

# MAIN ROADS

A Record of the activities of the  
Department of Main Roads, N.S.W.



Bridge over the Darling River at Bourke.

SEPTEMBER

1947

# MAIN ROADS.

Issued Quarterly by and with the Authority of the Commissioner for Main Roads.

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*Vol. XIII No. 1*

*Sydney, September, 1947.*

*Price: One Shilling.*

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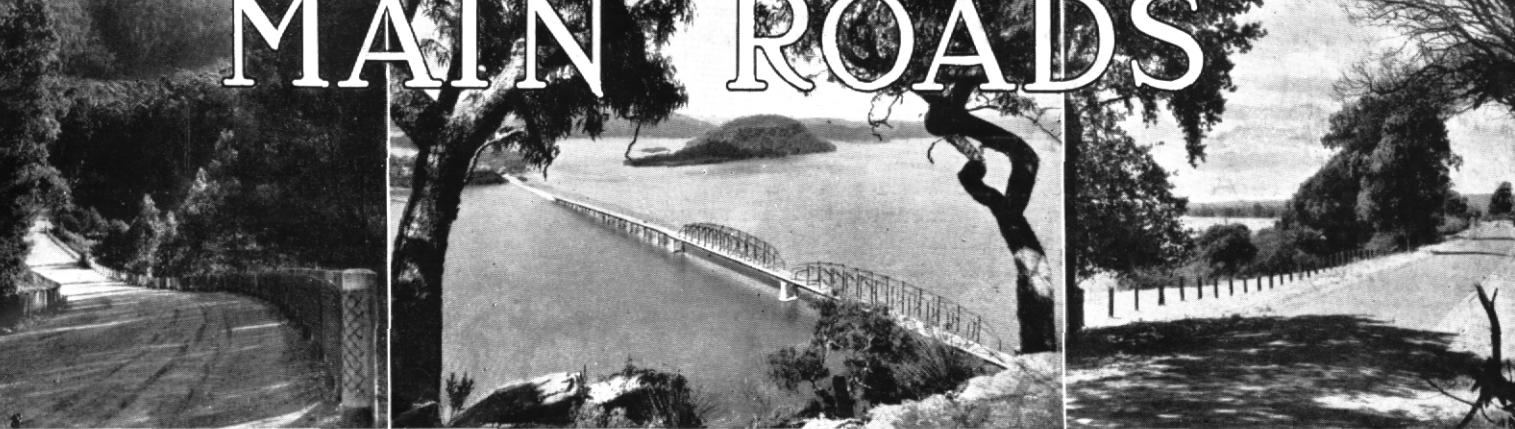
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*Next Issue: December, 1947.*

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## Trend in Motor Vehicle Registration in New South Wales.

Motor vehicles registered in New South Wales in 1910 numbered 4,478. The increase during the twelve years which followed to 1922 averaged just over 4,000 a year, but a rapid rise took place from that time until the beginning of the financial depression at the end of 1929, the increase averaging approximately 28,000 each year. The pre-depression maximum registration was 251,348. The recession to 207,178 at the 30th June, 1932, was only temporary, and from then up to the war period registrations again rapidly increased until the peak of 329,219 was reached at the 31st August, 1939.

The conditions following the outbreak of war, including the enlistment of defence personnel, resulted in a slight decrease of registrations, and this was accentuated when the imposition of petrol rationing in September, 1940, restricted the use which owners could make of their vehicles. The minimum number of

registrations during the war was 266,829 at the 31st October, 1942, since when there has been a progressive recovery, particularly following the end of hostilities and the gradual easing of petrol restrictions.

Although the rationing of petrol has not yet been entirely removed, there are now more vehicles registered than at any previous time, the figure being 358,450, at the 30th June, 1947. Motor vehicles are still in short supply and new vehicles can only be obtained under a system of priorities, but it is apparent that if sufficient vehicles were available to meet the demand, the number on the road would increase considerably.

There were 11.4 motor vehicles registered in New South Wales per 100 of population at the 31st March, 1947 (one vehicle to each 8.8 persons). A comparison with the position in other States of the Commonwealth is as follows:—

|                                               | Number of Motor Vehicles registered (excluding tractors, trailers and traders' plates). | Number of Motor Vehicles per 100 of Population. | Number of Persons per Motor Vehicle. |
|-----------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------|
| New South Wales ... ..                        | 334,197                                                                                 | 11.4                                            | 8.8                                  |
| Tasmania ... ..                               | 30,674                                                                                  | 12.1                                            | 8.3                                  |
| Victoria ... ..                               | 289,193                                                                                 | 14.1                                            | 7.1                                  |
| Queensland ... ..                             | 155,845                                                                                 | 14.2                                            | 7.1                                  |
| Western Australia ... ..                      | 70,689                                                                                  | 14.2                                            | 7.0                                  |
| South Australia ... ..                        | 108,771                                                                                 | 16.9                                            | 5.9                                  |
| Australian Capital Territory, Canberra ... .. | 2,628                                                                                   | 17.2                                            | 5.8                                  |
| Northern Territory ... ..                     | * 3,463                                                                                 | 65.1                                            | 1.5                                  |
| Total ... ..                                  | 995,460                                                                                 | 13.3                                            | 7.5                                  |

\*As at 30th June, 1946.

The only other countries in the world where there are more motor vehicles in proportion to population than in New South Wales and Australia are the United States of America, New Zealand and Canada, the number of persons per motor vehicle in those cases being approximately 4, 5 and 7 respectively.

Apart from the rapid growth in the total number of motor vehicles in New South Wales over a comparatively short period of time, there have been marked changes during this period in the proportions of the different types of vehicles used. When first introduced, the motor vehicle was a novelty, the unreliability of which caused its use to be confined to those with a particular flair for locating and repairing mechanical faults. As its efficiency improved, the motor vehicle in its next stage became a luxury used almost entirely for pleasure, and it was constructed for the most part in the form of a car or a motor cycle. Almost half of the motor vehicles in New South Wales in 1910 were motor cycles either solo or with side cars attached, but the improvement of design of car bodies, including the introduction of the sedan type and the development of light cars saw the decline of motor cycles which are now small in number compared with cars.

It was not until about thirty years ago that the performance of motor vehicles advanced to a stage where they became a sound proposition for business

purposes. In 1915, for instance, commercial vehicles represented only 4 per cent. of all motor vehicles; there has been an extraordinary increase since then in both the number and proportion of commercial vehicles. The decline in the number of commercial vehicles in use during the depression, and also during the war, was slight compared with other types of vehicles, and their increase since the war has been rapid. There were 77,503 commercial vehicles registered at the 30th June, 1939 (24 per cent. of total motor vehicle registrations), whereas the number at the 30th June, 1947, was 114,722 (32 per cent. of total motor vehicle registrations).

Commercial vehicles, on the average, are heavier than cars and motor cycles, and the wear and tear on road pavements has been increased to an appreciable extent as the result of the rise in the number of these vehicles in use. Apart from the weight factor, the mileage travelled by commercial vehicles is, on the average, much greater than by cars and motor cycles, both in normal circumstances, and as affected at present by the incidence of petrol rationing.

The total number of motor vehicles registered in New South Wales each year since 1910, according to type, is shown in Diagram No. 1. The proportion of the various types of vehicle to the total number in operation since 1910 is shown in Diagram No. 2.

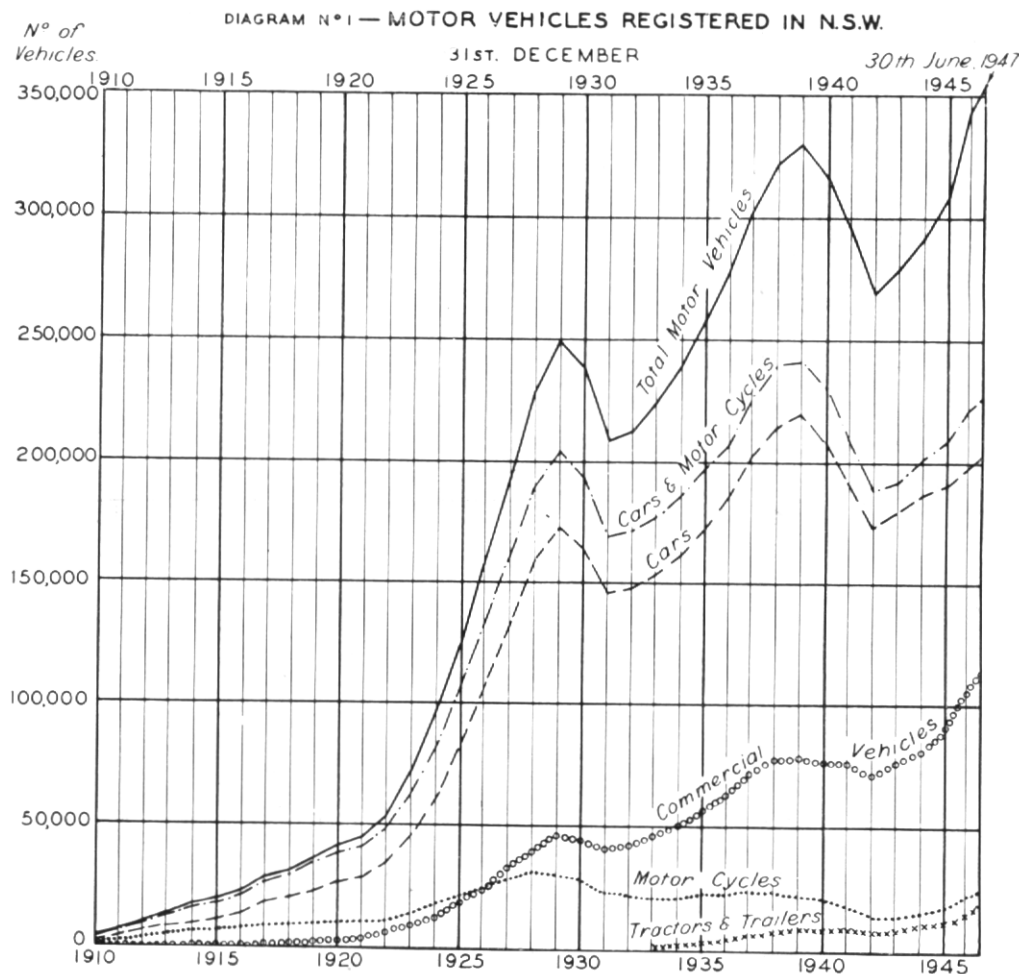
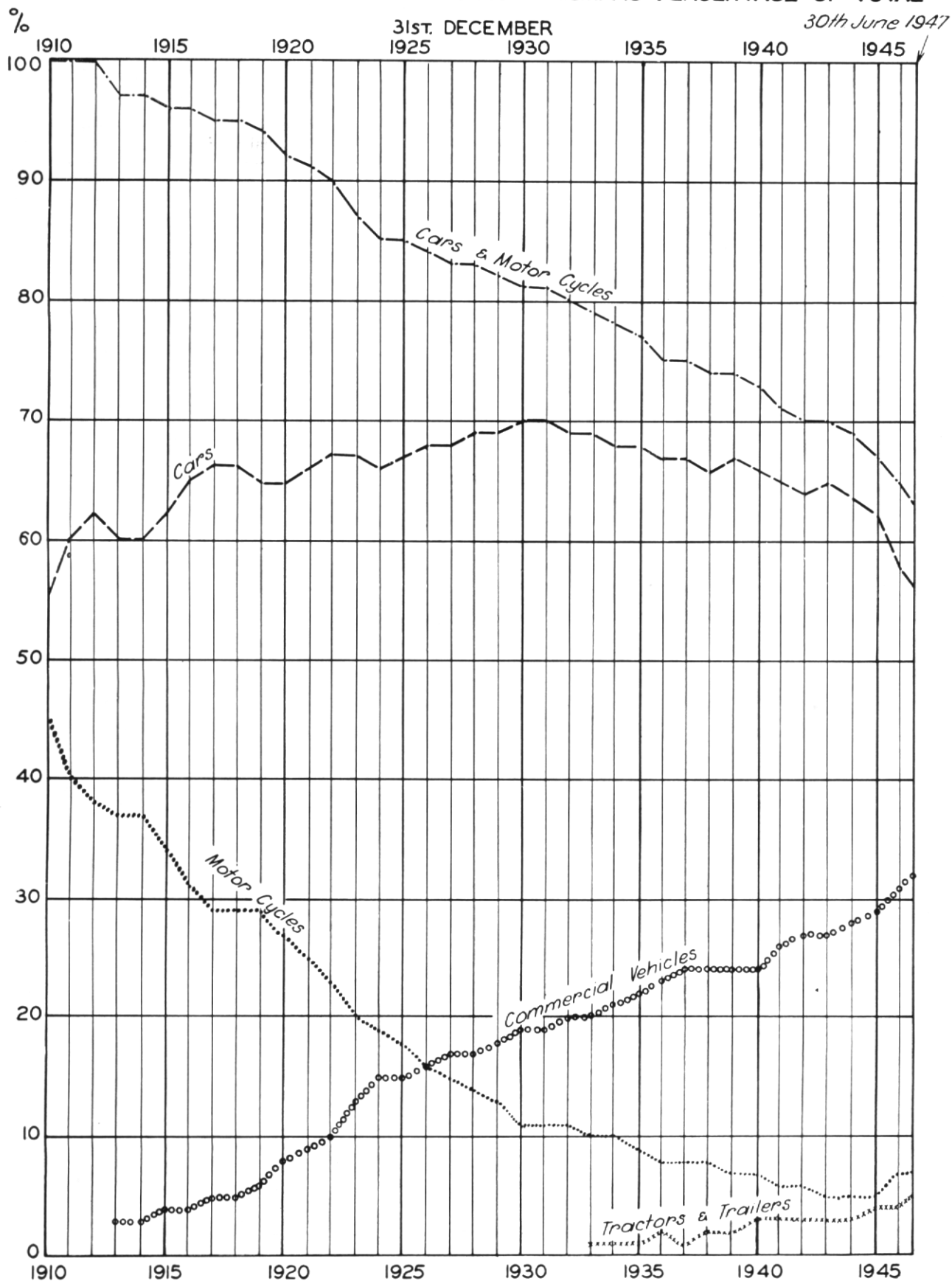




DIAGRAM Nº 2—TYPES OF MOTOR VEHICLES IN N.S.W. AS PERCENTAGE OF TOTAL



# The Design of Forms and Falsework for Concrete Bridge Construction

## 1. INTRODUCTION.

This article embodies methods and details of design of forms and falsework for reinforced concrete bridge construction as used by the Department. It is hoped that the publication of the information will assist engineers and contractors in obtaining better and more economical work, and will thereby aid in securing the full benefits of reinforced concrete as a constructional material.

Designs for falsework and formwork are usually of the following types:—

*Culverts* (see Fig. 1).—Forms consist of dressed timber sheathing, on joists for decks and on studs for walls. The forms for the various parts are in separate units, the deck unit or units being supported on bearers. The bearers are supported by a minimum number of posts, wedges to enable the forms to be "struck" being placed between top of posts and bearers or below the joists if the spans of the bearers are long. Wall sheathing is attached to studs; studs rest against wales, which are supported by strutting from the ground or from other walls. Wales on opposite sides of a wall may be connected by bolts. Adequate bracing, both transverse and longitudinal, is necessary.

*Columns* (see Fig. 2).—Forms for columns consist of sheathing material inside frames designed to be readily dismantled. Particular attention is required at the junction of columns with cross beams or headstocks to ensure rigidity. The forms must be securely held in correct position by bracing.

*Slab Decks* (see Figs. 3 and 4).—Forms consist usually of sheathing on timber joists placed laterally and supported on bearers, which are themselves supported on column or pile piers according to the nature of the ground, or on struts resting on the lower flanges of the stringers or girders in steel bridges. The wedges are best placed immediately below the joists. The timber joists extend past the sides of the structure, and frames are fitted to them for the support of the forms for the kerbs and the edges of the deck. Adequate bracing, both transverse and longitudinal, is necessary.

*Slab and Girder Bridge Decks* (see Fig. 5).—Forms usually comprise sheathing on cross frames supported by heavy bearers or girders on piers, the cross-frames being of a shape conforming with that of the girder stems and deck. The cross frames are extended and framed for support of the forms for the kerbs and the outer edges of the deck. The frames must be able to be readily dismantled to allow the sheathing on the sides of the girders to be removed first, followed by the sheathing under the deck, and finally the sheathing

under the girder stems. The frames are supported below the girder stems on wedges. Adequate bracing, both transverse and longitudinal, is necessary.

*Arches and Special Bridges*.—The details of forms for arches and for bridges of special shape, such as bow-string arches, will usually be a composite of the types of forms abovementioned, with a minimum number of wedges, or sand-boxes if the loads are large, for striking the arch forms.

*Long Spans or Deepwater Sites*.—It may be economical or desirable for safety to support formwork for superstructures of long-span bridges on long-span falsework. With very poor foundations for the falsework or very high structures, or where floods are severe, support may be provided by trusses spanning between the bridge piers or piers suitably spaced. Such trusses will require detailed design and consideration as to materials. Timber trusses with ring-connectors are usually suitable for the purpose. The seatings for the trusses on the permanent bridge piers also require suitable provision.

Similarly with shorter bridges over deep water or where the flood hazard is great it may be desirable to support the falsework from the permanent piers. In such cases, it will be desirable to incorporate special hangers in or over the headstocks of the piers or to arrange for temporary bolting of timbers to headstocks or columns, or to obtain support from the lower braces or cylinders of the bridge piers. In the latter case, special provision may be made for footings in the concrete. The use of rolled steel joists as supports for superstructure forms is of value for moderate spans.

## 2. MATERIALS.

### (i) *Materials for Sheathing.*

(a) *Timber*.—Among the softwood timbers which may be used for sheathing in contact with concrete are the following:—

| <i>Trade Name.</i>         | <i>Botanical Name.</i>      | <i>*Group.</i> |
|----------------------------|-----------------------------|----------------|
| Oregon (Douglas Fir) ..    | <i>Pseudotsuga folia</i> .. | D              |
| Crab Apple or White Birch. | <i>Schizomeria Ovata</i>    | C              |
| Yellow Carabeen ..         | <i>Sloanea Woolsii</i> ..   | C              |
| Radiata Pine ..            | <i>Pinus Radiata</i> ..     | D              |
| White Cypress Pine ..      | <i>Callitris Glauca</i> ..  | D              |
| Black Cypress Pine ..      | <i>Callitris Calcarata</i>  | D              |
| Polly Wood (Brown Beech).  | <i>Litsea Reticulata</i> .. | D              |

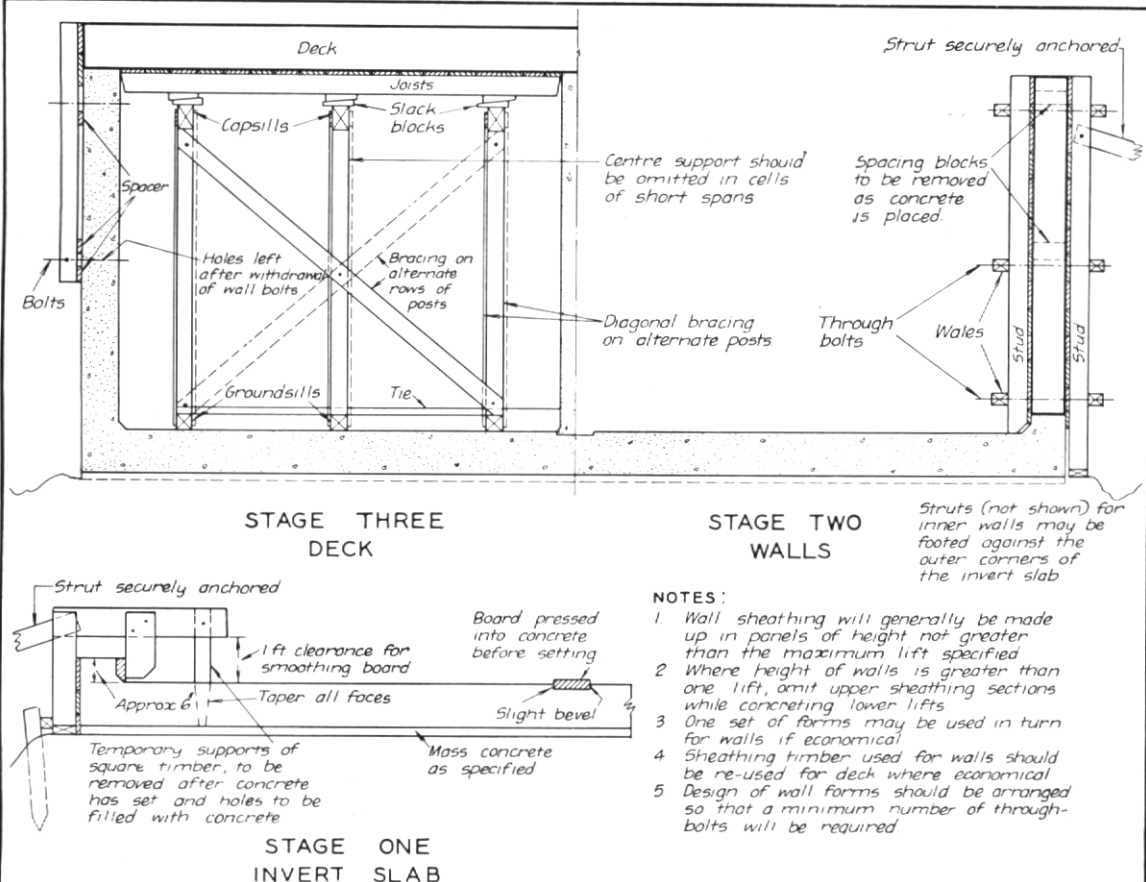


FIG 1 FORMS FOR R.C. BOX CULVERTS

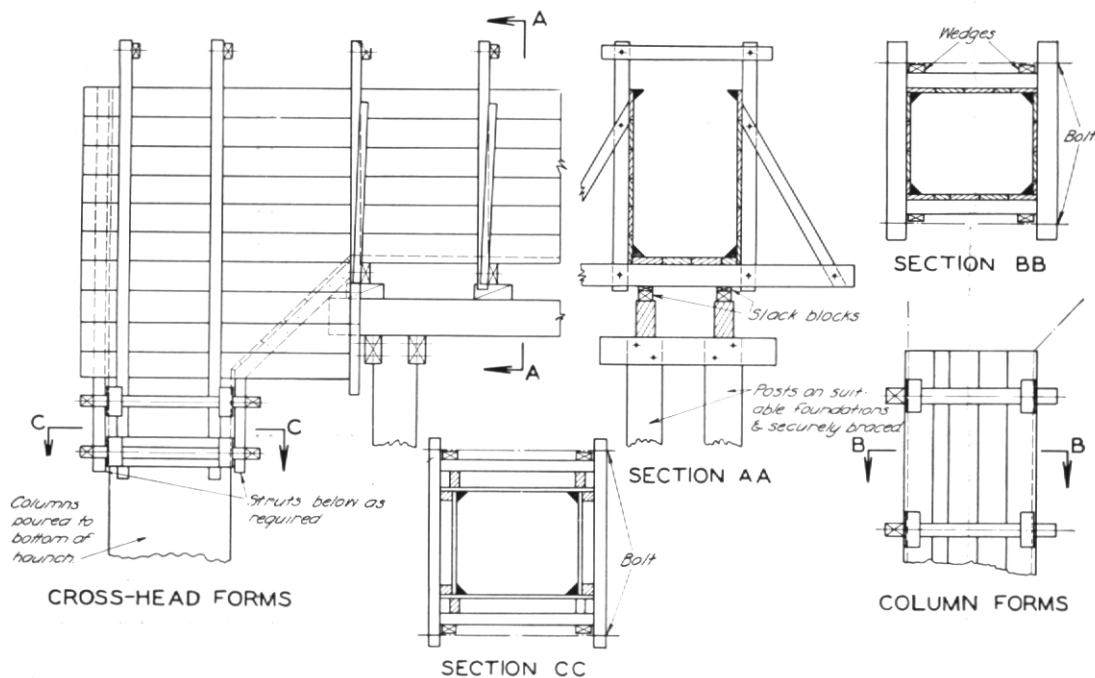


FIG. 2 PIER FORMS

| Trade Name.                                     | Botanical Name.                     | *Group. |
|-------------------------------------------------|-------------------------------------|---------|
| Hoop Pine (Colonial Pine, Richmond River Pine). | <i>Araucaria Cunninghamii</i> .. .. | D       |
| Sassafras .. ..                                 | <i>Doryphora Sassafras</i>          | D       |
| Silver Quandong (Blue Fig).                     | <i>Elaeocarpis Grandis</i>          | D       |

\*See C.S.I.R. Handbook of Structural Timber Design.

Timbers to be used for sheathing should, if possible, be readily sawn, dressed and bored. They should remain straight during use, should not warp or curl and should not split during nailing. Of the timbers listed, "Oregon" is the most favoured. "Crab Apple" is subject to borer attack and should be creosoted if stored. "Yellow Carabeen" boards less than 1¼ inch thick tend to curl. "Cypress Pine" is liable to split at the ends when nailed and to be damaged in stripping. It is used to best advantage in panels. "Hoop Pine" requires to be well seasoned before use, otherwise it warps. "Sassafras" does not split when nailed, but should be stacked out of the sun.

Where good appearance is essential, timber for sheathing should be dressed on all sides to ensure correct thickness and good matching.

For the backs of abutments and wingwalls sheathing timber need not be dressed. All other sheathing timber should be dressed on one face at least, and the two edges should be either dressed or tongued and grooved. Tongued and grooved boards are normally more applicable to repetition work, or where panels are used.

(b) *Plywoods and Pressed Woods*.—Waterproof plywood and similar boards are suitable for use for forms where a surface having a high degree of smoothness is required, where suitable sheathing timbers are costly or unavailable, or where repetitive use of panels is proposed. Such boards will normally be supported on battens, on joists or studs, as the case may be. Battens may be of hardwood or other timber unsuitable for use in direct contact with fresh concrete.

(c) *Steel*.—Sheet steel may be used for forms and has much the same use as plywoods and pressed woods. A high degree of surface smoothness can be ensured if the steel is kept clean and free from rust. Flat galvanised sheets are suitable for the purpose and should be nailed with clouts starting from the centre of sheets and proceeding towards the edges. Thin sheets tend to buckle in repetition use. Steel sheets require close support on battens and the spacing of battens should be designed for deflection of the sheets between battens in accordance with the provisions herein.

When steel forms are used, greater care in packing and finishing the surface is required than in the case of wooden forms due to the difficulty in removing surplus water, which in wooden forms is absorbed to some extent or can escape through the joints of the timber.

Special pressed steel or manufactured steel forms have an application in some circumstances such as

where a large amount of repetition work is to be undertaken.

(d) *Pre-cast Concrete and Asbestos Cement*.—Forms of pre-cast concrete or of pre-cast asbestos cement to be left in place in the finished work have some application, such as for use as jack-arches in steel beam bridges, as cylinders for bridge piers, or for scuppers and special mouldings.

#### (ii) *Material for Structural Members.*

The material for structural members is normally timber on account of its availability and economy, but steel girders are sometimes used.

Timber for structural members may be of softwood or hardwood, softwood being the more workable, and, therefore, more favoured by carpenters. However, on account of availability and relative cost, hardwood is generally used in Australia. The hardwood timbers included in the C.S.I.R., Group B, are likely to be used in falsework in preference to those in Group A, as the latter are generally in demand for permanent work. The following tables indicate the important timbers—Groups A and B—available in New South Wales.

| Trade Name.            | Botanical Name.                                        |
|------------------------|--------------------------------------------------------|
| Group A.               |                                                        |
| Box, coast grey ..     | <i>Euc. bosistoana</i> .                               |
| Box, grey ..           | <i>Euc. hemiphloia</i> group.                          |
| Gum, grey ..           | <i>Euc. propinqua</i> group and <i>Euc. punctata</i> . |
| Ironbark, grey ..      | <i>Euc. paniculata</i> group.                          |
| Ironbark, red ..       | <i>Euc. crebra</i> .                                   |
| Ironbark, red ..       | <i>Euc. sideroxylon</i> .                              |
| Ironbark, red ..       | <i>Euc. siderophloia</i> .                             |
| Group B.               |                                                        |
| Ash, silvertop ..      | <i>Euc. sieberiana</i> .                               |
| Bangalay ..            | <i>Euc. botryoides</i> .                               |
| Blackbutt ..           | <i>Euc. pilularis</i> .                                |
| Bloodwood, red ..      | <i>Euc. corymbosa</i> .                                |
| Box, brush ..          | <i>Tristania conferta</i> .                            |
| Box, yellow ..         | <i>Euc. melliodora</i> .                               |
| Gum, forest red ..     | <i>Euc. tereticornis</i> group.                        |
| Gum, Maiden's ..       | <i>Euc. maideni</i> .                                  |
| Gum, southern blue ..  | <i>Euc. globulus</i> group.                            |
| Gum, spotted ..        | <i>Euc. maculata</i> group.                            |
| Gum, Sydney blue ..    | <i>Euc. saligna</i> .                                  |
| Mahogany, red ..       | <i>Euc. resinifera</i> group.                          |
| Mahogany, white ..     | <i>Euc. acmenioides</i> group.                         |
| Stringbark, red ..     | <i>Euc. macrorrhyncha</i> .                            |
| Stringybark, white ..  | <i>Euc. eugenioides</i> .                              |
| Stringybark, yellow .. | <i>Euc. Muellieriana</i> .                             |
| Tallowood ..           | <i>Euc. microcorys</i> .                               |

Sawn timber is desirable for joists, bearers, studs and wales. It will generally be economical to use round timber for piles, large posts and girders. Timber for structural members is generally used without dressing.

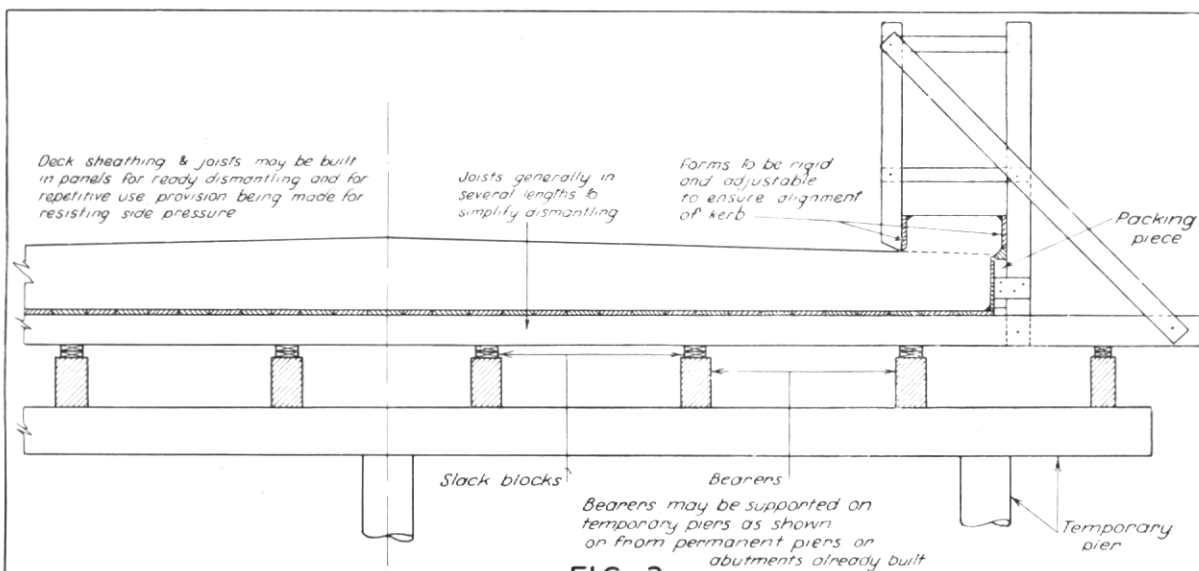


FIG. 3  
FORMS FOR SLAB DECK

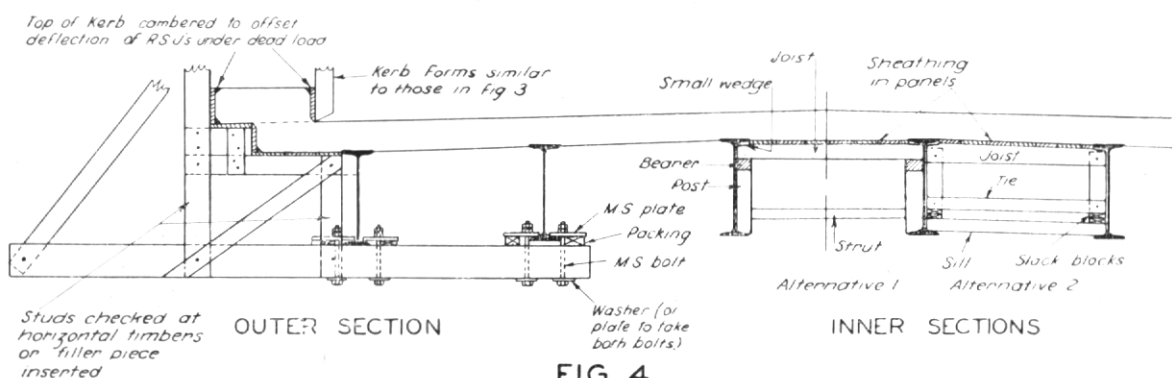


FIG. 4  
FORMS FOR SLAB DECK ON R.S.J.'s

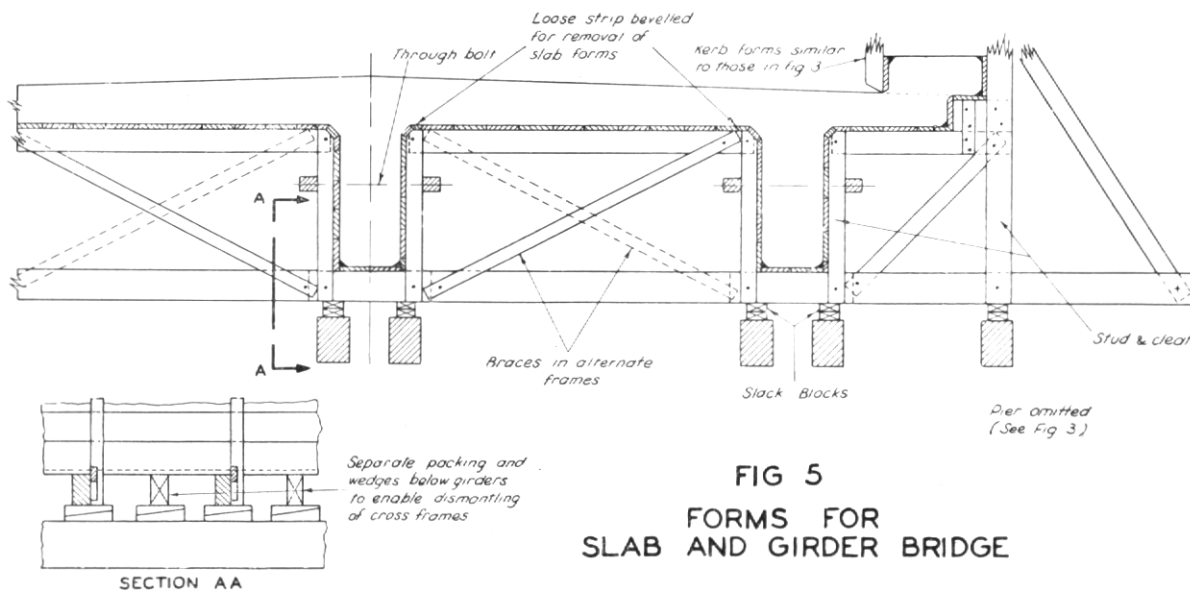


FIG. 5  
FORMS FOR  
SLAB AND GIRDER BRIDGE





**Falsework and Forms for a long-span continuous reinforced concrete girder bridge over a tidal stream, there being small risk of flood damage.**

Tubular steel scaffolding, for which some manufacturers market proprietary connectors, is used for falsework in some cases. Detailed design of such scaffolding is, of course, necessary to ensure its safety. This article does not include rules for such structures.

Rolled steel joists are suitable for use as bearers for support of superstructure formwork and may be economical in special cases.

(iii) *Wedges.*

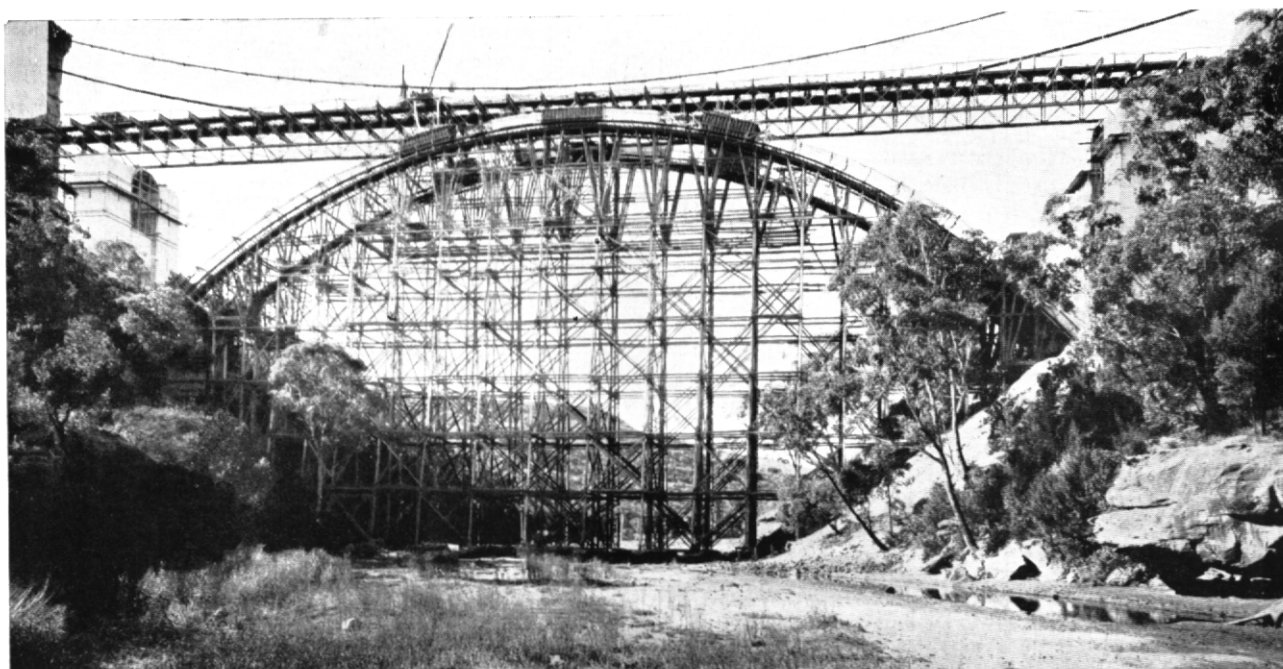
Wedges in falsework are used to simplify the striking of forms and to take up slack, hence the term "slack blocks." The bearing capacity of a wedge is

dependent upon the area of surface in contact with the post or other part against which it bears, and on the type of timber used.

Wedges should be cut on a slope of approximately 1 in 8 whether of hardwood or of softwood and should be correctly paired. An example of a pair of wedges for light duty is as follows:—

4-inch x 4-inch timber 8 inches long, cut longitudinally with the ends respectively  $2\frac{1}{2}$  inches x  $1\frac{1}{2}$  inches thick.

Wedges should never be used immediately behind the sheathing timbers, but should be behind or below



**Falsework for a large arch span over a stream with high banks and low flood level.**

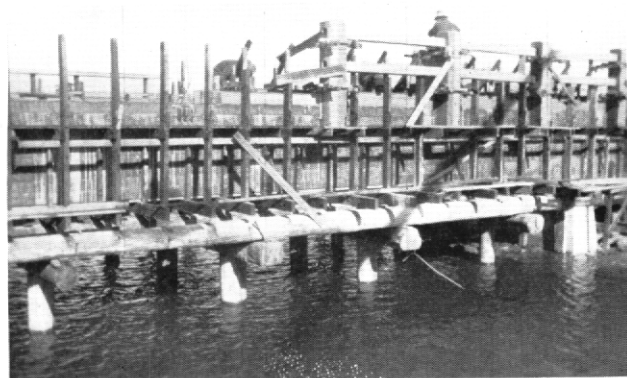


**Falsework and Forms for a rigid frame reinforced concrete beam bridge over a stream subject to flooding. A substantial opening has been provided for flood flow. Two sets of longitudinal timbers have been used on account of haunches.**

the supporting frames or bearers, a reasonable minimum of wedges being aimed at consistent with adequate facility for striking the forms.

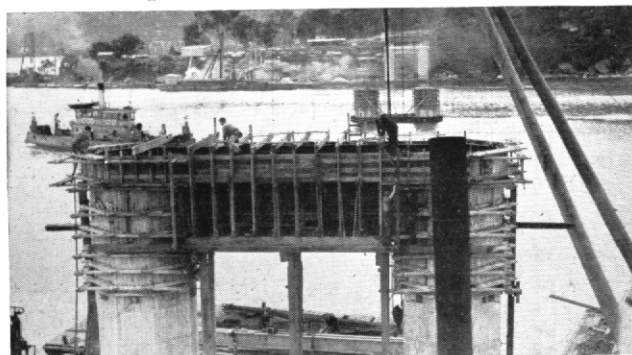
#### (iv) Nails.

Nails are used for attaching sheathing to joists or studs and for miscellaneous work. In designing nailed



**Falsework and Forms for a simply supported girder bridge over tidal water. Forms for the posts of concrete handrail are also shown, the rails having been pre-cast.**

joints, it must be remembered that the dismantling of nailed joints damages the timber. Generally, the length of a nail should be two and a half times the thickness of the timber held, but the length of nails for sheathing, where ready removal is desirable, should



**Forms for the top of a large pier. Support was obtained from bolts in the concrete of the columns.**

be only twice the thickness of the sheathing. Square-edged boards usually require two nails per joist. Nails should not be driven closer to each other than about one-half their length, nor closer to the edge of the timber than about one-quarter their length.

The standard sizes of nails used and the approximate number per pound are as follows:—

| Diameter. |         | Number per pound and usual lengths. |     |     |     |     |     |     |     |     |     |
|-----------|---------|-------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| S.W.G.    | Inches. | 1½"                                 | 1¾" | 2"  | 2¼" | 2½" | 3"  | 3½" | 4"  | 5"  | 6"  |
| 14        | 0.080   | 460                                 | 370 | 280 | ... | ... | ... | ... | ... | ... | ... |
| 12        | 0.104   | 240                                 | 215 | 190 | 170 | 150 | ... | ... | ... | ... | ... |
| 11        | 0.116   | 206                                 | 184 | 158 | 144 | 130 | ... | ... | ... | ... | ... |
| 10        | 0.128   | ...                                 | ... | 127 | 113 | 100 | 81  | ... | ... | ... | ... |
| 9         | 0.144   | ...                                 | ... | 100 | 90  | 80  | 67  | ... | ... | ... | ... |
| 8         | 0.160   | ...                                 | ... | ... | ... | 65  | 60  | 44  | 39  | ... | ... |
| 7         | 0.176   | ...                                 | ... | ... | ... | ... | 48  | 40  | 35  | ... | ... |
| 6         | 0.192   | ...                                 | ... | ... | ... | ... | 42  | 35  | 30  | 24  | ... |
| 5         | 0.212   | ...                                 | ... | ... | ... | ... | ... | ... | ... | 21  | ... |
| 4         | 0.232   | ...                                 | ... | ... | ... | ... | ... | ... | ... | ... | 13  |

The thinner nails are used in the softer timbers and the thicker nails in hardwoods.

The holding power of nailing preferably should not exceed 400 lb. per square foot of sheathing in order to facilitate dismantling. The number of nails to be used in joints and sheathing may be calculated from the following table:—

| Loading.                                                                | Safe Load per Nail—lb.<br>C.S.I.R. Timber Group. |          |          |
|-------------------------------------------------------------------------|--------------------------------------------------|----------|----------|
|                                                                         | B.                                               | C.       | D.       |
| (a) Lateral loads on nails driven across the grain of the timber ... .. | 26L                                              | 22L      | 18L      |
| (b) Lateral loads on nails driven along the grain of the timber ... ..  | 16L                                              | 13L      | 11L      |
| (c) Axial loads on nails driven across the grain of the timber ... ..   | 570 d.L.                                         | 330 d.L. | 180 d.L. |
| (d) Axial loads on nails driven along the grain of the timber ... ..    | 340 d.L.                                         | 200 d.L. | 110 d.L. |

Where "L" is the total length of the nail in inches, and it is assumed that 0.6 L at least is driven into the supporting timber.

"d" is the diameter of the nail in inches.

The table of safe loads on nails is based upon data obtained from "Modern Timber Design" by Howard Hanson and "American Civil Engineer's Handbook" by Merriman and Wiggin. The data has been adapted to the C.S.I.R. Groups of Timber B, C and D.

#### (v) Bolts.

Bolts are preferred to nails where ready dismantling is required, and particularly where re-erection is proposed, in order to obtain a maximum salvage of timber. Bolts are also more reliable than nails. Bolts are used in the joints of cross frames for girder bridges, in wales, capwales and bracing of piers,

between the sides of wall forms, and in column frames. Holes of slightly larger diameter than that of the bolt should be used to make the withdrawal of bolts as simple as possible. Bolts which will be within the concrete when this is placed should be adequately coated with beeswax or tallow and arranged to minimise adherence and to facilitate removal. Such bolts should be turned within twenty-four hours of placing the concrete and again once or twice during the curing period. Through bolts may also be fitted with removable ends, the stem of the bolt being left in the concrete with not less than the standard cover of concrete over its ends.

The safe load on bolts in side bearing on timber may be taken as follows:—

SAFE LOADS FOR BOLTS IN SIDE BEARING ON TIMBER.—POUNDS PER BOLT.

(This table is based on tests carried out by the United States Department of Agriculture, Tech. Bull. No. 332, Oct., 1932.)

| Diameter of bolt. | Bearing parallel to grain. |                 |                 |                 | Bearing perpendicular to grain. |                 |                 |                 |
|-------------------|----------------------------|-----------------|-----------------|-----------------|---------------------------------|-----------------|-----------------|-----------------|
|                   | Thickness of timber.       | Group B timber. | Group C timber. | Group D timber. | Thickness of timber.            | Group B timber. | Group C timber. | Group D timber. |
| Inches.           | Inches.                    | lb.             | lb.             | lb.             | Inches.                         | lb.             | lb.             | lb.             |
| $\frac{1}{2}$     | 1                          | 1130            | 750             | 650             | 1                               | 500             | 336             | 231             |
|                   | $1\frac{1}{2}$             | 1670            | 1114            | 966             | 2                               | 1010            | 672             | 462             |
|                   | 2                          | 2080            | 1388            | 1203            | 3                               | 1450            | 970             | 693             |
|                   | $2\frac{1}{2}$             | 2250            | 1500            | 1300            | 4+                              | 1510            | 1008            | 813             |
|                   | 3+                         | 2260            | 1510            | 1310            | .....                           | .....           | .....           | .....           |
| $\frac{3}{8}$     | 1                          | 1410            | 938             | 812             | 2                               | 1140            | 760             | 522             |
|                   | $1\frac{1}{2}$             | 2100            | 1402            | 1215            | 3                               | 1710            | 1140            | 784             |
|                   | 2                          | 2760            | 1840            | 1595            | 4                               | 2120            | 1415            | 1040            |
|                   | $2\frac{1}{2}$             | 3260            | 2170            | 1880            | 5+                              | 2140            | 1425            | 1150            |
|                   | 3                          | 3490            | 2328            | 2018            | .....                           | .....           | .....           | .....           |
|                   | $3\frac{1}{2}$             | 3540            | 2358            | 2041            | .....                           | .....           | .....           | .....           |
|                   | 4+                         | 3540            | 2360            | 2048            | .....                           | .....           | .....           | .....           |
| $\frac{1}{2}$     | $1\frac{1}{2}$             | 2530            | 1688            | 1462            | 2                               | 1270            | 846             | 582             |
|                   | 2                          | 3360            | 2240            | 1942            | 3                               | 1910            | 1270            | 873             |
|                   | $2\frac{1}{2}$             | 4110            | 2746            | 2380            | 4                               | 2520            | 1680            | 1164            |
|                   | 3                          | 4680            | 3120            | 2705            | 5                               | 2850            | 1895            | 1434            |
|                   | $3\frac{1}{2}$             | 4960            | 3312            | 2870            | 6+                              | 2860            | 1903            | 1535            |
|                   | 4                          | 5090            | 3394            | 2940            | .....                           | .....           | .....           | .....           |
|                   | $4\frac{1}{2}+$            | 5100            | 3400            | 2950            | .....                           | .....           | .....           | .....           |
| $\frac{7}{8}$     | 2                          | 3940            | 2625            | 2275            | 2                               | 1400            | 933             | 642             |
|                   | 3                          | 5730            | 3820            | 3310            | 3                               | 2100            | 1400            | 962             |
|                   | 4                          | 6750            | 4500            | 3900            | 4                               | 2800            | 1867            | 1284            |
|                   | 5                          | 6940            | 4630            | 4012            | 5                               | 3430            | 2284            | 1604            |
|                   | 6+                         | 6940            | 4630            | 4012            | 6                               | 3710            | 2475            | 1885            |
|                   | .....                      | .....           | .....           | .....           | 7+                              | .....           | .....           | 1981            |
| 1                 | 2                          | 4500            | 3000            | 2600            | 2                               | 1520            | 1015            | 698             |
|                   | 3                          | 6670            | 4452            | 3860            | 3                               | 2280            | 1523            | 1047            |
|                   | 4                          | 8320            | 5550            | 4810            | 4                               | 3040            | 2030            | 1396            |
|                   | 5                          | 9000            | 6000            | 5200            | 5                               | 3800            | 2535            | 1750            |
|                   | 6+                         | 9060            | 6042            | 5240            | 6                               | 4390            | 2932            | 2095            |
|                   | .....                      | .....           | .....           | .....           | 7                               | 4530            | 3020            | 2340            |
|                   | .....                      | .....           | .....           | .....           | 8+                              | 4570            | 3050            | 2460            |

The allowable load on a bolt at an angle (A) to the grain equals:—

$$PQ$$

$$P \sin A + Q \cos A$$

where P = allowable load parallel to grain.

Q = allowable load perpendicular to grain.

A = inclination of load to grain.

(vi) Wire.

Wire should not be used for joining falsework. It should be confined to use as a tie between the sides of wall forms and should be used only where the surface of the concrete will not be exposed in the finished work. Arrangements should be made for satisfactory tensioning and for cutting back the wire to give the standard cover of concrete over its ends. In general, the use of bolts is considered preferable to the use of wire.

3. DESIGN PRACTICE.

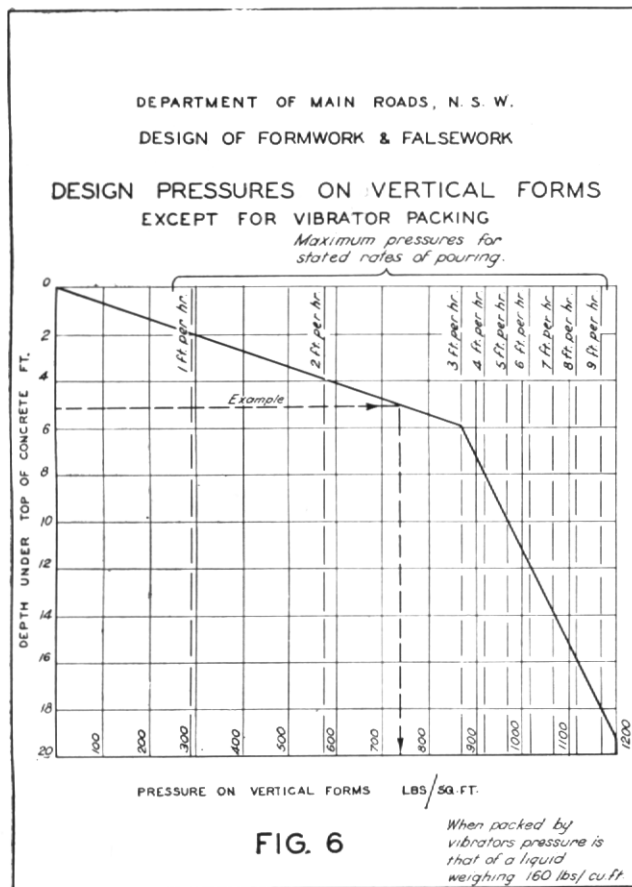
(i) *Loadings to be Taken Into Account.*—The loadings to be taken into account in preparing a design for forms and falsework are as follows:—

(a) Dead load of falsework.

(b) Dead load of concrete including reinforcement at 150 lb./cu. ft.

(c) Construction live load of 30 lb./sq. ft., including the forms.

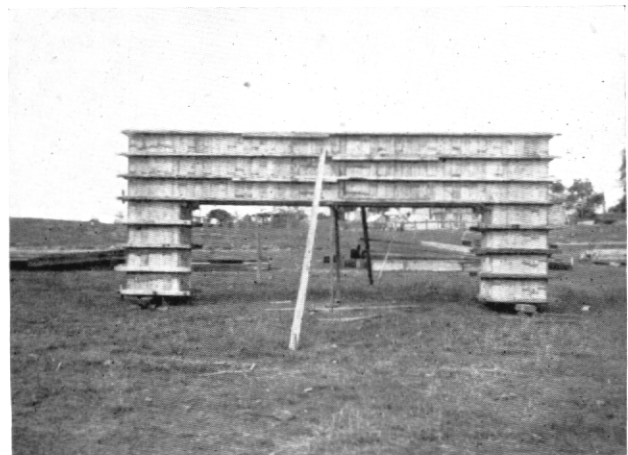
(d) Lateral pressure of concrete in the forms, depending on the rate of vertical filling of the forms with concrete, and the temperature of setting of the concrete and the method of packing. (See Graph., Fig. 6.)



(When using Fig. 6, read off the "depth below the surface" of the concrete on the vertical scale, and the "rate of pouring" on the top horizontal scale, the intersection of these two readings gives the "pressure" in pounds per square inch, read on the bottom horizontal scale. The dark line represents the line of maximum pressure corresponding to initial set in the concrete, and no greater pressures are obtainable with higher rates of pour than are given by the intersection of the "depth" line with this line of maximum

pressure. The example indicated is for a depth of concrete of 5.2 ft., and the maximum pressure obtainable is 740 lb. per square foot when the rate of pour is 2.5 ft. per hour or over. Note that where concrete is packed by vibrators the forms shall be designed for the full pressure from a liquid weighing 160 lb./cu. ft.)

- (c) Wind pressure of 30 lb./sq. ft. on the area visible in side elevation.
- (f) Water pressure =  $1.4V^2$  lb./sq. ft. on the area of falsework in side elevation below flood level, plus 2 ft. depth of flood debris if the stream is likely to carry debris, where  $V$  is the average velocity in feet per second.
- (g) Temperature (when relevant).



**Prefabricated Forms for a small pier. Forms to be placed by Flying Fox.**

(ii) *Working Stresses.*—The stresses adopted for purposes of preparation of the formwork design tables given in this article are as shown below.

The tabulated stresses are for "standard" grades of timber and are approximately 33 per cent. higher than the stresses recommended by the Council for Scientific and Industrial Research for timber in permanent structures, except for modulus of elasticity, which is unchanged. If "select" grades of timber are used, the

| Description.                                             | Working Stress—(lb./sq. inch).         |                                        |                                        |                                        |
|----------------------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
|                                                          | Timber.<br>Group A.                    | Timber<br>Group B.                     | Timber<br>Group C.                     | Timber<br>Group D.                     |
| Bending and Tension, parallel to grain ...               | 3,200                                  | 2,670                                  | 2,130                                  | 1,600                                  |
| Bearing, parallel to grain ...                           | 2,400                                  | 2,000                                  | 1,600                                  | 1,200                                  |
| Bearing, perpendicular to grain ...                      | 1,200                                  | 930                                    | 665                                    | 400                                    |
| Shear—Beams ...                                          | 270                                    | 210                                    | 160                                    | 95                                     |
| Shear—Joint details ...                                  | 400                                    | 320                                    | 240                                    | 145                                    |
| Columns ...                                              | $2,400 \left(1 - \frac{L}{90D}\right)$ | $2,000 \left(1 - \frac{L}{90D}\right)$ | $1,600 \left(1 - \frac{L}{90D}\right)$ | $1,150 \left(1 - \frac{L}{90D}\right)$ |
| $\left(\frac{L}{D} \text{ less than } 30\right)$         | .....                                  | With max.<br>of 1650                   | With max.<br>of 1350                   | With max.<br>of 1000                   |
| Where $L$ = Unsupported length.)<br>D = Least dimension. |                                        |                                        |                                        |                                        |
| Modulus of elasticity ...                                | .....                                  | $2.1 \times 10^6$                      | $1.7 \times 10^6$                      | $1.5 \times 10^6$                      |



Frames for a three-girder bridge superstructure.

working stresses shown in the table may be increased by 25 per cent. except that allowable stresses for "Bearing—perpendicular to the grain" and the values for "Modulus of Elasticity" should remain as shown in the table.

(iii) *Allowable Deflections.*—Deflection not to exceed  $1/300$  of the span for main spans, sides and bottoms of beam webs, front faces of walls, kerbs, edges of deck, posts, handrails and other exterior surfaces which will be seen in the completed work, and  $1/150$  of the span for rear faces of walls and other surfaces which will not be seen in the completed work.

(iv) *Piers for Falsework.*—Falsework should be secure against settlement and damage during construction and during curing of the concrete. A minimum number of piers should be adopted in order to minimise collection of drift in floods. Spread footings, *i.e.*, sills or concrete blocks, where used, should be safe from scour and should be of adequate dimensions for the nature of the material in the foundations. Piers should be braced and anchored against overturning.

In soft ground, piers should generally consist of driven timber piles or be built on piles. The maximum desirable loading per pile is as follows:—



Frames and Forms for the kerbs of a truss span having a reinforced concrete deck.

| Length.          | Load. | Dia. at tip. | Dia. at Butt. |
|------------------|-------|--------------|---------------|
|                  | tons. | inches.      | inches.       |
| Up to 40-ft. ... | 20    | 10           | 16            |
|                  | 15    | 9            | 15            |
|                  | 10    | 8            | 14            |
| 50-ft. ...       | 20    | 9            | 16            |
|                  | 15    | 8            | 15            |
|                  | 10    | 7            | 14            |
| 60-ft. ...       | 20    | 8            | 16            |
|                  | 15    | 7            | 15            |
|                  | 10    | 6            | 14            |

Piles extending above ground should be checked as columns, the lower end of the unsupported length being taken as 5 ft. below ground level in average ground. Pile heads should be trimmed and ringed adequately to avoid damage during driving. The method of estimating the bearing capacity from test penetrations and of driving, potting and silling, should conform with good practice and, in general, with the requirements of M.R. Form No. 164 (Specification for Timber Beam Bridge).

(v) *Allowance for Settlement.*—Allowance should be made in setting the level of forms to provide for settlement of foundations, for taking up of slack between abutting surfaces and for side compression on timbers. With average carpentry, an allowance of  $1/16$ " should be made for each loaded contact surface between timbers (but not between wedges), plus  $1/16$ " in each case where end grain bears on side grain. Due allowance should also be made for deformation due to end compression of posts and piles.

No allowance is required for settlement of piles driven to tests conforming with the design loads. The settlement of footings on soils or on piles driven to less than the required tests is indeterminate and discretion is required in making allowance for settlement.

It is highly desirable that falsework rest only on the most unyielding foundation or support practicable in the particular conditions existing at the site, as should unanticipated settlement occur during the construction of the bridge, the appearance of the completed work is likely to be permanently marred. No risks whatever should therefore be taken in the selection of footings for falsework.

(vi) *Joints in Falsework.*—The use of nails and bolts at joints has already been described. In timber truss supports, ring connectors are desirable. Round timber should be suitably flattened at joints.

(vii) *Striking of Forms.*—The use of pairs of wedges under frames or bearers is the usual device for striking forms. Where heavy concentrated loads must be taken, as in bridges of very long span or large arch bridges, metal sand boxes are more appropriate than wedges. These consist of cylinders and plungers, filled with dry sand, with adequate provision for keeping the sand dry and for escape of the sand during striking of the forms. The loads on sand boxes should not exceed 900 lbs. per sq. in. of sand. For very heavy



loads, hydraulic or screw jacks may be used for striking forms, but are not set in place until the actual striking.

(viii) *Data for Design*.—The tables given for sheathing (Figs. 7, 8 and 9), and the graph for joists, studs and wales (Fig. 11), and the table for through-bolts (Fig. 10), enable suitable designs of these timbers to be prepared. For design of beams, timber columns and struts, standard design practice is to be used, working stresses for timber being as indicated previously. If steel is used, design should be in accordance with normal structural practice for erection work.

#### 4. REPETITION IN USE OF FORMWORK.

(i) *Effect of Design of Structure*.—Repetitive use of formwork is desirable to ensure a maximum economy of materials. Suitable design of the bridge structure itself and suitable planning of the construction work may facilitate repetition in use of formwork with consequent saving in finished concrete costs. De-

| DEPARTMENT OF MAIN ROADS, N. S. W.<br>DESIGN OF FORMWORK & FALSEWORK<br>SHEATHING—TIMBER GROUP B<br>MAXIMUM SPACING OF JOISTS AND STUDS<br>FOR VARIOUS THICKNESSES OF SHEATHING                                                                         |                       |                 |                  |                  |                  |                  |                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|------------------|------------------|------------------|------------------|-----------------|
| Depth<br>below<br>surface                                                                                                                                                                                                                               | Pressure<br>per sq ft | $\frac{3}{4}$ " | 1"               | $1\frac{1}{4}$ " | $1\frac{1}{2}$ " | $1\frac{3}{4}$ " | 2"              |
| 6"                                                                                                                                                                                                                                                      | 100                   | 3'-0"<br>3'-9"  | 3'-11"<br>4'-11" | 4'-11"           |                  |                  |                 |
| 1'-2"                                                                                                                                                                                                                                                   | 200                   | 2'-4"<br>3'-0"  | 3'-2"<br>4'-0"   | 3'-11"           |                  |                  |                 |
| 1'-10"                                                                                                                                                                                                                                                  | 300                   | 2'-1"<br>2'-7"  | 2'-9"<br>3'-5"   | 3'-5"<br>4'-4"   | 4'-1"            |                  |                 |
| 2'-6"                                                                                                                                                                                                                                                   | 400                   | 1'-10"<br>2'-4" | 2'-6"<br>3'-1"   | 3'-1"<br>3'-11"  | 3'-9"            |                  |                 |
| 3'-3"                                                                                                                                                                                                                                                   | 500                   | 1'-9"<br>2'-2"  | 2'-4"<br>2'-11"  | 2'-11"<br>3'-7"  | 3'-6"<br>4'-4"   | 4'-0"            |                 |
| 3'-11"                                                                                                                                                                                                                                                  | 600                   | 1'-7"<br>2'-1"  | 2'-2"<br>2'-9"   | 2'-9"<br>3'-5"   | 3'-3"<br>4'-1"   | 3'-10"           |                 |
| 4'-7"                                                                                                                                                                                                                                                   | 700                   | 1'-7"<br>1'-11" | 2'-1"<br>2'-6"   | 2'-7"<br>3'-2"   | 3'-1"<br>3'-9"   | 3'-7"            | 4'-1"           |
| 5'-4"                                                                                                                                                                                                                                                   | 800                   | 1'-6"<br>1'-9"  | 2'-0"<br>2'-3"   | 2'-6"<br>2'-11"  | 3'-0"<br>3'-6"   | 3'-5"<br>4'-2"   | 3'-11"          |
| 6'-0"                                                                                                                                                                                                                                                   | 900                   | 1'-5"<br>1'-8"  | 1'-11"<br>2'-3"  | 2'-4"<br>2'-9"   | 2'-10"<br>3'-4"  | 3'-4"<br>3'-11"  | 3'-9"           |
| H 6'-8"<br>V 11'-0"                                                                                                                                                                                                                                     | 1000                  | 1'-5"<br>1'-7"  | 1'-10"<br>2'-1"  | 2'-3"<br>2'-8"   | 2'-9"<br>3'-2"   | 3'-2"<br>3'-8"   | 3'-8"           |
| H 7'-4"<br>V 15'-0"                                                                                                                                                                                                                                     | 1100                  | 1'-4"<br>1'-6"  | 1'-9"<br>2'-0"   | 2'-2"<br>2'-6"   | 2'-8"<br>3'-0"   | 3'-1"<br>3'-6"   | 3'-6"<br>4'-0"  |
| H 8'-0"<br>V 19'-0"                                                                                                                                                                                                                                     | 1200                  | 1'-3"<br>1'-5"  | 1'-8"<br>1'-11"  | 2'-2"<br>2'-5"   | 2'-7"<br>2'-10"  | 3'-0"<br>3'-4"   | 3'-5"<br>3'-10" |
| H is depth of horizontal forms below surface of concrete<br>V is depth of vertical forms below surface of concrete as cast<br>Take top figures in body of table for exterior surfaces (see Section 4 of article) and lower figures for hidden surfaces. |                       |                 |                  |                  |                  |                  |                 |

FIG. 7

| DEPARTMENT OF MAIN ROADS, N. S. W.<br>DESIGN OF FORMWORK & FALSEWORK<br>SHEATHING—TIMBER GROUP C<br>MAXIMUM SPACING OF JOISTS AND STUDS<br>FOR VARIOUS THICKNESSES OF SHEATHING                                                                         |                       |                 |                 |                  |                  |                  |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|-----------------|------------------|------------------|------------------|----------------|
| Depth<br>below<br>surface                                                                                                                                                                                                                               | Pressure<br>per sq ft | $\frac{3}{4}$ " | 1"              | $1\frac{1}{4}$ " | $1\frac{1}{2}$ " | $1\frac{3}{4}$ " | 2"             |
| 6"                                                                                                                                                                                                                                                      | 100                   | 2'-9"<br>3'-6"  | 3'-8"<br>4'-7"  | 4'-7"            |                  |                  |                |
| 1'-2"                                                                                                                                                                                                                                                   | 200                   | 2'-2"<br>2'-9"  | 2'-11"<br>3'-8" | 3'-8"            |                  |                  |                |
| 1'-10"                                                                                                                                                                                                                                                  | 300                   | 1'-11"<br>2'-5" | 2'-8"<br>3'-3"  | 3'-4"<br>4'-1"   | 4'-0"            |                  |                |
| 2'-6"                                                                                                                                                                                                                                                   | 400                   | 1'-9"<br>2'-3"  | 2'-4"<br>2'-11" | 2'-11"<br>3'-8"  | 3'-6"<br>4'-1"   |                  |                |
| 3'-3"                                                                                                                                                                                                                                                   | 500                   | 1'-7"<br>2'-0"  | 2'-2"<br>2'-8"  | 2'-8"<br>3'-4"   | 3'-3"<br>4'-0"   | 3'-9"            |                |
| 3'-11"                                                                                                                                                                                                                                                  | 600                   | 1'-6"<br>1'-10" | 2'-0"<br>2'-5"  | 2'-6"<br>3'-0"   | 3'-0"<br>3'-8"   | 3'-7"            | 4'-1"          |
| 4'-7"                                                                                                                                                                                                                                                   | 700                   | 1'-5"<br>1'-8"  | 1'-11"<br>2'-3" | 2'-5"<br>2'-10"  | 2'-11"<br>3'-5"  | 3'-5"<br>4'-0"   | 3'-10"         |
| 5'-4"                                                                                                                                                                                                                                                   | 800                   | 1'-5"<br>1'-7"  | 1'-10"<br>2'-1" | 2'-4"<br>2'-8"   | 2'-9"<br>3'-2"   | 3'-3"<br>3'-8"   | 3'-8"          |
| 6'-0"                                                                                                                                                                                                                                                   | 900                   | 1'-4"<br>1'-6"  | 1'-9"<br>2'-0"  | 2'-3"<br>2'-6"   | 2'-8"<br>3'-0"   | 3'-1"<br>3'-6"   | 3'-7"<br>4'-0" |
| H 6'-8"<br>V 11'-0"                                                                                                                                                                                                                                     | 1000                  | 1'-4"<br>1'-5"  | 1'-8"<br>1'-11" | 2'-2"<br>2'-4"   | 2'-7"<br>2'-10"  | 3'-0"<br>3'-3"   | 3'-5"<br>3'-9" |
| H 7'-4"<br>V 15'-0"                                                                                                                                                                                                                                     | 1100                  | 1'-3"<br>1'-4"  | 1'-8"<br>1'-9"  | 2'-1"<br>2'-3"   | 2'-6"<br>2'-8"   | 2'-11"<br>3'-2"  | 3'-4"<br>3'-7" |
| H 8'-0"<br>V 19'-0"                                                                                                                                                                                                                                     | 1200                  | 1'-2"<br>1'-4"  | 1'-7"<br>1'-9"  | 2'-0"<br>2'-2"   | 2'-5"<br>2'-7"   | 2'-10"<br>3'-0"  | 3'-3"<br>3'-5" |
| H is depth of horizontal forms below surface of concrete<br>V is depth of vertical forms below surface of concrete as cast<br>Take top figures in body of table for exterior surfaces (see Section 4 of article) and lower figures for hidden surfaces. |                       |                 |                 |                  |                  |                  |                |

FIG. 8

sirable bridge design requirements for repetition are as follows:—

- Make all spans of a slab and girder bridge equal.
- Make all widths of deck panels equal.
- Make at least those parts of all piers above ground similar.
- Design abutments with minimum surface area.
- Minimise the use of curves unless required for architectural reasons.
- Avoid individual detailed embellishments.

In any bridge design prepared with a view to repetitive use of formwork it is necessary to bear in mind that detailed design of the forms for easy stripping is essential for economy, as damage to timber involves wastage and added cost. Easy stripping also ensures economy of labour.

In addition to repetition within a particular job, standardisation of structures or of types of structures may enable repetitive use of formwork from job to job.

| DEPARTMENT OF MAIN ROADS, N. S. W.<br>DESIGN OF FORMWORK & FALSEWORK<br>SHEATHING—TIMBER GROUP D<br>MAXIMUM SPACING OF JOISTS AND STUDS<br>FOR VARIOUS THICKNESSES OF SHEATHING |                      |                 |                  |                  |                  |                  |                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|------------------|------------------|------------------|------------------|-----------------|
| Depth below surface                                                                                                                                                             | Pressure per sq. ft. | $\frac{3}{4}$ " | 1"               | $1\frac{1}{4}$ " | $1\frac{1}{2}$ " | $1\frac{3}{4}$ " | 2"              |
| 6'                                                                                                                                                                              | 100                  | 2'-8"<br>3'-5"  | 3'-6"<br>4'-6"   | 4'-5"            |                  |                  |                 |
| 1'-2"                                                                                                                                                                           | 200                  | 2'-2"<br>2'-8"  | 2'-10"<br>3'-7"  | 3'-7"<br>4'-5"   | 4'-3"            |                  |                 |
| 1'-10"                                                                                                                                                                          | 300                  | 1'-10"<br>2'-3" | 2'-5"<br>3'-0"   | 3'-1"<br>3'-9"   | 3'-8"<br>4'-5"   | 4'-4"            |                 |
| 2'-6"                                                                                                                                                                           | 400                  | 1'-8"<br>1'-11" | 2'-3"<br>2'-11"  | 2'-9"<br>3'-3"   | 3'-4"<br>3'-11"  | 3'-11"           |                 |
| 3'-3"                                                                                                                                                                           | 500                  | 1'-7"<br>1'-9"  | 2'-1"<br>2'-4"   | 2'-7"<br>2'-11"  | 3'-1"<br>3'-5"   | 3'-7"<br>4'-0"   | 4'-2"           |
| 3'-11"                                                                                                                                                                          | 600                  | 1'-6"<br>1'-7"  | 1'-11"<br>2'-1"  | 2'-5"<br>2'-7"   | 2'-11"<br>3'-1"  | 3'-5"<br>3'-8"   | 3'-11"<br>4'-2" |
| 4'-7"                                                                                                                                                                           | 700                  | 1'-5"<br>1'-6"  | 1'-10"<br>1'-11" | 2'-4"<br>2'-5"   | 2'-9"<br>2'-11"  | 3'-3"<br>3'-5"   | 3'-8"<br>3'-11" |
| 5'-4"                                                                                                                                                                           | 800                  | 1'-4"<br>1'-5"  | 1'-9"<br>1'-10"  | 2'-3"<br>2'-3"   | 2'-8"<br>2'-9"   | 3'-1"<br>3'-2"   | 3'-6"<br>3'-8"  |
| 6'-0"                                                                                                                                                                           | 900                  | 1'-3"<br>1'-3"  | 1'-8"<br>1'-8"   | 2'-2"<br>2'-2"   | 2'-7"<br>2'-7"   | 3'-0"<br>3'-0"   | 3'-5"<br>3'-5"  |
| H 6'-8"<br>V 11'-0"                                                                                                                                                             | 1000                 | 1'-3"<br>1'-3"  | 1'-7"<br>1'-7"   | 2'-0"<br>2'-0"   | 2'-5"<br>2'-5"   | 2'-10"<br>2'-10" | 3'-2"<br>3'-2"  |
| H 7'-4"<br>V 15'-0"                                                                                                                                                             | 1100                 | 1'-2"<br>1'-2"  | 1'-7"<br>1'-7"   | 1'-11"<br>1'-11" | 2'-4"<br>2'-4"   | 2'-9"<br>2'-9"   | 3'-1"<br>3'-1"  |
| H 8'-0"<br>V 19'-0"                                                                                                                                                             | 1200                 | 1'-1"<br>1'-1"  | 1'-6"<br>1'-6"   | 1'-10"<br>1'-10" | 2'-3"<br>2'-3"   | 2'-7"<br>2'-7"   | 3'-0"<br>3'-0"  |

*H is depth of horizontal forms below surface of concrete*  
*V is depth of vertical forms below surface of concrete as cast*  
*Take top figures in body of table for exterior surfaces (see Section 4 of article) and lower figures for hidden surfaces.*

FIG. 9

The size of sections of forms constructed with a view to repetition use should be adjusted to the method of handling. With no equipment, sections will necessarily be small in order that they may be handled by hand or by improvised lifting gear. When such equipment as a "flying fox" is available, sections of forms may be correspondingly large.

(ii) *Effect of Continuous Beam and Frame Designs.*—In the construction of continuous beams or frames, it is necessary to retain the supports for the adjacent span or spans in place while casting and curing any span. This involves the use of somewhat more falsework than with simple beam spans, but usually allows repetition in use of the sheathing and immediate supports except those below the girder stems. When haunching of the beams is included in the design, special frames and shaping of forms are required at the haunches, but repetitive use is possible in a bridge of a number of spans.

(iii) *Effect of Nature of Sheathing Material.*—Oregon pine, and other timbers which nail readily, lend

themselves to repetition in use as sheathing, as they can be stripped and re-used with a minimum of wastage. Cypress pine and other timbers which are likely to split upon nailing, must be built into panels for repetitive use. This can frequently be arranged with economy. Plywoods and other fabricated boards are in standard sizes, and will be most efficiently used as panels on hardwood battens at a suitably close spacing, with boards or strips of pine timber to fill-in beside the panels. Steel sheets lend themselves to panels of fixed sizes and may also require filling pieces.

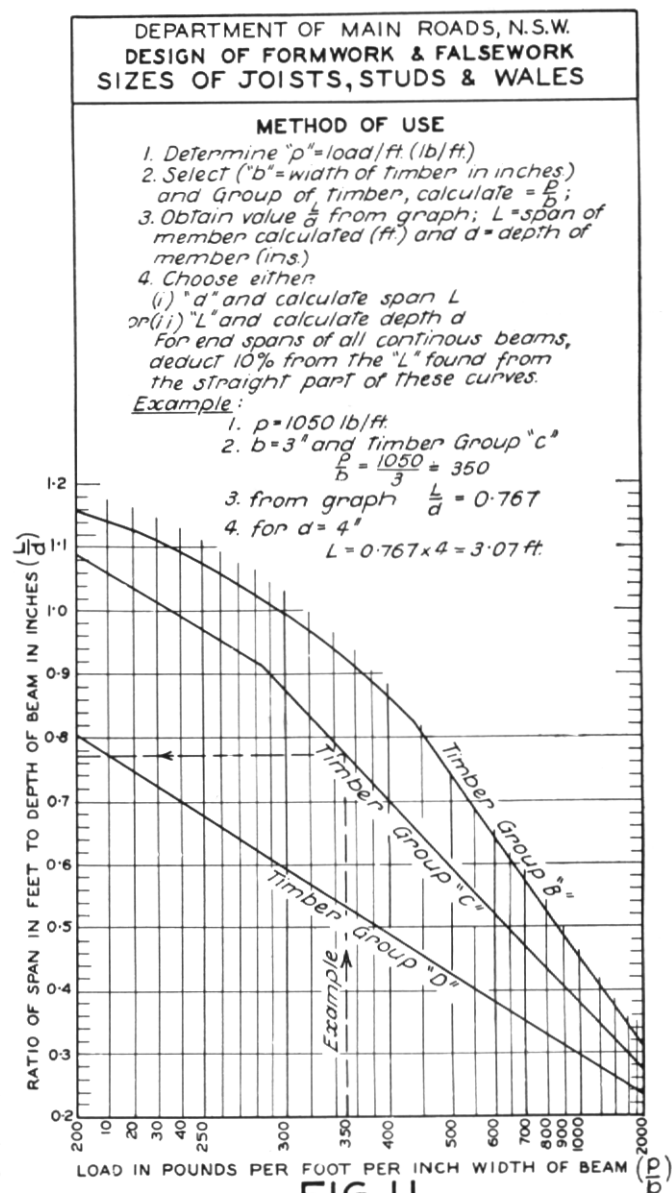


FIG. 11

(iv) *Effect on Bridge Costs of Maximum Repetitive Use of Forms.*

Maximum repetitive use of forms has the following advantages:—

- (1) Minimum quantity of form materials required.

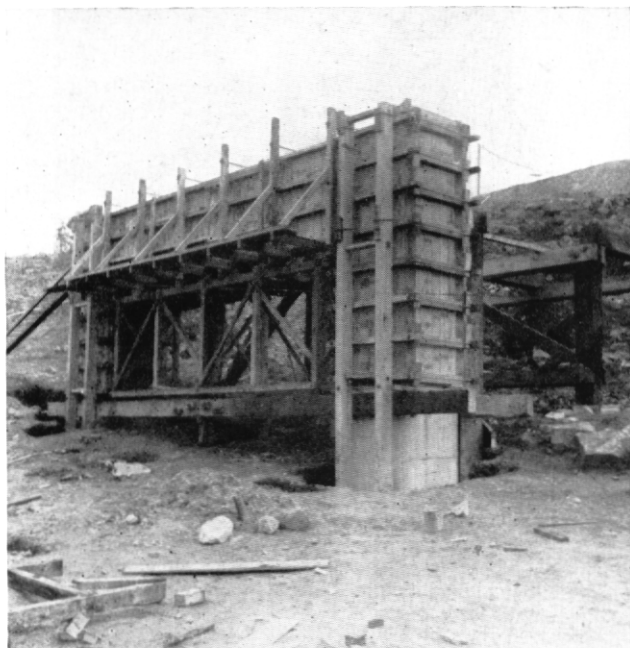


DEPARTMENT OF MAIN ROADS N. S. W.  
DESIGN OF FORMWORK & FALSEWORK  
MAX. SPACING OF BOLTS IN WALES & BEARERS  
(IN TENSION & BEARING)

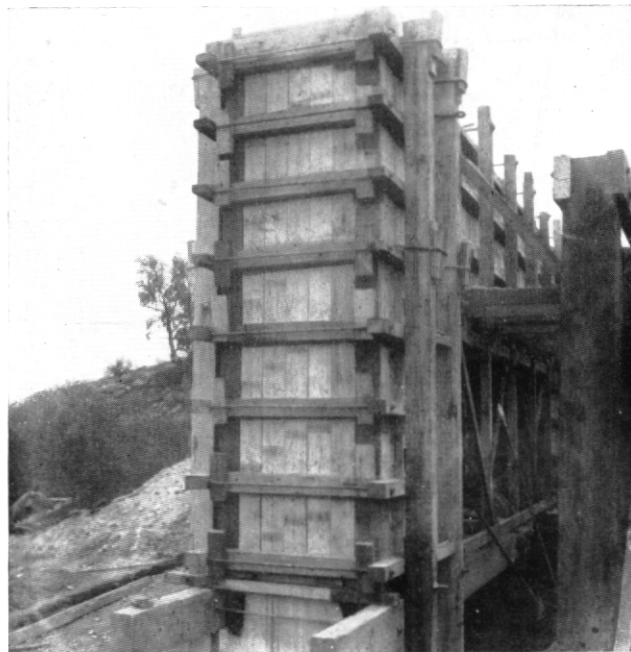
NOTE: SPACING OF BOLTS IS ALSO DETERMINED  
BY THE ALLOWABLE SPAN OF WALES.

| Class of Timber                             |      | B                |                 |                  |                 |                  | C                |                 |                  |                 |                  | D                |                 |                  |                 |                  |
|---------------------------------------------|------|------------------|-----------------|------------------|-----------------|------------------|------------------|-----------------|------------------|-----------------|------------------|------------------|-----------------|------------------|-----------------|------------------|
| Bolt dia                                    |      | $\frac{1}{2}$ "  | $\frac{5}{8}$ " | $\frac{3}{4}$ "  | $\frac{7}{8}$ " | 1"               | $\frac{1}{2}$ "  | $\frac{5}{8}$ " | $\frac{3}{4}$ "  | $\frac{7}{8}$ " | 1"               | $\frac{1}{2}$ "  | $\frac{5}{8}$ " | $\frac{3}{4}$ "  | $\frac{7}{8}$ " | 1"               |
| Side of washer                              |      | $1\frac{1}{2}$ " | 2"              | $2\frac{1}{2}$ " | 3"              | $3\frac{1}{2}$ " | $1\frac{1}{2}$ " | 2"              | $2\frac{1}{2}$ " | 3"              | $3\frac{1}{2}$ " | $1\frac{1}{2}$ " | 2"              | $2\frac{1}{2}$ " | 3"              | $3\frac{1}{2}$ " |
| Allowable load on bolt or washer - Lbs.     |      | 2100             | 3650            | 5460             | 7600            | 10000            | 1500             | 2670            | 4160             | 6000            | 8200             | 900              | 1600            | 2500             | 3600            | 4900             |
| LOAD PER FOOT RUN OF WALES OR BEARERS - LB. | 400  | 5'-3"            |                 |                  |                 |                  | 3'-9"            | 6'-8"           |                  |                 |                  | 2'-3"            | 4'-0"           | 6'-3"            |                 |                  |
|                                             | 600  | 3'-6"            | 6'-1"           |                  |                 |                  | 2'-6"            | 4'-5"           | 6'-11"           |                 |                  |                  | 2'-8"           | 4'-2"            | 6'-0"           |                  |
|                                             | 800  | 2'-8"            | 4'-7"           | 6'-10"           |                 |                  |                  | 3'-3"           | 5'-2"            |                 |                  |                  | 2'-0"           | 3'-1"            | 4'-6"           | 6'-1"            |
|                                             | 1000 | 2'-1"            | 3'-9"           | 5'-5"            |                 |                  |                  | 2'-8"           | 4'-2"            | 6'-0"           |                  |                  |                 | 2'-6"            | 3'-7"           | 4'-11"           |
|                                             | 200  |                  | 3'-0"           | 4'-7"            | 6'-4"           |                  |                  | 2'-3"           | 3'-6"            | 5'-0"           | 6'-10"           |                  |                 | 2'-1"            | 3'-0"           | 4'-1"            |
|                                             | 400  |                  | 2'-7"           | 3'-11"           | 5'-5"           |                  |                  |                 | 3'-0"            | 4'-3"           | 5'-10"           |                  |                 |                  | 2'-7"           | 3'-6"            |
|                                             | 600  |                  | 2'-3"           | 3'-5"            | 4'-9"           | 6'-3"            |                  |                 | 2'-7"            | 3'-9"           | 5'-1"            |                  |                 |                  | 2'-3"           | 3'-1"            |
|                                             | 800  |                  | 2'-0"           | 3'-0"            | 4'-3"           | 5'-7"            |                  |                 | 2'-3"            | 3'-4"           | 5'-7"            |                  |                 |                  | 2'-0"           | 2'-9"            |
|                                             | 2000 |                  |                 | 2'-9"            | 3'-10"          | 5'-0"            |                  |                 | 2'-1"            | 3'-0"           | 4'-1"            |                  |                 |                  |                 | 2'-6"            |
|                                             | 200  |                  |                 | 2'-6"            | 3'-6"           | 4'-6"            |                  |                 |                  | 2'-9"           | 3'-9"            |                  |                 |                  |                 | 2'-3"            |
|                                             | 400  |                  |                 | 2'-4"            | 3'-2"           | 4'-2"            |                  |                 |                  | 2'-6"           | 3'-5"            |                  |                 |                  |                 | 2'-1"            |
|                                             | 600  |                  |                 | 2'-1"            | 2'-11"          | 3'-10"           |                  |                 |                  | 2'-4"           | 3'-2"            |                  |                 |                  |                 |                  |
|                                             | 800  |                  |                 |                  | 2'-9"           | 3'-7"            |                  |                 |                  | 2'-2"           | 2'-11"           |                  |                 |                  |                 |                  |
|                                             | 3000 |                  |                 |                  | 2'-6"           | 3'-4"            |                  |                 |                  | 2'-0"           | 2'-9"            |                  |                 |                  |                 |                  |
|                                             | 200  |                  |                 |                  | 2'-5"           | 3'-1"            |                  |                 |                  |                 | 2'-7"            |                  |                 |                  |                 |                  |
|                                             | 400  |                  |                 |                  | 2'-3"           | 2'-11"           |                  |                 |                  |                 | 2'-5"            |                  |                 |                  |                 |                  |
|                                             | 600  |                  |                 |                  | 2'-1"           | 2'-9"            |                  |                 |                  |                 | 2'-3"            |                  |                 |                  |                 |                  |
|                                             | 800  |                  |                 |                  |                 | 2'-8"            |                  |                 |                  |                 | 2'-2"            |                  |                 |                  |                 |                  |
|                                             | 4000 |                  |                 |                  |                 | 2'-6"            |                  |                 |                  |                 | 2'-1"            |                  |                 |                  |                 |                  |

FIG. 10



**Forms in position for two-column pier showing framed support for transom.**



**Details of Forms for pier shown in Fig. 2.**

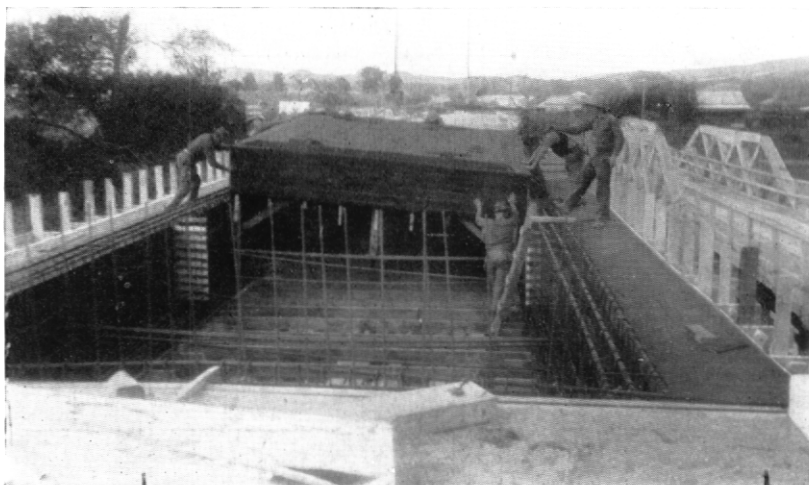
- (2) Greater uniformity and appearance of concrete surfaces.
- (3) Saving in labour if stripping is easy.

It has the following disadvantages:—

- (1) The stripping must be done very carefully and labour costs for this section of the work may be greater on this account.
- (2) If the sizes of panels available are not exactly suitable for the work, wastage by cutting or filling in with strips involves added cost.

- (3) Personnel must become familiar with the handling of form sections in order to ensure maximum economy.

In general, a maximum repetition in use of forms contributes greatly to securing minimum cost of concrete bridge construction, but must be accompanied by skilful design of the bridge and of the forms and falsework, as well as careful stripping, cleaning and handling of the materials. Co-ordination of the operations in the various stages of construction is also necessary.



**A panel of prefabricated formwork being lowered into position by a Flying Fox in a two-girder reinforced concrete bridge.**

# The Western Division and its Road System.

## PART 1.—General description of physical features, population and industries.

The Western Division of New South Wales comprises that portion of the State that is bounded on the north by Queensland, on the west by South Australia, on the south by Victoria, and on the east by an irregular line roughly parallel to the coast of New South Wales. It covers 125,000 square miles, being forty per cent. of the area of the State. It differs from the remainder of the State in that most of the land is still under the control of the Crown in various forms of lease, and the area is not divided into Shires for purposes of local government. The Western Division is somewhat greater than the size of Victoria and Tasmania together, and about five-sixths the size of California.

The road system of the Western Division presents problems of a special nature arising mainly from the climatic conditions of the area and the resulting sparse population. For example, in the eastern portion of the State there are 166 persons on the average for each mile of Main Road, but in the Western Division there are only about nine persons per mile of Main Road.

In order to see the roads of the Western Division in correct perspective, it is necessary first to review briefly the climatic and physical conditions of the area and to examine the population and industry which the road system is planned to serve. These are the subjects of Part I of this article published in this issue of *Main Roads*. Part II, to be published in the next issue, will describe the road system itself, and its particular problems.

The Western Division consists of a vast area of prairie and plain, broken only very occasionally by low isolated hills or ranges. The only ranges of significance are the Barrier Range running north and south and reaching an altitude of between 1,000 and 2,000 feet, and on which Broken Hill is situated, and the Grey Ranges in the north-western corner on the Queensland border. The average elevation of the Division is under 500 feet. (See Fig. 1.)

While there are many vast treeless areas in the Division, the greater part is covered with various types of low growing trees and shrubs. Yet this huge area, so typical of the more remote parts of the Australian interior, carries a total population of only about 53,000 persons, of whom more than half are in the essentially mining city of Broken Hill.

The reason for this seeming anomaly is, of course, the same as that which applies to large areas throughout inland Australia—the rainfall is inadequate in quantity and too unreliable in incidence to support closer settlement, even when supplemented by the artesian bore waters which are available in some parts. (See Fig. 2.)

There are six principal towns in this vast western terrain—the City of Broken Hill in the far west with 27,770 people, mainly dependent on mining and the third largest town in New South Wales, Cobar, in the eastern part of the Division with 1,830 people, partly dependent on mining; Wentworth in the south-western corner with 860 people, partly supported by areas irrigated from the Murray and Darling Rivers, at whose junction it is situated; Wilcannia with 680 people, situated on the Darling River almost centrally in the Division, a former river port; Bourke and Brewarrina towards the north-eastern corner of the Division with 2,000 and 890 people respectively situated on the Darling and Barwon Rivers, and also former river ports. The total population of these six towns is just over 34,000 persons. It will be seen, therefore, that only about 19,000 persons are living on properties and in the smaller towns and villages.

The Western Division is characterised by its low rainfall, the average annual rainfall varying from 15 inches along much of the eastern border of the Division to as little as 8 inches at and north of Broken Hill. In the northern half of the Division the rain falls mainly in the summer and in the southern part mainly in the winter, as elsewhere in New South Wales. As previously stated, the incidence of the rainfall is most variable.

In summer, shade temperatures are frequently over 100 degrees Fah., and dust storms are not uncommon during the summer months. In other periods of the year the nights are cool but the days fine, and mild to warm, especially in the northern parts. It is only in the summer months that the climate renders living conditions unpleasant. Even in summer high temperatures are tempered by low humidity.

Although the Division is not divided into Shires for purposes of local government, the six principal towns are incorporated as Municipalities. Other administrative functions are effected by the State Government, the Department of Main Roads being responsible for all road works.

*Soils.*—East of the Darling River, the soils are mainly brown soils of light texture, black soils or mallee soils. The black soils border what are or have been the principal drainage lines. The mallee soils are mainly in the south, adjacent to the mallee area in Victoria, although there are some patches in the central area. West of the Darling River there are principally desert loams, with isolated patches of black soil in the north, and a continuous fringe of black soil along the Darling River and some mallee areas in the south. (See Fig. 3.)

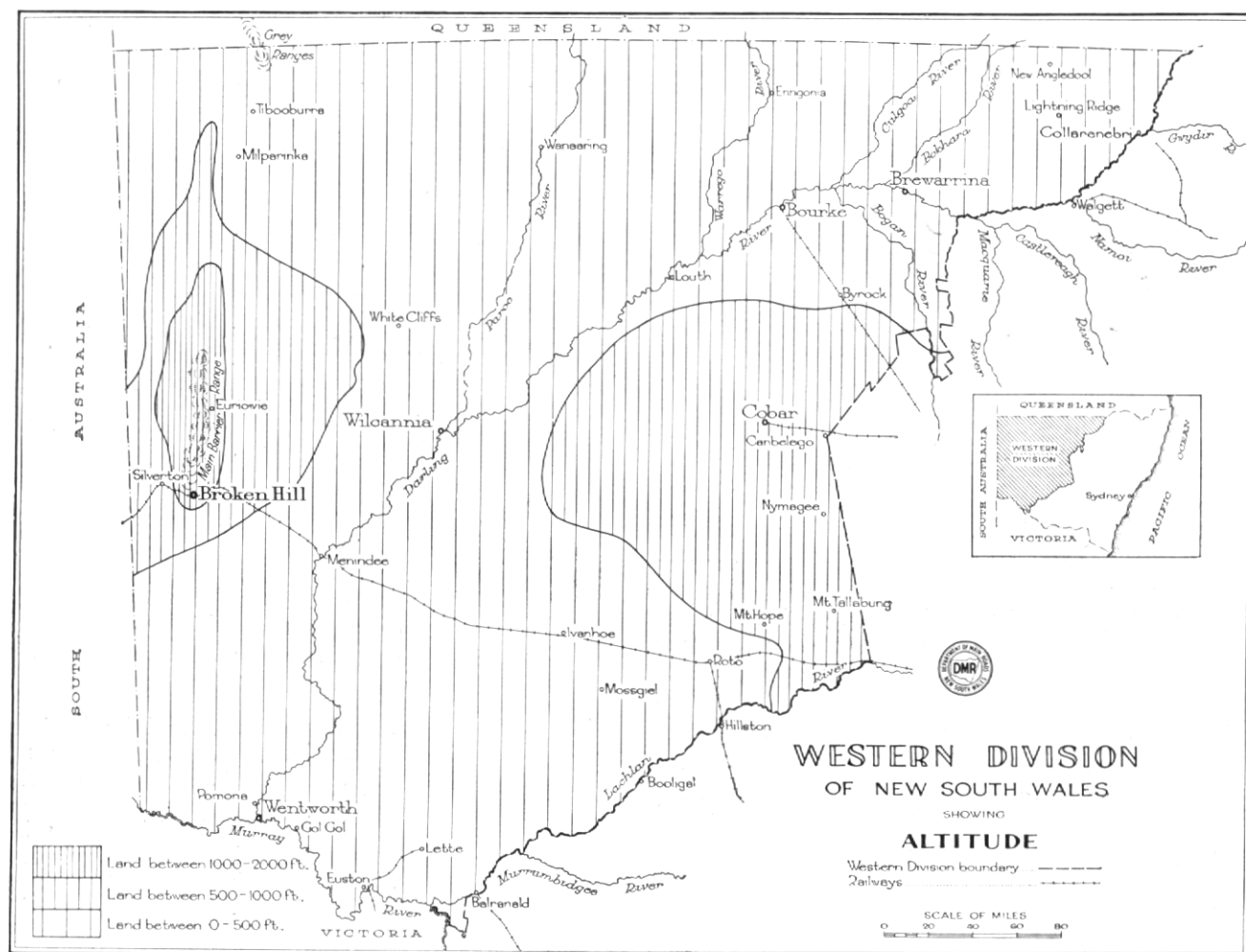


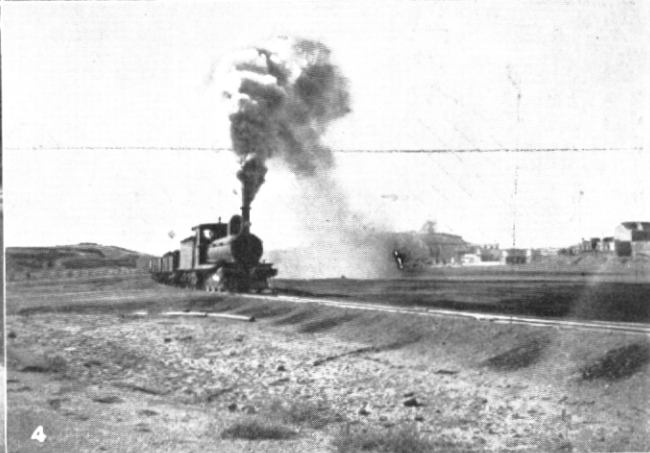
Fig. 1.

*Vegetation.*—The vegetation varies with the soils and rainfall, and is characteristic of inland Australia. Much of the tree growth is edible by stock, and is frequently used when herbage is non-existent in time of drought. The predominant types are Wilga, Mulga, Belah, Boonery, Beefwood, Leopard Wood, Cypress Pine, Needlewood, Ironwood, Gidgee, Brigalow, Kurrajong, Boree, Yarran, Myall and Eucalypts such as Mallee, Coolibah and Bimble Box. Each area of uniform soil type and climate has its particular pattern of tree growth. (See Fig. 4.) The main streams are lined with Murray Red Gums in the central and southern parts of the Division and with Coolibahs in the northern part. The principal trees used for planting at towns, villages and homesteads are the White Cedar, the Pepper Tree and the Silky Oak, which are notable for their drought resistant qualities. Many other varieties of trees are planted, but require systematic watering.

*Water.*—The principal stream is the Darling and Barwon River, the name "Barwon" applying for the first 200 miles from the Queensland border, to its confluence with the Culgoa River. It flows from the north-east corner to the south-west corner of the

Division, a distance of 600 miles in a straight line, but 1,400 miles along the meandering river. Its average fall between Bourke and Wentworth is under three inches per river mile, and it flows generally in a deep tree-lined channel with steep sloping sides, thirty to forty feet below the surrounding plains. While normally the stream itself is only a few feet deep, in times of flood the Darling is an impressive sight, and occasionally spreads out over the adjacent countryside. In times of drought, it has ceased to flow. It provides water for the four principal towns on its banks and for intermediate villages and homesteads. Water from the Darling River was sent regularly by rail from Menindee to Broken Hill, a distance of 73 miles, from August, 1944, until January, 1946, when local supplies at Broken Hill were insufficient. Darling River water will be available to Broken Hill by pipe when works now being undertaken are completed. There are a few small weirs on the river to impound town supplies. A start has now been made to provide between thirty and forty low weirs throughout the length of the river.

The principal tributaries of the Darling River in the Western Division join it in the northern one-third of its length. They are the rivers Moonie, Bokhara,



# Contrasts in Transport

1. Station hand's Camel Buggy on Mt. Woods Station near Tibooburra.
2. A Drover in the Goodooga District.
3. Murray River Paddle Steamer "Marion" near Mildura.
4. Train at Broken Hill North Mine.
5. Stock Transporter on Bourke-Hungerford Road.
6. Sydney-Charleville Plane at Bourke Aerodrome.

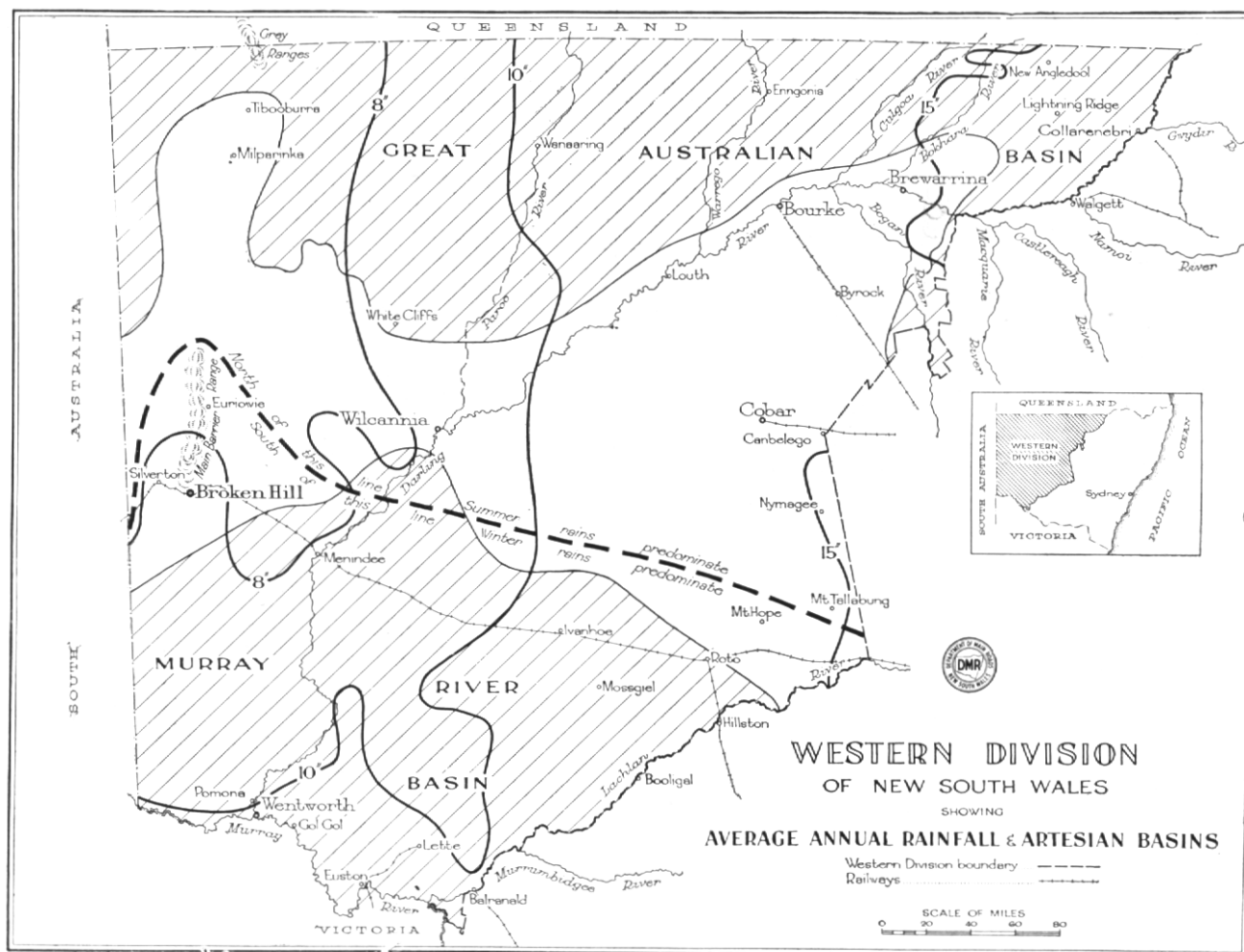


Fig. 2.

Culgoa, Warrego and Paroo from the north and the rivers Gwydir, Namoi, Castlereagh, Macquarie and Bogan from the east and south-east. The flood flow of the Paroo River rarely reaches the Darling River.

Much of the water which overflows from the Darling River and its tributaries in time of high flood remains in lakes and shallow basins, and is soon lost by evaporation, the rate of evaporation being as high as ninety inches per annum.

The Western Division is served by artesian water over its northern one-third, which is within the Great Basin that embraces much of Queensland, and extends also into the Northern Territory and South Australia. An area in the south of the Division comes within the Murray Basin. The underground water from artesian sources has made pastoral settlement possible in areas of low rainfall and limited surface water.

The quantity and quality of the water from artesian bores vary considerably. There are 250 flowing bores in the Division and 93 which have ceased flowing and are now being pumped. The total yield from these bores is approximately ten million gallons per day. The largest individual yield is that from the Angeldool No. 2 Bore at 956,000 gallons per day.

Public watering places for stock are provided at intervals of about twelve to twenty miles along stock routes. These are bore water supplies where surface water is not available.

*Population.*—The following table shows the populations of the principal towns and the total population of the Division at different periods since 1881:—

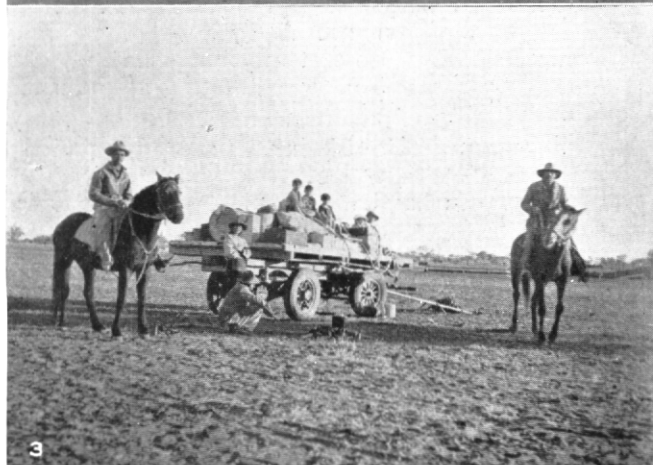
| Centre.                | 1881.  | 1891.  | 1901.  | 1911.  | 1921.  | 1933.  | 1940.  |
|------------------------|--------|--------|--------|--------|--------|--------|--------|
| Wentworth ... ..       | 752    | 801    | 642    | 558    | 817    | 840    | 860    |
| Bourke ... ..          | 1,378  | 3,149  | 2,600  | 1,593  | 1,430  | 1,778  | 2,000  |
| Brewarrina ... ..      | 489    | 683    | 798    | 798    | 605    | 804    | 890    |
| Cobar ... ..           | 1,859  | 1,189  | 3,371  | 4,430  | 1,437  | 1,163  | 1,830  |
| Broken Hill ... ..     | ...    | 19,789 | 27,500 | 30,972 | 26,337 | 26,925 | 27,770 |
| Wilcannia ... ..       | 1,424  | 1,287  | 939    | 670    | 592    | 623    | 680    |
| Unincorporated ...     | 16,006 | 31,664 | 21,668 | 18,421 | 15,189 | 18,740 | 18,860 |
| Total for Division ... | 21,763 | 58,638 | 57,412 | 57,442 | 46,467 | 50,882 | 52,890 |

(Figures for 1881, 1891, 1901 and 1940 from *Statistical Register*, figures for 1911, 1921 and 1933 from Commonwealth Census.)

Several interesting points are revealed by these figures:—

1. The population of the Western Division in 1945 was 1.8 per cent. of the total population





Some Aspects of Life in the Western Division.

1. Main-street, Wentworth.
2. Opal Fields, Lightning Ridge.
3. Party of aboriginal drovers.
4. General Hospital, Broken Hill.
5. Bush Nurse's Home on the banks of the Paroo Billabong at Wanaaring.
6. Meat Works at Bourke.

of the State in the same year (2,900,000), whereas the area of the Western Division is 40 per cent. of that of the State.

2. Over 50 per cent. of the Western Division population live in the City of Broken Hill.
3. At least half the population of the Division (principally in Broken Hill and Cobar) is supported directly or indirectly by the mining industry.
4. There has been a decrease in total population since 1891.
5. The decrease has been greatest in the unincorporated portion of the Division.

The early settlement of the Division was made by pastoralists, and because of the aridity of the area it was natural that the rivers should become the early centres of settlement. The Darling River became the supply route for river steamers, and the riverside towns became important inland ports to the settlers.

From about 1880 onwards, mining pursuits became an important factor in the further settlement of the Division, and as a consequence it became necessary to develop new supply routes, and railways and roads supplemented and ultimately replaced the river supply route.

The mining industry is subject to fluctuations which affect population, as will be noted from the figures for Cobar, a copper mining centre, and for Wilcannia, which was the inland port for the goldfields of the Tibooburra and Milparinka districts, and the opal fields of White Cliffs. The decline in total population of the unincorporated portions of the Division may be largely accounted for by the cessation or decline of operations at these and other small mining centres such as Mt. Hope, Nymagee, Canbelego and Lightning Ridge, and by improved road transport causing a shift of business from the smaller to the larger centres.

### INDUSTRIES.

*Grazing.*—The grazing of sheep and, to a less extent, cattle, is the most widespread industry in the Western Division, as the climate precludes agriculture except where irrigation is possible. Further, whilst the soils are fertile, they are not highly productive due to climatic deficiencies, so that in comparison with other parts of the State the carrying capacity of the land is small.

The following table showing the sheep population of New South Wales and of the Western Division at various periods has been compiled from the Official

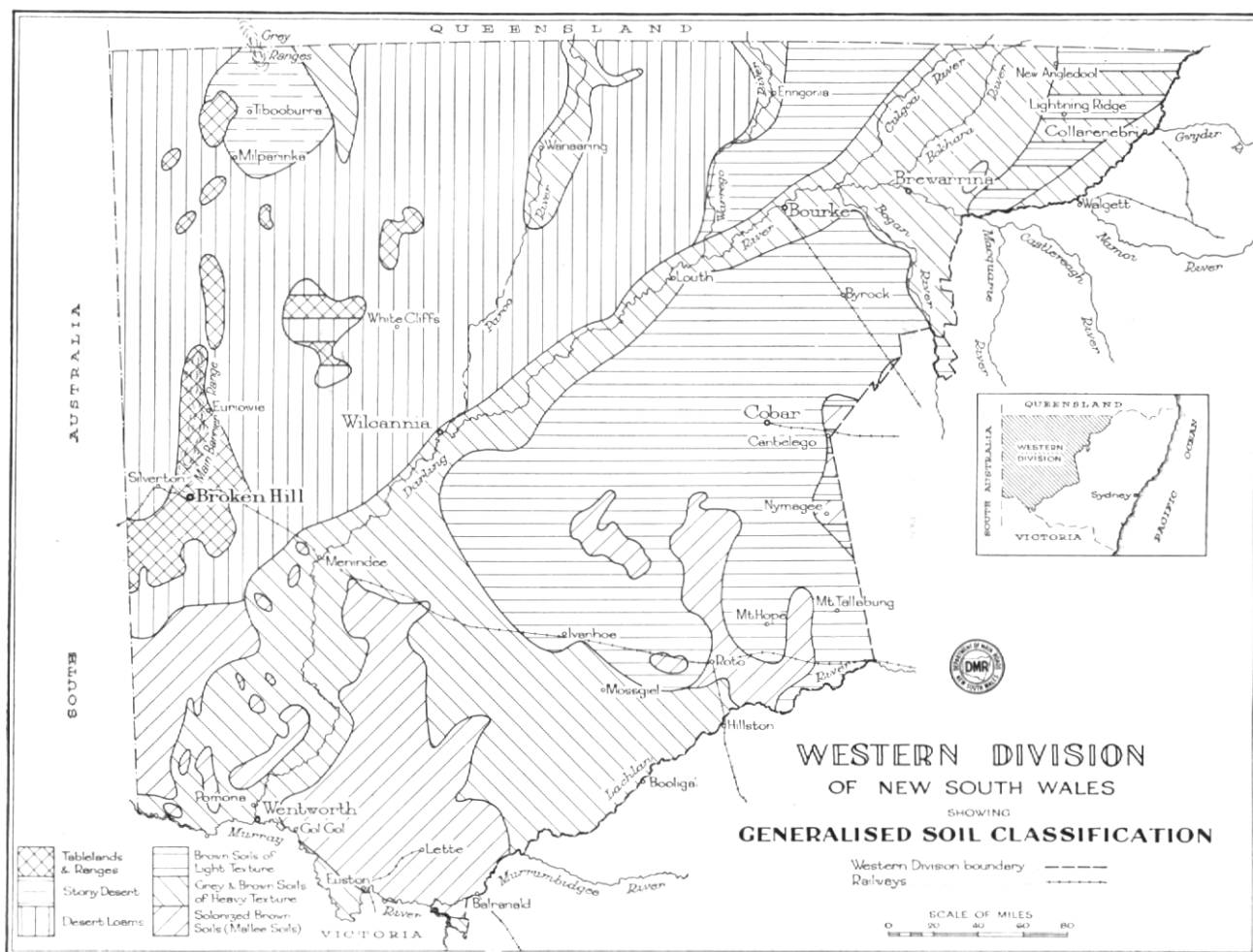


Fig. 3.

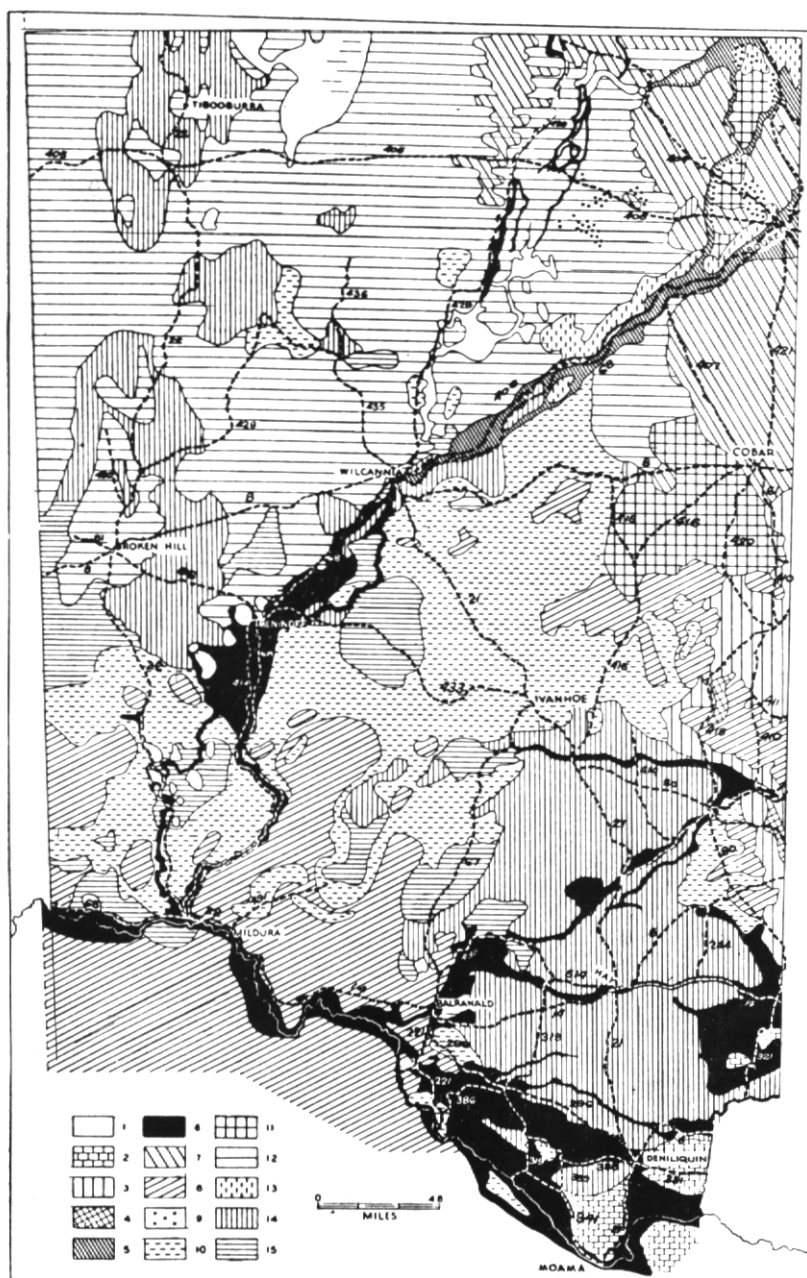


Fig. 4.

THE VEGETATION DISTRIBUTION IN THE WESTERN DIVISION OF NEW SOUTH WALES MAINLY FROM A MS. MAP BY DR. N. C. W. BEADLE.

Map published by courtesy of Professor J. Macdonald Holmes.

1. Claypans.
2. Eucalyptus Woollsiana association (grey boxes).
3. Eucalyptus populifolia-Callitris glauca type (bimble box and pine).
4. Eucalyptus dealbata-Eucalyptus sideroxylon association (gum and ironbark).
5. Eucalyptus coolabah association (coolabah).
6. Eucalyptus bicolor association (black box).
7. Eucalyptus populifolia-Acacia association.
8. Eucalyptus oleosa-Eucalyptus dumosa association (mallee).
9. Acacia cambagei association (gidgee).
10. Casuarina-Heterodendron association (belah-rosewood).
11. Acacia-eremophila association.
12. Acacia aneura association (mulga).
13. Astrebla lappacea association (Mitchell grass).
14. Atriplex vesicarium association (saltbush).
15. Kochia pyramidata-K. sedifolia association (bluebush).



Unusual Surface Features in the Western Division.

1. Road between Milparinka and Wanaaring crossing cane grass swamp.
2. State Highway No. 22. Portion of Gibber Plain near Tibooburra.
3. State Highway No. 8. Broken Hill to South Australian Border. Outlet of culvert blocked with sand. Result of wind erosion.
4. Mulga Tree killed by drought and wind erosion.
5. Example of severe stream erosion adjacent to Broken Hill-Milparinka Road.
6. Another example of stream erosion.

Year Book for New South Wales, 1940-41:—

| Sheep Population.                                | 1891.      | 1911.      | 1931.      | 1941.      | 1942.      |
|--------------------------------------------------|------------|------------|------------|------------|------------|
| New South Wales ...                              | 61,831,000 | 48,830,000 | 53,366,000 | 55,568,000 | 56,738,000 |
| Western Division ...                             | 16,403,000 | 7,936,000  | 6,723,000  | 7,505,000  | 7,532,000  |
| Sheep per square mile, Western Division only ... | 130.6      | 63.2       | 53.6       | 59.8       | 60.0       |

In the earlier years of settlement, the dangers of overstocking and the need for periodical resting of the country to preserve natural vegetation and to arrest soil erosion were not fully appreciated, and as a result, some country deteriorated considerably. The influx of rabbits was also a contributory cause of the deterioration.

The areas of country suitable for cattle raising are much less than the areas occupied by sheep. There has, however, been an increase in the cattle population of the Division since the beginning of this century, possibly due to additional water supplies becoming available from artesian bores enabling further suitable cattle country to be developed. There is a large meat works at Bourke.

The following table showing the cattle population of New South Wales and of the Western Division at various periods has been compiled from the *Official Year Book of New South Wales, 1940-41* (figures include dairying and other cattle):—

|                      | 1891.     | 1911.     | 1931.     | 1941.     | 1942.     |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| New South Wales ...  | 2,128,000 | 3,194,000 | 2,840,000 | 2,769,000 | 2,878,000 |
| Western Division ... | 101,000   | 119,000   | 64,000    | 62,000    | 68,000    |

*Agriculture.*—As mentioned earlier in this article, the Western Division is generally beyond the western limit of safe agriculture without irrigation. Agriculture by irrigation in the form of vineyards for the production of sultanas and raisins, and citrus and other orchards is, however, a thriving industry in the Wentworth area adjacent to the Darling and Murray Rivers and, to a lesser extent, at Pomona and Menindee on the Darling River. Citrus and other fruits and most kinds of vegetables for local consumption are also grown successfully by irrigation at the various centres of population along the Darling and Barwon Rivers.

*Mining.*—The minerals produced from the Western Division comprise gold, silver, copper, lead, zinc, tin and opals.

In 1876, the Silvertown fields were discovered some miles west of Broken Hill. These are not now being worked. In 1883, the now famous silver-lead deposits of Broken Hill were discovered by early pioneers of the west—McCulloch, Rasp and Phillip Charley. The ore production from Broken Hill has reached over 63 million tons and the total value of the output amounts to over £200,000,000. The limit of the wealth of the phenomenal line of lode which curves under the City of Broken Hill is not known. Broken Hill is, to-day, a thriving and prosperous city, and while essentially a mining town, it is also the social and commercial centre for a large area of country extending beyond the South Australian and Queensland borders.

Copper is found in the eastern portion of the Division. At the present time Cobar is the only centre where extensive copper mining is being carried out. In earlier years copper mines were also in production at Nymagee, Canbelego and Mt. Hope.

Early in this century Milparinka and Tibooburra were centres of gold mining activity. Like many of the earlier goldfields, they have been almost abandoned. To-day, Milparinka comprises an hotel and a post office, and the population of Tibooburra is less than 100.

Opals have been mined for many years at White Cliffs, Lightning Ridge and, to a lesser extent, at other places. The White Cliffs fields were discovered in 1884 and working of the field commenced actively in 1889, when there was a population of 2,000 at White Cliffs. In the first twenty-five years of operation, opal to the value of over £1,000,000 was mined. The relatively large populations supported by the opal industry in the earlier part of the century have dwindled to a hundred or less at each main field.

Tin in small quantities is mined at Mt. Tallebung near the eastern boundary of the Division. Tin was also mined at Euriowie, north of Broken Hill, but production ceased in 1925.

### THE ROAD SYSTEM.

Part II of this article will be published in the next issue of this journal, and will describe the road system of the Western Division as developed hitherto, and the problems involved in its improvement to serve the people and industries of the area.

The Department recently accepted the tender of Mr. K. McCallum, of Holbrook, for the construction of a reinforced concrete bridge over Tarcutta Creek on the Hume Highway in the Shire of Kyeamba at a cost of £8,231 4s. 2d.





Photo. by courtesy of Hall and Co., 20 Hunter-street, Sydney, N.S.W.

## Sydney Harbour Bridge—Finance and Passenger Traffic

Sydney has a population of one and a half million people and of that number, one fifth or three hundred thousand live on the northern side of the Harbour. With the business heart of the city located on the southern side, the situation requires a considerable movement of traffic across the Harbour. Prior to the construction of the Sydney Harbour Bridge this requirement was met almost entirely by the use of passenger and vehicular ferries, the only alternative being a bridge crossing nearly seven miles by road from the City.

While the construction of a bridge to span the Harbour at the gate of the inner City had been the dream of generations past, it was the rapid growth of motor vehicles after the end of the first world war that created a situation which demanded action, and the dream became a reality in 1932 when the Sydney Harbour Bridge was completed and opened to traffic.

The capital cost of the project to the 30th June, 1947, and the sources of finance were as follows:—

| <i>Capital Cost.</i>                                                                                |           | £          |
|-----------------------------------------------------------------------------------------------------|-----------|------------|
| Main and Approach Spans .. .. .                                                                     | 7,138,260 |            |
| Acquisition of land and property .. .. .                                                            | 1,020,011 |            |
| Capitalised interest and exchange in respect of loan moneys spent to the date the bridge was opened | 1,494,988 |            |
| Miscellaneous expenses .. .. .                                                                      | 93,061    |            |
|                                                                                                     |           | £9,746,329 |

The disposal of land and property still on hand may finally reduce the capital cost to approximately £9,600,000.

When the planning of the Bridge reached concrete form it was first proposed, as set out in the Sydney Harbour Bridge Act of 1922, that the cost should be met to the extent of one-third by a rate levied on property in the City of Sydney and in the Local Governing areas within the Metropolitan area on the northern side of the Harbour, and to the extent of two-thirds by the Railway Authority. The rate levied on property owners commenced in 1923 and was fixed at ½d. in the £ on the Unimproved Capital Value of the land. It was not contemplated when the construction of the bridge was undertaken that trams would cross the structure, nor that there would be any toll charge in respect of road vehicles. The original Act of 1922 was amended immediately prior to the opening of the bridge on 19th March, 1932, so as to provide that the rate on property owners should cease at the end of 1939, while authority was given for tolls

| <i>Sources of Finance.</i>                                                                |           | £          |
|-------------------------------------------------------------------------------------------|-----------|------------|
| Repayable loan funds provided by the State Government .. .. .                             | 8,066,395 |            |
| Contributions by Local Governing Councils to the date the bridge was opened .. .. .       | 1,327,466 |            |
| Interest accrued on the Councils' contributions to the date the bridge was opened .. .. . | 337,978   |            |
| Miscellaneous .. .. .                                                                     | 14,490    |            |
|                                                                                           |           | £9,746,329 |



or charges to be levied in respect of tram and road traffic in addition to rail traffic. Goods traffic is not carried across the Bridge by rail.

Since the bridge was opened, there have been changes from time to time in the amounts of the charges to be borne by the various classes of contributors. The rate payable by property owners was reduced from  $\frac{1}{2}$ d. in the  $\frac{1}{4}$ £ on the Unimproved Capital Value to  $\frac{1}{3}$ d. as from 1933 and to  $\frac{2}{9}$ d. as from 1936, while it was removed altogether at the end of 1937. Contributions by tram and omnibus travellers to the Bridge Fund were first determined at approximately  $\frac{1}{4}$ d. per person for each crossing, but this amount was reduced at the beginning of 1939 to approximately  $\frac{1}{4}$ d.

Similarly the contributions of railway travellers to the Bridge Fund, first determined at an average of just over  $\frac{1}{2}$ d. per person for each crossing, are now slightly less than  $\frac{1}{4}$ d. Except in respect of those using omnibuses, little variation has taken place so far as road travellers are concerned, and the contribution per person in respect of those travelling in passenger vehicles other than omnibuses—that is excluding lorries—averages  $\frac{1}{2}$ d. for each crossing.

All the changes which have been made in contributions since these were finally determined following on the opening of the Bridge have been in the nature of reductions, and this has been made possible because of the increase in the traffic using the structure.

Apart from the incidence of changes in the nature of the contributors and in the actual charges made against those using the Bridge, the revenues have been considerably affected by variations in the volume of traffic. The Bridge was opened in March, 1932, during a period of financial depression when both passenger and road-vehicle traffic were at a low ebb. There was subsequently a progressive increase of passengers and road vehicles each year until the institution of petrol rationing on the 1st October, 1940, caused a falling away of road vehicles and road passengers. The steepness of this fall increased as petrol restrictions gradually reached their peak in February, 1942, and it was not until September, 1945, that a gradual easing

of the restrictions began. The recession of road traffic caused by petrol rationing resulted to some extent in a diversion of road travellers to the train, tram and omnibuses with a consequent increase of passenger traffic on those services. There was actually an overall increase in number of persons using the Bridge during the war years. This increase of total passenger traffic was not accompanied by an increase of total revenue—in fact the reverse applied, because, as already explained, the average rate of contributions per road traveller exceeds that of the rail, tram and omnibus traveller and the amount paid by the increased number of rail, tram and omnibus travellers fell short of what was lost by reason of the reduction in the number of road travellers.

The number of persons using the different forms of transport and the revenue received from the various sources each year since 1933-34 are shown in diagram No. 1 on page 28.

It is estimated that the number of bridge crossings by persons during 1946-47 was 61,457,000, or an average of 168,400 per day as follows:—

|                          | Total.     | Average<br>per day. |
|--------------------------|------------|---------------------|
| In private road vehicles | 13,938,000 | 38,200              |
| In trains .. ..          | 23,312,000 | 63,800              |
| In trams .. ..           | 16,565,000 | 45,500              |
| In omnibuses .. ..       | 7,642,000  | 20,900              |
| Total                    | 61,457,000 | 168,400             |

In contrast to the variations in revenues which have occurred, the commitments chargeable against the revenues have remained fairly constant, and the amounts due for the year 1946-47 as set out at the foot of this page might be quoted as representative of a typical year. A dissection of the total expenditure chargeable against bridge revenues to the 30th June, 1947, is also given. (The figures quoted will be subject to slight adjustment on finalisation of the accounts for 1946-47.)

It will be seen that the major commitment is for loan charges which amount to approximately £1,000 each day.

| Item.                                                                                                | 1946-47.  |                      | From the date of opening to the 30th June, 1947. |                      |
|------------------------------------------------------------------------------------------------------|-----------|----------------------|--------------------------------------------------|----------------------|
|                                                                                                      | Amount.   | Percentage of Total. | Amount.                                          | Percentage of Total. |
| <b>Loan Charges—</b>                                                                                 |           |                      |                                                  |                      |
| Interest .. .. .                                                                                     | £ 266,598 | 84.4                 | £ 4,574,995                                      | 89.3                 |
| Sinking Fund .. .. .                                                                                 | 66,500    |                      | 693,104                                          |                      |
| Exchange .. .. .                                                                                     | 35,517    |                      | 652,090                                          |                      |
| Loan Management Expenses .. .. .                                                                     | 1,473     |                      | 35,880                                           |                      |
|                                                                                                      | 370,088   |                      | 5,956,069                                        |                      |
| <b>Maintenance and minor improvement of bridge and approaches including lighting and cleaning ..</b> | 53,000    | 12.1                 | 480,093                                          | 7.2                  |
| <b>Cost of collecting Road Tolls .. .. .</b>                                                         | 14,000    | 3.2                  | 147,966                                          | 2.2                  |
| <b>Administration Expenses .. .. .</b>                                                               | 1,000     | 0.2                  | 13,880                                           | 0.2                  |
| <b>Miscellaneous .. .. .</b>                                                                         | 600       | 0.1                  | 72,883                                           | 1.1                  |
|                                                                                                      | £438,688  | 100 Per cent.        | £6,670,891                                       | 100 Per cent.        |

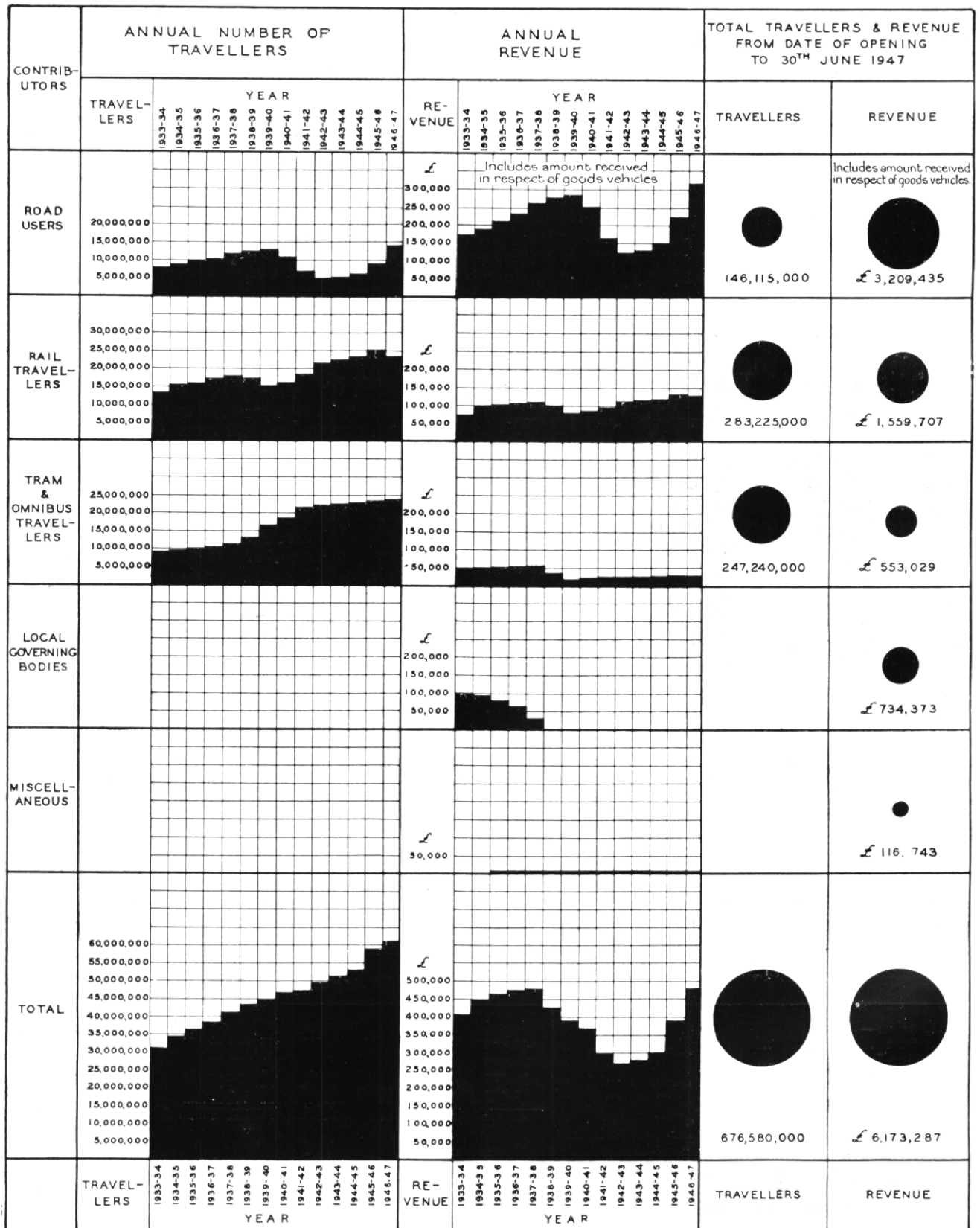


Diagram No. 1. Number of persons using the Sydney Harbour Bridge and total revenue during each year from 1933-34 to 1946-47.

The repayable loan moneys amounting to £8,066,395 at 30th June, 1947, are being liquidated by the Sinking Fund method over a period of fifty-three years, expiring in about 1985.

The financial operations during each year from 1933-34 onwards are shown in the diagram which follows:—

These concessions were made as surpluses on operations resulted from the increasing traffic before the War. The drastic reduction of road traffic following on petrol rationing had a serious effect on revenues, however, as by far the major portion of the bridge revenues was contributed by the owners of road vehicles, and substantial deficits were consequently experienced from 1942 to 1945.

| YEAR                                                     | REVENUE     | EXPENDITURE | RESULT OF OPERATIONS FOR THE YEAR |   |   |   |             |         |   |   |   |   | ACCUMULATED POSITION AT END OF YEAR |   |   |   |   |         |           |   |   |   | YEAR |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |             |
|----------------------------------------------------------|-------------|-------------|-----------------------------------|---|---|---|-------------|---------|---|---|---|---|-------------------------------------|---|---|---|---|---------|-----------|---|---|---|------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|-------------|
|                                                          |             |             | DEFICIT                           |   |   |   |             | SURPLUS |   |   |   |   | DEFICIT                             |   |   |   |   | SURPLUS |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |             |
|                                                          |             |             | (HUNDRED THOUSAND POUNDS)         |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |             |
|                                                          | 0           | 1           | 2                                 | 3 | 4 | 5 | 6           | 0       | 1 | 2 | 3 | 4 | 5                                   | 6 | 6 | 5 | 4 | 3       | 2         | 1 | 0 | 1 | 2    | 3 | 4 | 5 | 6 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |  |             |
| 1933 — 34                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1933 — 34   |
| 1934 — 35                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1934 — 35   |
| 1935 — 36                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1935 — 36   |
| 1936 — 37                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1936 — 37   |
| 1937 — 38                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1937 — 38   |
| 1938 — 39                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1938 — 39   |
| 1939 — 40                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1939 — 40   |
| 1940 — 41                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1940 — 41   |
| 1941 — 42                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1941 — 42   |
| 1942 — 43                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1942 — 43   |
| 1943 — 44                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1943 — 44   |
| 1944 — 45                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1944 — 45   |
| 1945 — 46                                                |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | 1945 — 46   |
| * 1946 — 47                                              |             |             |                                   |   |   |   |             |         |   |   |   |   |                                     |   |   |   |   |         |           |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  | * 1946 — 47 |
| TOTAL FROM DATE OF OPENING TO 30 <sup>TH</sup> JUNE 1947 | *£6,173,287 |             |                                   |   |   |   | *£6,670,891 |         |   |   |   |   |                                     |   |   |   |   |         | *£497,604 |   |   |   |      |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |             |

\* Subject to slight adjustment upon finalization of accounts for the year 1946-1947

Diagram No. 2. Result of financial operations at the Sydney Harbour Bridge during each year from 1933-34 to 1946-47.

As previously indicated, the levy on property owners of the City of Sydney and of the Local Governing areas on the northern side of the Harbour has been discontinued, and reductions of the toll charges payable by those using the bridge have also been effected.

The maximum accumulated deficit was £545,241 at 30th June, 1946. A surplus of approximately £47,000 resulted from operations during 1946-47, and the accumulated deficit at 30th June, 1947, stood at approximately £498,000.

## Painting Gantry for Peat's Ferry Bridge.

The new highway bridge over the Hawkesbury River was opened on the 5th May, 1945, and has since been carrying a large volume of traffic on the main northern highway from Sydney. In size and importance, it is the largest bridge, other than the Sydney Harbour Bridge, under the control of this Department. The atmosphere at the site of the bridge is frequently

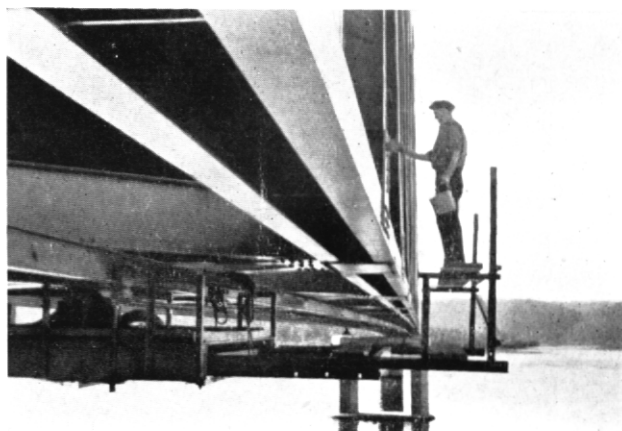
impregnated with salt, owing to the short distance from the coast and the fact that the bridge is over tidal water. The whole bridge is situated in an exposed position, and the locality is subject to frequent fogs.

In a structure of this size, it is necessary to provide an efficient system of maintenance, so that the bridge will not deteriorate to such an extent as to reduce its

capacity for carrying traffic. It is comparatively easy to inspect and carry out maintenance work on the part of the structure above the deck, but below deck the work is rendered more difficult. To facilitate maintenance below deck level a gantry has therefore now been provided, carried beneath the spans.

The bridge itself is constructed of steel and concrete, there being two steel truss spans each 440 feet long, eight steel plate web girder spans each 90 feet long, one steel approach girder span 45 feet long, and eight rolled steel joist spans each 40 feet long on the northern side. The total length is approximately 1,970 feet. The bridge is on a grade running down from the centre of the two truss spans in each direction, the maximum under the steelwork being three per cent. The width of roadway, which is between the trusses, is 30 feet, and a footway six feet wide is situated on the upstream side of the bridge, making a width overall of approximately 42 feet. The underside of the truss spans is 38 feet above high tide level. It will be realised that these conditions render any temporary staging very difficult to erect, and it would require to be very secure in order to enable the men to work satisfactorily.

The inspection and painting gantry which has been erected is carried underneath the whole of the steel spans, with the exception of the rolled steel joist approach spans on the northern side, by two steel joists 10 inches deep, bolted to the bottom flanges of cross girders. The gantry itself consists of a light, welded steel frame, the width being 25 feet to allow movement inside the trusses, and the height 3 feet 1 inch to enable it to go under the cross girders and over the reinforced concrete brace at the top of the piers. In addition, the gantry carries extension platforms which can be pushed out from the main gantry underneath the steel trusses and main girders, enabling work to be carried out on



Gantry in position under the Truss Spans.

the outside of these members and the underside of the footway.

The gantry runs on the rolled steel joists referred to above on four travelling wheels, which are geared to hand-operated machinery on the traveller itself, and the retractable platforms for carrying out work beyond the width of the main gantry are also operated by hand gear and wire rope with pulleys.

The rolled steel joist runners were supplied and erected by the contractors for the erection of the bridge, and the gantry itself was manufactured at the Central Workshop of the Main Roads Department. The erection was carried out by the Department.

The photograph above shows the gantry in position underneath the truss spans.

### SYDNEY HARBOUR BRIDGE ACCOUNT.

Income and Expenditure for the period 1st July, 1946, to 30th June, 1947.

| <i>Income.</i>             |          | <i>Expenditure.</i>                      |          |
|----------------------------|----------|------------------------------------------|----------|
|                            | £        |                                          | £        |
| Road Tolls .....           | 321,532  | Cost of Collecting Road Tolls .....      | 14,000   |
| Contributions—             |          | Maintenance and Minor Improvements ..... | 42,426   |
| Railway Passengers .....   | 128,362  | Alterations to Archways .....            | 10,574   |
| Tramway Passengers .....   | 18,163   | Administrative Expenses .....            | 1,000    |
| Omnibus Passengers .....   | 8,408    | Loan Charges—                            | £        |
| Rent from Properties ..... | 9,220    | Interest .....                           | 266,598  |
|                            |          | Exchange .....                           | 35,517   |
|                            |          | Sinking Fund .....                       | 66,500   |
|                            |          | Management Expenses .....                | 1,473    |
|                            |          |                                          | 370,088  |
|                            |          | Miscellaneous .....                      | 600      |
|                            | £485,685 |                                          | £438,688 |

NOTE: The figures in this Statement are subject to adjustment upon completion of accounts for the year.

# Tenders Accepted.

The following Tenders (exceeding £500) were accepted by Councils during the months of April, May and June, 1947:—

| Council.                 | Road No. | Work.                                                                                                                                | Tenderer.                            | Amount.     |
|--------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------|
|                          |          |                                                                                                                                      |                                      | £ s. d.     |
| Bland Shire ...          | ...      | Supply, delivery and spreading 1,020 cub. yds. gravel ...                                                                            | G. Broad ...                         | 562 0 0     |
| Blaxland Shire ...       | 55       | Construction of approaches to Cox's River Bridge ...                                                                                 | J. and A. Lighezzolo ...             | 9,878 0 0   |
| Boomi Shire ...          | 232      | Supply, delivery and spreading 8,400 cub. yds. loam 5 m. 08 chns. to 12 m. 08 chns. Garah to Boomi.                                  | Muggleton Bros. ...                  | 1,015 0 0   |
| Do ...                   | 367      | Supply, delivery and spreading 4,800 cub. yds. loam 37 m. 34 chns. to 42 m. and 42 m. 35 chns. to 49 m. 69 chns., Garah to Mungindi. | A. Gall ...                          | 720 0 0     |
| Do ...                   | 367      | Supply, delivery and spreading 7,680 cub. yds. loam 51 m. 35 chns. to 55 m. 35 chns. Garah to Mungindi.                              | A. Gall ...                          | 1,050 0 0   |
| Do ...                   | 507      | Supply, delivery and spreading 5,040 cub. yds. gravel 6 m. 50 chns. to 9 m. 20 chns., Mungindi to Boomi.                             | A. Peachy ...                        | 1,197 0 0   |
| Cockburn Shire ...       | 1,093    | Construction of timber bridge over Limestone Gully on Attunga-Somerton Road.                                                         | A. Gam ...                           | 929 11 0    |
| Colo Shire ...           | 519      | Supply and application of fluxed bitumen for 2.75 m. ...                                                                             | B.H.P. By-Products Pty. Ltd.         | 1,673 17 8  |
| Culcairn Shire ...       | 331      | Supply of 2,400 cub. yds. gravel, between 23 m. and 26 m., and supply 1,120 cub. yds. gravel between 18 m. 4.750 and 20 m. 1.580.    | F. Carstens ...                      | 646 0 0     |
| Glen Innes Municipality. | 9        | Supply and delivery of 532 cub. yds. crushed aggregate ...                                                                           | Chesterfield and Jenkins             | 748 3 0     |
| Gostwyck Shire           | 12       |                                                                                                                                      |                                      |             |
|                          | 73       | Supply of 28½ tons 80-100 penetration bitumen f.o.r. Uralla.                                                                         | Shell Co. of Australia, Ltd.         | 624 12 6    |
| Gulgong Shire ...        | 55       | Supply and delivery of 3,000 cub. yds. gravel Mudgee-Gulgong Road.                                                                   | A. C. Stephens ...                   | 525 0 0     |
| Do ...                   | 55       | Supply and delivery of 4,660 cub. yds. gravel ...                                                                                    | A. C. Stephens ...                   | 1,003 16 3  |
| Holbrook Shire ...       | 284      | Gravel re-sheeting between 19½ m. and 21½ m., and between 30 m. 64 chns. and 31 m. 64 chns.                                          | F. H. Delaney ...                    | 567 14 2    |
| Do ...                   | 331      | Supply and delivery of gravel ...                                                                                                    | R. G. Barber ...                     | 945 0 0     |
| Hornsby Shire ...        | ...      | Supply and delivery into stock-piles of 573 tons of ½-in. aggregate.                                                                 | Blue Metal & Gravel Pty. Ltd.        | 600 6 6     |
| Hume Shire ...           | 57       | Supply of 750 cub. yds. aggregate ...                                                                                                | Hurricane Hill Quarries              | 975 0 0     |
|                          | 125      |                                                                                                                                      |                                      |             |
|                          | 355      |                                                                                                                                      |                                      |             |
| Illabo Shire ...         | 78       | Bituminous surfacing and re-surfacing ...                                                                                            | B.H.P. By-Products Pty. Ltd.         | 3,374 0 6   |
|                          | 243      |                                                                                                                                      |                                      |             |
| Jemalong Shire ...       | 17       | Supply and delivery f.o.r. Forbes, of 920 cub. yds. of ¾-in. and 257 cub. yds. of ¾-in. aggregate.                                   | C. R. Wilkins ...                    | 1,642 17 11 |
| Do ...                   | 56       | Supply, delivery and spreading 4,464 cub. yds. of gravel                                                                             | E. Short ...                         | 865 1 0     |
| Do ...                   | 377      | Supply, delivery and spreading 4,816 cub. yds. gravel                                                                                | E. Short ...                         | 1,853 16 0  |
| Kearsley Shire ...       | 195      | Supply and delivery of 1,492 cub. yds. of aggregate to stock-piles.                                                                  | Beavis Bros. ...                     | 965 10 6    |
| Lachlan Shire ...        | 61       | Supply, delivery and spreading 5,572 cub. yds. of gravel ...                                                                         | W. J. Haddon ...                     | 1,181 12 0  |
| Do ...                   | 57       | Supply, delivery and spreading 8,832 cub. yds. of gravel                                                                             | W. J. Haddon ...                     | 1,826 13 4  |
|                          | 346      |                                                                                                                                      |                                      |             |
| Lake Macquarie Shire.    | ...      | Supply and application of 12,040 gals. of bitumen—re-surfacing access road from Awaba to R.A.A.F. Station, Rathmines.                | B.H.P. By-Products Pty. Ltd.         | 535 17 6    |
| Do ...                   | ...      | Supply and delivery of 851 tons of slag for re-surfacing access road from Awaba to R.A.A.F. Station, Rathmines—4.2 m.                | B.H.P. By-Products Pty. Ltd.         | 1,604 16 0  |
| Liverpool Plains Shire.  | 72       | Scarifying and reshaping ...                                                                                                         | J. R., W. K., and L. F. Shanley.     | 1,791 7 6   |
|                          | 55       |                                                                                                                                      |                                      |             |
| Do                       | 357      | Gravel re-sheeting ...                                                                                                               | R. A. Wilson ...                     | 5,039 2 6   |
| Lyndhurst Shire          | 246      | Supply and delivery of 2,780 cub. yds. of gravel                                                                                     | Messrs. Road Building and Repair Co. | 770 5 10    |
| Do ...                   | 390      | Supply and delivery of 3,261 cub. yds. of gravel                                                                                     | Messrs. Road Building and Repair Co. | 733 14 6    |
| Marthaguy Shire          | 333      | Supply, delivery and spreading 3,048 cub. yds. of sandy loam on sections between Warren and Carinda.                                 | C. Woodward ...                      | 894 6 6     |
| Do ...                   | 333      | Supply, delivery and spreading 5,876 cub. yds. of sandy loam on sections between Warren and Carinda.                                 | C. Woodward ...                      | 853 13 4    |
| Nambucca Shire           | 10       | Construction of R.C. Bridge over Allomera Creek ...                                                                                  | M. C. Lawson ...                     | 10,141 17 0 |
| Nepean Shire ...         | 154      | Supply and application of up to 14,500 gals. Duratenax ...                                                                           | Australian Gaslight Co.              | 1,087 10 0  |
|                          | 155      |                                                                                                                                      |                                      |             |
| Do ...                   | 154      | Supply and delivery of 695 tons, ½-in. aggregate to stock-piles.                                                                     | Blue Metal & Gravel Pty. Ltd.        | 504 10 0    |
|                          | 155      |                                                                                                                                      |                                      |             |

| Council.              | Road No.                 | Work.                                                                                                                                                     | Tenderer.                                       | Amount.    |
|-----------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------|
|                       |                          |                                                                                                                                                           |                                                 | £ s. d.    |
| Patrick Plains Shire. | 181<br>503               | Surfacing with bitumen 8,170 sq. yds. on M.R. 503 (5.23 m. to 6.10 m. from Singleton) and 8,450 sq. yds. on M.R. 181 (6.10 m. to 7.00 m. from Singleton). | B.H.P. By-Products Pty. Ltd.                    | 873 5 11   |
| Rylstone Shire ...    | 54<br>215                | Gravel resheeting ... ..                                                                                                                                  | J. and A. Lighezzolo ...                        | 1,237 6 3  |
| Severn Shire ...      | 12                       | Supply, deliver and spread 5,200 cub. yds. gravel between 3 m. and 6 m. east of Glen Innes.                                                               | Frost and Spriggs ...                           | 975 0 0    |
| Sutherland Shire      | 227                      | Removal of Tramway embankment and extension of culvert between Jackson Avenue and Miranda Road.                                                           | N. H. Bowers and Leard Pty. Ltd.                | 739 0 0    |
| Timbreebongie Shire.  | 354                      | Supply and delivery of 3,704 cub. yds. gravel ... ..                                                                                                      | E. Short ... ..                                 | 756 4 8    |
| Do ...                | 1,184                    | Supply and delivery of 7,680 cub. yds gravel ... ..                                                                                                       | Messrs. E. Lenehan, W. Hutchinson and L. Walsh. | 2,560 0 0  |
| Tomki Shire ...       | 140                      | Light Flush re-seal of sections ... ..                                                                                                                    | B.H.P. By-Products Pty. Ltd.                    | 983 13 10  |
| Tumut Shire ...       | 4                        | Supply of 2,500 cub. yds. of gravel ... ..                                                                                                                | A. Sheather ... ..                              | 562 10 0   |
| Turon Shire ...       | 54                       | Construction of approaches to bridge over Windburndale Rivulet.                                                                                           | A. C. Stephens and Sons                         | 1,726 0 4  |
| Urana Shire ...       | 1,014                    | Construction between 1 m. N.E. of Boree Creek and 2 m. 4,400 ft. towards Kywong.                                                                          | J. H. Finlayson ...                             | 914 1 0    |
| Wakool Shire ...      | 221                      | Supply, delivery and spreading 3,600 cub. yds. of Limestone gravel between 3.2 m. and 6.7 m.                                                              | G. H. Willox ... ..                             | 1,710 0 0  |
| Do ...                | 14                       | Supply, delivery and spreading 5,960 cub. yds. of limestone gravel between 2.45 m. and 24.6 m.                                                            | Messrs. J. R. and V. Price.                     | 1,615 4 0  |
| Waradgery Shire       | 501                      | Re-surfacing with limestone gravel and marly loam ...                                                                                                     | Messrs. L. J. Jackson and N. C. Hurst.          | 587 0 0    |
| Do ...                | 514                      | Reforming and loaming between 9.4 m. and 13.5 m. ...                                                                                                      | Messrs. L. J. Jackson and N. C. Hurst.          | 1,115 0 0  |
| Waugoola Shire ...    | 56                       | Supply, delivery and spreading 30,600 cub. yds. gravel ...                                                                                                | Mackie Bros. ... ..                             | 615 0 0    |
| Do ...                | 78                       | Supply, delivery and spreading of 2,800 cub. yds. of gravel                                                                                               | Walter Bryant ... ..                            | 657 10 0   |
| Do ...                | 310                      | Supply, delivery and spreading 30,200 cub. yds. of gravel                                                                                                 | Walter Bryant ... ..                            | 786 13 0   |
| Weddin Shire ...      | 236<br>237.<br>239 & 398 | Supply, delivery and spreading 10,968 cub. yds. of gravel                                                                                                 | Messrs. L. J. Laundess and S. Loader.           | 2,187 17 0 |

### PAYMENTS FROM THE ROAD FUNDS FOR PERIOD.

1st July, 1946, to 30th June, 1947.

#### COUNTY OF CUMBERLAND MAIN ROADS FUND:—

Amount paid.

|                                                     |         |
|-----------------------------------------------------|---------|
|                                                     | £       |
| Construction of Roads and Bridges .....             | 349,831 |
| Cost of Acquisition of Land for Road Widening ..... | 21,038  |
| Maintenance of Roads and Bridges .....              | 364,250 |
| Interest, Exchange and Repayment of Loans .....     | 92,594  |
| Other Expenditure .....                             | 100,220 |

Total .... £927,933

#### COUNTRY MAIN ROADS FUND:—

|                                                       |           |
|-------------------------------------------------------|-----------|
| Construction of Roads and Bridges .....               | 666,412   |
| Cost of Acquisition of Land for Road Widening .....   | 1,897     |
| Maintenance of Roads and Bridges .....                | 1,856,337 |
| Interest, Exchange and Repayment of Loans .....       | 196,430   |
| Purchase and Repair of Plant and Motor Vehicles ..... | 340,764   |
| Other Expenditure .....                               | 236,654   |

Total .... £3,298,494

#### DEVELOPMENTAL ROADS FUND:—

|                                         |        |
|-----------------------------------------|--------|
| Construction of Roads and Bridges ..... | 39,414 |
| Other Expenditure .....                 | 2,014  |

Total .... £41,428

#### SUMMARY ALL FUNDS:—

|                                                       |           |
|-------------------------------------------------------|-----------|
| Construction of Roads and Bridges .....               | 1,055,657 |
| Cost of Acquisition of Land for Road Widening .....   | 22,935    |
| Maintenance of Roads and Bridges .....                | 2,220,587 |
| Interest, Exchange and Repayment of Loans .....       | 289,024   |
| Purchase and Repair of Plant and Motor Vehicles ..... | 340,764   |
| Other Expenditure .....                               | 338,888   |

Total .... £4,267,855

NOTE: The figures in this statement are subject to audit.



# MAIN ROADS STANDARDS.

**NOTE:—Numbers prefixed by "A" are drawings, the remainder are specifications unless otherwise noted.**

## EARTHWORKS AND FORMATION.

- Form No.
- 70\* Formation. (Revised, July, 1946.)
- A 1532\* Standard Typical Cross-sections.
- A 1149\* Flat Country Cross-section, Type A. (Revised, 1930.)
- A 1150\* Flat Country Cross-section, Type B. (Revised, 1936.)
- A 1151\* Flat Country Cross-section, Type D1. (Revised, 1936.)
- A 1152\* Flat Country Cross-section, Type D2. (Revised, 1930.)
- A 1470 Flat Country Cross-section, Type E1. (Revised, 1937.)
- A 1101 Typical Cross-section One-way Feeder Road. (1936.)
- A 1102 Typical Cross-section Two-way Feeder Road. (1931.)
- A 83 Earthworks Quantity Diagram.
- A 114 Rubble Retaining Wall. (1941.)
- 271 Setting out side widths (instruction for use of ordinary survey instruments).
- 272 Setting out side widths (instruction for use of tape-staff).

## PAVEMENTS.

- 71\* Gravel Pavement. (Revised, January, 1939.)
- 228\* Reconstruction with Gravel of Existing Pavements. (Revised, January, 1939.)
- 254 Supply and Delivery of Gravel. (Revised, August, 1939.)
- 72\* Broken Stone Base Course. (Revised, October, 1933.)
- 216\* Telford Base Course. (Revised, August, 1931.)
- 68\* Reconstruction with Broken Stone of Existing Pavement to form a Base Course. (Revised, October, 1933.)
- 296 Tar. (Revised, March, 1939.)
- 337 Bitumen. (Revised, February, 1939.)
- 395 Bitumen Emulsion. (Revised, September, 1942.)
- 351 Supply and Delivery of Aggregate. (Revised, July, 1941.)
- 65\* Waterbound Macadam Surface Course. (July, 1939.)
- 301\* Supply and Application of Tar and/or Bitumen. (Revised, August, 1946.)
- 122\* Surfacing with Tar. (Revised, May, 1940.)
- 145\* Surfacing with Bitumen. (Revised, August, 1940.)
- 93\* Re-surfacing with Tar. (Revised, May, 1940.)
- 94\* Re-surfacing with Bitumen. (Revised, July, 1940.)
- 230\* Tar or Bitumen Penetration Macadam, Surface Course, 2 inches thick. (Revised, December, 1936.)
- 66\* Tar or Bitumen Penetration Macadam, Surface Course, 3 inches thick. (Revised, September, 1936.)
- 125\* Cement Concrete Pavement (April, 1939) and Plan and Cross-section, A 1147 (March, 1932).

## GENERAL.

- 342\* Cover Sheet for Specifications, Council Contract. (Revised, April, 1939.)
- 24B\* General Conditions of Contract, Council Contract. (Revised, February, 1947.)
- 64\* Schedule of Quantities.
- 39\* Bulk Sum Tender Form, Council Contract. (Revised, August, 1946.)
- 38\* Bulk Sum Contract Form, Council Contract.
- 121\* Provision for Traffic (Revised, March, 1944) with general arrangement, A 1323\* and details A 1325\* of temporary signs. (Revised, January, 1947.)
- A 1342\* Warning Signs, Details of Construction.
- A 1346 Iron Trestles for Road Barriers.
- A 1341 Timber Trestle and Barrier.
- A 1824 Light Broom Drag. (1941.)
- A 1924 Pipe Frame Drag.
- A 178 Mould for Concrete Test Cylinder.
- A 1381-3 } Tree Guards, Types A, B, C, D, E, F, and G.
- A 1452-5 }
- 197\* Hire of Council's Plant. (Revised, April, 1937.)
- A 478\* Specimen Drawings, Rural Road Design, with drawings A 478A\* and A 478B\*.
- A 478C\* Specimen Drawing, Flat Country Road Design.
- A 1113\* Rural Road Plan and Longitudinal Section Form (tracing cloth).
- A 1114\* Rural Road Cross-section Form (tracing cloth).
- A 1115\* Urban Road Plan Forms (tracing cloth).
- 193 Duties of Superintending Officer (instructions). (Revised, July, 1938.)
- A 1645 Stadia Reduction Diagram. (1939.)
- 355\* Instructions for Design of Two-lane Rural Highways (1937).
- A 1487\* Horizontal Curve Transitions (diagrams).
- A 1488\*, A 1488A\*, A 1488B\*, and A 1488C\*.—Horizontal Curve Transitions (tables for speeds of 30, 40, 50, and 60 miles per hour).
- A 1614 Widening of Shoulders on Crests.

Form No.

- 369\* Instructions for Design of Urban Roads (1939).
- 288 Instructions for Design of Intersections (1939).
- 402 Instructions for Design of Rural Intersections (acceleration and deceleration lanes). (1941.)

## KERBS, GUTTERS, AND GULLY PITS.

- 243 Integral Concrete Kerb and Gutter and Vehicle and Dish Crossings (Revised, July, 1939) and Drawing. (A 134A).
- 245 Gully Pit (Revised, May, 1939) and Drawings (a) with grating (A 1042); (b) Kerb inlet only (A 1043); (c) with grating and extended kerb inlet (A 1352); (d) extended kerb inlet (A 1353).
- A 190 Gully Grating. (1933.)
- A 1418 Concrete Converter. (1936.)

## FENCING.

- 142 Split Post and Rail Fencing and Drawing (A 43).
- 141\* Post and Wire Fencing (Revised, September, 1934) and Drawings (a) Plain (A 494); (b) Rabbit-proof (A 498) (c) Flood gate (A 316).
- 143 Ordnance Fencing (Revised, February, 1934) and Drawing A 7. (Revised, November, 1939.)
- 144 Chain Wire Protection Fencing and Drawing (A 149).
- 246 Location of Protection Fencing (instruction). (Revised, May, 1940).
- A 1301 Motor Traffic By-pass 9 feet wide. (1936.)
- A 1875 Motor Traffic By-pass 20 feet wide. (1942.)

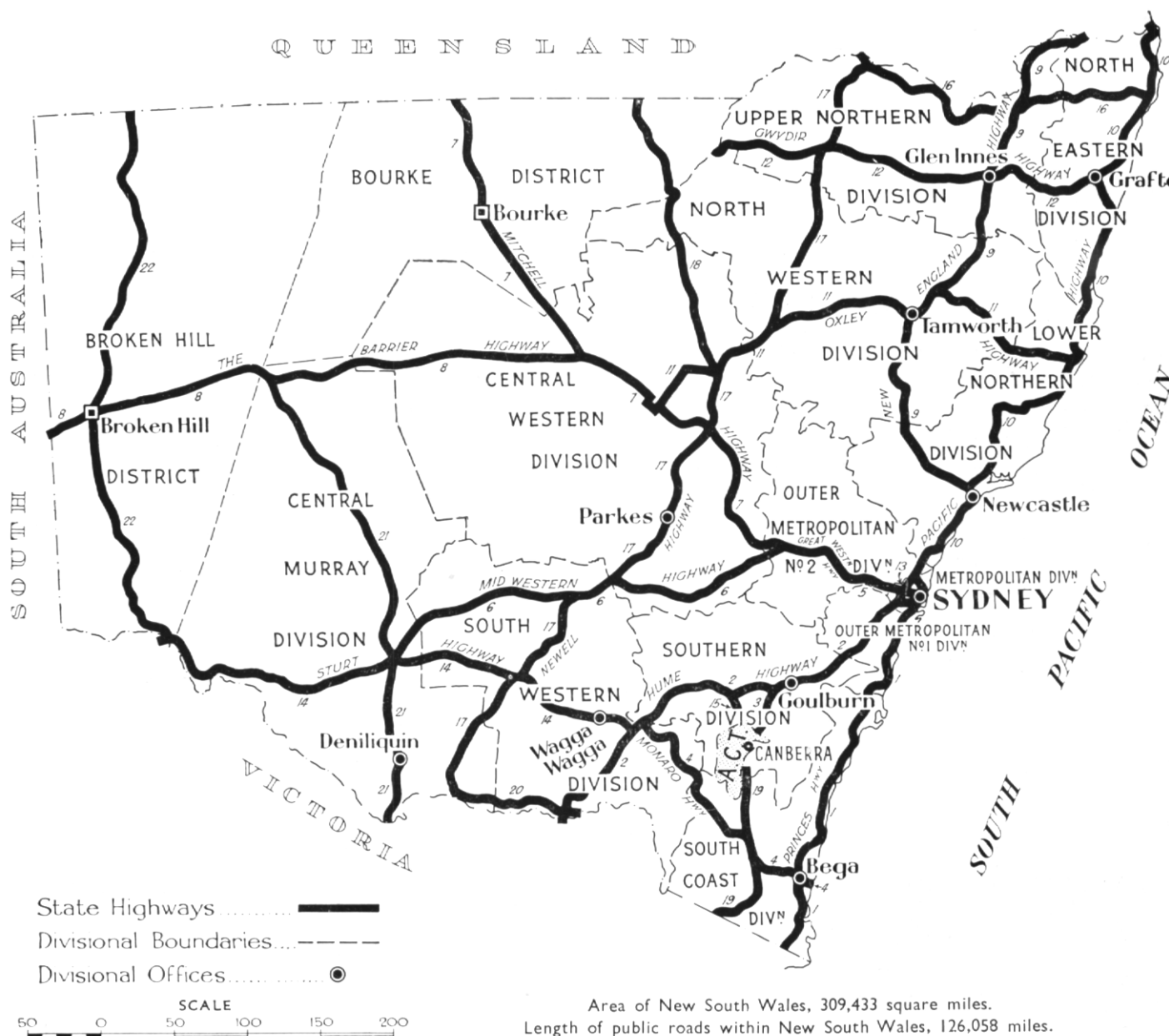
## BRIDGES AND CULVERTS.

- A 4 Standard Bridge Loading (general instruction). (1938.)
- A 4A Standard Bridge Loading (instruction for dead-end Developmental Roads.) (Revised, 1938.)
- 18\* Data for Bridge Design. (Revised, August, 1944.)
- 84\* Data accompanying Bridge or Culvert Designs.
- A 26 Waterway Diagram. (Revised, 1943.)
- 371 Waterway Calculations. (1939.)
- A 421 Boring Gear, 2 inches. (1930.)
- A 44 Boring Gear, 3½ inches. (1926.)
- A 2847 Rod Sounding Apparatus. (1945.)
- 25\* Pipe Culverts and Headwalls (Revised, December, 1939) and drawings, Single Rows of Pipes, 15 in. to 21 in. dia. (A 143\*), 2-3 ft. dia. (A 139\*), 3 ft. 6 in. dia. (A 172\*), 4 ft. dia. (A 173\*), 4 ft. 6 in. dia. (A 174), 5 ft. dia. (A 175), 6 ft. dia. (A 177); Double Rows of Pipes, 15 in. to 21 in. dia. (A 211\*) 2-3 ft. dia. (A 203\*), 3 ft. 6 in. dia. (A 215) 4 ft. dia. (A 208), 4 ft. 6 in. dia. (A 207), 5 ft. dia. (A 206), 6 ft. dia. (A 213); Treble Rows of Pipes, 15 in. to 21 in. dia. (A 210), 2-3 ft. dia. (A 216), and Straight Headwalls for Pipe Culverts, 15-24 in. dia. (A 1153\*).
- A 1\* Joint for Concrete Pipes. (Revised, August, 1933.)
- A 142\* Sidehill Inlet Sump. (Revised, July, 1930.)
- 138\* Pre-Cast Concrete Box Culvert (April, 1940) and drawings, 9 in. high (A 485\*), 12 in. (A 446\*), 1 ft. 6 in. (A 447\*), 2 ft. (A 448\*), 2 ft. 6 in. (A 449).
- A 311 Concrete Arch Culvert, 5 ft. high. (1931.)
- A 314 Concrete Arch Culvert, 10 ft. high. (1931.)
- 206\* Reinforced Concrete Culvert (Revised, November, 1944) and instruction sheets (A 305, A 359, A 306, A 304).
- A 1832 Cast-in-Place Concrete Pipe Culverts. (1942.)
- A 309\* Concrete Culvert Posts. (Revised, June, 1937.)
- 300 Pile Drivers, specification for 25 ft., and drawings for 50 ft. (A 209), 40 ft. (A 253), and 25 ft. portable (A 1148).
- A 1886 Arrangement of Bolting Planks for various widths of deck. (1943.)
- A 45 Timber Bridge, Standard Details. (Revised, March, 1941.)
- A 1701 Timber Beam Skew Bridge Details. (1941.)
- 164 Timber Beam Bridge (Revised, April, 1947.) and instruction sheets, 16 ft. (A 71), 18 ft. (A 68), 20 ft. (A 70) and 22 ft. (A 1761). Amended Aug. 1946.
- A 1226 and A 1165 Low Level Timber Bridges, instruction sheets for 16 feet, and 18 feet between kerbs. (1932.)
- A 1222, A 1166, and A 1223 Single Span Timber Culverts, instruction sheets for 16 ft., 18 ft. and 20 ft. between kerbs. (1931.)
- 130\* Timber Culvert and drawings, 1 ft. 6 in. high (A 427), 2 ft. (A 428), 3 ft. (A 429), 4 ft. (A 430), 5 ft. to 8 ft. high (A 431). (1928.)
- 326 Extermination of Termites in Timber Bridges. (Revised, October, 1940).
- A 222\* Pipe Handrailing Details. (Revised, February, 1938.)
- 350 Reinforced Concrete Bridge. (Revised, January, 1946.)

Standards marked \* may be purchased from the Government Printer, Sydney.

Others may be purchased from the Head Office of the Department of Main Roads, 309 Castlereagh Street, Sydney, single copies being free to Councils.

# State Highway System of the State of New South Wales



Area of New South Wales, 309,433 square miles.  
Length of public roads within New South Wales, 126,058 miles.

## MILEAGE OF ROADS CLASSIFIED UNDER THE MAIN ROADS ACT, AS AT 1st JULY, 1946.

|                                                                                                        |               |
|--------------------------------------------------------------------------------------------------------|---------------|
| State Highways.....                                                                                    | 6,487         |
| Trunk Roads .....                                                                                      | 3,720         |
| Main Roads .....                                                                                       | 12,629        |
| Secondary Roads (County of Cumberland only) .....                                                      | 78            |
| Developmental Roads .....                                                                              | 2,749         |
|                                                                                                        | <hr/>         |
|                                                                                                        | 25,663        |
| UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act ..... | 2,193         |
| <b>TOTAL ...</b>                                                                                       | <b>27,856</b> |

