N	105	200 E N	160 D N

T4-2

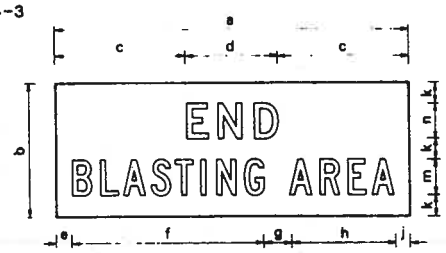


White letters on red ground

	a	b	c	d	e	f	g	h	j	k	m
T4-2A	1200	600	57	661	94	353	45	47	404	80	204

n	o	p	s	t	u	v	w	x
86	332	172	856	70	100 C M	50	90	120 C M

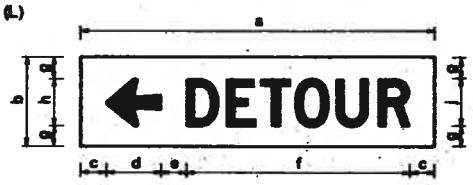
T4-3



White letters on red ground

	a	b	c	d	e	f	g	h	j	k	m	n
T4-3A	1200	450	445	310	56	651	94	353	46	70	120 C M	120 DM

T5-1(L)



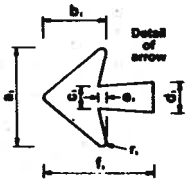
Black letters and arrow on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T5-1A(L)	1200	300	85	184	85	761	70	180	180 DN
T5-1B(L)	1800	450	126	273	130	1141	105	240	240 DN

T5-1(R)

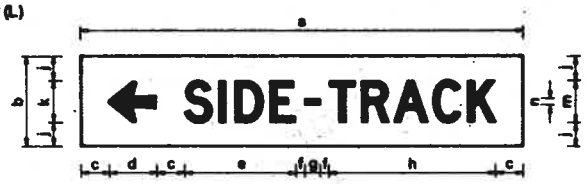
Black letters and arrow on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j
T5-1A(R)	1200	300	85	761	184	85	70	180 DN	180
T5-1B(R)	1800	450	130	1141	273	126	105	240 DN	240



	a1	b1	c1	d1	e1	f1	r1
T5-1A(L or R)	180	106	37	50	13	184	7
T5-1B(L or R)	240	150	55	74	19	273	11

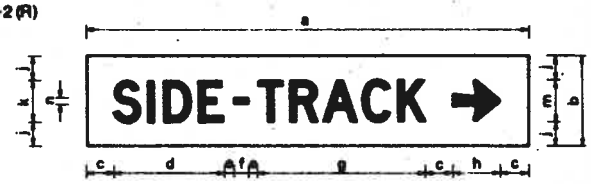
T5-2(L)



Black letters and arrow on yellow reflectorised ground

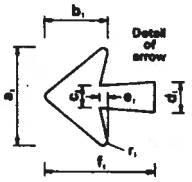
	a	b	c	d	e	f	g	h	j	k	m	n
T5-2A(L)	1500	300	86	159	376	30	60	570	80	140	140 DN	22
T5-2B(L)	1800	450	110	273	434	42	40	639	105	240	240 BN	30

T5-2(R)



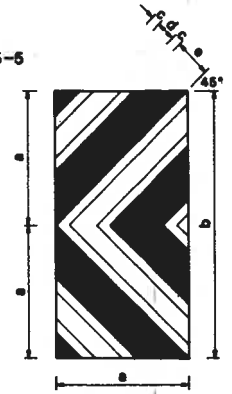
Black letters and arrow on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n
T5-2A(R)	1500	300	86	376	30	60	570	159	80	140 DN	140	22
T5-2B(R)	1800	450	110	434	42	40	639	273	105	240 BN	240	30



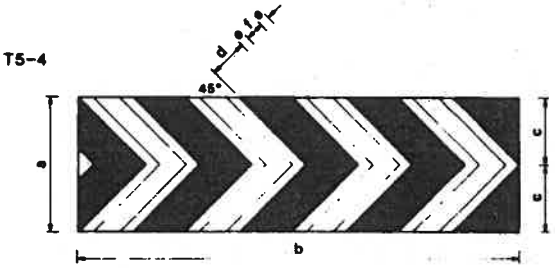
	a1	b1	c1	d1	e1	f1	r1
T5-2A(L or R)	140	80	32	43	11	159	8
T5-2B(L or R)	240	154	55	74	19	273	11

T5-5



	a	b	c	d	e
T5-5A	450	900	32	64	128

T5-4

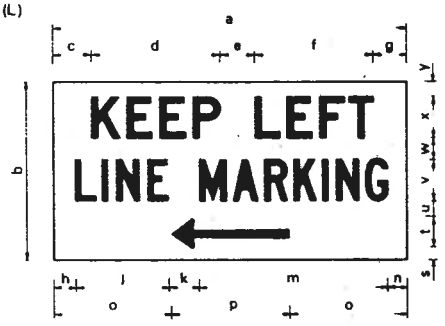


	a	b	c	d	e	f
T5-4A	450	1500	225	128	32	64

White chevrons on black ground

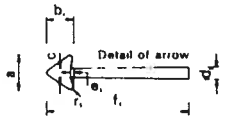
White reflective material 64 mm wide to be centrally placed on white bands

T6-1 (L)



	a	b	c	d	e	f	g	h	j	k	m	n	o	p	s	t	u	v
T6-1A(L)	1200	600	129	435	118	403	115	78	316	100	642	66	400	400	45	100	50	140 CN
T6-1B(L)	1800	750	171	675	187	620	147	203	417	133	856	191	660	480	65	120	65	140 DM

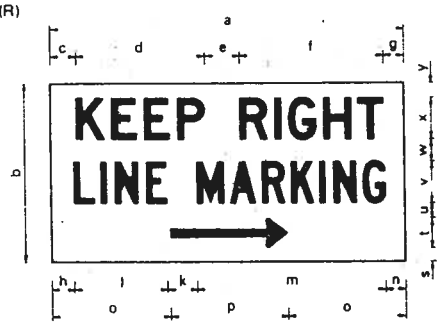
w	x	y
75	140 DN	50
85	200 DM	75



	a	b	c	d	e	f	r
T6-1A (L or R)	100	92	29	39	9	400	5
T6-1B (L or R)	120	110	35	46	11	480	6

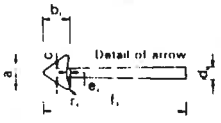
Black letters and arrow on yellow ground

T6-1 (R)



	a	b	c	d	e	f	g	h	j	k	m	n	o	p	s	t	u	v	w
T6-1A(R)	1200	600	87	435	119	488	71	76	316	100	642	66	400	400	45	100	50	140 CN	75
T6-1B(R)	1800	750	95	675	188	767	75	202	417	133	856	192	660	480	65	120	65	140 DM	85

x	y
140 DN	50
200 DM	75



	a	b	c	d	e	f	r
T6-1A (L or R)	100	92	29	39	9	400	5
T6-1B (L or R)	120	110	35	46	11	480	6

Black letters and arrow on yellow ground

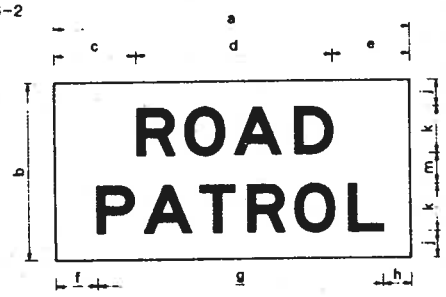
R6-201

EXAMPLE ONLY

Black letters and border on white reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m	n	o	p	r	s
R6-201A	450	350	5	15	177	96	69	317	64	40	374	36	50	60 DM	35	35
R6-201B	600	450	6	18	235	130	92	423	85	54	498	48	60	80 DM	45	45

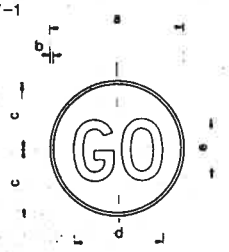
T6-2



Black letters on yellow reflectorised ground

	a	b	c	d	e	f	g	h	j	k	m
T6-2A	1200	600	276	660	264	139	966	95	90	160 EM	100
T6-2B	1500	750	295	934	271	96	1360	44	75	240 EN	120

T7-1

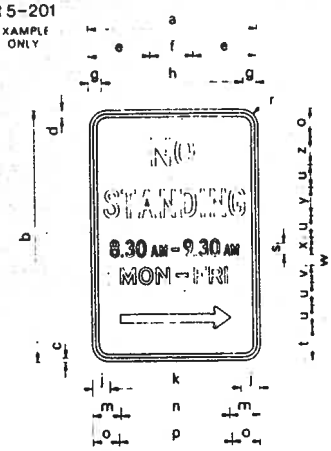


White letters and border on green ground

	a	b	c	d	e
T7-1A	450	9	225	300	200 DN
T7-1B	600	12	300	362	240 DN

R5-201

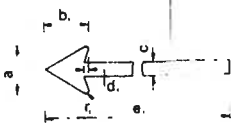
EXAMPLE ONLY



Red letters, numerals, arrow and border on white ground

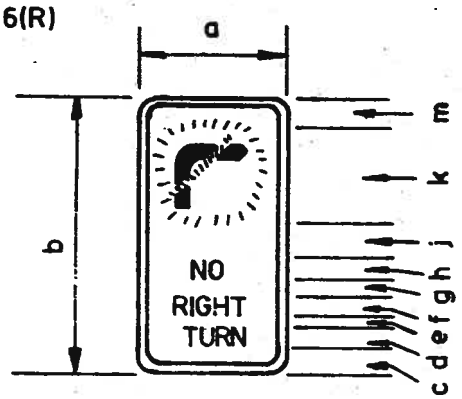
	a	b	c	d	e	f	g	h	j	k	m	n	o
R5-201A	300	450	6	12	111	78	23	254	34	232	53	194	50

p	r	s	t	u	v	w	x	y	z
200	30	20 CN	60	40	30 EN	20	30 CN	50 CN	50 DN



	a.	b.	c.	d.	e.	f.
R5-201A	40	32	15	3	200	

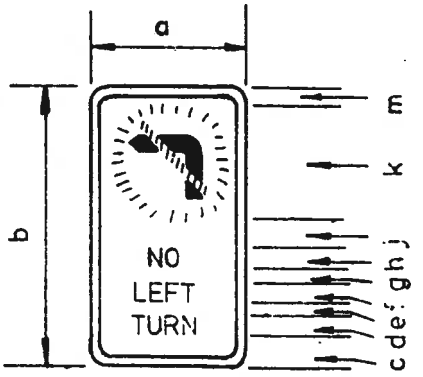
R2-6(R)



Black letters arrow and border on white reflectorised ground, red reflectorised symbols.

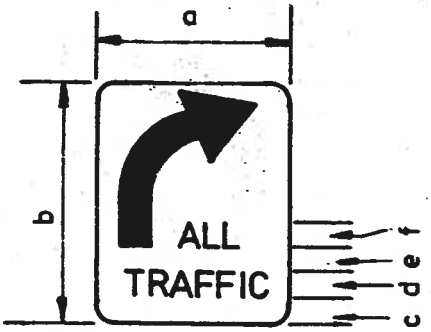
	a	b	c	d	e	f
R2-6A(R)	450	900	60	75	50	75
	g	h	j	k	m	
	50	125	50	335	60	

R2-6(L)



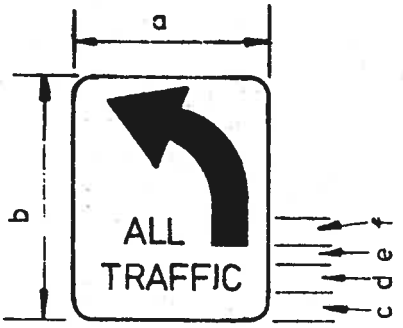
Black letters arrow and border on white reflectorised ground, red reflectorised symbols.

	a	b	c	d	e	f
R2-6A(L)	450	900	60	75	50	75
	g	h	j	k	m	
	50	125	50	335	60	



Black letters symbol and border on white reflectorised ground

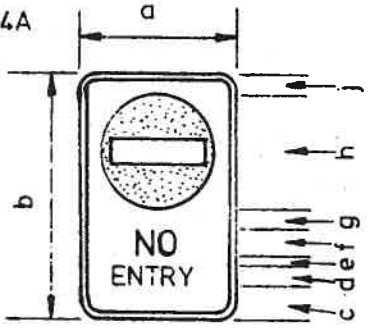
	a	b	c	d	e	f
(R)	600	900	100	100	50	100



Black letters symbol and border on white reflectorised ground

	a	b	c	d	e	f
(L)	600	900	100	100	50	100

R2-4A

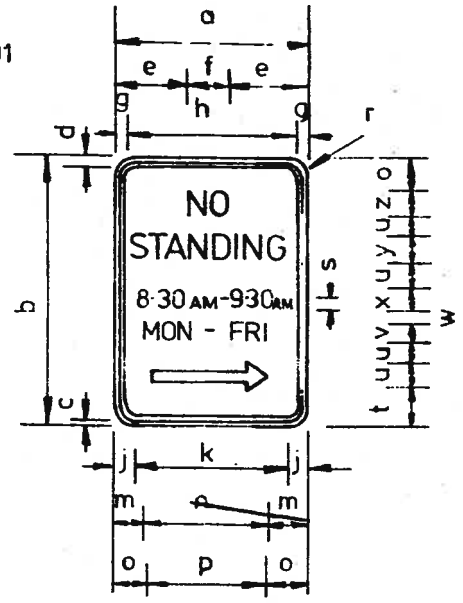


	a	b	c	d	e	f
R2-4A	450	750	88	75	56	100
	g	h	j			
	50	300	81			

Black letters and border with white reflectorised ground and bar, red reflectorised signal.

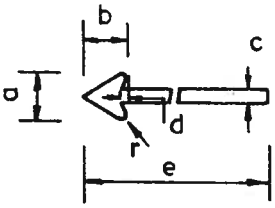
(Also required where detour on side track is for one-way operation only

R5-201



Red letters, numerals, arrow and border on white ground

	a	b	c	d	e	f
R5-201(A)	300	450	6	12	111	78
	g	h	j	k	m	n
	23	254	34	232	53	194
	o	p	r	s	t	u
	50	200	30	20 CN	60	40
	v	w	x	y	z	
	30 EN	20	30 CN	50 CN	50 DN	

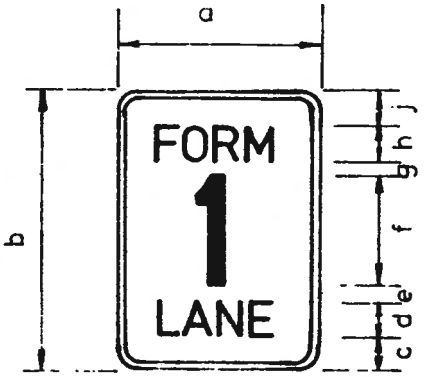


	a	b	c	d	e	r
R5-201A	40	32	15	3	200	3

Daylight only
Red letters on white ground

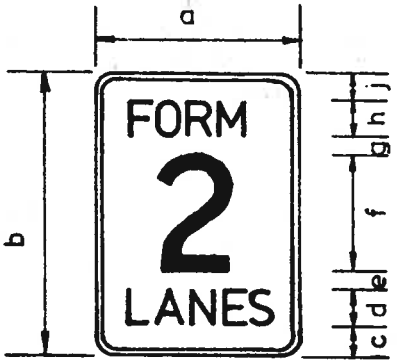
Daylight and night
Red retro - reflective letters on white retro - reflective ground

Required for kerbside lane if adjacent lane is closed.



Black letters and numeral on white reflectorised ground

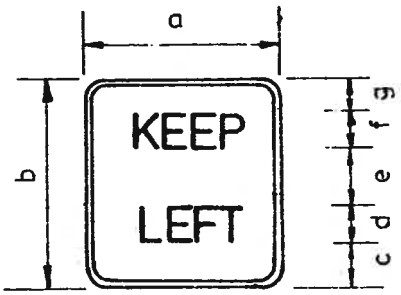
	a	b	c	d	e	f
	750	1050	127	150	75	356
	g	h	j			
	75	150	127			



Black letters and numeral on white reflectorised ground

	a	b	c	d	e	f
	750	1050	127	150	75	356
	g	h	j			
	75	150	127			

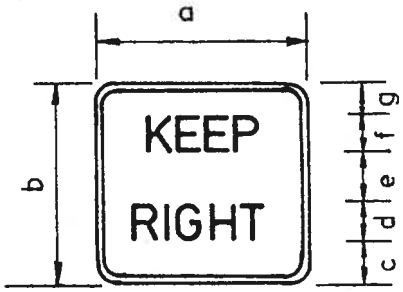
R2-3(L)



Black letters and border on white reflectorised ground

	a	b	c	d	e	f	g
R2-3A(L)	450	600	100	150	100	150	100

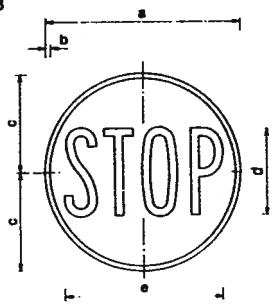
R2-3(R)



Black letters and border on white reflectorised ground

	a	b	c	d	e	f	g
R2-3A(R)	558	600	100	150	100	150	100

R6-7
R6-8



Black letters and border on fluorescent red-orange ground (R 6-7)
White reflectorized letters and border on red reflectorized ground (R 6-8)

	a	b	c	d	e
R6-7A, R6-8A	450	9	225	200 AM	368
R6-7B, R6-8B	600	12	300	200 CM	540

Flagmen's handheld bat

M.R. Form No. 326
(Revised February, 1958)

Department of Main Roads, N.S.W.

INSTRUCTIONS

FOR

EXTERMINATION OF TERMITES (WHITE ANTS) IN TIMBER BRIDGES

1. DESCRIPTIONS AND HABITS*

White ants live in nests in or on the ground, and in trees and stumps. In these nests three different castes are found, each having its particular function in the social economy of the white ant community. These castes are known as (a) workers, (b) soldiers and (c) male and female forms. The workers are most numerous in the nest, and are small, soft, white-bodied blind insects with well-developed jaws. They carry on the work of the nest building, foraging for food, and caring for the young and the reproductive forms. The soldiers are provided with much longer jaws, and in some species they also have a small opening at the top of the head from which, when disturbed, they can exude a sticky white fluid which is strongly repellent to other insects that may attack them. They are usually blind and do not leave the nest, their function being to protect it from invaders.

Once a year swarming occurs and winged male and female forms with well-developed eyes are produced and these leave the nest in large numbers with the advent of suitable warm weather. After the flight their wings fall off and a few of these forms may pair and found new colonies in the ground adjacent to timber or in old stumps, etc.

After the first brood of young has been produced the female white ant becomes incapable of movement, for the abdomen becomes greatly distended by the large mass of eggs developed. This female is then known as the queen and becomes the central figure of the nest which the workers build up round her, and she may live and continue to lay eggs for many years and thus increase the population of the colony. Supplementary queens are occasionally found in the nests.

White ants feed entirely on vegetable substances, mainly timber, and the workers travel considerable distances underground from their nests to reach food supplies. They will never work in the light, and if they have to cross open spaces they construct covered runways. On account of these habits they are never seen unless disturbed. The workers travel to and from the nest to their food supply in a continuous stream and cannot exist without communication with their nest.

Each colony is self-contained and has no connection with other colonies. The dwelling of the colony consists either of inter-communicating cavities within the wood or of connecting passageways within both the ground and the wood, often inter-connected by dark earth-like runways or tunnels constructed by the termites.

An important habit of termites is the constant licking or grooming of their own bodies and the bodies of other members of the colony.

This habit is of the most practical importance in their extermination, since any poisonous substance in the form of fine dust which is caught on the fine hairs covering their bodies is passed on from one to another.

2. INSPECTION FOR PRESENCE OF TERMITES

When inspecting a bridge for the presence of termites preparatory to extermination treatment, it is essential that the termites be not disturbed in any way, such as by hammering, chopping or breaking open of runways, galleries and nests.

The presence of termites in a bridge is indicated by the disturbance and failure of the timber being attacked; by the existence of destroyed timber that may have become exposed; the characteristic faecal pellets or ant dirt dropped by the termites from their workings; by the presence of clay-covered runways leading from nests to workings; by swarming cuts, i.e., small cuts made by the termites from their galleries inside the wood to the surface and locked with clay which they remove when the winged forms are ready to swarm during spring and early summer; by the presence of nests in the vicinity, either in the form of clay or located in dead timber and in the dead heart of growing trees.

Some termites have their nests in the timber being attacked and have been reported in barges in Sydney Harbour and other places.

3. POISON DUST TREATMENT

It is found that the most reliable method of exterminating termites is by blowing suitable poison in powder form into the runways or galleries. This consists of arsenic powder only used dry. The termites brush against the poison dust as they pass to and fro and the dust is caught by the fine hairs on their bodies. Owing to the termites' habit of "grooming" one another, the poison is spread from insect to insect,

and within a fortnight the entire colony is destroyed if the dust is correctly applied. The wood should be dry when the treatment is carried out, as if there is moisture in runways at the time of treatment, the desired result may not be obtained.

Treatment is best effected in warm weather in spring, prior to swarming. In the winter or cold period the termites, like other insects, reptiles, etc., are very inactive and treatment is unlikely to be successful.

The method of applying treatment when a gallery is detected close to the surface of the wood, is to gently split or prise up with a chisel or screwdriver a small portion of the wood, without breaking any away or disturbing the affected area. The nozzle of an insect powder blower is then inserted and an ounce or so of arsenical powder blown gently into the gallery. On withdrawing the nozzle, the hole must be stopped up at once with any soil or clay that is handy to prevent light entering and causing the termites to stop working.

In timber that is apparently solid, but where there is reason to believe that a colony exists somewhere within, the procedure is to bore three-eights (3/8) inch holes with brace and bit or auger to cut into any gallery or galleries. When one is reached it will be noticed that the wood has become appreciably softer and on withdrawing the boring tool, termite dirt or even termites themselves will be found in the borings. After blowing in a charge of poison powder the holes are stopped up, as previously explained.

On account of the extremely dangerous nature of the poison used, care must be taken to prevent it being spilt on the ground or where cattle and other domestic animals can lick it up. A respirator should be worn when handling it, and if any blows into the eyes they should be washed at once with a solution of boracic acid prepared by dissolving one and a half (1 1/2) ounces of powdered boracic acid in a pint of water. If the poison should be swallowed, take an emetic and call a doctor.

The poisonous arsenic powder is obtainable in three (3) pound tins at Divisional Offices.

4. ELIMINATION OF SOURCES OF INFESTATION

If a bridge is found to be infested, and poison dust treatment is carried out, there should be no disturbance of termite nests for at least three (3) weeks after treatment of the bridge. After this period, however, all refuse wood within fifty (50) yards of the bridge, such as stumps, roots, logs, dry limbs, etc., should be removed and burned. Sources of infestation should be looked for in fence posts, poles, and dead portions of living trees.

If a bridge is not infested with termites, it is still essential to clear up the surroundings of all possible harbour for termites.

5. USE OF LIQUID POISON TO PREVENT FURTHER ATTACKS

In all bridges dealt with, the ends of end girders and piles, and the ends adjacent to the abutments of end stringers and trusses, if free from termites, are to be treated against attack as follows:-

Holes shall be bored with a seven eights (7/8) inch auger at a distance of one (1) foot from the abutment ends of end girders. Holes in outer girders shall be bored on the side nearest the centre line of the bridge. The holes shall commence as close to the top of the girder as practicable and shall pass approximately through the centre of the girder and extend into the timber, a distance of approximately two-thirds (2/3) of its diameter. A hole shall be bored in each pile at a distance of one (1) foot or thereabouts above the ground surface. In pier piles, this hole shall be placed, where practicable, between the lower wale and the ground surface. A hole shall also be bored in each pile as close to the under side of the capwale as practicable. Holes in piles shall slope downwards, be inclined at approximately thirty (30) degrees to the vertical, pass through the centre line of the pile and extend to within about six (6) inches of the opposite surface. In end stringers and end truss members (as indicated above), holes shall be bored approximately one (1) foot from the end of the member in such a manner that they commence as close to the top of the member as practicable and extend a distance of approximately three-quarters (3/4) of its depth. In no case should less than four (4) inches of timber be left from the lower end of the hole in any direction. All holes shall be drilled in such places as will be at all times readily accessible subsequent to the completion of the work.

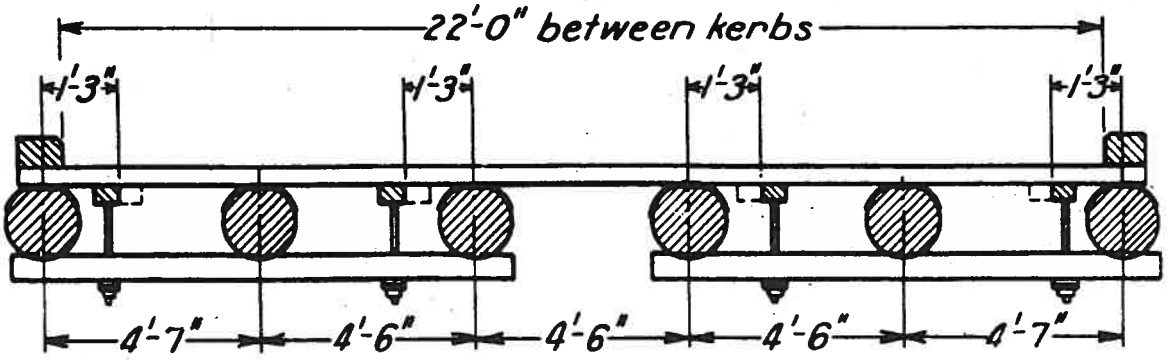
The liquid poison is made by mixing the arsenic powder with caustic soda and water as follows:-

Mix one (1) pound of caustic soda and three (3) pounds of arsenic powder with three (3) gallons of water, in a watertight cask or drum, using a bag for covering and a stick for stirring.

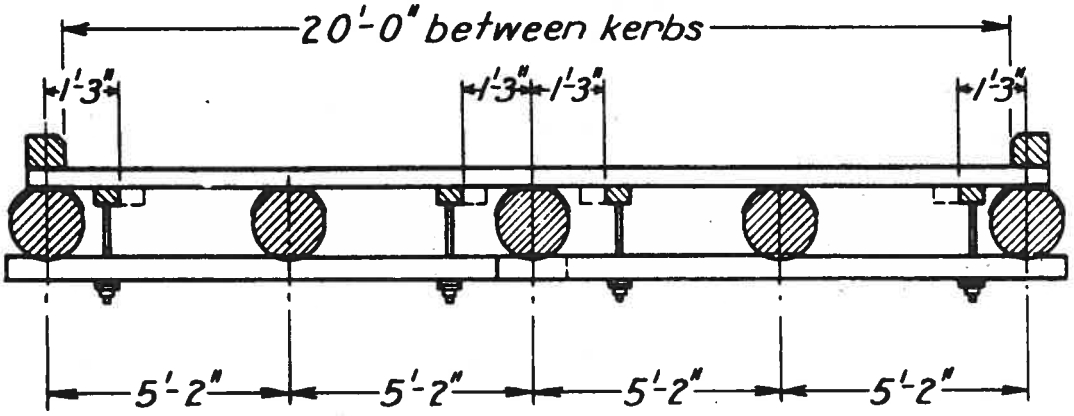
The holes shall be filled with the liquid poison and plugged with wooden plugs projecting sufficiently to allow of easy removal for further treatment.

Liquid poison is not be be used as a spray or to drench rotten timber

(Revised 1962)

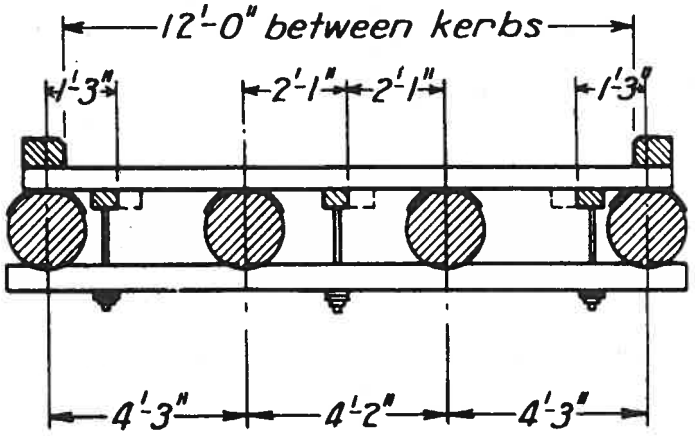


SIX GIRDER BRIDGE



Four rows of bolting planks continuous throughout bridge to be used.

FIVE GIRDER BRIDGE



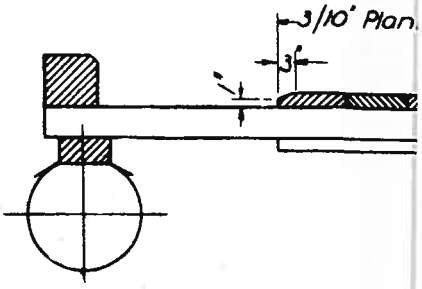
FOUR GIRDER BRIDGE

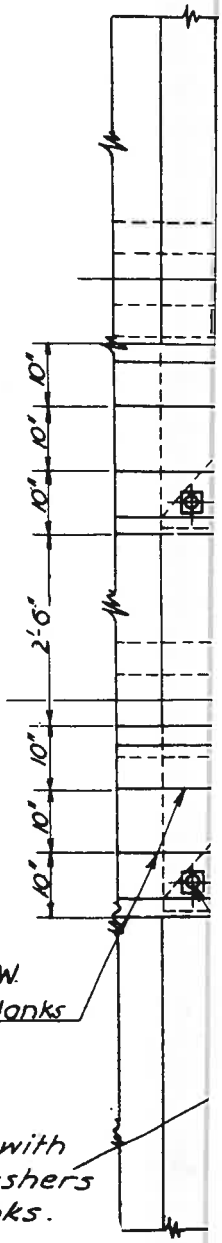
N.B.- All bolting planks and cross pieces 6" x 4".

Scale : ¼ in. = 1 ft.

DEPARTMENT OF MAIN ROADS, N.S.W.

TIMBER BEAM BRIDGES





3/10" x 2" H.W.
running planks

⅝" Square head bolts with
standard round washers
recessed into planks.

REDUC

M. R. Form No. 164.
(*Revised April*, 1947.)

DEPARTMENT OF MAIN ROADS,
NEW SOUTH WALES.

Specification for Timber Beam Bridge.

1. **NOMENCLATURE OF TIMBERS.**—For the purposes of this contract the standard trade common names of the timbers shall be used, and their equivalent botanical and standard trade reference names shall be as listed in the Standards Association of Australia Code No. O.2–1940 " Nomenclature of Australian Timbers." These include the following :—

Common Name.	*Reference Name.*
White Mahogany...	*E. acmenioides.*
Grey Box	*E. hemiphloia.*
Grey Box (Steel Box)	*E. rummeryi.*
Grey Box (Coast Grey Box, or Bosisto's Box)...	*E. bosistoana.*
Yellow Box	*E. melliodora.*
Tallowwood	*E. microcorys.*
White Stringybark	*E. eugenioides.*
Blackbutt	*E. pilularis.*
Grey Gum	*E. propinqua* or *punctata.*
River Red Gum	*E. rostrata.*
Sydney Blue Gum	*E. saligna.*
Forest Red Gum	*E. tereticornis.*
Spotted Gum	*E. maculata.*
Ironbark, Red (narrow-leaved)	*E. crebra.*
Ironbark, Red (broad-leaved)	*E. siderophloia.*
Ironbark (Grey)	*E. paniculata.*
Brush Box	*Tristania conferta.*
Turpentine	*Syncarpia laurifolia.*

2. **USES OF TIMBER.**—The uses of the various species of timber shall be in accordance with the list hereunder. Only one species of timber shall be used in the decking unless the bridge is over 60 feet in length, and then all planks of the same species shall be placed together.

(*a*) *Piles, Sills, Fence Posts.*—Grey Box, Tallowwood, Ironbark. In addition the following will be accepted :—* _____

(*b*) *Girders, Corbels, Capwales.*—Grey Box, Tallowwood, Ironbark. In addition the following will be accepted :—* _____

(*c*) *Decking.*—White Mahogany, Tallowwood, Ironbark, Grey Box, Brush Box, Blackbutt, Forest Red Gum, River Red Gum, Grey Gum. In addition the following will be accepted :—*_____

_____

(*d*) *Kerbs.*—White Mahogany, Tallowwood, Ironbark, Grey Box. In addition the following will be accepted :—*_____

(*e*) *Sheeting* (*abutments and wings*). *Gravel Boards, Spiking Planks.*—Tallowwood, Ironbark, Grey Box, River Red Gum, Grey Gum, Forest Red Gum. In addition the following will be accepted :—*

_____

(*f*) All sawn or hewn timber other than above—as for (*b*) " Girders, Corbels, Capwales." In addition the following will be accepted :—*_____

3. **INSPECTION OF TIMBER.**—Timber shall be inspected at the site of the work, and shall be delivered there at least 4 weeks before use, and all timber shall be on the site before the expiry of half the period for completion of the Contract. No timber shall be used unless passed by the Engineer or Superintending Officer. In addition, timber may be inspected by an Officer of the Department at the mill or railway siding, if so desired by the Contractor. Identification marks will be placed on the timber so passed. Reasonable notice shall be given by the Contractor to the Engineer to enable inspection to be carried out.

* Engineer to insert here names of suitable local timbers.

All round timber not previously inspected shall be delivered at the site with a ring of bark at least 2 feet long left on until the timber is passed and marked by the Engineer or Superintending Officer. Alternatively, a signed certificate from the Forestry Department, naming and identifying the timber, may be accepted. Any timber which is not seasoned at the time of inspection shall be of such sizes as to provide the finished dimensions called for on the drawings when the work is completed.

The passing of any timber at one inspection will not affect the right of the Engineer or Superintending Officer to condemn the same material at any subsequent inspection even if the timber is in position in the work.

4. **STACKING OF TIMBER.**—Immediately on delivery at the site all timber shall be stacked clear of the ground and supported at intervals. Round timber shall be stacked so that each log will be separated from adjacent sticks by at least 3 inches. Squared timber may be stacked as for round timber, and if in more than one layer each alternate layer shall consist of a minimum number of pieces which will prevent permanent set, and each piece of timber shall be separated from those adjacent to it horizontally by a minimum distance of 1 inch.

All timber stacked at the site shall be effectively protected, and should such timber become damaged or unsuitable it shall be rejected and shall be replaced by the Contractor at his own expense.

5. **QUALITY OF TIMBER.**—All timber shall be of the best quality, cut from well-matured trees, seasoned, sound, straight, free from decay, large and loose knots, gum veins, shakes, wanes, pipes, sapwood (sawn and hewn timber only), holes, and other defects, and shall hold fully the sizes shown on the drawings on acceptance of the finished structure. Unseasoned timber of the net sizes shown shall not be used. All squared timber having a cross-sectional area less than 50 square inches, capwales, and any other timber in which one dimension is more than 50 per cent. greater than the other shall be free from heart. Where heart occurs it shall be sound and shall not appear on the outside, and the centre of growth at the ends shall not be less than 2 inches from any face. All squared timber shall be sawn except kerbs and sills which may be hewn, and shall have clean sharp arrises. Hewn timber shall be square, smooth and free from axe marks. Sawn timber shall be cut square.

Round timber shall be of an even taper from end to end, and all irregularities shall be carefully trimmed off. All round timber shall be stripped of bark immediately after felling, except the ring of sound bark required for identification, which shall be removed just before the timber is placed in the work. No bark shall be removed from turpentine piles to be used in tidal waters, and every care shall be taken to protect the bark from damage.

6. **CARPENTRY.**—The whole of the timber work shall be executed in the best style of bridge carpentry. No round timber shall be dressed except as shown on the drawings or specified, and in all cases where the amount of cutting, facing, checking or scarfing is not shown or specified, it shall be referred to the Superintending Officer for his decision. All joints shall be neatly made in order to obtain a tight fit without wedging or packing. Unless otherwise specified or shown on the drawing, each piece of timber shall be without joint for its full length and shall have the ends sawn square, and wrought perfectly true at all contact surfaces.

All holes for bolts, spikes, and other fastenings, shall be truly bored and all mortise holes, tenons, scarfs, and joints shall be cut so as to fit accurately and tightly. Holes for bolts shall be bored with augers, with diameter not more than $\frac{1}{16}$ inch larger than the bolt, except the holes for the cup head bolts through the decking which shall be the same diameter as the bolt. Holes for square spikes shall be of diameter equal to width of shank of spike.

Squared timber shall be so fixed that the surface which was further from the heart of the tree will be the outer surface of the work. The heart side of all squared timber shall be placed downwards, except in the case of bracing and similarly situated members, when it shall be placed next to the timber to which it is fastened.

7. **CONNECTIONS.**—(Ironwork)—Unless otherwise specified or called for on the drawings, all bolts, straps spikes, plates, washers, and other ironwork shall be of best wrought iron or mild steel of uniform quality, free from cracks, scales, blisters, laminations, and all other defects. After manufacture and before leaving the shop all ironwork shall be scraped and cleaned and dipped while hot into boiled linseed oil.

Wrought iron shall conform to the Specification for Wrought Iron Grade A, B.S. No. 51–1939. Mild Steel shall conform to the Specification for Structural Steel A.S. No. A.1–1940.

Screw bolts shall have well forged square or round heads as required, and square nuts with threads accurately and cleanly cut to Whitworth standards for a length of four diameters. All nuts shall be well fitting without play. Lengths of bolts shown on drawings are approximate only, and the Contractor shall supply bolts of the correct lengths. Ends of bolts shall not project more than one-half diameter beyond the nuts.

Single square washers shall be used against timber behind all nuts and bolt heads, excepting in the case of bolt heads sunk flush with surfaces of kerbs, girders and decking, when the heads shall be tightly fitted into square or round holes, as the case may be, without washers. All such countersinks shall be tightly packed with an approved mixture of pitch or bitumen and sand to prevent lodgment of water. The sizes of washers shall be in accordance with the following table :—

Diameter of Bolt.	Size of Washer.		
	Side.	Thickness.	Hole.
$\frac{1}{2}$ inch	$1\frac{1}{2}$ inch	$\frac{1}{8}$ inch	$\frac{9}{16}$ inch
$\frac{5}{8}$ „	2 „	$\frac{3}{16}$ „	$\frac{11}{16}$ „
$\frac{3}{4}$ „	$2\frac{1}{2}$ „	$\frac{3}{16}$ „	$\frac{13}{16}$ „
$\frac{7}{8}$ „	3 „	$\frac{1}{4}$ „	1 „
1 „	$3\frac{1}{2}$ „	$\frac{1}{4}$ „	$1\frac{1}{8}$ „
$1\frac{1}{4}$ „	4 „	$\frac{5}{16}$ „	$1\frac{3}{8}$ „

Wood packings under nuts or bolt heads shall not be used. In addition to the square washer one spring washer shall be provided under the nut of each bolt through the decking.

ADDENDUM TO CLAUSE 7.

Notwithstanding anything contained in this clause connections in the decking shall be as specified in Clause 21.

ADDENDUM TO CLAUSE 21.

Each deck plant shall be secured to each bolting blank by a 5/8" bolt with square head (counterbored into deck planks) square nut 2 circular washers and a special lock washer as shown on the drawing with this specification, also where the yoke bolts occur. The prongs of the lock washer shall be drawn into the timber along the grain by screwing up. The same arrangement shall be used for the 5/8" bolts at the cross pieces (Yoke bolts). All circular and lock washers dipped in red lead, will be supplied by the Department. All bolts shall be dipped in red lead in linseed oil before placing.

The holes for 5/8" bolts shall be bored 11/16" diameter and the planks shall be recessed to a depth to make the head of the bolt flush with the surface. A special tool drilling on 11/16" dia. hole through 8 or 9 inches of timber and finishing by drilling a 2" dia. counterbored hole to the required depth in the one operation may be purchased from the Department.

ADDENDUM TO CLAUSE 23.

The Diameter of the fender posts shown on the drawings shall be one size after removal of sapwood. The posts shall be smooth and free from axe marks.

M. R. Form No. 164.

Delete sub-paragraph 5 of Paragraph b - "Driving" of Clause 12, "Piles" and substitute the following:-

"Piles may be driven by the aid of jets or by first excavating a hole or both. No extra payment will be made either for the use of jets or for the cost of any such excavation made. Where jets are used, before the desired penetration is reached their use shall be discontinued and the piles shall be driven with a hammer to secure final penetration. Carrying capacity shall be by the same test as for driven piles. Where excavation is carried out this may be made by means of a post-hole digger or other approved equipment but the diameter of the hole shall be not greater than the minimum diameter of the pile less 2 inches. The actual depth of the excation is to be determined by experiment and be such that the specified set or better is obtained when the pile is tested at contract level. Notwithstanding this, no excavation is to be taken to a depth closer than 3 ft. of the contract level of the pile."

8. NATURE OF FOUNDATIONS.—The data shown on the drawings as to the nature and depths of the various classes of material underlying the site of the structure are approximate only, and are given merely for the information of the Contractor.

The Contractor must satisfy himself as to the character of the material to be penetrated, and must assume all responsibility and risks involved therein.

9. CLEARING AND GRUBBING.—For the full width of the ground to be occupied by the whole of the work under this Contract when completed (*i.e.*, in other than plain country, from 3 feet from the top of the cutting on the high side thereof to the toe of the slope of the bank and, in plain country, for a width extending to 3 feet on either side of the limits of the formation) and for the extra widths necessary on the inside of curves to provide clear vision, if and where shown on the drawings, all trees, stumps, boulders, roots and scrub, except the trees that the Engineer may direct to be retained for ornamental reasons as specified below, shall be grubbed out to a depth of 12 inches below the finished surface of the roadway and, together with all lying and fallen timber and rubbish of every description, shall be burnt off or, if indestructible by fire, stacked at least 3 feet clear of all works, fence lines, fences, and tracks, as may be directed, within the surveyed boundaries of the road. All timber cleared in accordance with this specification shall become the property of the Contractor, but any timber remaining on the ground after the completion of the Contract shall automatically cease to be the property of the Contractor. Any trees which are, in the opinion of the Engineer, unsound and would, in his opinion, when falling, fall upon the roadway, and any trees or boughs which overhang the clearing, shall be cut down and disposed of. No growing trees shall be destroyed or damaged by the Contractor other than those specified or directed to be cleared. The stumps under embankments may be left in, provided they are covered not less than 2 feet and provided the stumps do not exceed 4 feet in height. On no account shall logs be placed near the toe of embankments to act as retaining walls. Every precaution shall be taken to prevent timber from falling on private property, and the Contractor shall remove at his own cost any timber so fallen or produce the written consent of the owner to it remaining there, before final payment is made. All damage of every kind, including damage to fencing occurring during clearing operations, shall be made good by the Contractor at his own expense.

The Contractor shall give the Engineer 14 days written notice of his intention to clear any section of the work so that the Engineer may inspect the site and determine whether any trees in the area specified to be cleared are of an ornamental nature and may be preserved without dangerous obstruction to the vision of drivers. He will mark or indicate to the Contractor those trees that he desires preserved for ornamental reasons, and the Contractor shall take particular care during the operations of clearing and road construction to avoid damaging or destroying such trees. Should any tree which it is desired to preserve come within the area to be covered by embankment the circumstance shall be brought to the notice of the Engineer, who will decide whether such tree is to be removed or protected by a small arched rubble retaining wall built around the tree trunk, with sufficient clearance to allow for growth and for the removal of debris. Such walls will be paid for as extras in accordance with the General Conditions of Contract.

Grub holes shall be inspected by the Superintending Officer before being filled in and, after approval, shall be filled with good loam, and shall be well consolidated and left higher than the surrounding surface to allow for further subsidence, by an amount of 3 inches per foot of depth.

10. FIRES.—The Contractor shall be responsible for all damage to fences, grass, cultivation, buildings, or other property occasioned by fires lighted for any purpose in connection with this Contract. No fires shall be lighted on the road for the purposes of this Contract during any period gazetted for the particular area under the provisions of the Careless Use of Fires Act, 1912, as amended by the Bush Fires Act, 1930, nor in any case later than the end of November or earlier than the end of March unless authorised in writing by the Engineer. The Contractor shall give the occupiers of adjoining properties 48 hours notice of his intention to burn.

11. PIERS AND ABUTMENTS.—Where piers and abutments consist of piles they shall be driven to the specified penetration, potted or silled, and constructed to the sizes and positions shown on the drawings.

Where shown on the drawings, abutments and wings shall be sheeted with 4-inch planking, 8-inch or 9-inch wide, laid in close contact, and commencing at the level shown on the drawings. Sheeting shall be in single pieces for each abutment and wing except that above a level 8 feet below the capwales; one square butt joint will be allowed in each piece of sheeting, the butt joints to be opposite the centre of a pile. Joints in sheeting shall be staggered. Abutment and wing sheeting shall be attached to piles with one 7-inch spike, either $\frac{3}{8}$-inch square or $\frac{7}{16}$-inch round, at each intersection, except that when two pieces of sheeting are butted one spike shall be used to each piece. Wing sheeting shall rest against the abutment sheeting and the capwales. Outer ends of wing sheeting, where cut on the splay, shall rest against a spiking rail housed into the tops of wing piles and bolted thereto flush with flattened backs of piles. Abutment sheeting shall rest against vertical piles, the piles being faced at back to a width of 3-inches. Saddle-backed wing caps shall be laid along wings and bolted and spiked to spiking rail, wing caps being neatly fitted at junction with kerbs and outer piles of abutment.

After construction of dry rubble walling at the back of sheeting as specified hereinafter, all spaces excavated for sheeting shall be back-filled to natural surface with sound earth, and well consolidated by ramming.

All shouldering and housing in piles for capwales, sills, bracing, wing spiking rails, wing caps, etc., shal be scribed out along the member to be fitted, and shall then be neatly and accurately cut and fitted.

Bolt holes in heads of piles shall be slotted vertically to allow capwales to maintain their seating on shoulders of piles after shrinkage.

Heads of inner piles of abutments and piers shall be cut off square at 1 inch below the top of capwales. Outer piles of piers shall be faced to give a flat bearing against corbels and girders, to which they shall be bolted as shown with bolt holes through piles slotted vertically to provide against shrinkage. Heads of outer abutment piles and of all wing piles shall be neatly bevelled off to the front edges of wing caps, and shall be capped with No. 22 gauge galvanised iron, turned down 3 inches at the edges and secured with 1-inch clouts.

12. PILES.—(*a*) *Description.*—Piles in abutments and piers shall have a minimum diameter at level of underside of capwales of 18 inches, and a minimum diameter at toe of 12 inches. All outer piles in piers and abutments (not wings) must therefore be 18 inches diameter 3 feet 6 inches from the butt. Piles in wings shall have minimum butt and toe diameters of 16 and 10 inches respectively. Each pile shall be pitched sufficiently long to ensure a sound head after driving. Piles for driving shall be pointed and, if shown on the drawings, shall be shod with approved shoes, firmly bedded on the toe of the pile. Shoes shall have malleable cast iron or wrought iron points, as shown on the drawings. When shoes are not required piles shall be driven with sharp or blunt points, as may be directed. Pile heads shall be protected during driving with a wrought iron ring 3 inches deep by 1 inch thick, fitting tightly but not shouldered.

(*b*) *Driving.*—Piles shall be driven truly vertical except where shown battered, with drop hammers weighing not less than 25 cwt. or with steam hammers of equivalent weight, to rock or to such depth that the last four blows of a 25-cwt. hammer falling 8 feet upon the solid head of the pile shall not produce an average penetration per blow greater than the following:—

For piles at least 10 feet in the ground ... ... ½ inch.

For piles at least 20 feet in the ground ... ... ¾ inch.

provided that in the latter cases, if required by the Engineer, the average set of three blows after 48 hours shall not exceed ½ inch. The penetration given above shall be taken under conditions of continuous driving, such that no break exceeding 15 minutes shall occur during the previous 2 feet of driving. If this condition is not fulfilled a set of ¼ inch per blow may be demanded, at the discretion of the Engineer. When the head of the pile is out of reach of the hammer a timber dolly may be used, but when used the weight of hammer or the height of drop shall be increased by 15 per cent. for the specified penetration. The depth of driving shall in no case be less than that shown on the drawings, regardless of the fact that the required set be obtained at a lesser penetration, unless a lesser depth is authorised by the Engineer.

For greater weights of drop hammers and for steam hammers the penetration shall be determined by the Engineer to give the same carrying capacity.

In the event of rock being struck close to the surface of ground the Engineer may direct that piles be potted or silled as specified hereafter, and any necessary adjustment in cost will be made in accordance with the General Conditions of Contract. Should any pile split or crack during driving, or become injured in any way, or prove too short, or become displaced from its true position, it shall be withdrawn at once and replaced by a sound or longer pile as may be required, at the Contractor's expense. No splicing of piles will be allowed except where shown on the drawings. All piles shall be driven in the presence of the Engineer or Superintending Officer, and the pile driver shall not be removed from the head of a pile without his sanction. Each pile, after being dressed ready to drive, shall have its length measured from the toe marked on it with chisel-cut figures at two points 5 feet apart which will be above ground, and with a scriber at one-foot intervals for the 5 feet adjacent to head of pile, and such marks shall not be injured, defaced or removed.

For wing piles, provided the elevation of toe shown on drawings is reached, the test may be waived at the discretion of the Engineer.

Piles may be driven by the aid of jets. Before the desired depth of driving is reached the jets shall be withdrawn and the piles shall be driven with a hammer to secure final penetration. Carrying capacity shall be by the same test as for driven piles.

In case the test specified above cannot be obtained without injury to the pile, or on account of the impracticable length required, the Engineer may direct that the number of piles be increased until the maximum load coming on any pile shall not exceed its safe carrying capacity, or make other variation to substructure design as he may consider necessary. All extra work so ordered will be paid for in accordance with the General Conditions of Contract.

(*c*) *Potting.*—Piles shall be potted into solid rock to the depths shown on the drawings, or as otherwise directed by the Engineer. The rock shall be excavated so that there will be at least 6 inches clearance from rock around the pile after it is placed in position. All loose and fractured rock and rubbish, debris, dirt, etc., and water shall be removed from the hole, and the floor of the hole shall be brought to a uniform surface square with axis of pile, by use of a two to one cement mortar.

The portion of any pile to be embedded in concrete shall be freed from sapwood. The diameter remaining after removal of sapwood shall be not less than 12 inches. The pile shall be cut off square and erected in position. After approval of the foundation by the Engineer or Superintending Officer, the pile shall be placed and the hole shall be tightly filled to surface of rock with cement concrete proportioned by volume consisting of 1 part of Portland cement (1 cubic foot to be 94 lb. in weight), 2 parts of clean, fairly coarse sand, and 4 parts of 1½-inch gauge clean, tough, broken stone or gravel.

Not sooner than 24 hours after placing of concrete the earth excavated to reach rock surface shall be back-filled around piles in 12-inch layers, well rammed, to ground surface.

(*d*) *Silling.*—Piles shall be silled at the depths shown on the drawings or as otherwise directed by the Engineer. The sill shall be in one length, and shall be neatly mortised to take tenons of piles, and dressed to provide uniform bearing to shoulders of tenons. Underside of sill shall be dressed to a horizontal surface, 7 inches wide. In earth excavation the base of excavation shall be dressed to provide a horizontal seating for sill, care being taken to avoid disturbing material below foundation level, and consolidated, if necessary, by ramming, all soft material being removed and replaced or further excavated, as may be directed. For silling on rock the rock shall be excavated to a horizontal bed, freed from all loose and decomposed material, and clean cut to a firm surface at the required level. After approval of foundation by the Engineer a seating of cement concrete shall be constructed to provide a level bed, the concrete being as specified under (*c*) above. The underside of the sill shall be dressed before placing on seating to give a uniform bearing on the seating; sill shall be firmly bolted to seating as shown on the drawings. Bolts shall be grouted into holes drilled in the rock with a cement grout consisting of one part of Portland cement and one part of clean sand. Earth excavated to construct silled piers or abutments shall be back-filled around sill and brought up evenly on all sides of piles in 12-inch layers to the natural ground surface, each layer being rammed.

Where the abutments are silled, wing piles shall be planted in excavated holes to the depths shown on drawings, or as directed by the Engineer, or, if in rock, potted as previously specified. Holes excavated in earth shall be back-filled to ground surface, after piles are placed, in 12-inch layers, well rammed.

(*e*) *Concrete Bases.*—Concrete bases for sills shall be of the form and dimensions shown on the drawings and the concrete shall be composed of 1 part of tested Portland cement, 2½ parts of clean, fairly coarse sand and 5 parts of broken stone or gravel, 2½-inch gauge. All concrete shall be placed in the dry and samples of concrete used or intended to be used in the work shall develop strengths of 1,500 and 2,000 lb. per square inch at 7 and 28 days respectively. Sills shall be firmly bolted to bases as shown on the drawings.

(*f*) *Lengths of Piles and Method of Payment.*—In the schedule of rates, quantities and amounts accompanying their Bulk Sum Tender tenderers shall divide the cost of piling into the following sections :—

1. Supply—per lin. foot.
2. Driving—per lin. foot.
3. Potting—per lin. foot.
4. Silling—per lin. foot.
5. Test pile or piles (if any)—bulk sum.

The rate shown for section 1 shall apply to piles delivered on the site to comply with the amended toe levels as determined by the Engineer following the driving of test piles, or if no test piles are driven then to comply with the levels shown on the drawings.

The rates shown for sections 2, 3 and 4 shall be supplied as required for the particular work under contract and shall apply to the length of pile in place after it is cut off to the correct level.

If no test piles are shown on the drawings or specified all piles shall be supplied to lengths to suit the levels shown on the drawings.

Where one or more timber test piles are shown on the drawings or specified the Contractor shall supply and drive piles of the lengths and in the positions shown or specified.

Should any timber test pile prove too short the Engineer may order such pile to be withdrawn and another driven. Payment for withdrawing test piles shall be in the sum of £2 per pile. Payment for supply and driving additional test piles will be made at a rate per foot obtained by dividing the bulk sum for the original test pile or piles by the original length as specified or as shown on the drawings. No extra payment will be made for the use of a dolly.

Should any test pile be withdrawn it shall become the property of the Department. If of suitable type, size and quality, the Engineer may direct that the Contractor use the whole or portion thereof in the structure as a pile, corbel, etc., and if the test pile be so used a deduction from the bulk sum for the length so used shall be made at rate in the schedule for supply of piles.

Following on the driving of test pile or piles, the Engineer will determine the amended toe levels of all other piles and shall notify the Contractor in writing. The Contractor shall thereupon supply all remaining piles of such lengths as to agree with the new toe levels.

(*g*) *Protection in Tidal Waters.*—

(i) Piles in tidal waters shall be protected with a sheathing of reinforced concrete pipes, if called for on the drawings. The pipes shall be of approved make with devices for thoroughly clamping together adjacent sections of pipe. The sheathing shall extend between the levels shown on the drawings, unless otherwise directed.

Reinforced concrete pipe shall be sound and straight and free from cracks, chips, porous spots, and other defects; patched or plastered pipe will not be accepted. The pipe shall be in lengths of not less than 3 feet, having ends true planes square to the axis of pipe.

Pipes shall be truly circular and the internal diameter of pipe shall be such as to give at least 3 inches clearance between pipe and pile at all points.

Pipes shall be at least 1½ inches thick and constructed of cement mortar, consisting of three parts of clean, sound and well graded quartz sand and one part of tested cement. Each pipe shall be reinforced centrally in its thickness throughout its length with No. 12 gauge mild steel wire, placed spirally and making not less than fifteen complete circuits per lineal foot with longitudinal wires to prevent displacement, or such other equivalent reinforcement as may be approved. It shall be protected from rapid drying and shall be cured for at least 4 weeks before use.

Joints shall consist of approved steel clamps, evenly spaced around the pipe, and a mortar " bandage " made with cement mortar, scrim and wire-netting, as follows :—Grout the top end of the length of pipe with a thin layer of cement mortar, consisting of 2 parts of sand to 1 part of cement, place the next length on top, taking care to see that clamp holes are opposite, and press it well down as tightly as possible. Wet the joint recess with a thin layer of cement mortar, press the clamps into position, pass the scrim and wire netting tightly around the pipe, join the ends by hooking the strands tightly together, and twisting with pliers. Spread another layer of mortar around and on the joint covering the scrim and netting, and finish off flush with outside of pipes.

Pipes shall be sunk after the piles are in place, using water jet or other means. After completion of sinking the space between pile and pipes shall be carefully cleaned out and packed for a depth of 3 feet from the bottom of pipes and for a length of 2 feet at the top of the pipes with cement concrete consisting of 1 part of Portland cement (1 cubic foot to be 94 lb. in weight), 2 parts of clean, fairly coarse sand, and 4 parts of clean, tough, broken stone or gravel, broken to ¾-inch gauge. The top of concrete shall be neatly finished off with a radial batter outwards of 1 horizontal to 1 vertical. The intervening space in the pipes between the top and bottom portions of concrete shall be filled with clean sand.

In order that any necessary adjustment for length may be made, a half length of pipe may be used at the top, or concrete may be extended neatly above and flush with pipes to a maximum height of 12 inches.

(ii) Metal sheathing shall be attached to piles or bracings in tidal water, if called for on the drawings. It shall extend between the levels shown on the drawings, or as directed. Before piles are driven the length to be sheathed shall be freed from sapwood, and tarred. Interior surface of the metal sheathing shall also be tarred.

Metal shall be approved copper or muntz-metal, uniform in thickness and quality, weighing not less than 16 oz. per square foot. It shall be neatly attached to the timber with clout nails 1 inch long, made from material of similar composition to the sheathing. Nails shall be 1 inch apart at all joints, and 6 inches apart (staggered) in intermediate rows, 3 inches apart. Joints shall have an overlap of 1½ inches. The lower edge of the metal sheathing shall be let into the pile to prevent stripping during driving. All bolts passing through metal sheathing shall be of approved yellow metal.

13. **CAPWALES.**—Capwales shall be placed in position, and holes for bolts shall be bored through capwales and pile, holes being staggered as shown. Capwales shall then be removed from piles, and holes through piles slotted downwards, after which capwales shall be replaced and bolted in position.

Ends of capwales shall be neatly capped with No. 22 gauge galvanised iron, attached with 1 inch clouts.

14. **BRACING.**—Where bracing is shown, it shall bear against each pile on a flat surface, the brace to be checked into the pile at least 1 inch. Braces shall extend at least 6 inches beyond end bolts, and shall be cut off square.

15. **CORBELS AND GIRDERS.**—Girders shall have square butt joints over centre of piers, and shall project over abutments as shown on drawings. Outer girders shall comply with the requirements of Clause 23, "Handrailing," hereunder. The upper sides of corbels, and the undersides of girders where they rest on corbels, sills or capwales, shall be flattened as shown on the drawing to give at least 8 inches horizontal width. Checks of corbels and girders over sills or capwales shall be square, and shall form a neat and tight fit. Checks of girders over corbels shall be neatly finished at the splay as shown on the drawings.

The tops of girders shall be flattened to give at least 6 inches horizontal surface to deck planks. Underside of girders and corbels shall be dressed at each bolt only sufficiently to give uniform bearing to washers, and not continuously for their full length. Undersides of girders and corbels shall be notched ¼ inch deep to give uniform bearing to the cross pieces through which pass the bolts for clamping down the deck.

The diameter of corbels shown on drawings shall be the minimum diameter before dressing as above.

The diameter of girders shown on the drawings shall be the minimum diameter at centre before dressing as above, and the finished depth over dressed faces at ends shall be not less than shown on the drawing. The minimum diameter of girder at small end shall be such that the abovementioned requirements can be fulfilled.

In low level bridges where shown on the drawings the girders shall be faced on one side to give uniform bearing 6 inches wide for the nosing pieces through which pass the bolts for clamping-down the deck.

16. **DAMPCOURSE.**—After girders are erected they shall be covered along the top with a strip of approved dampcourse not less than 18 inches wide.

Dampcourse shall have a minimum thickness of 0·11 inches and a minimum weight of 8½ oz. per square foot, and shall consist of at least 75 per cent. of bitumen, reinforced by hessian or other woven material (not felt or paper) not less than 8 and not more than 12 per cent. of the total weight, the remainder being an approved filler. After immersion in water at 41° F. (5° C.) for one hour, the dampcourse shall withstand bending in 2 seconds 180° round a 3-inch diameter mandrel without cracking.

Samples for testing will be taken by the Superintending Officer when the material has been delivered at the site of the work. Alternatively, samples may be submitted to the Department's Head Office prior to purchase.

Dampcourse shall be laid continuously along each line of girders, joints being lapped 2 inches and shall be attached to girders with two rows of approved broadheaded tacks at one foot centres. Joints shall be painted with dampcourse cement and tacked.

17. **BOLTING PLANKS.**—Bolting planks of the lengths shown on the drawings shall be provided for the full length of the deck up to the outer faces of the gravel boards, which shall be checked out to receive them. These planks need not be secured to the gravel boards nor bolted together where they overlap.

18. **CROSS PIECES.**—Where the Superstructure will be above high flood, cross pieces spaced as shown on the drawings shall be provided. The underside of girders and corbels shall be notched ¼-inch deep as herein specified to correctly locate and give uniform bearing to the cross pieces. The latter shall not be fastened to the girders, but shall be held in place merely by the ¾-inch bolts which pass through them, the bolting planks and the decking.

19. **NOSING PIECES.**—In low level bridges the cross pieces shall not be used, but nosing pieces secured to the sides of the girders with ¾-inch bolts shall be provided where shown an the drawings. These pieces shall be in not more than two lengths per span, butt-jointed and, at abutments shall finish at ends of girders.

20. **GRAVEL BOARDS.**—Gravel boards to retain the stone and earth filling shall be placed across ends of girders and attached thereto by ¾-inch square or $\frac{7}{16}$-inch round spikes 8-inches long, one at each intersection. Gravel boards shall extend to underside of girders, and if in more than one length for the full width of the bridge, shall be butt-jointed at the centre of a girder. The top edges of the upper boards shall be checked out to allow the bolting planks to extend to their outer faces.

21. DECKING.—Decking shall consist of sawn hardwood planking, each plank 8, 9 or 10 inches wide by 5 inches thick in one piece for the full width of the bridge. Planks shall be laid flush, cramped close, and where cross pieces are to be provided so that the centre line of each cross-piece below the girders is approximately coincident with the centre-line of a plank. All inequalities in thickness of planks shall be adzed down to provide a smooth surface. The heart side of the timber shall be placed downwards. Planks shall be laid square or skewed to the centre-line of the bridge as shown on the drawings.

Each deck plank shall be secured near its ends to the outer girders by one $\frac{3}{4}$-inch square or $\frac{7}{16}$-inch round spike 8 inches long, under each kerb, and to each longitudial bolting plank by one $\frac{5}{8}$-inch by 10-inch cup head bolt, except where the $\frac{3}{4}$-inch square head bolts occur at the cross pieces. Where cross-pieces are not used the deck shall be firmly clamped down by $\frac{3}{4}$-inch bolts at approximately 5 feet centres passing vertically through the decking, the bolting planks and the nosing pieces as shown on the drawings. The holes for the spikes shall be bored through the planks on a slight slope towards the centre of, and not more than $2\frac{1}{2}$ inches into the girders. The holes for the $\frac{5}{8}$-inch bolts shall be bored the same diameter as the bolt (the square portion of the shank being forced into the round hole), and the deck planks shall be recessed the same diameter as the head of the bolt for a depth to make the heads flush with the surface.

The holes for the $\frac{3}{4}$-inch bolts shall be bored $\frac{13}{16}$-inch diameter, and the heads shall be tightly fitted into square holes without washers, so that the heads are flush with the surface of the decking.

Washers are not required under the heads of bolts countersunk into the decking, but one square washer and one spring washer shall be provided under the nut of any such bolt.

The ends of the deck planks shall be sawn off flush with the outer edges of the kerbs, and in a regular manner, as shown on the drawings.

All countersinks in decking for bolt heads shall be tightly packed with an approved mixture of pitch or bitumen and sand to prevent lodgment of water.

22. KERBS.—Kerbs shall be of sawn or hewn timber, neatly finished with chamfered edge and of lengths as shown on drawings, and shall extend to fender post of bridge approaches if shown on the drawing. Joints in kerb shall be scarf joints tightly fitted. Kerbs shall be held in position by bolting through outer girders as shown on drawing. The surface of decking on which kerb is to rest shall be adzed to a true plane for the full length on each side of the bridge, so that a firm bearing will be made against every plank.

23. HANDRAILING.—Where shown on the drawing handrailing shall be provided consisting of rails and posts of dressed sawn timber. Intermediate posts shall have the top birdmouthed to receive top rail, and notched to receive lower rail, where any such rail is required. The hole for bolt which attaches post to the kerb shall be slotted vertically in the post, the bolt passing through the upper half of the hole. The handrail posts shall be fitted tightly against the kerbs and girders with vertical contact faces. The post may be cut for this purpose alongside the girder and corbel up to an amount of 3 inches and/or the girder may be recessed to accommodate the post, but the face of such recess shall not be less than 6 inches from the centre line of the girder. End (fender) posts shall be as shown on the drawing, firmly set in the ground of approaches accurately mortised to receive upper and lower rails; tops of posts shall be neatly rounded and finished with a wrought iron ring, tightly fitted. Rails on the bridge shall be in lengths of not less than two bays. Upper rails shall be laid on birdmouthed tops of posts, and attached to posts by wrought iron straps and bolts as shown, and shall be jointed over posts with horizontal scarfs 4 inches long. Lower rails shall rest in notches in posts and be bolted to posts as shown. Joints in lower rails shall be vertical scarfs 4 inches long, staggered with joints in top rails.

Where shown on the drawing two rows of galvanised steel fencing wire, No. 8 gauge, shall be placed passing through clearance holes bored in posts, and tightly strained in position with $\frac{1}{2}$-inch galvanised eye bolts 24 inches long, which shall be provided at both ends of the bridge through the fender posts.

24. PETROLEUM JELLY.—The ends of all piles, girders, corbels, capwales and bracing shall be treated with petroleum jelly applied hot as soon as delivered to the site. The ends of any such members sawn-off to correct lengths in the finished work shall be re-treated.

25. WOOD PRESERVING OIL.—Except where specified to be painted, tarred or treated with petroleum jelly, all surfaces of all sawn and hewn timber, and all piles for their full length except for use in tidal waters, shall receive two coats of creosote before being placed in position. All joints and butting surfaces shall be especially well payed and, in the finished work, oil shall be poured into the interstices and joints.

All oiling shall be completed before painting is commenced and oil shall not be applied during or immediately after wet weather or while the surface of the timber is wet. An interval of at least 48 hours shall elapse between each application.

Creosote shall conform to the S.A.A. Specification for Creosote A.S. No. K.55–1936.

26. TARRING.—Upper surfaces of deck planks shall, when laid, receive one coat of approved distilled coal tar, applied hot, and shall then be lightly sprinkled with clean coarse sand. Surfaces of members to be sheathed with muntz-metal, as well as the interior of the metal sheathing, shall be tarred before fixing as herein specified.

All tarring shall be completed before painting is commenced, and tar shall not be applied during or immediately after wet weather or while the surface of the timber is wet.

27. PAINTING.—After treatment of parts of structure with creosote, petroleum jelly and with tar, the posts and handrails and tops of kerbs including chamfered edge, shall be knotted, primed with one coat of red lead and raw linseed oil, and stopped with putty, and then painted with three coats of approved paint, consisting of best quality red lead for first coat and white lead for second and third coats, all mixed with

raw linseed oil. All checks, joints, etc., which will be inaccessible after the timber is erected shall receive two coats of paint before erection. The whole of the exposed ironwork, including bolt heads, nuts and washers, shall be cleaned and painted with two coats of approved black metallic paint. No painting shall be done during or immediately after wet weather or while the surface of the timber is wet. An interval of at least 48 hours shall elapse between the application of successive coats of paint, and each coat must be completely dry before the next is applied.

28. PROTECTION AGAINST WHITE ANTS.—Before placing the decking, holes ⅞-inch diameter shall be bored in end girders, 1 foot from abutment ends. Holes shall clear the decking, passing downwards approximately through the centre of the girders, the depth being two-thirds the diameter of the girder.

A hole shall be bored in each pile 1 foot above the natural surface and another hole 6 inches from the underside of capwales. Holes in piles shall slope downwards at a slope of 1 in 2, passing through the centre of the piles to within 6 inches of the opposite surface.

Arsenic powder and caustic soda will be supplied by the Department and these shall be mixed with water in the proportions indicated on the labels attached to the containers. The holes shall be filled with the liquid and immediately stopped with wooden plugs.

Holes shall be so placed that the plugs may readily be removed for further treatment.

The solution is poisonous to all forms of life and the greatest care shall be taken with the materials. The poison shall be locked up when not in use and all vessels shall be clearly branded "Poison." The Contractor shall take all responsibility for the use of the poisonous mixture.

29. DRY RUBBLE WALL.—Where abutments and wings are required to be sheeted, dry rubble walling shall be constructed to the dimensions given on the drawing. The walling shall be handpacked and of tough, durable stones of approved quality, laid roughly coursed, at least 25 per cent. of the stones being bond stones, *i.e.*, large, flat stones, overlapping two rows immediately beneath. The bed and side joints need not be dressed, but all thin and sharp projections shall be knocked off; bond stones to be roughly squared. The base of walling shall be on a horizontal and compact foundation level with bottom of timber sheeting of abutments and wings respectively. The walling shall be built tightly against the sheeting, interstices between the larger stones being filled by wedging in smaller stones. The top of rubble walling adjacent to wings shall be built of large stones sloped to conform to the surface slope of the embankment.

30. ROCK FILL.—Where indicated on the drawings or where directed by the Engineer, embankment shall be constructed of or protected from washing or slipping by rock fill, which shall be hand-packed of sound durable stones not less than ½ cubic foot in volume, the spaces between the stones being filled with spalls securely rammed into place.

31. STONE PITCHING.—Where indicated on the drawings or where directed by the Engineer, earth or rock slopes shall be faced with hand-packed pitching stones.

The stone pitching shall be of sound, durable stone, hammer dressed and at least 1 cubic foot in volume. The stones shall be placed in horizontal courses, the larger stones being used in the bottom and the smaller ones at the top, the minimum thickness at right angles to slope being 9 inches. The stones shall be laid in close contact so as to break joints, the weight of all stones being carried by earth or rock fill, and not by adjacent pitching stones. The spaces between the stones shall not exceed ½ inch in any case.

Where the nature of the stone will not permit of this, the Engineer may allow interstices up to 2 inches, but these shall be filled with 1 to 3 cement mortar. When interstices are grouted, weep holes for drainage shall be provided at intervals of 5 feet both vertically and horizontally.

The finished wall shall present an even, tight and reasonably smooth surface of the required contour.

32. FORMATION.—Where the formation of approaches is included in the Contract, such work shall be carried out in accordance with the specification for formation, the typical cross-section, the setting-out diagram for horizontal curves and the tabulated transitions attached herein.

Where the formation of approaches is not included in the Contract, but the new structure replaces an old structure with existing approaches at the same site, filling shall be placed behind the abutments and wings to the level of existing approaches to connect same to the new structure in a regular and approved manner.

All filling to a distance of 10 feet back from abutments and wings shall consist of approved gritty loam or gravel, free from clay, carefully spread and rammed in layers not exceeding 12 inches in depth and with batters as shown on drawings.

33. PAVEMENT.—Where pavement on approaches is included in the Contract, it shall be carried out in accordance with the specification for gravel pavement, the typical cross-section, the setting-out diagram for horizontal curves and the tabulated transitions therefor attached herein.

34. FENCING.—Where fencing is included in the Contract it shall be carried out in accordance with the specification and drawings therfor attached herein and shall be connected to bridge railings.

35. PROVISION FOR TRAFFIC.—(*a*) *General.*—The Contractor shall provide and maintain a temporary crossing for traffic during the construction period of the new structure as shown on drawings and or specified below. The Contractor shall observe all provisions hereunder unless departure from any of these provisions is authorised in writing by the Engineer. Should the Contractor fail immediately to remedy any defect of the temporary crossing or that portion thereof being used for traffic, the necessary work may be carried out by the Department or Council and the cost thereof shall be borne by the Contractor in accordance with the General Conditions of Contract.

Signs, lights, barriers, etc., for traffic shall be provided and maintained by the Contractor in accordance with M.R. Form 121 attached herein.

(*b*) *Use of Existing Bridge or Culvert.*—The existing bridge or culvert shall be used for traffic during the construction of the new structure. If shown on drawings the Contractor shall demolish that portion of the existing bridge which is necessary to clear the new structure. Alternatively the Contractor shall move the existing structure to a position shown on the drawings or approved by the Engineer. The minimum clear width for traffic shall be 10 feet at any stage of the work unless a smaller width is shown on drawings. The Contractor shall maintain the temporary crossing together with approaches for a distance of 100 feet from each end of the deck or as shown on the drawings in as serviceable a condition as when handed over until the new structure is opened to traffic or expiration of maintenance period, whichever is the earlier.

(*c*) *Use of Existing Causeway or Ford.*—When the existing causeway or ford is used for traffic the Contractor shall maintain the crossing and the immediate approaches for a distance 200 feet greater than the length of the new bridge or as shown on the drawings in as serviceable a condition as when handed over until the new structure is opened to traffic or expiration of maintenance period, whichever is the earlier.

(*d*) *Construction in Half Widths.*—When the new structure is wholly or partially on the same site as the existing structure or when called for on drawings, the latter may be partially demolished prior to the construction of the new bridge and/or the new structure constructed in half widths, if such method be shown on drawings. The order of this work in this case shall be strictly as shown on the drawings and the minimum clear width for traffic shall be 10 feet at any stage of the work, unless a smaller width is shown on the drawings. The Contractor shall maintain that portion of the existing structure not demolished and still used for traffic in as serviceable a condition as when handed over until the first half of the new structure is open to traffic.

(*e*) *Temporary Bridge or Ford.*—The Contractor shall provide and maintain a temporary bridge or ford as shown on drawing or as directed by the Engineer, at a location approved by the Engineer, together with approaches graded not steeper than 8 per cent. and of sufficient length to connect with the existing roadway at both ends. The crossing and approaches shall be at least 10 feet wide for traffic of a maximum vehicle load of 12 tons on 4 wheels having $\frac{1}{4}$ of the load on one axle, and shall comply in any other respect with M.R. Form 121 attached herein.

(*f*) *Maintenance of Temporary Crossing.*—The Contractor shall maintain the temporary crossing as specified above until the new structure is opened to traffic or expiration of maintenance period as defined in the General Conditions of Contract, whichever is earlier in point of time. The Contractor shall demolish all parts of the temporary crossing when no longer required for traffic.

(*g*) *Retention of Temporary Crossing.*—The Department or Council reserves the right to retain the temporary crossing beyond the expiration of the maintenance period, in which case the value of material in the temporary crossing shall be deemed to equal the cost of demolition. In this case all material in the temporary crossing shall remain the property of the Department or Council and the Contractor shall be acquitted of his obligation to demolish the temporary crossing. All signs, lights, barriers, etc., provided by the Contractor in accordance with M.R. Form No. 121 shall remain the property of the Contractor, and shall be removed on expiration of the maintenance period.

(*h*) *Demolition of Temporary Crossing.*—Should the temporary crossing be demolished by the Contractor the provisions contained in the clause Demolition of Existing Bridge or Culvert shall be deemed to apply in every respect to the temporary crossing also.

36. **DEMOLITION OF EXISTING BRIDGE OR CULVERT.**—The existing bridge or culvert, after completion of use as a temporary crossing if so required, shall be dismantled and removed from the site. All earth and rock in old approaches shall be removed clear of the waterway to the satisfaction of the Engineer.

All material removed from the old structure, excluding approaches, shall become the property of the Contractor and shall be removed by him from the site at his own expense and to the satisfaction of the Engineer. The old approaches shall be levelled off and the site left in a neat and acceptable condition. If suitable and required surplus filling may be placed in the approach embankments to the new structure as directed by the Engineer.

If, in the opinion of the Engineer, the retention of the old approaches will not result in the restriction of the waterway he may order that they be not removed or only partly removed, and, on account of such reduced work, he may direct that the Contractor receive lesser payment by an amount determined in accordance with the General Conditions of Contract.

The work of demolition of the existing structure shall be undertaken in accordance with the requirements of clause Provision for Traffic.

For the purpose of this work the approach fences (if any) on embankments shall be considered to form part of the existing structure.

37. **TEMPORARY OFFICE.**—The Contractor shall supply and erect a movable wooden office with weatherboard sides for the sole use of the Engineer or his representative appointed to superintend the works. Such office shall not be less than 8 feet by 6 feet by 8 feet high inside measurement, with boarded floor, movable glazed windows and door with lock. If a stove is provided by the Department or Council the Contractor shall instal it and provide the necessary flue. It shall be ventilated and weather-proof, and furnished with an approved drawing table, office stool, table with drawers, chair and wash-hand basin and jug. The Contractor shall have the office kept clean and in good order and upon completion of the Contract the office and fittings, other than the stove (if any), shall remain the property of the Contractor and shall be removed by him at his own expense from the site of the works.

38. **EXCAVATION OF CHANNEL.**—Excavation of the stream channel, if any, shall be carried out as shown on the drawings, and shall extend thence to join in a regular and approved manner with the existing stream bed. Any excavation of stream channel remaining after the completion of the structure other than shown on the drawing or specified, shall be back-filled in accordance with this specification.

39. REFLECTORS.—Two sets of "Catseye" reflectors provided by the Department shall be fixed by the Contractor, one at each end of the bridge on that end post on the left-hand side as the bridge is approached by road from either end, as shown on the drawings.

40. NAME PLATES.—Two name plates provided by the Department shall be fixed by the Contractor one at each end of the bridge on that end post (or in the case of bridges without end posts on the top of the kerb) on the right-hand side as the bridge is approached by road from either end. The position of the posts and the method of fixing shall be as shown on the drawings.

41. OPENING TO TRAFFIC.—The completed structure shall not be opened to traffic until authorised in writing by the Engineer, but such authorisation shall not relieve the Contractor of any of his obligations under this Contract.

42. MAINTENANCE.—The Contractor shall take all risks as to the stability of the bridge. After completion and before expiry of the period of maintenance set forth in the General Conditions of Contract, the Contractor shall make good to the satisfaction of the Engineer any failure of the whole or any portion of the structure; and in the event of his failure to commence such work within 14 days of such failure the necessary work may be carried out by the Department or Council, and the cost thereof borne by the Contractor in accordance with the General Conditions of Contract.

43. POSSESSION OF GROUND.—The time for completion shall be _____ weeks from date of acceptance of tender as stated in the General Conditions of Contract.

Where the approaches are not included in the bridge contract the Contractor shall vacate any ground which will be covered by the approaches to enable such approaches to be built when, in the opinion of the Engineer, the ground shall no longer be necessary for the purpose of actual construction.

BRIDGES 15

DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

Manual No. 6

BRIDGE MAINTENANCE

Methods to be followed in the Inspection, Testing and Maintenance of Bridges

Prepared for the use of Department of Main Roads bridge maintenance foremen and recommended as a guide to Municipal and Shire Councils

Costing

ISSUED 1962