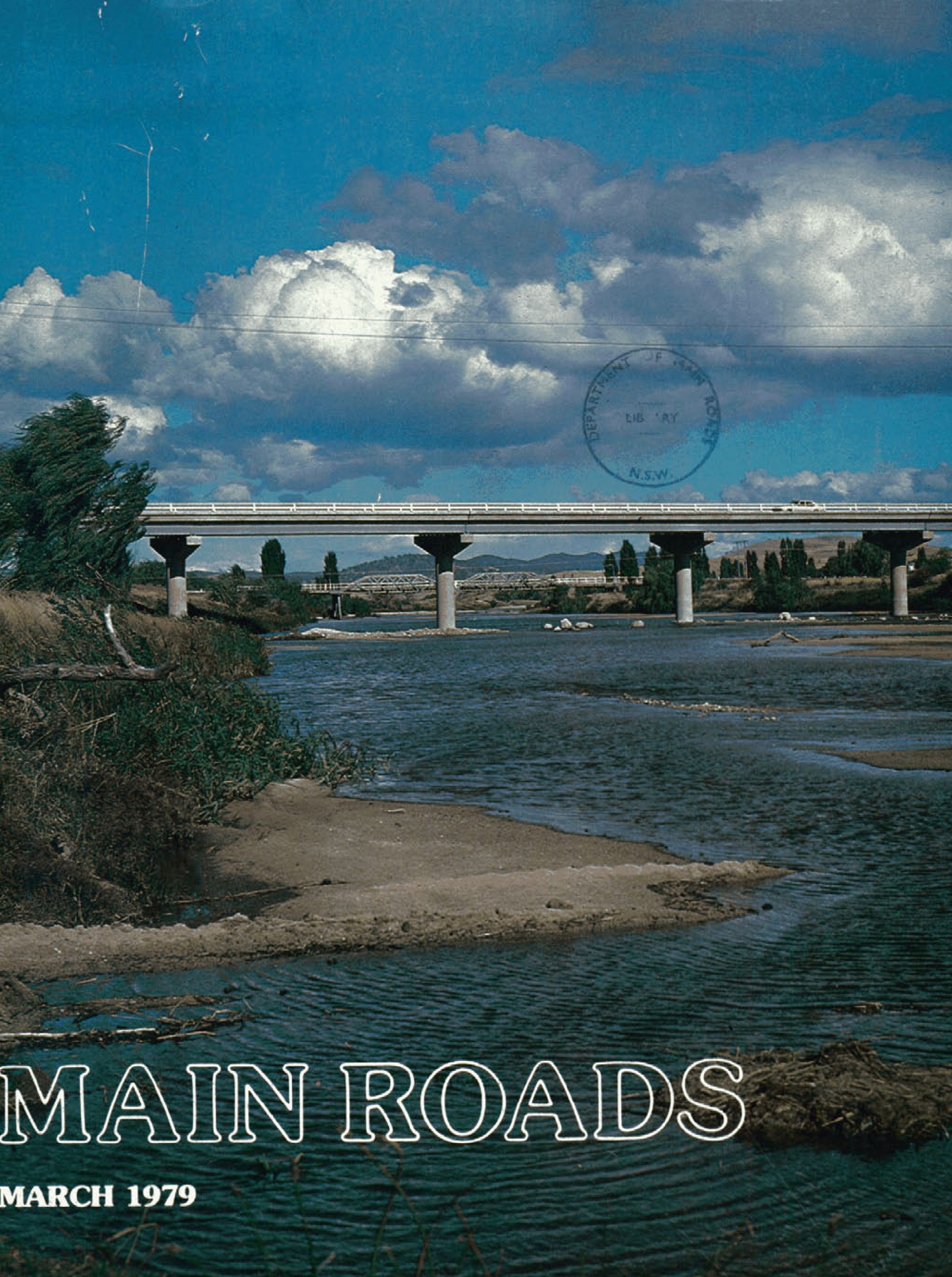


MAIN ROADS

MARCH 1979

The new Bondi Junction By-pass looking east from the pedestrian overbridge at Nelson Street.

MAIN ROADS

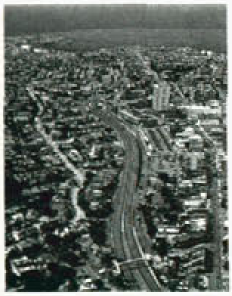
JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

MARCH 1979 VOLUME 44 No. 3

ISSN 0025-0597

CONTENTS

Front cover: This new bridge at Bredbo now carries the Monaro Highway over the Bredbo River. The old timber truss bridge can be seen in the background. (See pp. 92-94 for the full story.)



Back cover: This spectacular aerial view shows the Bondi Junction By-pass as it sweeps eastwards past the shopping Plaza and the new transport terminus, under construction. (See article commencing on p. 66.)

BACKWARDS AND FORWARDS

Clearly, *going backwards* means different things at different times and places.

For example, in the past, after an audience with royalty, it was customary to retire backwards as a sign of respect. In different circumstances, *backing off* is a term we use to describe what happens when we decide that "discretion is the better part of valour". But when an engagement is made, as in warfare, *going backwards* or retreating is generally bad for morale as well as bad for business.

Backing out means to go back on our commitment to do something and we speak of *back tracking* when we're uncertain of our position and wish to check it by returning to a place that we are familiar with.

So, although *going backwards* is often, but not always, a negative and undesirable movement, *glancing backwards* is not. At the opening of the new bridge at Bredbo (see story on pp. 92-94), the Deputy Commissioner for Main Roads, Mr Bruce Loder, congratulated the "Back to Bredbo" Organising Committee on its initiative, with the following words.

"When people go back to places, they appreciate seeing things which stimulate nostalgic memories and they also appreciate seeing new things which indicate the progress which has been achieved. Here today we have a combination of both."

Here, in this issue we also have a combination of both. We have gone back to the early days of the Speewa Ferry (pp. 82-86), looked at our Bridge Engineers and some of their projects over five decades (pp. 87-91), and recalled the concrete road pavement techniques of fifty years ago (pp. 77-78).

But, we also face forward, looking at new things such as the Bondi Junction By-Pass (pp. 66-67), a widened bridge at Fairfield (pp. 68-69), and the Department's laying of a rigid road pavement using the slip form process (pp. 70-77) – thereby achieving another first in Australia.

Yes, we like to recall and preserve the past but we're not (what you might call) "backwards in moving forwards". •

PRICE Fifty cents

ANNUAL SUBSCRIPTION
Two Dollars Post Free

Issued quarterly by the Commissioner for Main Roads B. J. Sexton

Editors may use information contained in this Journal unless specially indicated to the contrary, provided the exact reference thereto is quoted

Additional copies of this Journal may be obtained from Department of Main Roads, 309 Castlereagh Street, Sydney, New South Wales, Australia

Typeset by Keyset Phototype Pty. Ltd.

Printed by Blake and Hargreaves Pty. Ltd.

BONDI JUNCTION BY-PASS OPENS

Another community asset

The New Year got off to a good start with the opening on 9 January of the Bondi Junction By-pass. Wide coverage in the media saw the community benefits of the project justifiably highlighted.

Travel times have been reduced for local traffic as well as through traffic, which includes many visitors and surf-seekers on their way to the beautiful beaches further east.

A major safety feature has been built into the By-pass by the removal of conflicting cross traffic. Traffic congestion in Oxford Street (Main Road No. 172) and in other streets leading to the shopping centre at Bondi Junction has been considerably reduced by the removal of through traffic.

The By-pass and associated changes in traffic patterns have given immediate benefits to shoppers, by way of improved accessibility, greater shopper comfort and convenience and less noise and exhaust emissions. The reduced number of pedestrian/vehicle conflicts should also mean a dramatic downturn in the number of accidents.

Grass and shrubs were planted where the medians were wide enough, and on traffic islands of suitable size. More than 500 trees and shrubs planted by the Department are now growing in this area of the roadway. The By-pass itself provides open space through an otherwise high density residential area. Maintaining this open appearance along the boundaries of the road reserve at the western end are unobtrusive steel picket fences.

Pedestrian access over the By-pass has been provided by a footbridge at the western end opposite Nelson Street. At the northern end of this footbridge a small park, complete with park bench, has been established for those who wish to just sit and relax for a while.

The area beneath the viaduct is being paved by the Department for use as a ca park. The exposed verges of this area wil be landscaped by the Public Transport Commission.

The By-pass looking westwards with the city skyline in the background.

An aerial view of the By-pass showing construction in progress as at August 1978.

Traffic management

In conjunction with the opening of the By-pass, Oxford Street from Adelaide Street to Newland Street has now been closed to all road traffic, except buses and taxis. In addition, Bronte Road (Main Road No. 340) from Oxford Street to Spring Street as well as Grosvenor Street from Grosvenor Lane to Oxford Street have also been closed to traffic except for buses and taxis. When the bus/rail terminus opens later this year, these streets will then be closed completely to road traffic.

These closures have been made by Woollahra and Waverley Municipal Councils, with the approval of the Traffic Authority of New South Wales. The Councils are working together to introduce a pedestrian plaza in part of Oxford Street, at the heart of the shopping centre.

How things have changed! This is Bondi Junction — at the intersection of Oxford Street and Bronte Road — at the turn of the century.
—Reproduced by courtesy of the Public Transport Commission.

The Nelson Street pedestrian overbridge rises out of a tranquil park-like setting at the northern end.

To assist safe and convenient access to, from and near the By-pass, the Department has been active in the installation of traffic signals at the intersections of Oxford Street, Bondi Road and the By-Pass, Oxford Street and York Road, York Road and the By-pass and Ocean Street and Forth Street.

The traffic signal installations at Oxford and Queen Streets, and Queen and Ocean Streets, were reconstructed and linked with the co-ordinated signals along Oxford Street and the By-pass (between Nelson and Ocean Streets) and along Ocean Street (between Oxford and Forth Streets). This ensures minimal delays to vehicles entering and leaving the By-pass and using the adjacent road network. It also provides safe and controlled crossings for pedestrians.

The construction of the By-pass has been an integral factor in the growth of the Bondi Junction Commercial Centre. Changes and increases in vehicle and pedestrian movements have, as a result, led to the recent installation of traffic signals at the intersections of Edgecliff Road and Grosvenor Street, and of Birrell and Newland Streets, as well as at the intersection of Edgecliff Road and Junction Street.

Traffic movements will be closely monitored and any necessary adjustments will be made to the signalling system to ensure the smooth flow of traffic through the intersections. Additional traffic management measures will also be introduced if needed.

It is certain that the opening of the By-pass, and the associated alterations in traffic flow in nearby streets, will bring many benefits.
These will affect

- □ **not only road-users commuting daily from nearby suburbs,**
- □ **not only visitors on their way to Bondi Beach, Vaucluse House, Watsons Bay and other tourist attractions in the Eastern Suburbs,**
- □ **not only shoppers seeking quality bargains at this popular regional centre,**
- □ **but also residents, to whom it brings major changes (which we hope are all pleasant advantages) to their local community life. •**

An article on the construction of the Bondi Junction By-pass appeared in June 1977 issue of "Main Roads", Vol. 42, No. 4, pp. 98-101.

The Eastern Suburbs Railway will be officially opened by the Premier, Hon. N. K. Wran, M.P., Q.C., at 11 a.m. on Saturday, 23 June 1979. He will unveil a plaque at the Martin Place Railway Station and then travel to Bondi Junction in the first official train.

CONGESTION EASED BY WIDENED BRIDGE

Fairfield Railway Overbridge now carries six lanes of traffic

Traffic congestion on The Horsley Drive in the Fairfield area has been noticeably eased since October 1978. In that month, four additional lanes were opened to traffic after extensive widening of the bridge which carries the road over both the Main Southern Railway Line (north of Fairfield Station) and Prospect Creek.

The Horsley Drive extends from Wallgrove Road (Main Road No. 515) at Horsley Park to the Hume Highway (SH 2) at Carramar. The western section is declared as Secondary Road No. 2088 and the eastern section (from Smithfield Road) is proclaimed as Main Road No. 609.

The Horsley Drive is named after the English birthplace of Major Weston, who in 1817 took up residence in the property of his father-in-law, Major George Johnston (famed for quelling the convict rebellion at Castle Hill in 1804 and leading the troops who arrested Governor Bligh in 1808). Major Weston changed the name of the estate from "The King's Gift" to "Horsley" and the suburb which has since developed there is now known as Horsley Park.

Awkward intersection eliminated

Associated roadworks have contributed to the smoother flow along this important traffic artery. Notable among these is the underpass constructed by Fairfield Municipal Council under the last span at the Carramar end of the overbridge. This grade separation has eliminated the level intersection of Fairfield Street with The Horsley Drive. Before the underpass was put into service, the northern part of Fairfield Street met The Horsley Drive at a right angle, while the southern (and busier) part intersected it at approximately 45°. The arrangement was certainly not conducive to either safety or efficiency.

Design

The design of the superstructure of the new bridge followed closely that of the existing bridge. Heavier traffic loading was allowed for in the new design, which provided for strengthening of the edge girders of the old bridge to the same standard.

Early stages

Construction of the foundations for the first pier was undertaken by the Department's Divisional Office at Parramatta between October 1975 and March 1976. A subcontract was let for the construction of the bored piles. The pile cap was constructed by the Department's own forces.

Early completion of this foundation enabled Fairfield Muncipal Council to proceed with a contract for the construction of a large retaining wall for the underpass, partly on piled foundations, adjacent to Prospect Creek.

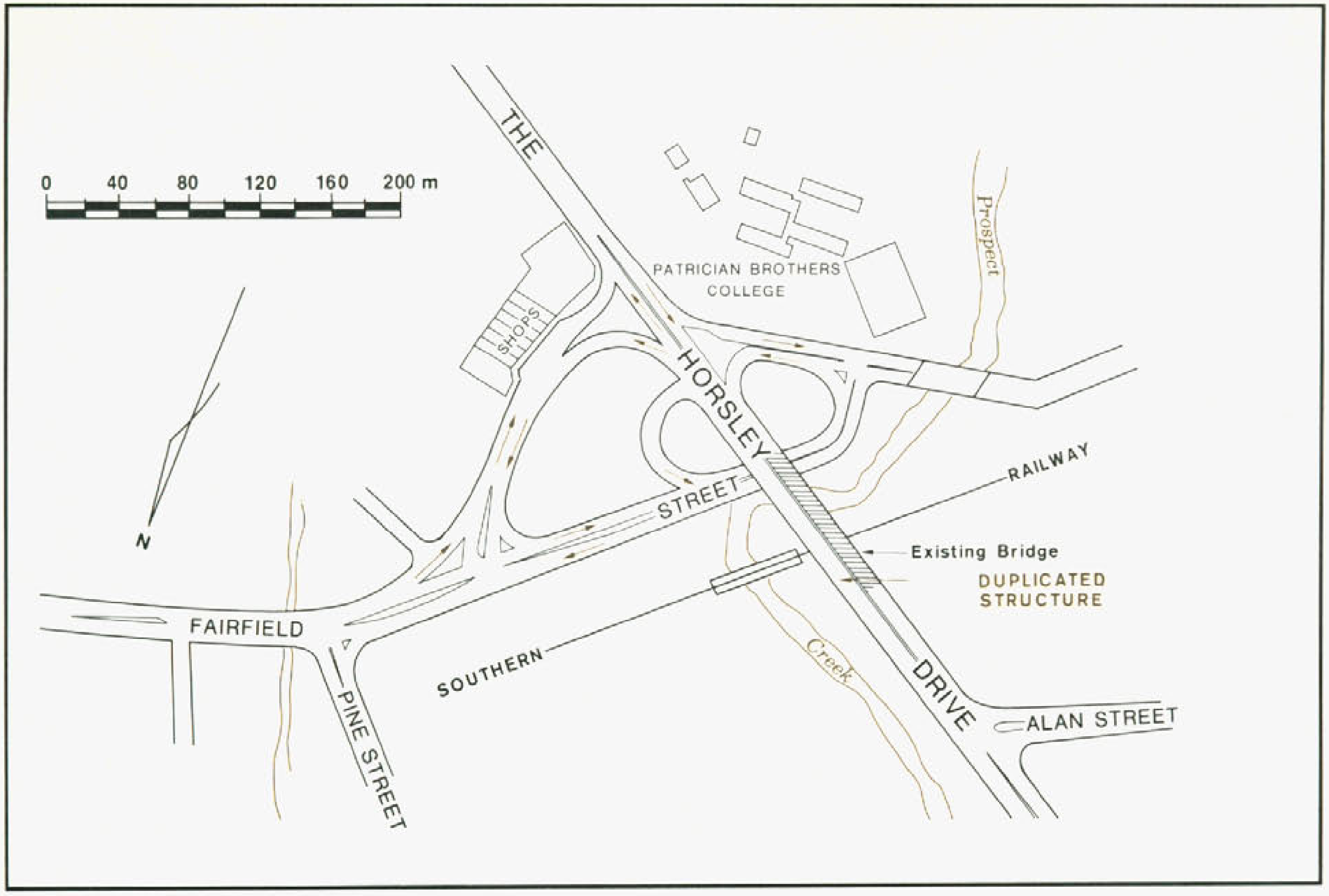
Roadworks were then able to proceed on the new connection in Fairfield Street. On 7 January 1977, a contract was awarded to Pearson Bridge (N.S.W.) Pty Ltd, for the widening of the railway overbridge.

Bored piles using Bentonite process

Piles for the bridge widening contract were constructed with the aid of Bentonite. The firm of Enterprise Bachy, experienced in this type of piling, subcontracted for a total of 1,100 linear m of 750 mm dia. and 900 mm dia. bored piling.

In the technique adopted a hole is drilled to the desired diameter and depth. As this drilling work proceeds Bentonite slurry (Bentonite clay and water) is fed into the drilled hole. The heavy slurry prevents the collapse of the walls of the excavation, which can be drilled full depth without the need for liners, either temporary or permanent.

Aerial view, looking westwards, showing construction as at August 1978.



After the cleaning of all loose material by "airlift" methods from the bottom of the pile shaft (which is socketed into hard shale), a reinforcing cage is lowered through the Bentonite slurry. Concrete is then pumped through a pipe inserted through the slurry to the base of the bored pile. The concrete displaces the Bentonite slurry, which is recovered and pumped to a storage tank for cleaning and recycling. Two rows of bored piles were constructed by this method at each pier and abutment.

Sheet pile cofferdamming was used to construct the concrete base to Pier No. 2, which was cast directly onto the hard shale next to, and below, Prospect Creek.

Columns and abutments

Solid rectangular reinforced concrete columns up to 13.5 m high were constructed to match closely those used on the old bridge. The cross heads at the tops of the columns of the new and old bridges have been dowelled together to prevent movement between the new and the old bridge decks.

A reinforced concrete cantilever abutment was adopted for Abutment A (Carramar end) and a spill-through counterfort type for Abutment B.

Precast girders

The 115 precast pretensioned T girders for the bridge were manufactured at Teralba (Newcastle) by Basic Industries Pty Ltd. Erection of the 17.5 m girders over the rail tracks was done by mobile cranes at carefully selected times to minimise delays to rail traffic.

To form the 23 girders in each span into a unified load-bearing deck slab, an extensive transverse stressing system was employed, incorporating 41 cables per span.

Finishing the job

Lightweight concrete was placed over the prestressed girders to "shape" the crossfalls on the new and old decks. It was also used to form the 1.5 m wide median which separates the opposing lanes of traffic.

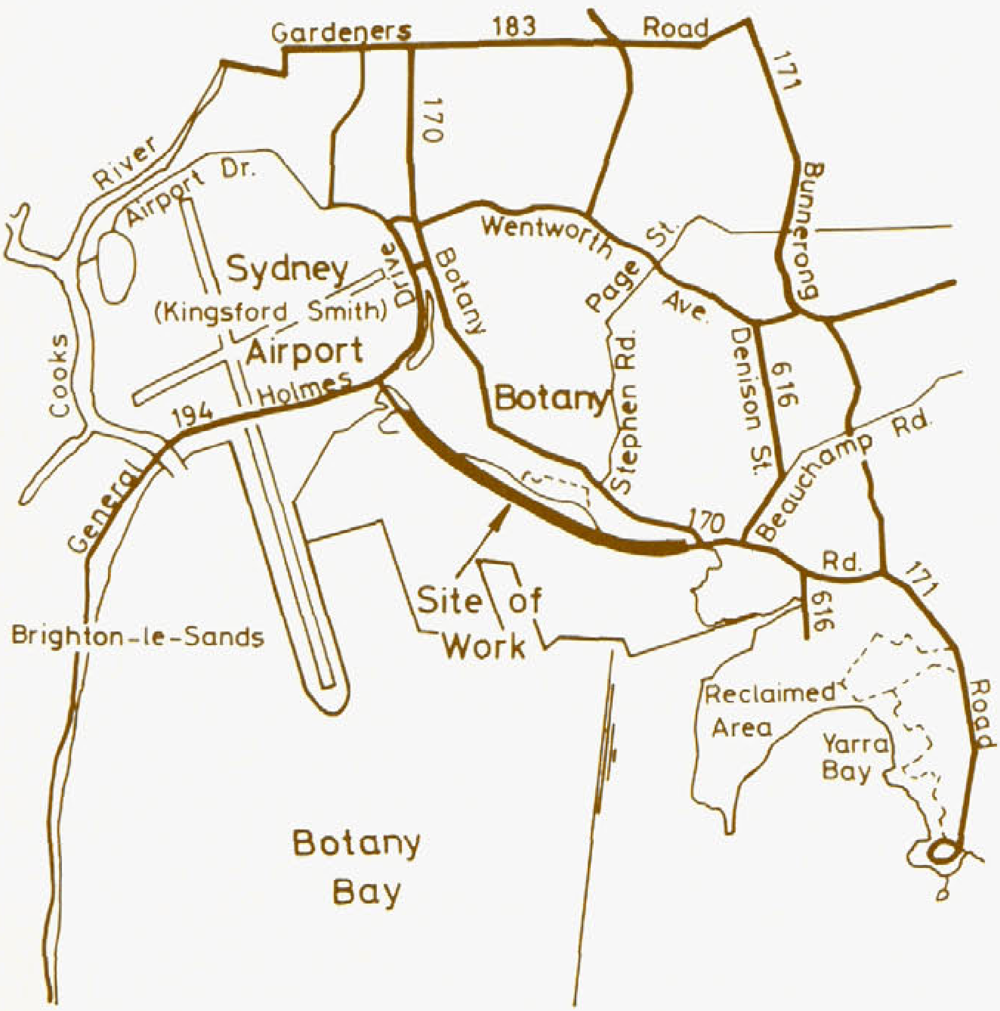
Handrails of the three-rail type were selected for the new bridge and to replace railing used on the older bridge. The rails visually accentuate the vertical curve of the bridge.

The completion of the widening work on 19 October 1978 marked a further step forward in the Department's plans to improve traffic facilities in the Fairfield area. ●

See colour photographs on inside back cover.

NEW CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

on The Foreshore Road at Botany



In conjunction with the continuing development of Port Botany as the second port for Sydney, the Department of Main Roads is engaged in an extensive plan of roadworks to improve road traffic flow in the area. Included in the plan is a new route for heavy port traffic, to by-pass the residential and shopping areas of Botany.

An article outlining the Port Botany development and the Department's associated road improvements in the area was published in the March 1978 issue of "Main Roads" (Vol. 43, No. 3, pp. 66-71).

The roadworks consists principally of —

1. a new divided carriageway road, The Foreshore Road (Main Road No. 617), connecting General Holmes Drive (Main Road No. 194) with Botany Road (Main Road No. 170) at Banksmeadow,
2. the widening of Botany Road to six lanes through Banksmeadow to Bumborah Point Road (Main Road No. 616), and
3. the provision of a six-lane divided road extending Botany Road to Bunnerong Road (Main Road No. 171).

At the western end, The Foreshore Road will connect to General Holmes Drive in a partially grade-separated interchange allowing virtually uninterrupted traffic flow to and from the port complex.

The major item of new construction is The Foreshore Road, which has a divided carriageway 3.8 km long. This roadway has been built on land reclaimed by dredging sand from Botany Bay and depositing it on the northern foreshore.

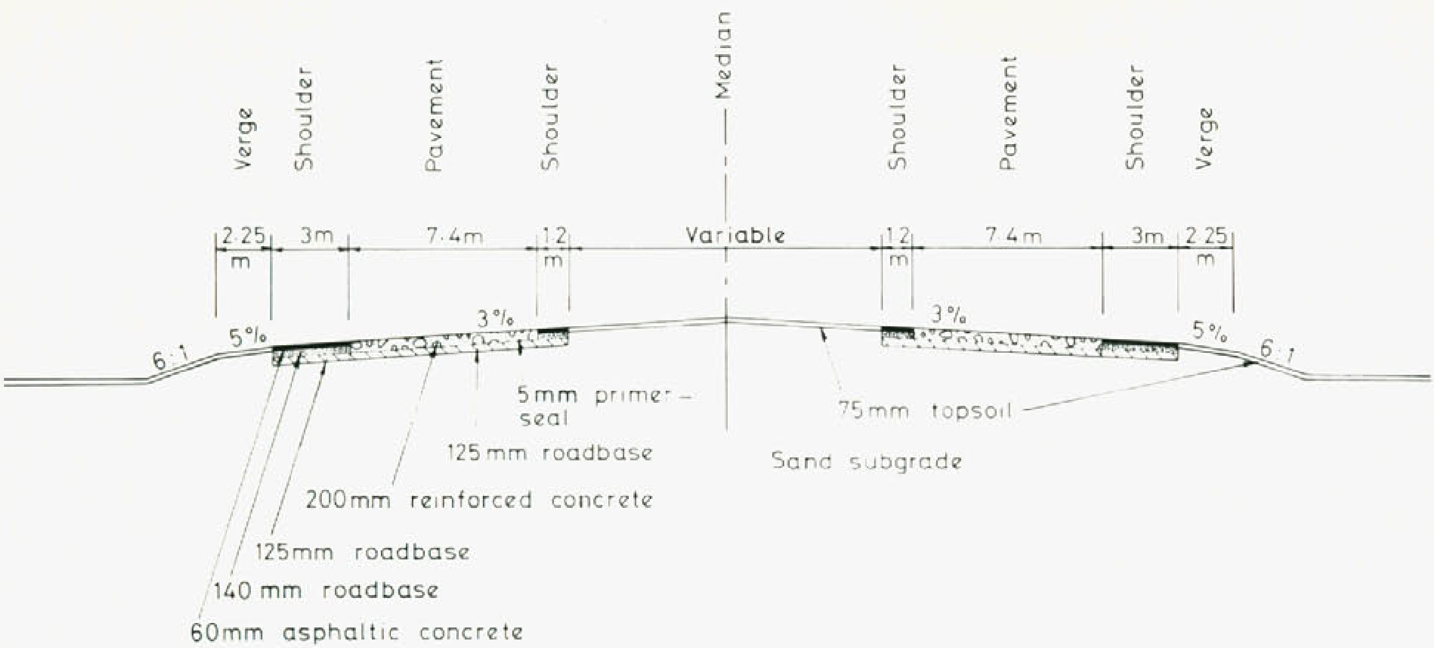
Road design

The design of The Foreshore Road has two unusual features. Firstly, the road foundation or subgrade is entirely of sand pumped to shore by a dredge operating in the Bay. Secondly, the road is level for its entire length, requiring special care in the design of surface drainage.

The road has two carriageways divided by a wide median. Each carriageway consists of two travelling lanes 3.7 m wide, an outer shoulder 3 m wide and an inner or median shoulder 1.2 m wide.

Pavement design

Several alternative pavement designs were considered, including jointed concrete and deep lift asphalt, both on a blast furnace slag base. The principal design parameters were the sand



Typical Cross Section

subgrade, which has California Bearing Ratio values between 3 per cent and 8 per cent, and the traffic travelling over the road, which is expected to include more than 11 million heavy vehicles during the next 20 years.

A continuously reinforced concrete pavement was chosen for its long life expectancy and low maintenance requirements. The selected sub-base was a 125 mm thick layer of fine crushed rock (lime treated breccia).

This continuously reinforced concrete pavement (referred to as CRCP) is only the second such pavement to be constructed by the Department. It is the first rigid pavement to be slip-formed in Australia. A CRCP is a monolithic structure with no transverse joints and this eliminates the most adverse features of the conventional jointed concrete pavement, providing quieter running. It is structurally stronger, with better riding qualities and lower maintenance costs.

The pavement is constructed with heavy steel reinforcement so that fine cracks occur at closely spaced intervals of 1 m to 3 m. The continuous longitudinal reinforcement keeps these cracks tightly closed and load transfer across the cracks is maintained by aggregate interlock.

The joints in conventional jointed concrete pavements not only detract from the otherwise good riding qualities of the road, but are a potential source of weakness. The entry of water results in a pumping action developing beneath the slabs under live loading.

Concrete slab design

In designing the CRCP for The Foreshore Road at Botany, the experience gained during similar pavement construction on the Pacific Highway at Clybucca (on the North Coast near Kempsey) was beneficial. (See article in the December 1975 issue of "Main Roads", Vol. 41, No. 2, pp. 58-9).

In the present project, both the concrete strength and percentage of steel were increased slightly to improve crack spacing. A steel ratio of 0.67 per cent was adopted with a concrete flexural strength, at age 90 days, of 4.75 MPa. This corresponds to a compressive strength at 28 days of 34 MPa. A tolerance of ± 4 MPa was specified on the compressive strength to ensure uniformity of the concrete mix.

Cold-worked deformed bars (Grade 410) of 16 mm diameter were used for the longitudinal reinforcement. The bar spacing was 150 mm and the slab thickness was 200 mm. Continuity of the longitudinal reinforcement was maintained by tied lap joints, with a minimum overlap of 400 mm. The lap joints were staggered over the width of the pavement to obviate any discontinuity and to permit natural inducement of transverse cracks.

The transverse reinforcement was 12 mm diameter cold-worked deformed steel (Grade 410) at 500 mm centres. Minimum concrete cover over the steel was 60 mm on top and 100 mm underneath.

Longitudinal tie bars were provided between pavement slabs to keep the joint tightly closed. These were 12 mm cold-worked deformed bars at 500 mm centres, each 1.2 m long. A deformed joint was not provided.

Three concrete anchors were placed at 13 m centres at the western extremity of the work to reduce end movement of the slab. At the eastern end, a terminal joint was provided, consisting of a wide-flange beam set on a concrete sill to allow for slab movement of up to $\pm$ 50 mm. The different end treatments will provide a practical comparison between the relative merits of the two systems.

Concrete mix

Special consideration was given to the composition of the concrete mix, because of the demanding nature of the work and to ensure its suitability for use with the slip-form paver. Accordingly, additional requirements for the concrete mix were specified. In addition to the Department's normal high degree of control over concrete mix production, laboratory drying shrinkage of the mix was limited to 450 microstrain at 28 days.

It was specified also that the fine aggregate or sand component must constitute between 38 per cent and 40 per cent of the total aggregate content. The maximum aggregate size was limited to 20 mm to ensure adequate frictional qualities in the concrete running surface of the road. Fly ash was not used for the same reason.

A vinsol resin air entraining agent was used to improve workability. The air content was limited to 4 per cent — 6 per cent to ensure the concrete's durability in the heavily saltcharged environment along the foreshore of Botany Bay. Inclusion of a lignin-type retarder in the mix ensured workability under all temperature conditions.

Trial mixes were checked in the Department's Materials and Research Laboratory for shrinkage, strength (both compressive and flexural), consistence by the slump test and workability through the slip-form paver by means of the Vebe test. The mixes were also checked for air content using an Air Meter.

The final mix design adopted was:

Cement (Goliath Type A)	270 kg/m^3
20 mm crushed river gravel	850 kg/m^3
10 mm crushed river gravel	250 kg/m^3
Nepean Sand (8 per cent moisture)	660 kg/m^3
Cronulla Sand (5 per cent moisture)	200 kg/m^3
Water Reducing Agent (W. R. Grace)	670 ml/100 kg of cement
Air Entraining Agent (W. R. Grace)	50 ml/m^3

Construction programme

Construction of the pavement for The Foreshore Road commenced in January 1978, with trimming and compaction of the subgrade. A base of 125 mm of lime treated fine crushed rock was placed, compacted and covered with a sand primer-seal. This ensured uniform frictional qualities and provided a satisfactory base for placement of the steel reinforcement. Slip-forming of the concrete pavement began on 2 November 1978, and was completed in March 1979. Shoulder construction, consisting of 125 mm of lime treated fine crushed rock and 75 mm of asphaltic concrete, is programmed for completion in June 1979.

Subgrade

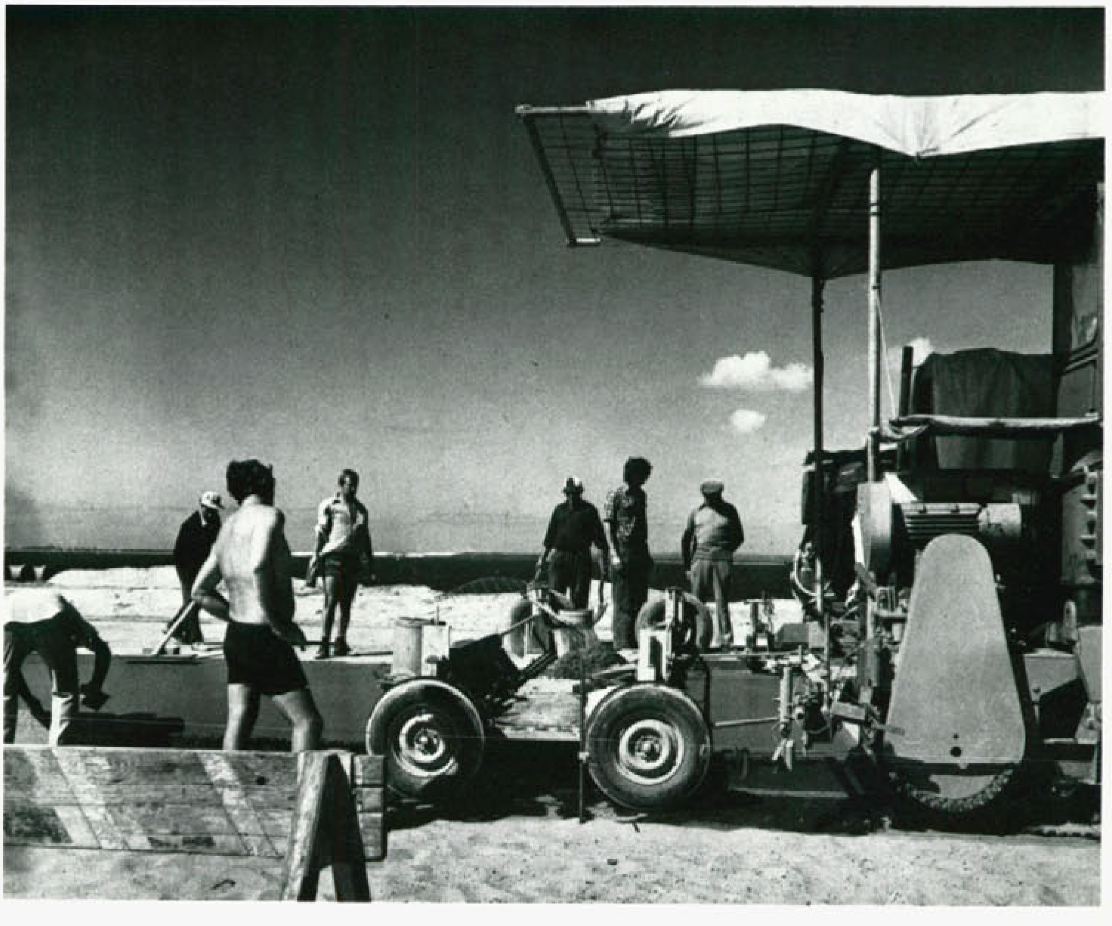
The preparation of the dredged sand subgrade was one of the special features of the work. Following shaping and levelling, sections of the formation approximately 30 m long were surrounded by an embankment or bund then flooded with water pumped from Botany Bay.

Compaction was by a 16 t smooth drum vibrating roller, towed by a Caterpillar D9 Tractor-Dozer, working in 150-290 mm of water. Twenty passes achieved a minimum density of 100% Standard Proctor Compaction to a depth of approximately 1.5 m.

Base course

The base layer of lime-treated fine crushed rock was placed directly on the sand subgrade. It was compacted to 100% Standard Proctor Compaction using heaving pneumatic-tyred rollers.

Following compaction the base was trimmed using the Department's new CMI PR 375 Roto-Mill Pavement Profiler working to pre-set stringlines (see article in September 1978 issue of "Main Roads", Vol. 44, No. 1, pp.7-9). This



The concrete was formed to shape as it passed through the machine, and beneath the finishing platform. The edges were repaired by hand where necessary.

machine trimmed a width of 2.8 m in one pass to an accuracy of ±5 mm. The base was then covered with a sand primer-seal to provide a sound platform for subsequent operations.

Deflection survey

Before commencing construction of the concrete pavement, a deflection survey was carried out using the Department's Deflectograph to detect weak points in the foundation. The survey provided deflection measurements at 4 m intervals in both wheel tracks of a test truck with an 8.2 t axle load, moving at 2 km/h. The mean 85 percentile deflection on all carriageways was 0.4 mm. No areas of weakness were located.

Slip-form paver

For the construction of the CRCP, a Stothert and Pitt CPP60 Slip-form Paver (imported from the United Kingdom) was hired from McGregor Paving Ltd.

The CPP60 is designed to lay single lanes, but has a laying width range of 2.4 m to 4.6 m. It is independently powered and incorporates an electronic control and guidance system. Concrete is supplied direct from trucks through a conveyor with a lightweight receiver located on the adjacent carriageway.

The machine is easily transported and for on-site manoeuvres can move at approximately 6 m/minute. During laying operations the machine progresses at an average speed of 25 m/h, but this varies according to the supply of concrete and the dimensions of the pavement.

Setting out for paver

The line and level of the concrete pavement were controlled by two piano wire stringlines attached to steel pins placed at 3 m intervals. A team of five men set out and checked these control lines.

After one lane of each carriageway was completed, the paver placed the adjacent lane using the first slab as the control for line and level on one side, and just one stringline for level control on the other. This decreased the amount of setting out required for the second lanes.

Concrete and steel

The concrete was supplied by Ready Mixed Concrete Pty Ltd from batching plants at Botany and Alexandria, using transit mixers with capacities of 5.0 m^3 and 6.6 m^3. On arrival at the site, each load was checked immediately for slump and cylinders moulded as necessary. An uninterrupted supply of concrete was of vital importance during the whole operation.

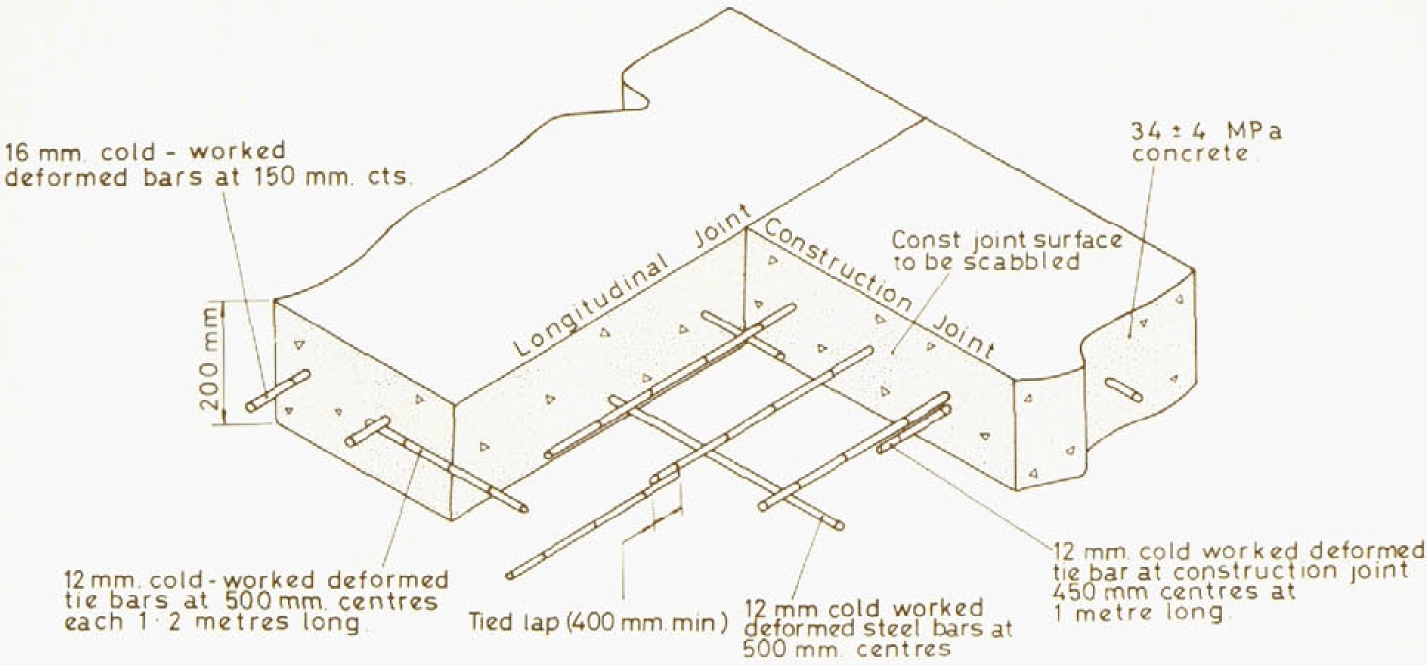
The steel bars were placed under contract by a specialist firm. The transverse bars were placed first, each on four 100 mm steel bar chairs; then the longitudinal bars were laid over and fixed to the transverse bars. The lapping of the longitudinal bars was staggered to obviate any discontinuity.

Concrete Paving

The daily output during concrete placement averaged 140 m^3/day (8 hours) with a maximum output of 263 m^3. Output varied with rate of delivery, slump and workability. The team on paving operations generally consisted of:

- 1 — Ganger
- 1 — Labour to check batching at batching plant
- 1 — Tally Man to record arrival and departure times and to check slump
- 1 — Chute Operator

A constant supply of concrete was necessary to maintain uniform pavement qualities. The taut stringline (arrowed) was used to guide the paver.



2 – Labourer to install tie bars (first carriageway only)
1 – Labourer to spray curing compound
1 – Labourer to broom (i.e texture) the surface
2 – Concrete Finishers to smooth (and repair if necessary) the edges of the slabs
2 – Concrete Finishers to smooth any "boney" sections (working from platform behind paver)
2 – Paver Operators (supplied with the Paving Machine)

Texturing and curing

Pavement texture for maximum skid resistance was achieved initially by brushing transversely with a wire tufted broom. Later a heavier wire tape, as provided on the Department's mobile street sweepers, was used. A mobile carriage was specially manufactured for this purpose. Pavement texture was measured by the Department's Test Method T240 (Sand Patch Method). The average texture depth of ten tests was specified as not less than 1 mm.

Immediately after texturing, a jet sprayline fitted on a rubber-tyred tractor applied a chlorinated rubber curing compound. The application rate was approximately one litre to 3 m^2.

Pavement monitoring

Instrumentation to monitor steel and concrete strains and temperatures at various depths within the pavement was installed at two locations along the westbound carriageway. The sensors were installed and connected to a Data Logger in February 1979.

Each site was instrumented with strain gauges fixed to alternate longitudinal reinforcing bars. At each site, 13 gauges were staggered over a 2 m length. Dummy gauges were also placed at the same depth, for comparison purposes.

"Demec" type pins were placed in the concrete pavement surface at one site and movement was measured between them.

Temperature is monitored at each of the two instrumentation sites by means of thermistors embedded in the pavement at depths of 20 mm, 70 mm, 120 mm and 170 mm. Air temperature thermistors were also installed. One site was equipped with temperature transducers.

During the week after the concrete was poured, ten of the gauges were read at hourly intervals using the Data Logger, and all gauges were read three times a day.

Since the first week all gauges are being read twice weekly.

Cracking

The transverse crack spacing and width was monitored during March 1979, when the slabs were one week to three months old. Further monitoring will be carried out at three monthly intervals.

The cracking was checked by investigating random 50 m lengths in each 500 m length of pavement. Crack spacings were measured with a metric wheel and crack widths were measured with a 60-magnification crack-measuring microscope.

The cracking behaviour was somewhat similar to that experienced at Clybucca. For the concrete poured over two months, the average crack spacing was found to be 2.68 m. Average crack width was 0.035 mm.

Generally, crack spacing was closer at the starting point of a pour than at the finishing point, due to the former being restrained and the latter free.

A fine crack only has occurred along the longitudinal joint between the slabs and therefore it is not intended to seal the joint at this stage.

Concrete strength

The concrete supplier was responsible for taking and curing the necessary test cylinders. A pair of cylinders was required to be moulded for each 15 m^3 of concrete.

A total of 1,011 cylinders (excluding rejects) were tested for 28-day compressive strength. In addition the Department prepared and tested 482 cylinders for 7-day strength.

The results achieved for the concrete which had a characteristic compressive

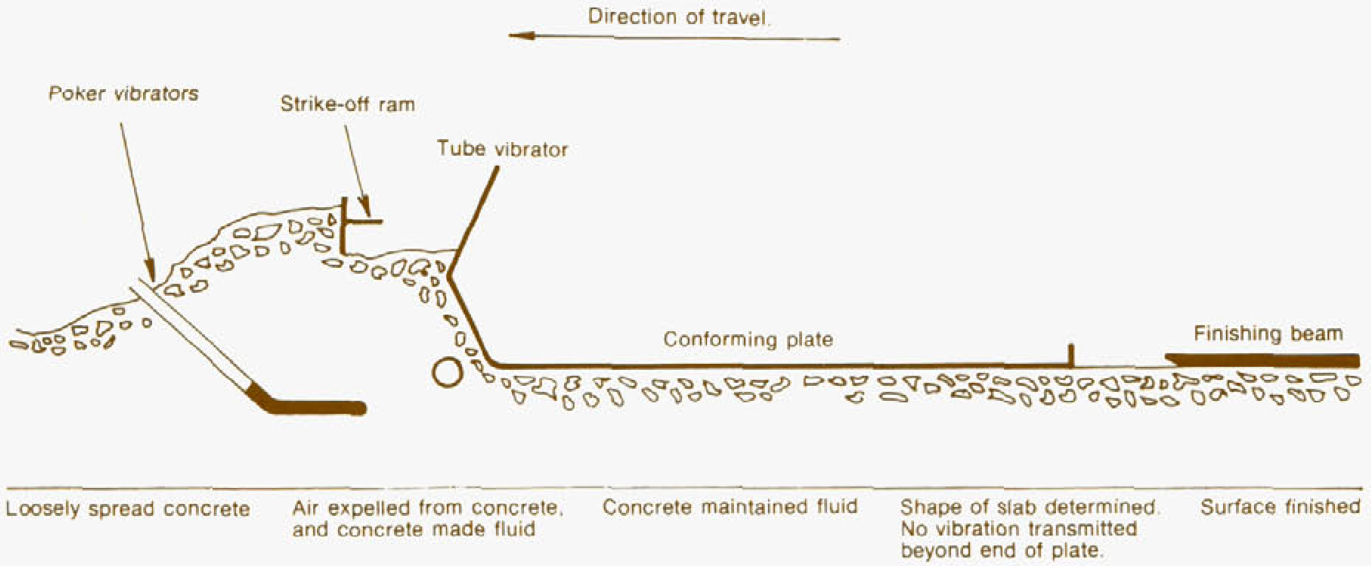


Diagram of concrete paving technique

strength of 30 MPa were:

- at 7 days (DMR cylinders)
  Mean Strength 22.68 MPa
  Standard Deviation 2.31 MPa, and
- at 28 days (Supplier's cylinders)
  Mean Strength 31.62 MPa
  Standard Deviation 3.14 MPa

A production mix sample was taken for testing on 15 December 1978. The mean results were

- shrinkage at 28 days 430 microstrains
- compressive strength at 28 days 33.5 MPa, and
- flexural strength at 28 days 4.65 MPa

Riding quality

The riding quality of the continuously reinforced concrete pavement was tested with the Department's Roughness Meter before vehicles were allowed to use it.

The results of the roughness measurements were:

- eastbound outer lane 27 counts/kilometre
- eastbound median lane 30 counts/kilometre
- westbound outer lane 29 counts/kilometre
- westbound median lane 33 counts/kilometre

These results are a marked improvement on the results obtained at Clybucca, where hand laying methods were employed, and more than meet the desirable specification for a freeway-type pavement. They confirm the accuracy of control which is possible with the slip-form paver.

Skid resistance

Before vehicles were allowed on the road, the pavement was also tested for skid resistance using the Department's SCRIM. The tests were made on a warm dry day at a test speed of 80 km/h. The Sideways Friction Coefficient was measured at 20 m intervals along all four pavement lanes. The desired minimum reading at 80 km/h is 40 and the actual readings varied between 41 and 89. The median lanes which had a wire broom finish had an average Sideways Friction Coefficient of 71. The outer lanes, which had a coarser texture from the heavier wire tape treatment, had an average of 54.

Readings of the Sideways Friction Coefficient will be taken every three months to evaluate the effectiveness of the pavement texture under traffic.

Construction costs

Total actual cost of the concrete work was approximately $1.04 million for a total pavement area of 44 500 m². Elements of the cost were:

- materials (including concrete, steel and curing compound) $16.54/m²
- hire of slip-form paver $ 0.72/m²
- steel fixing (contract) $ 0.95/m²
- labour $ 5.21/m²

Total Direct Cost $23.42/m²

In addition, administration costs have been estimated to be $4.00/m².

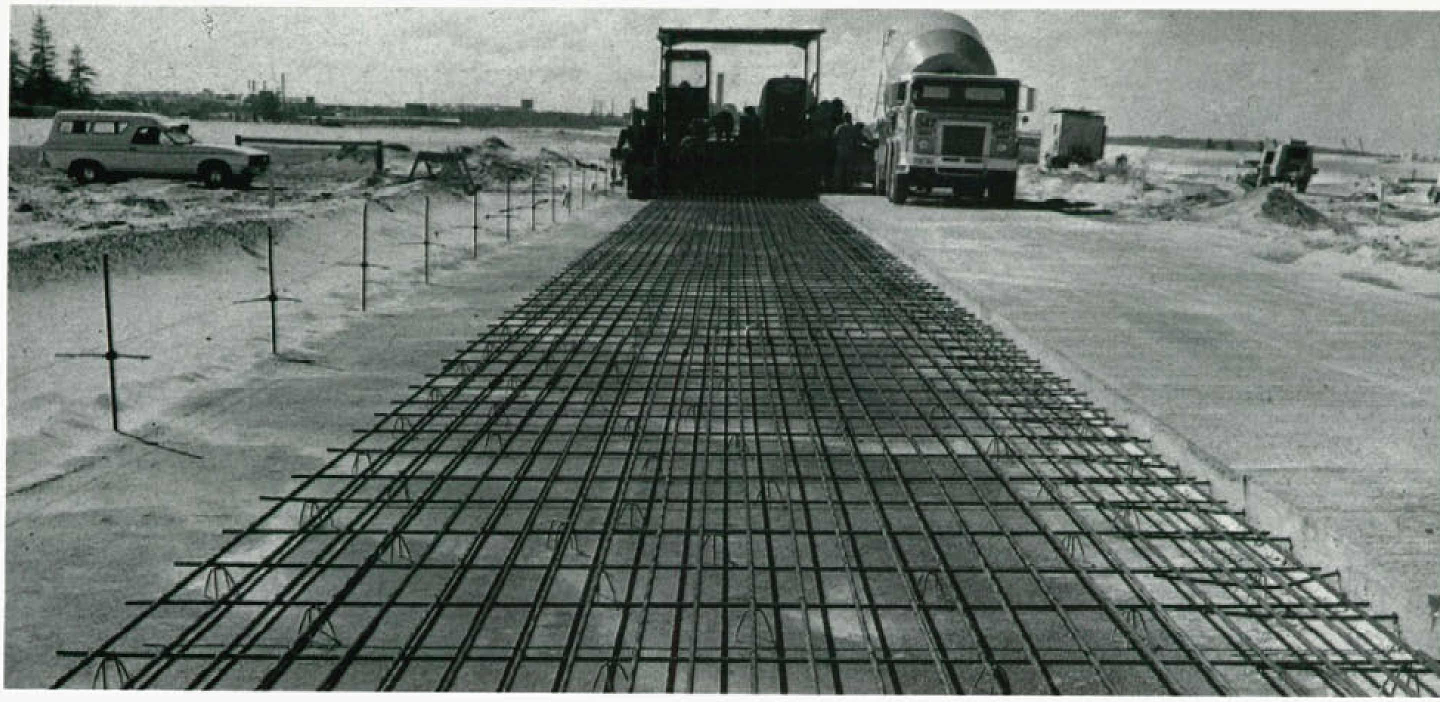
Supervision of this project was carried out for the Metropolitan Engineer (Mr. J. Neeson) by the Works Engineer of the South Metropolitan Works Office at Rockdale (Mr. L. Dowling) and two engineers at the site (Mr. P. Kenny and Mr. S. Warrell). ●

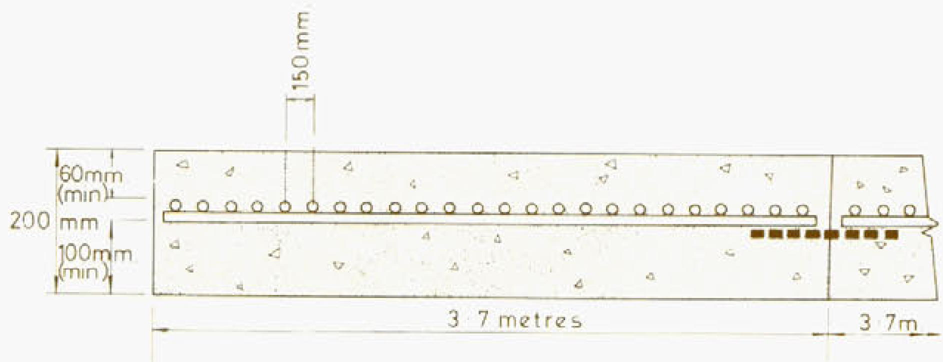
For permission to reproduce a number of their photographs we thank the Cement and Concrete Association of Australia.

Colour photographs of work on The Foreshore Road appear on pp. 79, 80 and 81.

As well as the references mentioned in the article above, a number of other interesting articles about concrete road pavements have appeared in earlier issues of "Main Roads". The best of these is "Building Concrete Pavements — Experience on Main Roads in N.S.W." in the June 1953 issue, Vol. 18, No. 4, pp. 98-103. Other articles include

- *"Joints and Reinforcement in Cement Concrete Pavements", March 1931, Vol. 2, No. 7, p. 105.*
- *"Methods and Materials for the Repair of Bituminous and Concrete Pavements", May 1938, Vol. 9, No. 3, pp. 108-9 and August 1938, Vol. 9, No. 4, p. 153.*
- *"Road Construction Development 1925-40", May 1940, Vol. 11, No. 3, p. 84.*
- *"Construction of Concrete Pavements" (Report of overseas practices), May 1940, Vol. 11, No. 3, pp. 91-4.*
- *"Maintenance of Cement Concrete Pavements of Main Roads in the Sydney District", December 1951, Vol. 17, No. 2, pp. 54-7.*
- *"Concrete Pavement Construction — Trial Section of Changed Design", September 1952, Vol. 18, No. 1, pp. 29-31.*
- *"Stages in Concrete Pavement Construction on Main Roads" (photographic record), December 1955, Vol. 21, No. 2, pp. 52-3.*





Cross sectional details of continuously reinforced concrete pavement.

Above: Steel bars awaiting the slip-form paver's approach. Note the staggered lapping of the longitudinal bars. A completed lane of pavement can be seen on the right.

Right: Chlorinated rubber curing compound being sprayed on the textured concrete surface.

CONCRETE PAVING — 50 YEARS AGO

By way of comparison with the techniques and machinery described in the proceeding article on the new continuously reinforced concrete pavement being provided on The Foreshore Road at Botany, we'd like to include some details of how cement concrete roads were built in the late 1920's by the Main Roads Board.

Imperial measurements have been retained in these references but, for those who wish to *metricate* them, we have included necessary conversion rates at the end of this article.

Firstly, a few facts about the concrete paving machine, five of which were used by the Board. This was a self-propelled machine, driven by a 4-cylinder petrol engine and moving on caterpillar tracks. It had a mechanically-operated elevating hopper and a broom-and-bucket distributor. The water supply was regulated by an automatic cut-off cistern which could be set to hold the desired amount of water.

Each paver was usually fed by 25 cwt end-tipping trucks, working in pairs — one carrying 1½ inch and ¾ inch metal and the other carrying sand and cement — the contents of a pair of trucks making up a complete 28.25 cubic feet batch.

The number of lorries required to feed each paver depended, of course, on the length of the *lead*, from the stock piles to the operating site. Four pairs of trucks were required for a *lead* of one mile. (See Board's 1926-27 Annual Report, pp. 6-8).

As an example of the efficiency reached in the laying of cement concrete pavements, the Board's 1928-29 Annual Report announced (on page 14) that their metropolitan day labour organisation laid, *on an average, over 1,000 square yards of 7 inches to 9 inches reinforced concrete pavement per ordinary working day throughout the period of any work.*

In the reconstruction of Lyons Road, Drummoyne (Secondary Road No. 2006), which was completed in July 1929, the average output of the paver for the whole work was 1,142 square yards per ordinary working day, with peak outputs of 1,890 and 1,638 square yards.

Quick-hardening cement was used at intersections and the cost of laying the concrete slab (including dowel bars, edge bars and bar mat reinforcement), was 15 shillings per square yard, plus excavation at 4s. 2d. per cubic yard and disposal of the spoil at 2s. 4d. per cubic yard.

As an example of an early major road pavement project undertaken using cement concrete, we need look no further than the much publicised construction of the Hornsby to Hawkesbury River section of the new Sydney — Newcastle Road. This has been amply chronicled in the March 1930 issue of "Main Roads" (Vol. 1, No. 6, pp. 130-7, 142), expanded in the 30-page article by Mr. T. H. Upton on "The Establishment of Direct Road Communication between Sydney and Newcastle" in the May, June and July 1932 issues of the Journal of The Institution of Engineers, Australia (available free in reprint form from the Department's Public Relations Section) and summarised in the Department's book "The Roadmakers" (pp. 118-121).

The Board's decision to lay a cement concrete pavement south of the Hawkesbury River had a sound economic basis. Of the tenders submitted for the work, it was the cheapest type of pavement.

Excluding the cost of formation and subsidiary works, the cost per square yard of each type (based on the lowest tender in each case) was:

- tar macadam with broken stone base — 18s. 7d.
- bituminous concrete with broken stone base — £1 7s. 0d.
- portland cement concrete — 16s. 4½d.

Cement concrete had other advantages, such as requiring only one operation and needing the minimum quantity of materials. These were important factors in view of the limited operating space available for paving equipment especially between Berowra and the Hawkesbury River, where suitable side tracks were not available. For this reason, the adoption of a class of pavement which could be completed for its full depth in one operation had outstanding advantages for those requiring construction in two or more layers.

However, better water supplies became imperative. To supply mixing water for the paver and water for keeping the covering on the concrete slab wet during curing (as well as drinking and washing water for the camps), it was estimated that a maximum rate of 39 gallons of water per minute would be required. Local water supplies were inadequate and it was necessary to install special 3-inch pipes with pumps along the road from the Water Board mains near Hookham's Corner, first to Mt. Colah and eventually right down to the Hawkesbury River (a total distance of over 14½ miles). A number of large tanks, providing a storage capacity of 6,000 gallons were also necessary.

The concrete pavement was 20 feet wide, (of 1-2-3 mix), 7 inches thick at the centre, 9 inches at the edges, with a deformed longitudinal joint down the centre, transverse joints at approximately 50 feet intervals, and reinforced on fills with bar mesh to the extent of 60 lb. per 100 square feet. The pavement was flanked on either side with earth shoulders 4 feet wide and had between it and the subgrade a layer of bush sand 3 inches thick.

Silicate of soda, at the rate of 1 gallon per 250 square feet of pavement was applied 24 hours after the concrete was laid. This treatment was later abandoned on the Board's work as abrasion tests, using a sand blast apparatus, were found not to support the generally accepted view of improving the wearing qualities of the concrete.

The paver used was a 27E Smith machine. Each batch consisted of 12.2 cubic feet of ¾ inch metal, 12.2 cubic feet of 1½ inch metal, 16.5 cubic feet of sand and 8 cubic feet of cement. Materials were conveyed from the stock piles to the paver by 2-ton lorries with power-operated tipping bodies. Each lorry obtained the materials for one complete batch by visiting each stock pile

One of the Smith 27B concrete paving machines used by the Main Roads Board — *in operation on the new* Sydney-Newcastle Road near Berowra in 1928. Note the raised position of the feeding hopper.

A truck loads the premixed material into the hopper of the paving machine. The travelling bucket at the right pours the concrete onto the roadway.

in turn and there receiving from the batching hopper of a Barber Greene loader, the correct quantity of the particular aggregate. The final visit was to the cement shed, where six jute or eight paper bags of cement were emptied into the truck.

Each loader could fill its hopper from the stockpile and empty it into a lorry in ten seconds. The complete loading cycle for each lorry for 1½ inch metal, ¾ inch metal, sand and cement, was 1 minute 45 seconds, of which 50 seconds were occupied in obtaining the aggregates and 55 seconds in obtaining the cement. Two loading platforms were used at the cement shed to avoid undue congestion at that point. The volume of the batch bulked wet, using crushed basalt, was 28.2 cubic feet or sufficient to pave approximately 5.2 square yards of road.

The first section from Hookhams Corner to Mt. Colah (3 miles in length) was completed in February 1929. The cost per square yard of concrete laid, including dowel and edge bars, was 16s. 7d. As side tracks were available throughout this section, the pavement was laid full width in one operation.

In October 1928, a commencement was made on the earthworks of the second section from Mt. Colah to Berowra. Though not as heavy as those of the third section (from Berowra to Kangaroo Point on the Hawkesbury River) these were nevertheless sufficiently heavy to require ample time for consolidation. It was anticipated that, by commencing them at that time, they would be ready to take the concrete surface as soon as the paving of the third section had been completed. This would enable the concrete work to proceed continuously for 11⅔ miles from the Hawkesbury River to Mt. Colah.

The laying of the concrete pavement was commenced at the Kangaroo Point end in September 1929 and completed to Mt. Colah in May 1930. A job schedule was drawn up, requiring a rate of progress of 1 mile of pavement each fortnight, or equivalent to an output of 1,225 square yards of pavement per available day.

At first, owing to the very long lead of 3¾ miles from stock piles to paver, the lorry contractors' inability to secure sufficient vehicles to keep the paver continuously supplied, and the restricted space for turning the lorries supplying the paver, only comparatively moderate daily outputs (of approximately 1,000 to 1,200 square yards) were obtained. As the work advanced, and the distance from the depot decreased, the lorries available sufficed for the work, batches arrived with greater frequency at the paver, and outputs increased accordingly.

With many deep cuts and fills restricting access, the only approach to the paver for the lorries supplying the raw materials was along the formation and it was foreseen that the turning of these to back in and tip their loads into the boot of the paver would cause inconvenience and delay. To permit them to turn under their own power, it would have been necessary to widen out the formation but this was not a practical solution.

Although turntables were known to have been used in similar circumstances abroad, they had not previously been tried out for this purpose in Australia. It was considered, however, that the circumstances demanded the introduction of this equipment and a locally manufactured turntable was purchased for £317 and put into use during October 1929. Its success was at once apparent.

On the first day the turntable was introduced, the day's output rose from 1,250 to 1,545 square yards and for the following month the average output per day was 1,574 square yards, with peaks of 1,850, 1,849 and 1,663 square yards. The maximum of these was reached on 12 November 1929 and represented 360 batches of concrete, at the rate of 38.9 batches per hour, or one batch every 92 seconds! The total weight of dry material which passed through the paver during this day was 760 tons, equivalent to the weight of material carried on a goods train of forty-eight trucks of 16 tons capacity each.

Whereas formerly it had taken approximately 4 minutes for each lorry to turn under its own power, the turning was now accomplished in from ½ to 1 minute. Fewer lorries were required (on this account alone, the saving more than paid the cost of the equipment) and congestion on the road where the lorries turned was eliminated. Part of the credit for the improved rate was, no doubt, also due to the gradual welding of the various operations into a smooth flowing cycle.

Another interesting detail of organisation, small in itself, but nonetheless important in the overall procedure, was the arrangement for bringing forward each day the side forms stripped from the work done two days previously. As no vehicle could travel beyond the end of the newly laid concrete, these forms had to be carried forward by hand and there loaded on a lorry to be transported perhaps half a mile or more ahead for re-use. As the loading of this lorry anywhere near the paver while concreting was proceeding would have caused congestion, this operation was carried out each day by a special gang, starting at 4 a.m. and finishing before 7.30 a.m. when the day's paving commenced.

Following the curing of the concrete slabs, a gang of about fifty men was engaged in clearing off the earth covering, trimming and consolidating the shoulders, finishing the joints with bitumen, and erecting the protection fencing.

continued on p.87

Construction of The Foreshore Road has progressed well. This aerial photograph was taken in March this year.

Construction at the north-western end of The Foreshore Road near its junction with General Holmes Drive. The elevated decking in the foreground will eventually carry General Holmes Drive's southbound carriageway over The Foreshore Road.

The Stothert and Pitt CPP 60 slip-form paver at work o
140 m³/day (8 hours). Pavement texture for maximum
to the second trailer. The first trailer held a platform fr

A NEW STYLE O

**As described
70 to 76 of thi
reinforced co
being constru
to form The F
land reclaime
of Botany Ba
This is only th
pavement bu
and is the firs
slip-formed i**

◀
An uninterrupte
vital importance

▶
The independen
laying width of 2
supplied directl
conveyor with a
the adjacent car

Road. The daily output from this machine averaged
vas achieved by brushing with a wire broom attached
ncrete finishers worked.

Looking east along the route of The Foreshore Road, showing the railway overpass under construction, the link with Beauchamp Road (on the left centre) and the Caltex depot (on the right centre). The slip-form paver can also be seen.

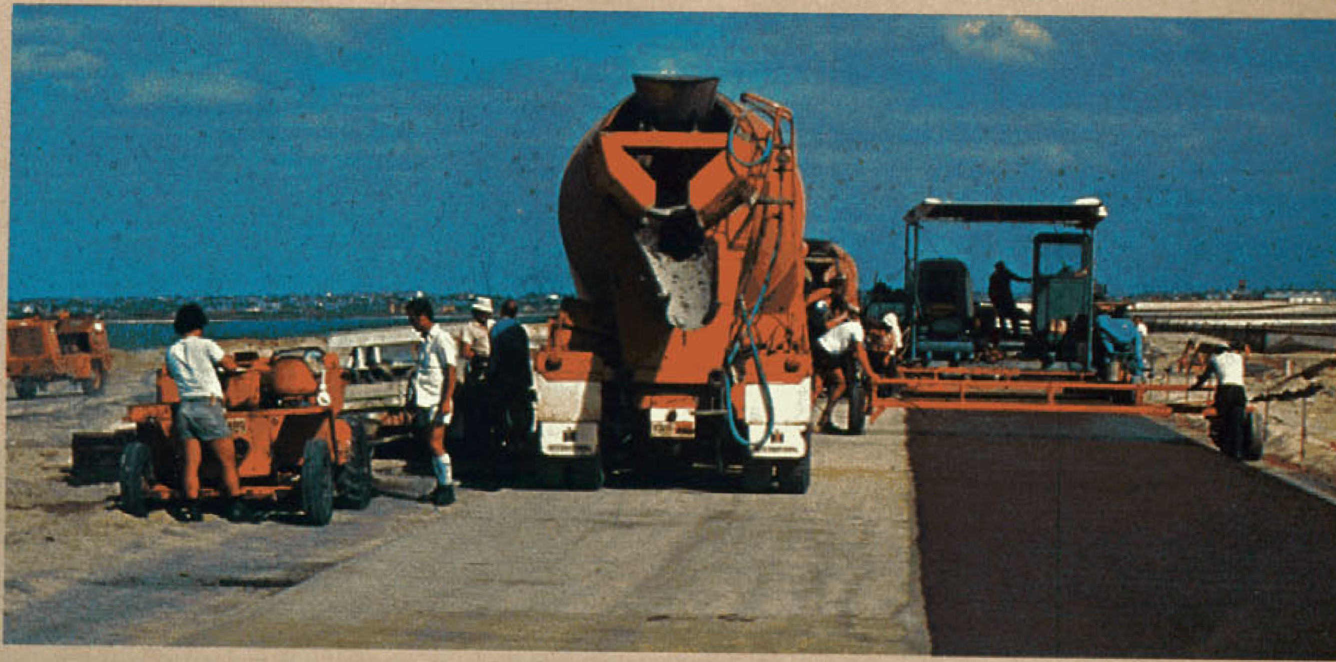
CONCRETE ROAD

on pages
tinuously
nent is
Department
d, along
hern shore

h
artment
ent to be

ete was of
operation.

50 has a
crete is
ugh a
ver located on



The new steel-hulled ferry on its maiden voyage with a 10-tonne test load.

The first steel pontoon lies in the river awaiting assembly.

The four pontoons assembled, end guides are fitted and the ferry takes sha

Hull assembled, and both flaps attached.

The drive unit being prepared ready for fitti

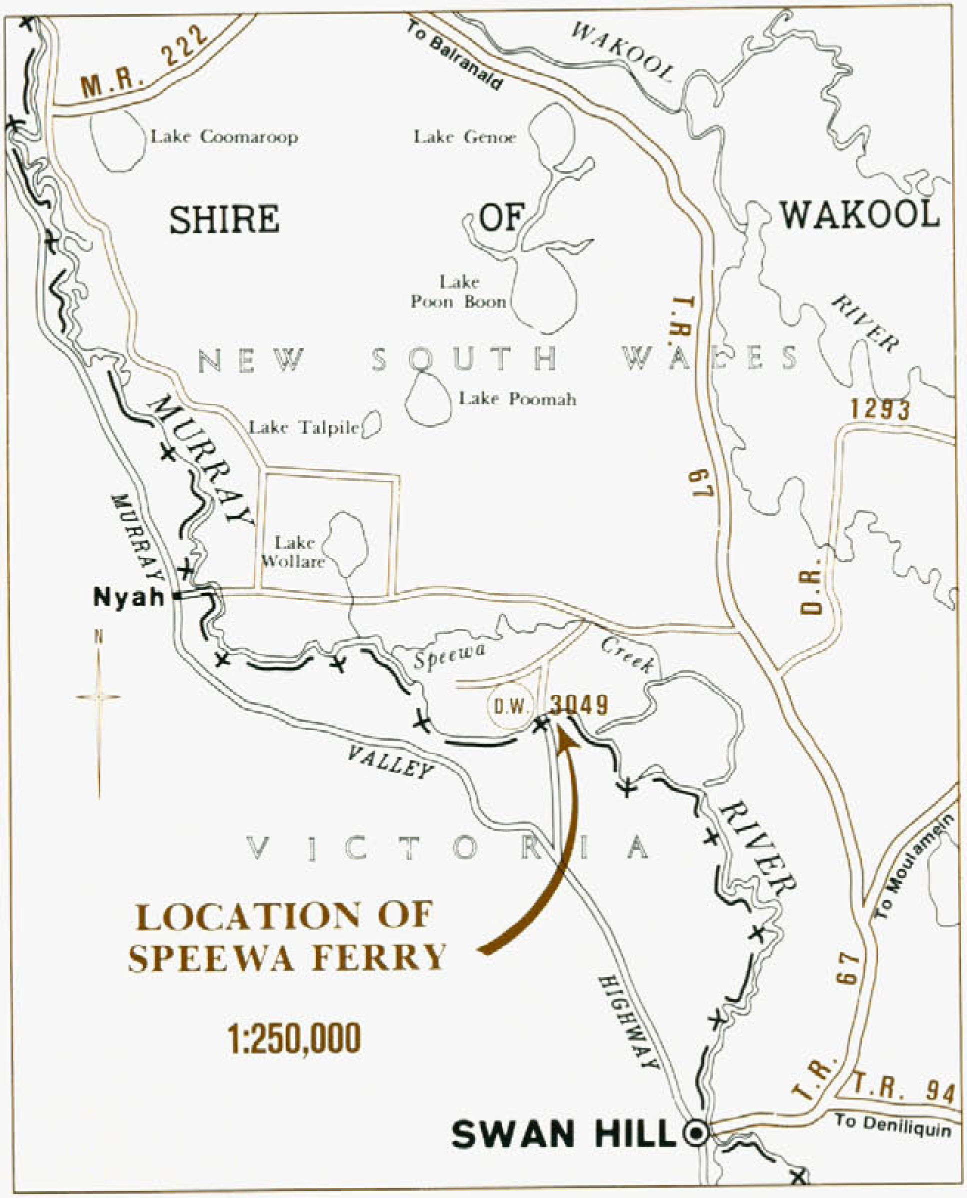
NEW FERRY

at Speewa on the Murray

'o a traveller, there are two ways of
ɔoking at a river or other sizeable body
f water. If one is travelling in a
vater-borne vessel, the water itself can be
n open way to the destination. Any land
ear the surface, or rising out of it, is an
obstacle to be avoided or overcome.
However, to the *"landlubber"*, the
opposite holds true. A river, lake or bay
is a blockage in his path.

Sometimes the water obstacle can be
bridged. But this is an expensive solution
and the amount of traffic has to be
sufficient to make it an economic
proposition. Tunnelling is even more
costly.

Where traffic is very light and the crossing
distance is not too great, the most



efficient river crossing (in terms of cost) is often a ferry. At its simplest, a ferry is just a barge pulled back and forth across a river by means of a rope, which also serves as a guide and keeps the vessel from drifting away. This is how it was done in the old days.

The mighty Murray

The Murray River is the major river of south-eastern Australia. Along with its tributaries, it drains vast areas of New South Wales, Victoria and South Australia. Its upper reaches to the east form most of the border between New South Wales and Victoria. The Murray has been an important navigable waterway since pioneering times, although not much used nowadays by larger vessels.

Sprawling as it does over three States, the Murray River necessarily cuts across many major and minor roads. Many of these crossings are now bridged but some of those with low traffic usage are still crossed by means of simple punt-type ferries.

Speewa Ferry origins

One of these crosses the Murray River at Speewa, between Nyah and Swan Hill, Victoria.

Records of the crossing's early days are fairly fragmentary as it was originally a private venture. The first punt to ply the crossing was apparently installed by Mr. J. F. Jager, a local landowner. It linked land he owned on Speewa Island (N.S.W.) with the township of Speewa (Vic.) and was commenced some time before 1914. Speewa Island is the area of land isolated by the Murray River to the south and west, and by Speewa Creek to the north and east.

The punt was a simple affair, winching its way slowly across the river. The site then was slightly more than a kilometre upstream of the present position. It was later shifted because of flood problems.

In 1919 Mr. Jager subdivided his Speewa Island land into 19 farms. As an incentive to buy, he left the punt for the convenience of the new settlers.

The "Speewa Islanders" put up a cottage for a caretaker/ferryman and paid him a salary. For them travel was free, but others paid a fee for the service.

Government take-over

By 1923 the vessel was showing its age. A Victorian government shipwright inspected it. His report said that it would cost as much to repair it as to build a new one of the same dimensions.

Early in 1924, the Department of Public Works decided to take over the ferry, paying £170 for the cottage, winches, ropes, etc. The punt itself was obtained *gratis*, which is not surprising considering its apparently dilapidated condition.

D.M.R. No. 62 being floated downstream — the last voyage.

However, Supervising Engineer Evans did NOT recommend taking over the caretaker. He wrote *"At the date of my visit, he was under the influence of drink and made himself more or less objectionable and I was given to understand that this was not an uncommon occurrence"*.

Replaced . . . at last

By 1926, plans were afoot to replace the ageing Speewa punt with a freshly overhauled vessel to be brought from Tooleybuc (which is not far downstream to the south-west of Kyalite).

In March 1927 the ferry sank at its moorings. The records show that this happened several times in its life. After being repaired, it went back into service. A report later that year said it was *"leaking so badly that constant pumping was required to keep her afloat. It may collapse at any time"*.

By this time the old ferry had acquired a guide rope. Both it and the drive rope had enough slack to hang deep enough to allow normal river traffic to pass.

By the end of 1927, the ferry from Tooleybuc was on site. However, it was discovered that the old punt's cables were not suitable for the replacement vessel — and so a further delay occurred.

Finally, suitable wire rope was installed and the refurbished replacement went into service in May 1928. No guide rope was fitted at this stage.

Motor supersedes muscles

In 1952 the punt was motorised with an 8 horsepower "Vinco" engine, driving through a leather-faced clutch to a gearbox and a large drive wheel around which passed the wire rope. The extra wear and strain on the rope resulted in breakages, so a second wire was fitted on the opposite side of the vessel, to act both as a guide and a safety measure.

After an extensive rebuild in 1953, the ferry served satisfactorily except for rapid clutch wear. This problem was solved in 1963 when the punt was fitted with a more powerful diesel unit in place of the petrol engine. This had hydraulic drive which eliminated the need for a clutch. The single large drive wheel was replaced by a pair, to give better traction.

These alterations added considerable mass to the drive side and buoyancy tanks were fitted under the cabin to prevent listing.

Aside from the addition of a reduction gearbox and minor alterations to the hydraulic system, the ferry at Speewa operated in that format until the end of 1978.

Getting on and off

Along this part of the Murray River, the banks are high and steep, so approaches were cut ramp-fashion to give vehicles an easier grade.

The ferry vessel was fitted with flaps at the ends. These were lowered to ground on the approaches to allow vehicles (and pedestrians) easy boarding and disembarking. However, the Murray is subject to large seasonal variations and at low river levels the ferry hull tended to go aground before the flap reached the approach road. Even with the powered drive, it could be difficult to free it from the mud.

Consequently, wooden landing stages mounted on skids were constructed to act as land-based extensions of the ferry flaps. The ferry did not then have to approach as close to the shoreline.

As the river level changed, the ferry nudged the landing stage higher or pulled it back using its normal drive. The only alternative to this system would have been to concrete the approaches and dredge to maintain a channel. The cost of this solution would be excessive.

Costs up, usage down, future uncertain

By the early 1970's, the cost of maintenance of the ferry vessel had risen considerably. This was due to the general inflationary trend and to the advancing deterioration of the timber hull. Other operating costs (wages, fuel, etc.) also increased.

The total cost of operating the service is now shared equally by the bodies responsible for main roads in Victoria — the Country Roads Board — and in New South Wales — the Department of Main Roads.

The steadily rising costs of providing the service, and the drop in usage in recent years, caused the Governments involved to consider closing it. This proposal led to a great deal of debate among local people and associations, their Parliamentary representatives, and the Government authorities concerned. Residents on the northern side (on Speewa Island) felt that they would be particularly disadvantaged by the loss of the crossing.

Most of the objection was on behalf of the children who, although living in New South Wales, attended Speewa Primary School across the Murray River in Victoria. Many felt it would be too much of a hardship for them to be bussed (or have to travel by private car) the roundabout route via Swan Hill or Nyah, where there are bridges. (There is northern access to and from Speewa Island via a bridge across Speewa Creek and then the local road which runs from Trunk Road No. 67 to Nyah).

There were also those residents who expected some disruption, or at least inconvenience, to their business and social lives. Some pointed out that the ferry crossing had been a unifying force, allowing the people on both sides of the river to develop as a single community.

D.M.R. No. 90 — a link between Speewa Island and "the mainland" — lies ready for service.

A new ferry?

Several designs for a new ferry vessel, to keep the service going indefinitely, were proposed in the Department. Investigation showed that technical difficulties and high running costs made them impractical at this site.

Finally in 1977, a compromise solution was reached. It was decided that the service would remain open until the end of 1980. This would allow the older children to complete their final and more demanding primary years without disruption. At the same time, it would allow a full three years for alternative school arrangements to be made for the younger ones.

Since it was unlikely that the then current ferry would last that long, a temporary replacement would be needed. It had to be one that could be used again somewhere else to make the proposition economically sound. This requirement indicated that the new ferry vessel should be a "knockdown" type, prefabricated and then assembled on site. The design had to allow for comparatively simple dismantling for moving to another location, using a minimum of skilled labour, in all these operations.

Prefab punt

Designed and built at the Department's Central Workshop at Granville, the new vessel is based on an assembly of four watertight steel boxes or "pontoons".

These "pontoons", each 5.3 m x 2.4 m x 1.2 m (depth) were sandblasted and finished with tar epoxy at the Workshop at Granville. Linked together later on site with steel pins, they formed the basic hull, measuring 10.8 m x 5.0 m. Onto this were bolted the other major components.

The deck is a galvanised steel grid on a support frame of steel bars, also galvanised. Individual sections of the deck grid can be lifted for inspection. The deck structure covers the gaps between the steel boxes and spreads vehicle wheel loads. It is also safer for pedestrians than the plain top of the four linked "pontoons" would be, especially considering that the deck will be adversely affected by oil droppings from vehicles and other droppings from livestock.

The only timber on the vessel itself is the decking of the steel-framed flaps. Measuring 4 m from hinge to end, these are slightly longer than those on its predecessor. This extra length is required because of the new ferry's slightly greater draught of 0.8 m. New landing stages have been built of hardwood at each approach.

Other ferry features

The old ferry was dismantled and its drive unit mounted on the new one. A more powerful Lister 15 horsepower engine was fitted and a heavier reduction gearbox. Dual controls are fitted in the all-steel overhung cabin, which is bolted in place.

The superseded vessel had non-standard rope guides and drive wheels. These were not used on the replacement vessel, which has equipment compatible with other Departmental ferries.

An aluminium dinghy is slung from davits on the side opposite the cabined "engine room".

The "carriageway" of the ferry (which is functionally part of the road) is 3.5 m wide between steel kerbs and 10.7 m long. This is sufficient for two average-size cars in tandem.

The vessel's unladen displacement is approximately 29 tonnes. It will carry a nominal 13 tonnes. This is the standard mass of a loaded two-axle truck with dual rear wheels.

To protect young children, the tubular steel handrails and end-gates are filled in with chainwire mesh. This is also necessary because the ferry frequently transports livestock on the hoof. For this purpose, chains are carried to divide the carriageway into sections — in order to keep the animals from crowding into one end and making the ferry unstable.

Assembled, dismantled, assembled again

The ferry was designed to be broken down into three semi-trailer loads, the maximum mass of a component being 3 tonnes.

After fabrication and before despatch, all the Granville-made parts were test-assembled to ensure that on-site assembly would be a simple straightforward process, with no last-minute "bugs" to cause delay. Dismantling and re-assembly may well occur several times during the vessel's working life.

The three semi-trailers arrived at Speewa on Monday, 8 January 1979. The following day assembly began on the river, with the aid of a crane. The old ferry had already been taken out of service on 2 January and moored to one side. This cleared the assembly site and facilitated the exchange of the drive unit. The withdrawal of the service was planned to be within the school holiday period in order to keep the inconvenience to a minimum.

Assembly of the new vessel was completed on Friday, 19 January, giving a total of only nine working days for the job. After it was tested in action with a 10-tonne load, it went into service the same day. This was three days ahead of the target date.

When its time at Speewa is up, the vessel is expected to be taken apart and put together again to replace one of the four timber ferries still operating under the Department's care in New South Wales.

Fast work

This project, carried out at the Department's Central Workshop and at the Murray riverside, was characterised by a sense of urgency from its inception. The whole task, from original design concept to commissioning, took less than ten months. Between the first and the final stage came detailed design, ordering and supply of *bought-in* components, fabrication, trial assembly, dismantling, transport to site, re-assembly and testing. The whole project was a creditable achievement by the Central Workshop team and other Departmental personnel involved.

Unlike the usually elegant free-moving ferries, the tethered types seldom have names, usually just numbers. The one that "passed away" this year at Speewa was known simply as D.M.R. No. 62. The new one is officially known as D.M.R. No. 90.

Although it is only a little ferry vessel, it is doing a big job and although it brings only a temporary reprieve from the final curtailment of the service, it is a better and safer crossing for the residents of Speewa and Speewa Island. ●

FOUND IN THE FILES

Over the years, the Speewa Ferry has had a succession of caretakers, who have reported many mishaps and problems. Here are a few quotes from the yellowing pages of some early files.

One morning in the 1930's, the caretaker found the dinghy missing and reported it apparently stolen. *"I have not received any information from the Victorian Police in regard to stolen boat. Two boats enables me to have one on each bank of river so that the public can work the ferry at meal hours, etc."*

His indiscretion over the public's operation of the ferry brought a sharp rejoinder from his superiors. *"In reply to your memo, I have to advise that definite hours have been set out in the Agreement for meals and for the operation of the ferry, and under no circumstances is the general public to be allowed to operate the ferry."*

In any case the dinghy hadn't been stolen. *"I have to report finding Lost Boat sunk in 10 ft. of water in river but did not recover oars. Boat is in good order."*

Inexperienced self-helpers could be a hazard. *"I have to report that on the morning of .... at about 2 a.m. Mr. ...., carrier, of .... crossed the river without my permission with a 2 ton V8 Ford truck, loaded with 85 bags of barley. When nearing the Victorian bank the ferry submerged; the load falling into the river, carrying away the wheel house and the side railing. I don't know what other damage, if any, until ferry is refloated. The truck was undamaged."*

The gates on shore came in for their share of punishment.
"It was very foggy at the time; the truck stopped about 20 yds past the gate and I heard one of the occupants say something about "hit some b..... thing."

Safety equipment was fitted, although the connections might have been a bit inadequate . . . at least on one occasion. *"I regret to state that I lost one of the two lifebuoys belonging to the Ferry. It must have blown off with the strong wind. I had them tied with string to the top rail but the string must have rotted."* ●

Once poured, the concrete is spread and finished by hand.

CONCRETE PAVING — 50 YEARS AGO

continued from p.77

South of Cowan there were several fairly long sections on which the old road and the new coincided, and side tracks could not be provided. To pave these to the full width would have necessitated closing the road to traffic entirely during the curing period. Alternatively, the use of quick-hardening cement to enable the road to be opened in a few days would have meant very considerable additional expense because of the lengths involved. In order to avoid any interruption to traffic following paving, it was arranged that, by means of a supplementary two-bag mixer used as a central mix, one half of these widths should be paved in advance of the normal programme and opened to traffic. In a few cases, the paver itself was moved forward to do this work.

Between 10 September 1929, when concreting commenced, and 6 May 1930, when the road pavement was completed (with the exception of 666 square yards of pavement at the approaches to the Kangaroo Point ferry dock, which were subsequently laid in quick hardening cement with a two-bag mixer) a total of 141,381 square yards of concrete were laid by the "Smith" paver.

The average area laid per day worked was	1,400 sq. yds.
The average area laid per available working day was	927 sq. yds.
The total number of days worked was	101
the total number of available working days was	152½
The available days not worked were made up as follows . . .	
Wet weather	27 days
Water supply pump under repair	4 days
Paver under repair	16 days
Shortage of material through non arrival of supplies ordered	2½ days
Transferring depot and paver from Berowra to Ku-ring-gai	2 days
Total	51½ days

The concreting from the Hawkesbury River to Mt. Colah covered a total of 143,623 square yards and was carried out at a total cost of £143,385 3s. 7d.

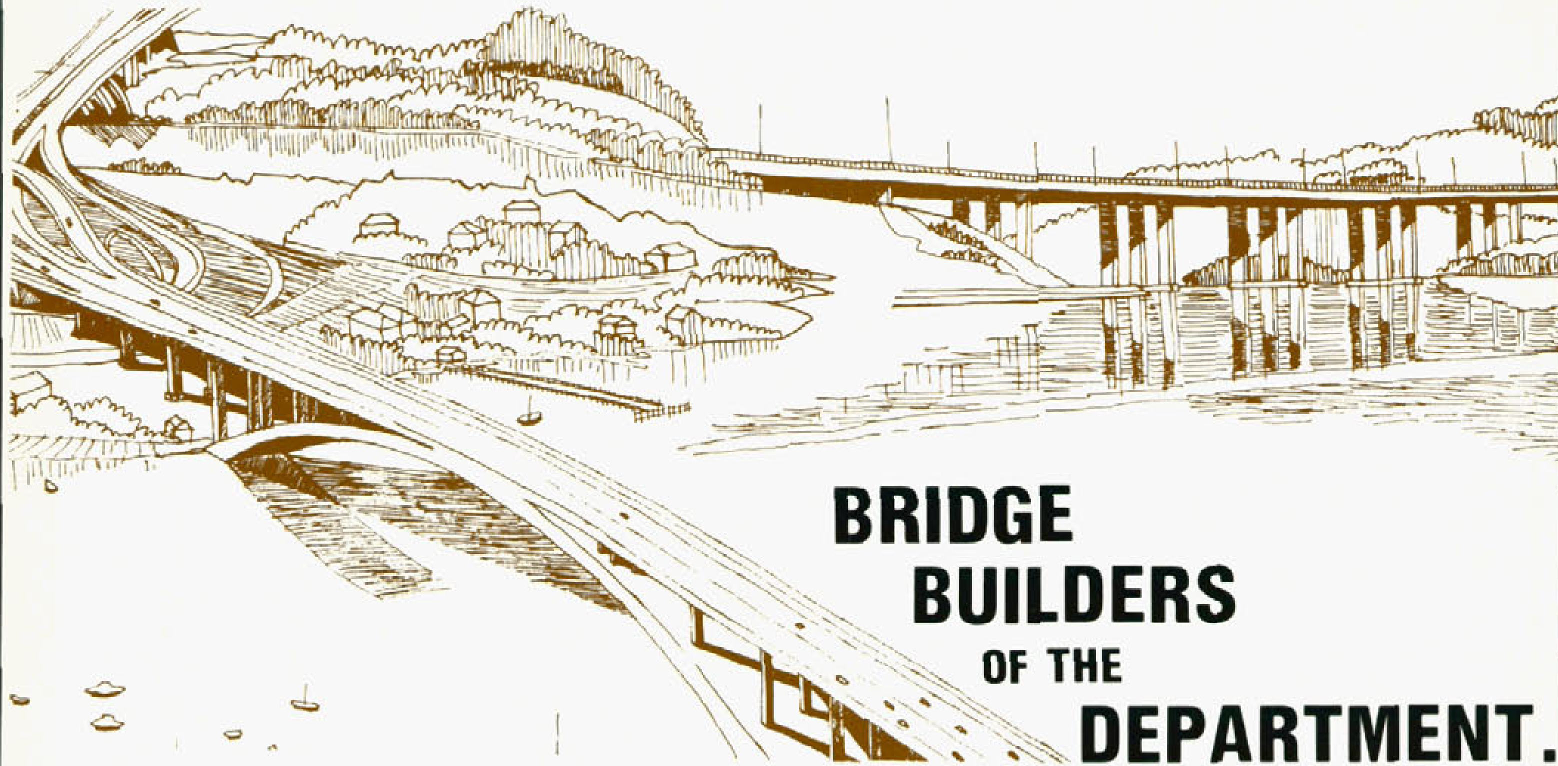
The section from Hornsby (Hookham's Corner) to the Hawkesbury River (Kangaroo Point) was opened to traffic on 2 June 1930. The total cost (including bridges and property resumptions), was £380,302 of which £166,046 was spent directly on the road pavement. The total cost per mile was £24,809 of which less than half (£11,347) was for the concrete pavement and sand sub-base. ●

For converting the Imperial measurements quoted in the article above into their metric equivalents, the following rates are offered.

1 inch = 25.4 mm	*1 ft. = 30.5 cm*
1 yard = 0.914 m	*1 mile = 1.61 km*
1 ft.^{2} = 929 cm^2	*1 yd^2 = 0.836 m^2*
1 yd.^{3} = 0.765 m^3	*1 gal = 4.55 litres*
1 lb = 454 g	*1 ton = 1.02 t*

The following are some of the articles on other specific concrete pavement construction projects which have appeared in "Main Roads".

- *"The Construction of the Hume Highway between Crossroads and Narellan," February 1931, Vol. 2, No. 6, pp. 87-91.*
- *"Concrete Pavement Construction on Pennant Hills Road, Showground Road and at Castle Hill", March 1953, Vol. 18, No. 3, pp. 84–5.*
- *"New Concrete Pavement at Bexley", September 1953, Vol. 19, No. 1, p. 16.*



BRIDGE BUILDERS OF THE DEPARTMENT.

... 50 Years of Statewide Service

1978 was the Golden Anniversary of the establishment of a separate Bridge Section within the then Main Roads Board — predecessor of the present Department of Main Roads. This is the first of two articles which describe some of the achievements of the Bridge Section over the last 50 years, and record the names and some brief details of the careers of some of the men behind the achievements.

The list of accomplishments and of the officers involved is in no sense comprehensive and includes but a few of the many bridges built and but a sprinkling of the many bridge engineers, draftsmen, foremen and others who have played an important role in this continuing story. Many remain unnamed still and unknown to the community in general, but this State owes much to the breadth of their vision and to the calibre of their workmanship.

For three and a half years after the first inaugural meeting of the Main Roads Board in March 1925, the Board had no Bridge Section. Bridge design, construction and maintenance tasks were then supervised directly (as were roadworks) by either the Chief Engineer, Metropolitan or the Chief Engineer, Country.

A change was foreshadowed in June 1928 with the transfer from the Department of Public Works (PWD) to the appropriate local councils of responsibility for the 191 bridges and 12 ferries which were then classified as National Works, in the eastern and central areas of the State. The Board sought Government approval to accept responsibility for them and on 18 September 1928 it took over these National Works from the councils and accepted the full cost of any subsequent maintenance and/or reconstruction.

In the same month, the Board appointed its first Bridge Engineer, Mr. Spencer Dennis, and established the Bridge Section. Prior to his transfer, Mr. Dennis was Supervising Engineer with the PWD and was in charge of the construction by contract of the bridge over the Georges River at Tom Uglys Point. This specific responsibility to the PWD was continued after his appointment to the Board's service.

Before the appointment of Mr. Dennis, Mr. Howard Sherrard (later to become Commissioner for Main Roads from 1953 to 1962) held the position of Designing Engineer from April 1926 until February 1928 and of Bridge and Designing Engineer from then until September 1928.

Mr. Dennis' strong personality and his previous 19 years of bridge experience gave a firm basis for the development of a very effective Bridge Section, which he guided for 23 years until he retired in June 1951.

Mr. Dennis was followed by his former assistant, Mr. Frank Laws, for the period from July 1951 to September 1953, by Mr. Allan Clinch from September 1953 to December 1962, by Mr. Frank Cook from December 1962 to June 1974 and by Mr. Arthur Middlehurst from June 1974 to May 1977. The present Chief Engineer (Bridges) is Mr. Lyn Evans.

Some brief biographical details about these officers will be given in our next issue.

The bridges designed by the Main Roads Board in its earliest years, not surprisingly, followed PWD practice and

At the time of its construction in 1930, this bridge over Walkers Creek, on the Barton Highway, was the largest reinforced splayed arch road bridge in Australia. An article describing its construction appeared in the October 1931 issue of "Main Roads", Vol. 3, No. 2, pp. 28-9.

This reinforced concrete bowstring arch bridge over Shark Creek on the Pacific Highway near Maclean was completed in 1936 and was the first of its type to be built in New South Wales. The design by the Department was also noteworthy, being the first to introduce temporary hinges in the arch rib to avoid moments from rib compression and extension of the tie. An article on this bridge appeared in the May 1936 issue of "Mains Roads", Vol. 7, No. 3, pp. 89-91.

standard plans. Short span bridges were commonly of timber beam construction, using the excellent hardwood then readily available. Larger spans used rolled steel joists or rivetted plate girders and steel trusses, although two or three timber or timber and steel composite trusses, designed by the PWD, were built by the Board.

In the mid-1920's, concrete road bridge construction was still a relatively new concept in New South Wales. The first reinforced concrete bridge was a somewhat indeterminate arch-cum-girder structure built in 1905 over the Hawkesbury River at North Richmond at the beginning of Bells Line of Road. Only a handful of reinforced concrete girder and slab bridges appear to have been built before 1925.

The Board's own bridge plans were prepared under the overall direction of Mr. Frank Laws. Direct supervision of concrete bridge design was by Mr. William Bate, who joined the Board in 1925 as a "casual draftsman" in the Drawing Office and retired as Associate Bridge Engineer in 1967, after almost 42 years continuous service in bridge design work. For steel and timber structures, supervision was by Mr. George Linton who was appointed to the Board in 1927, as an Assistant Engineer. He moved on from the Bridge Section in 1942 and retired as Divisional Engineer of the North Western Division in 1961. The supervision of steel bridge design was taken over by Mr. Cliff Robertson who transferred from the PWD in 1932 and retired in 1965, while holding the position of Designing Engineer for Bridges. The Bridge Section designers soon turned more frequently to reinforced concrete than to timber for short and medium bridges, because their lower maintenance costs made them cheaper bridges in the long term. Simply supported slab spans of up to 7.6 m (25 ft.) and 'T' beam spans of up to 18.3 m (60 ft.), were usual. However, more sophisticated arrangements were adopted where foundation conditions justified the construction of continuous or frame structures with footings on rock or on piles driven to rock.

Continuous girder bridges of up to 27.4 m (90 ft.) span (such as the bridge over the Lane Cove River on Epping Road) were built, as well as a number of arch bridges. These included some unusual but elegant splayed slab arches which carried the road filling directly on the slab. One example with an 18.3 m (60 ft.) span across Walkers Creek on the Barton Highway near its junction with the Hume Highway. At the time of its construction in 1931, this was the longest played arch road bridge in Australia.

Conventional arches included the 48.8 m (160 ft.) span built in 1934 across the Kooreelah Creek on what is now the Mt. Lindesay Highway, the 29 m (95 ft.) span built in 1938 to carry Epping Road over Stringy Bark Creek and others ranging in span up to the 103.6 m (340 ft.) arch span introduced to support the deck of the old suspension bridge at Northbridge when the cables were removed in the 1930's.

A few bowstring tied concrete arches with spans of about 34.4 m (113 ft.) were built where foundations were not entirely

The only all-welded steel truss span built by the Department was for this bridge over the Manilla River at Barraba on the Tamworth-Barraba Road, completed in 1935. An article on the bridge and the comparison of designs for riveted and welded truss spans appeared in the May 1936 issue of "Main Roads", Vol. 7, No. 3, pp. 111-114.

suited to normal arch construction. The first of these was completed in 1936 at Shark Creek on the Pacific Highway near Maclean. Another was built in 1938 at Hillas Creek on the Hume Highway on the deviation between Tumblong and Tarcutta.

Many of the larger reinforced concrete bridge designs were undertaken by Mr. Alfred Halvorseth, a Norwegian born engineer of great talent. He joined the Board in 1926 as an Engineering draftsman and started immediately on bridge design work. He was still in the Bridge Section as a supervising Engineer when he retired from the Department in 1954.

Another engineer who spent his entire career of over 34 years on design work in the Bridge Section was Russian-born Mr. Vladimir Karmalsky. He joined the Board as an Engineering Draftsman in 1927 and was a Supervising Engineer for ten years prior to his retirement in 1961.

Early steel trusses were of fully riveted construction, but in the 1930's Bridge Section designers turned their attention to shop welded, site rivetted construction. However, in 1935 a fully welded steel truss of 30.5 m (100 ft.) span — the first and only all-welded span built by the Department — was incorporated in the new bridge over the Manilla River at Barraba. A standard design for shop welded field rivetted truss bridge was developed for spans from 36.6 m (120 ft.) to 47.5 m (156 ft.) which were in use until 1956 when rivets were replaced with high strength bolts. The last standard steel truss bridge to be built by the Department was completed at Harwood in 1966, to carry the Pacific Highway over the Clarence River. The longest steel truss spans built by the Department were two 146.3 m (480 ft.) long main spans for the bridge over the Hawkesbury River on the Pacific Highway at Peats Ferry — completed in 1945.

Where opening span bridges wefe necessary to enable shipping to pass, the Department favoured two varieties, the bascule (or hinged) span and the vertical lift span. The site and the nature of shipping requirements determined the design selected. Typical of the bascule opening span bridge is the steel bridge built in 1936 to carry the Pacific Highway over the Tweed River at Barneys Point, between Murwillumbah and Tweed Heads. A good example of the vertical lift span type of construction is the bridge over the Hunter River at Hexham, built in 1952.

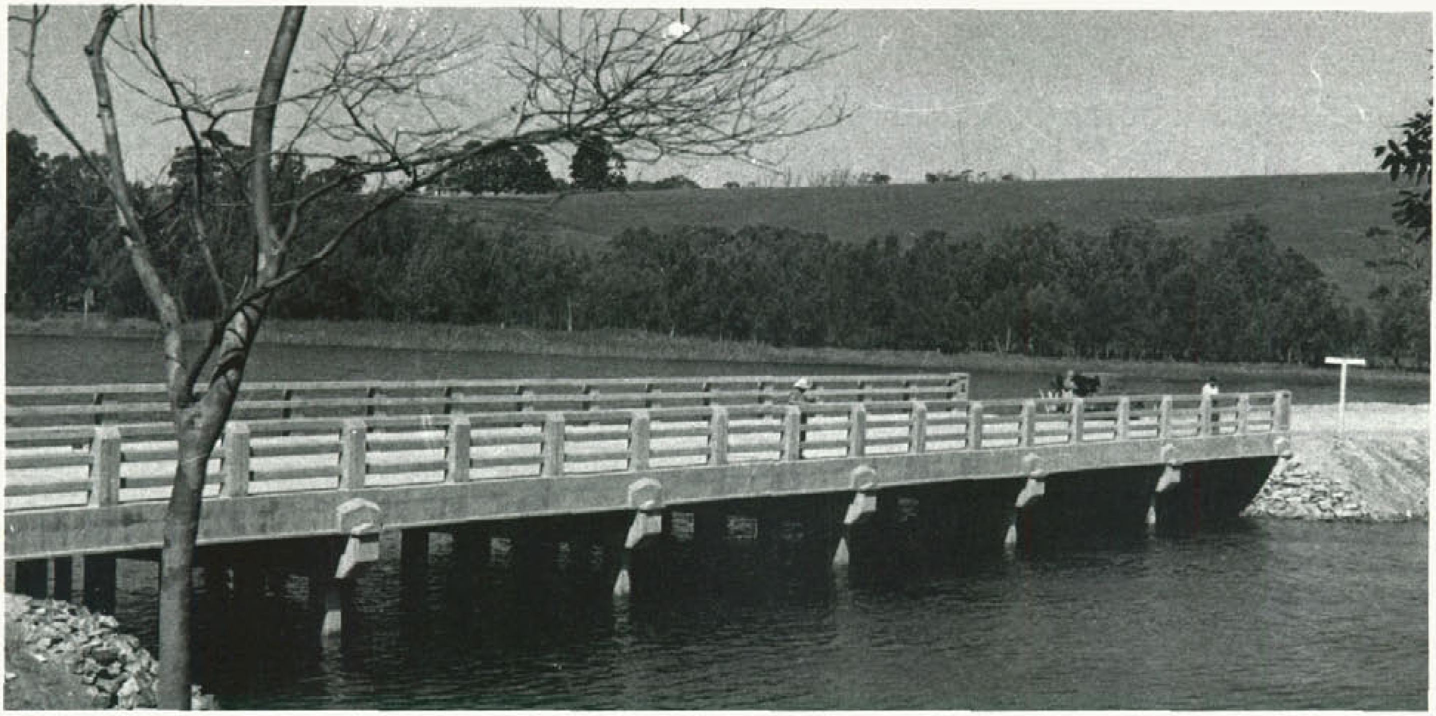
The width of bridge decks increased over the years to match the needs of higher traffic volumes and higher vehicle speeds. Originally a deck width of 6.1 m (20 ft.) was accepted as adequate for bridges of permanent materials or for large timber bridges. Other timber bridges were only 4.9 m (16 ft.) or 5.5 m (18 ft.) in width. In 1938, a width of 6.7 m (22 ft.) was adopted for bridges in the County of Cumberland and on State Highways, Trunk Roads and Ordinary Main Roads adjacent to towns. Other bridges were to be 6.1 m (20 ft.) wide. In 1947 these widths became 6.7 m (22 ft.) or 7.3 m (24 ft.) and 6.1 m (20 ft.) or 6.7 m (22 ft.) respectively, depending on the traffic volumes. Currently bridge decks for two lane roads are 9.2 m (30 ft.) wide on State Highways and the more heavily trafficked Main Roads and 8 m (26 ft.) wide on other roads.

Similarly, design loads for bridges have increased to cater for greater vehicle weights. Early bridges were designed for a "steam roller" type loading of 17 tonnes spread over 2 axles. In the 1940's bridge designers commenced using the American AASHO design l&ading which was for a semi-trailer having a total mass of approximately 32 tonnes distributed over 3 axles. This was formally adopted as a standard design loading by the Department in 1957 and later by the National Association of Australian State Road Authorities (NAASRA). The latest design load specified by NAASRA in 1976 is for a semi-trailer type vehicle with a total mass of 44 tonnes, the load being distributed over 5 axles.

In the post-war years, great advances were made in bridge designs, which became more sophisticated. The 1950's saw the introduction of prestressed concrete bridges — the first one to be designed by the department being at Bobbin Head. This was a post-tensioned concrete 'I' girder bridge completed in 1956. About the same time, the first bridges using precast prestressed bridge units of 9.1-10.7 m (30-35 ft.) span were constructed where the Princes Highway crosses Corunna Lake and Nangudga Lake just south of Narooma. Dr. Lawrence Challen, who joined the Bridge Section in 1939, was responsible for developing the Department's early design of prestressed concrete bridges. Dr. Challen remained with the Bridge Section for his entire Departmental career, through to his retirement in 1965.

The 1950's also saw the introduction of composite steel and concrete girder designs which enabled steel girders to be used for simply supported spans up to 30.5 m (100 ft.). This type of design was later extended to continuous bridges where the foundation conditions were suitable.

In 1959, a contract was let by the Department for the construction of a new bridge over the Parramatta River at



Just south of Narooma on the Princes Highway, this bridge over Corunna Lake, and the nearby structure over Nangudga Lake, were completed in 1957. This was the first use by the Department of precast prestressed concrete members in bridge construction. A reference to these bridges appeared in the September 1957 issue of "Main Roads", Vol. 23, No. 1, p. 4.

Gladesville. The Bridge Section had prepared a design for a steel cantilever truss bridge but this bridge was destined never to be built. The contract was let on the basis of a design for a 277.4 m (910 ft.) concrete arch span prepared by consulting engineers G. Maunsell and Partners of London. The Department later agreed to an increase in length of the main span of 304.8 m (1,000 ft.) which until recently was the longest concrete arch span constructed in the world.

The construction of Gladesville Bridge in the early 1960's ushered in an era of major bridge construction using sophisticated designs which brought the Department's Bridge Section designers into world class and drew wide attention to their competence and innovative approach.

This was largely due to the efforts of Mr. Albert Fried who, from 1939 until 1975, added his considerable talents to the work of the Bridge Section, rising to become Assistant Bridge Engineer (Design). Mr. Fried was responsible for the design of many major prestressed concrete bridges, including the Captain Cook Bridge at Taren Point, in 1962 (construction completed in 1965), Roseville Bridge over Middle Harbour in 1964 (opened in 1966) and Stockton Bridge at Newcastle in 1968 (opened in 1971). He was also responsible for the design of the steel trough girder bridge which, since 1973 has carried the Sydney-Newcastle Freeway over the Hawkesbury River and the prestressed concrete cantilever truss bridge over Brisbane Water at The Rip, a bridge of unique design — completed in 1974.

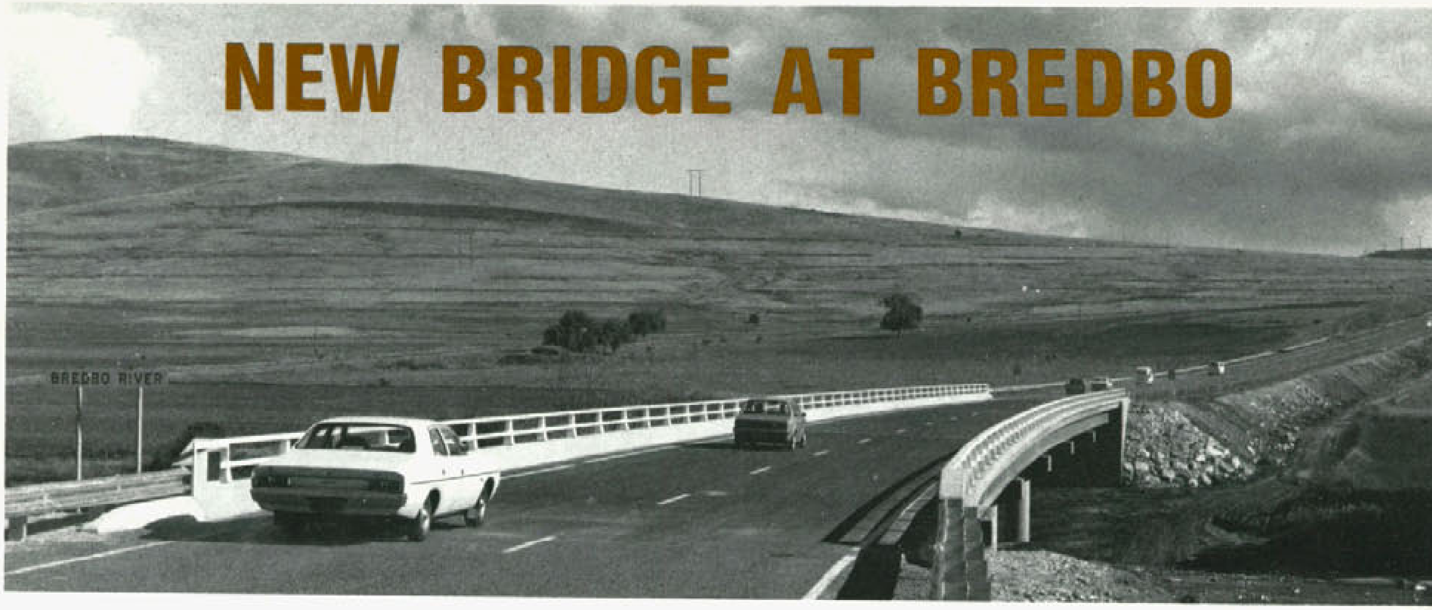
As an example of the peak reached in quantity as well as quality of new bridge construction, in 1967-68 the Department completed a total of 193 bridges and bridge-size culverts, totalling 1345.4 m in length. In fact, in the ten years from 1 July 1959 to 30 June 1969, a total of 1306 bridges and bridge size culverts (i.e. those 6.1 m (20 ft.) long and over) were completed. Thus, in this period, the Department and local councils, by contract and with their own forces, completed on average, one bridge every 2.8 days.

Recently, officers in the Bridge Section have prepared designs for three crossings of the Nepean River on the F5 — South Western Freeway, the first two being prestressed concrete segmental box girder bridges at Douglas Park and Menangle. For the third crossing at Pheasants Nest, two designs were prepared, one for an underslung suspension bridge and the other for a three span balanced cantilever structure totalling 305 m long. Both designs were for prestressed concrete construction and the latter design was successful when tenders were received.

In conclusion, mention should be made of future works to be undertaken by Bridge Section Design Staff. Despite a reduction in the effective value of construction funds, several major bridges will be commenced in the next five years. Design work is well advanced on a bridge to carry the F5 — South Western Freeway over the Georges River at Casula, a bridge over the Murray River at Mildura, and a bridge over Mooney Mooney Creek for a new section of the F3 — Sydney-Newcastle Freeway — just north of the Hawkesbury River. ●

There have been numerous articles in "Main Roads" over the years, describing both individual bridgeworks and Departmental bridge building policies and techniques. These range from technical articles (such as "Design of Concrete Slabs for Bridges — Methods adopted by the Department of Main Roads" in May 1936, Vol. 7, No. 3, pp. 98-102 and November 1936, Vol. 8, No. 1, pp. 24-31) to general articles (such as "Bridging the Rivers" in March 1950, Vol. 15, No. 3, pp. 88-90). Another worth mentioning is "Ten Years of Progress in Bridge Design in the N.S.W. Department of Main Roads" (February 1940, Vol. 11, No. 2, pp. 40-5).

NEW BRIDGE AT BREDBO



On Saturday, 24 March this year, the normally 200 or so population of Bredbo swelled to an estimated 800. It was "Back to Bredbo Day" and past residents (and their descendants) gathered in the township for the festivities. The crowd was probably augmented by other people of the Monaro district, who also had an interest in another event. This was the opening by the Minister of Roads, Hon. H. F. Jensen, of a new bridge to carry the Monaro Highway over the Bredbo River, on the southern outskirts of Bredbo. This bridge replaced the existing timber structure which dated back to the previous century.

Origins

As is so often the case with a small settlement in a young colony, Bredbo's early days are not too well documented. Even its name is still somewhat of a puzzle.

In the book *Cooma Country* (published in 1976 by the Cooma – Monaro Historical Society), the author Lauri Neal says that "in 1836 John Church had a run on Monaro and lived at Bradbow River . . . the earliest known reference to the actual name of Bredbo was in 1837". Mrs Neal's statements are based on an undated publication of Bredbo Public School entitled *Historical Outline of Bredbo*. In some other references the spelling "Bredbow" appears. Perhaps this was a transitional form.

Whatever the origin of its present name, Bredbo has had a colourful past.

In the latter part of the last century and into the 1920's gold was mined in the area. Stagecoaches carrying the precious metal from there and Kiandra were occasionally "*bailed up*" by bushrangers near the town, in the days when "*bushies*" roamed the roads.

"There was movement . . ."

Many have claimed the fame of being the inspiration for A. B. (Banjo) Paterson's "The Man from Snowy River". Two of the claimants lived at Bredbo.

One was Lachlan Cochran, an early settler in the district, who died in 1920 at Cootamundra Hospital. The other was Charles McKeahnie, a noted horseman of the Bredbo region. He died in the Bredbo Hotel from injuries he received when his horse fell "*on the small bridge at the south end of Bredbo*", writes Mrs Neal. Presumably this was the timber bridge which has now been replaced.

Backbone of the Monaro

The Monaro Highway (State Highway No. 19) has been referred to as the "backbone" of the Monaro district. This district was originally called "Brisbane Downs", and was once regarded as including part of Gippsland in Victoria. The Highway begins at the border of the Australian Capital Territory and runs southwards for 212 km until it reaches the Victorian border.

North, in the Australian Capital Territory, the continuation of the Monaro Highway joins the Barton and Federal Highways, and through them is linked to the Hume Highway, another vital interstate traffic artery. The Snowy Mountains Highway joins the Monaro Highway from the wes at Cooma and from the east at just south of Nimmitabel.

Like so many backbones, the Monaro Highway has its weak spots. One of them was the old bridge at Bredbo, roughly half-way between Canberra and Cooma.

Once adequate, but now . . .

The timber bridge served its purpose well, within its limitations. Its long service stands as a tribute to the skills of the men who designed it and of those who built it.

Completed in 1894, it is a fine example of timber bridge construction and typical of many others that were built by the Department of Public Works throughout the State in the late 1800's and early 1900's to take advantage of our then abundant supply of excellent hardwood.

With a timber beam span at each end and a pair of timber truss spans at its centre, the old bridge had a total length of 87 m. With its minimum width of 4.6 m – a single lane only – it was below the standard required of a bridge on a major highway. For, in spite of all warnings, there are always the impatient few who try to beat oncoming traffic onto the bridge. So, in the interest of safety, it has now been replaced and will soon be demolished.

Styled for our generation

The new bridge is situated 250 m downstream from the old, on a deviation of the Monaro Highway, which provides an improved alignment and replaces several awkward bends with one long smooth curve.

The new bridge has six 21.3 m spans, supported by the abutments and five intermediate piers. The overall length is 128.4 m and the total width is 10 m, with a kerb-to-kerb measurement of 9 m.

Doubling the road width at this highway bottle-neck must certainly increase its carrying capacity, and just as certainly improve its safety record, which is the primary aim of the Department's work.

Advances in two fields of construction technology have made great changes in the art and craft of bridge building in Australia since timber structures were the norm.

On the one hand, steel has become readily available and a variety of welding methods have nearly ousted bolted and rivetted fabrication. On the other hand, developments in reinforced concrete have eliminated the need for complex trusses in short and medium-length road bridges.

Freed from the limitations imposed by timber's characteristics, engineers have been able to design bridges that cost less to build and maintain, and can have a simple clean-lined beauty that blends smoothly with their surroundings.

The aesthetics of simplicity

As an example, consider the single-column cylindrical concrete piers of the new bridge. They stand in sharp contrast to the seeming forest of timber piles that support the spans of the original. They are a more representative image of the community's feelings for good design in the 1970's.

The new bridge's piers are topped by reinforced concrete cross-pieces that support longitudinal steel girders. These run between abutments and piers and between the piers themselves. The girders, six abreast along the length of the bridge, were fabricated at the Department's Central Workshop and delivered to the site for erection by the contractor, Nelmac Pty Ltd.

These girders in turn support a composite reinforced concrete deck which is topped by the familiar black asphaltic surface finish. Traffic railing situated on modified New Jersey concrete kerbs complete that part of the bridge.

Out of sight . . .

Below the river bed level are reinforced concrete pile caps which transfer the load of the bridge to the piled foundations. The piles are tubular steel units driven down through sand, gravel and boulders into a stratum of hard clay.

Part of the estimated 800-strong crowd gathered at the bridge opening ceremony.

After being driven to full depth, each pile had its upper 4 m excavated. The core material was then replaced by a cast-in-place reinforced concrete "plug".

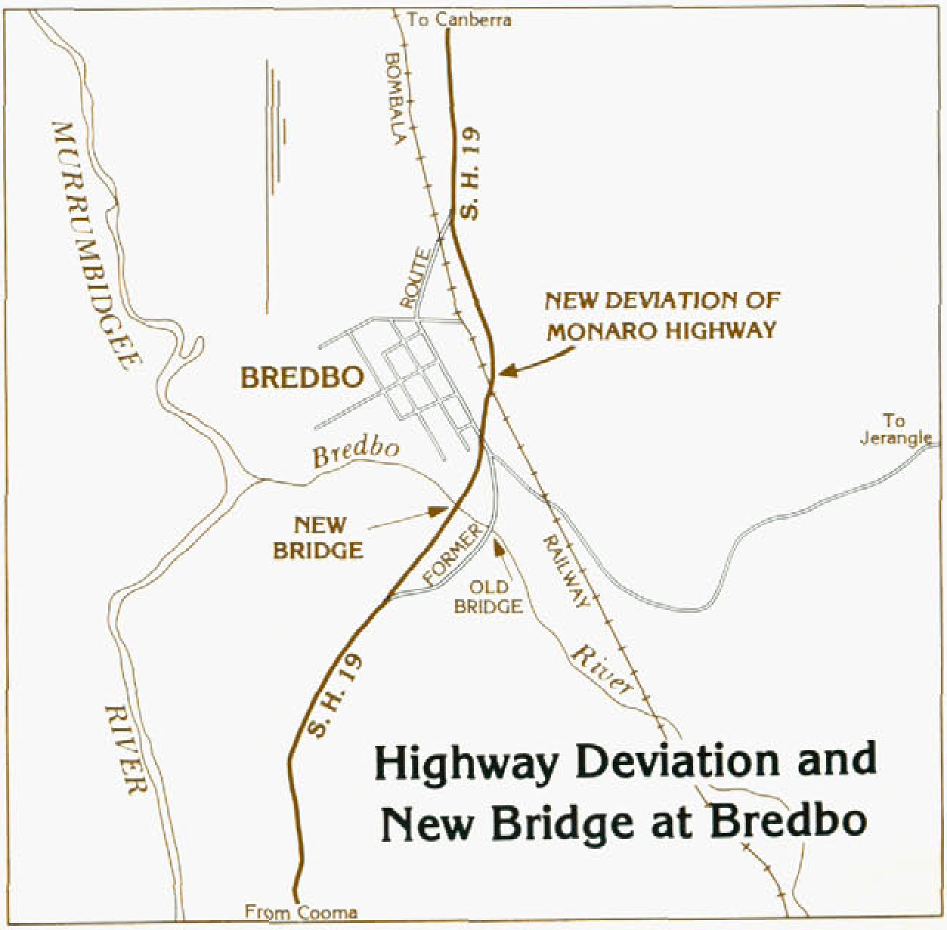
Unusual pile testing technique

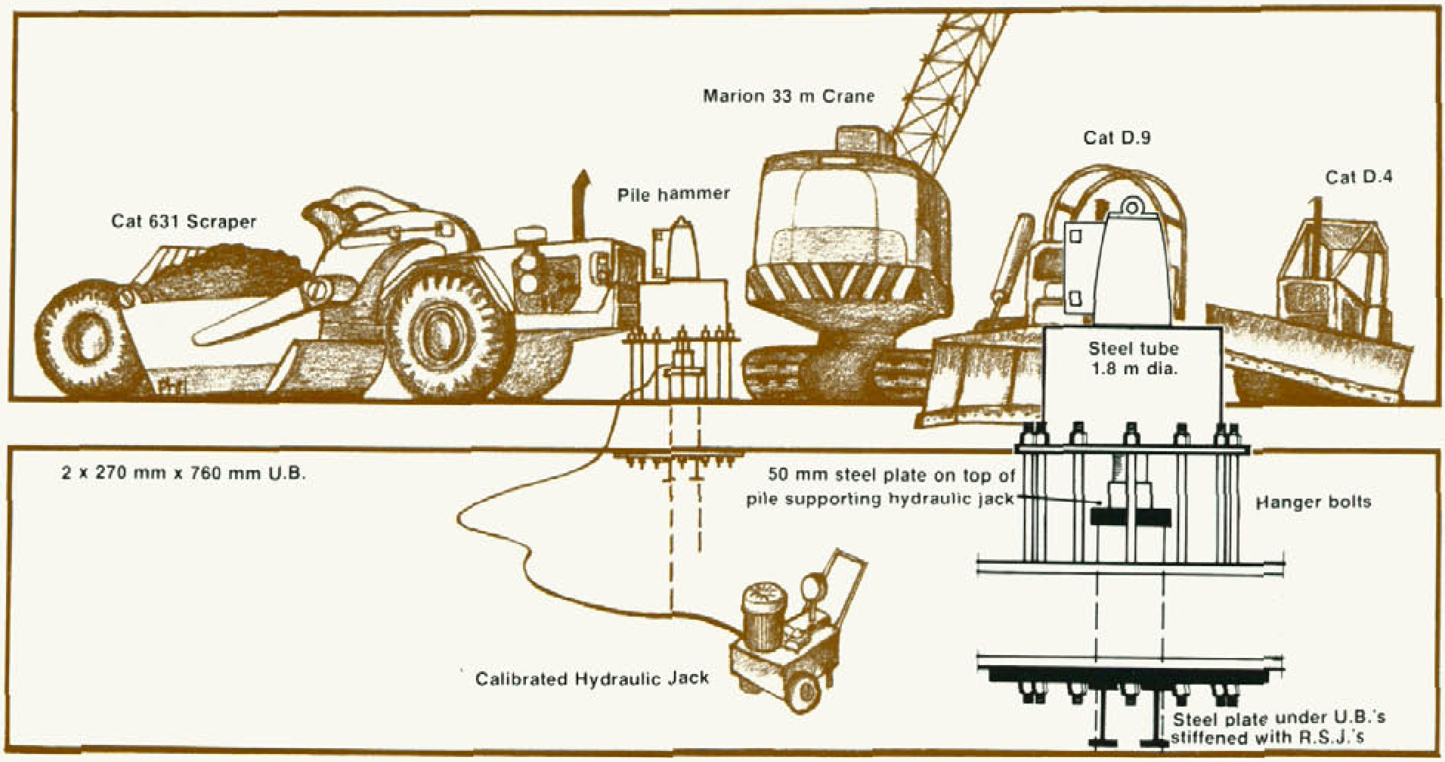
The standard method of testing foundation piles involves loading them for a period, then measuring their recovery after the load has been removed.

In hard rock, the loading is usually done with the aid of a number of rock anchors located around the pile. From this rigid amount, a hydraulic jack can exert a calibrated force on the pile in question.

In softer surroundings, generally a static load of passive weights is applied. Local stone, concrete blocks or steel ingots are commonly used as test masses.

At the Bredbo site, the contractors, Nelmac Pty Ltd, were faced with an awkward problem in pile testing. The surrounding natural material was too soft to allow rock anchors to be used. On the other hand, there was a lack of locally





TEST LOAD ON PILE 5 NEW BREDBO RIVER BRIDGE

located material suitable for "dead loading". The tonnage of concrete needed was prohibitive and the nearest source of steel ingots was Port Kembla, over 350 km away by road. Hauling inert steel to and from the bridge location for test purposes would have been decidedly uneconomic.

Engineers with Nelmac Pty Ltd came up with an unorthodox but simple and effective solution to the problem posed at Bredbo. The company had available a range of mobile construction plant, both its own equipment and units which could be hired at reasonable rates. Also on hand were a number of universal beams, rolled steel joists and sheets of mild steel plate left over from other jobs.

Instead of using the mobile machinery as a direct test load, Nelmac Pty Ltd used it as the "anchor" for a hydraulic jack which exerted the requisite downward force.

From the steel members available, a simple rig was fabricated. Onto this, various items of machinery were positioned, including a loaded Caterpillar 631 Scraper, a Marion 33 m Crane, Caterpillar D4 and D9 Bulldozers and a pile hammer. The wheeled and tracked vehicles were just driven into place, while the crane arranged the placement of the non-mobile components. The calibrated hydraulic jack was mounted on the rig between this mass of machinery and the pile to be tested.

The total mass of the arrangement was well above the 130 tonnes required by the testing schedule. As the dead load did not leave the ground, the contractor was spared the problem of balancing the total conglomeration.

An unusual and perhaps unique answer to an on-site problem.

Bredbo's big day

The opening of the new $565,000 bridge was the highlight of a "Back to Bredbo" Day, organised by the Bredbo Progress Association, to coincide with the official ceremony. Included in the festivities were a luncheon, afternoon tea, barbecue dinner and dance in the evening. A display of photographs of former residents of Bredbo proved a great attraction.

Following the cutting of the ribbon and unveiling of a plaque by Mr. Jensen, the bridge was opened to traffic. The first car to cross the bridge was a 1930 A Model Ford Sports Coupe, which belongs to and was driven by Mr. Peter Learmont, with Mr. Jensen and Mr. Learmont's daughters as passengers. It was followed by a 1917 Overland Tourer belonging to Mr. Frank Rodwell.

Reporting the activities of the day, the Cooma-Monaro Express (of 27 March 1979) announced enthusiastically . . .

"Saturday was the big day for Bredbo — the culmination of many months of planning and construction activity on the bridgeworks, and of planning for the Back to Bredbo Day. Predictably, it was an outstanding success.

"One of the amazing characteristics about small villages such as Bredbo is their ability to organise community extravaganzas. In this respect they proportionately run rings around the larger towns.

"Perhaps it's just a reflection of the greater integration between all sectors of the community which exists in the smaller centres. Enthusiasm and community spirit are more easily infectious with closer personal contact.

"But whatever it is, Bredbo's got it.

"Congratulations on a magnificent effort, residents of Bredbo and environs. The Bridge Opening was an event that will be long remembered. And the Back-to-Bredbo festivities are sure to have made a lot of ex-Bredboites wish that they were back in Bredbo, and visitors keen to return." •

Tenders Accepted by Councils

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 31 December 1978.

Council	Road No.	Works or Service	Name of Successful Tenderer	Amount
Camden	Main Road No. 154	Supply of asphaltic concrete for reconstruction on improved alignment 0 km to 3.4 km from Main Road No. 178 at Narellan, including approaches to new bridge over Narellan Creek.	Boral Asphalt Ltd	$73,200.00
Camden	Main Road No. 154	Supply of fine crushed rock for reconstruction on improved alignment, 0 km to 3.4 km from Main Road No. 178 at Narellan, including approaches to new bridge over Narellan Creek.	Readymix Group (N.S.W.)	$25,950.00
Carrathool	Various	Supply of aggregate for work on Trunk and Ordinary Main Roads within Shire	Griffith Metal, Sand and Gravel Pty Ltd.	$37,675.00
Carrathool	Various	Supply of bitumen for resealing works on Trunk and Ordinary Main Roads within Shire.	Allen Bros. Asphalt Ltd	$143,937.07
Goulburn	State Highway No. 2	Bitumen prime coating	Emoleum (Aust) Ltd	$50,147.39
	Main Road No. 256	Reconstruction and bituminous surfacing.		
Goulburn	State Highway No. 2	Supply and lay hotmix on Hume Highway (Cowper Street) Goulburn	Allen Bros Asphalt Ltd	$36,000.00
Jerilderie	Various	Supply of aggregate for work on Trunk and Ordinary Main Roads within Shire.	North Eastern Readymix Concrete (Wangarata) Pty Ltd.	$20,736.45
Jerilderie	Various	Supply of bitumen for resealing works on Trunk and Ordinary Main Roads within Shire.	B.P. (Aust) Ltd	$28,299.69
Lockhart	Trunk Road No. 78	Bituminous surfacing and primer seal, and reseal between 46.3 and 57.3 km south of Wagga Wagga	Streamline Sprayers Pty Ltd	$30,427.85
Manning	Rural Local Road — Little Run Road	Erection of bridge over Dingo Creek, 30 km north west of Wingham	Geoffrey Stewart Constructions Pty Ltd	$104,920.50
Narraburra	Main Road No. 387	Bituminous sealing works betwen 35 km to 43 km west of Temora	Canberra Asphalters Pty Ltd	$35,910.74
Orange	Rural Local Road — Anson Street	Construction of bridge over railway line in Anson Street, Orange	N. & V. Bucan	$135,580.22
Queanbeyan	Various	Bitumen surfacing of various town streets	Allen Bros Asphalt Ltd	$55,817.90
Queanbeyan	Various	Supply and lay asphalt in various town streets	Canberra Asphalters Pty Ltd	$49,900.00
Tallaganda	Truck Roads Nos. 79, 91, and 92 and Main Road No. 271	Supply and spray cut back bitumen	Allen Bros. Asphalt Ltd	$29,969.81
Timbrebongie	Main Road No. 354	Reconstruction work between 21.2 and 28.9 km south of Narromine	Shorncliffe Pty Ltd	$27,876.30
Wakool	Various	Supply of aggregate for works on Trunk and Ordinary Main Roads within Shire.	Lake Boga Quarries Pty Ltd	$44,240.87
Wakool	Various	Bituminous surfacing and re-surfacing works on Trunk and Ordinary Main Roads within Shire	Streamline Sprayers Pty Ltd	$115,959.34
Wollondilly	Main Road No. 177	Supply and lay asphaltic concrete on Appin Road between 0 km and 0.88 km from Main Road No. 610	Bitupave Ltd	$46,282.10
Wollondilly	Main Road No. 610	Supply and lay asphaltic concrete on damaged pavement between 0 km and 5.8 km south of Appin	Boral Asphalt Ltd	$182,028.60
Yarrowlumla	Various	Bituminous resurfacing of various roads within Shire	Streamline Sprayers Pty Ltd	$25,134.51

Tenders Accepted by the Department of Main Roads

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 31 December 1978.

Road No.	Work or Service	Name of Successful Tenderer	Amount
Sydney Harbour Bridge and approaches	Installation of closed circuit television system	Wormald International (Aust) Pty Ltd trading as Wormald Security Controls	$223,509.00
F3 — Sydney-Newcastle Freeway	Shire of Gosford. Removal and re-erection of guardrail	G. McFadden	$50,655.00
F5 — South Western Freeway	Shire of Wollondilly. Construction of bridge over Freeway on Avon Dam Rd. 87.2 km south of Sydney.	Oneata Investments Pty Ltd	$255,036.26
State Highway No. 2	Hume Highway. Shire of Mulwaree. Supply and delivery of cover aggregate.	Farley and Lewers (N.S.W.) Pty Ltd	$27,043.00
State Highway No. 3	Federal Highway. Shires of Yarrowlumla, Gunning and Mulwaree. Supply and delivery of up to 3 000 t of 20 mm fine crushed rock.	Readymix Group (N.S.W.)	$20,331.00
State Highway No. 5	Great Western Highway. City of Greater Lithgow. Underpinning and stabilisation of reinforced concrete pavement, 0.15-1.5 km west of Lithgow.	Power Element Company	$39,280.75
State Highways Nos. 5, 6, and 7, Main Roads Nos. 184 and 516 and Trunk Road No. 55	Great Western, Mid Western Mitchell Highways and other roads. Cities of Blue Mountains, Greater Lithgow, Bathurst, Shires of Evans, Rylstone and Mudgee. Pavement marking of centre, lane and edge lines.	Mercury Linemarking	$24,189.00

Tenders Accepted by the Department of Main Roads

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 31 December 1978.

Road No.	Work or Service	Name of Successful Tenderer	Amount
State Highway No. 9	New England Highway. City of Tamworth. Reconstruction and widening from Gipp Street to Peel River bridge.	Tamworth Construction Pty Ltd	$405,170.00
State Highway No. 9	New England Highway. Shire of Murrurundi. Location investigation for reconstruction work over Liverpool Range.	David Young Drilling Pty Ltd	$26,000.00 (estimate)
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 7,500 m³ of A1 base course gravel for reconstruction work including passing lane at Minimbah between 34.8 and 37.1 km west of Maitland.	Les Russell and Son Pty Ltd	$23,100.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 12,350 m³ of lower base gravel for reconstruction work including passing lane at Minimbah, between 34.8 and 37.1 km west of Maitland	Less Russell and Son Pty Ltd	$38,038.00
State Highway No. 9	New England Highway. City of Greater Cessnock. Supply and lay up to 1 250 t of 10 mm dense graded asphaltic concrete for reconstruction work between Branxton and Black Creek, 23.7-25.9 km west of Maitland.	Bitupave Ltd	$46,862.00
State Highway No. 10	Pacific Highway. Shire of Coffs Harbour. Manufacture, supply and delivery of bridge planks for bridge over Double Crossing Creek, 23.4 km north of Coffs Harbour.	Hastings Prestressed Concrete Pty Ltd	$26,220.00
State Highway No. 10	Pacific Highway. Shire of Coffs Harbour. Construction of bored piles for bridge over Double Crossing Creek, 23.4 km north of Coffs Harbour.	Vibropile (N.S.W.) Pty Ltd	$116,725.60
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and lay up to 1320 t of 10 mm asphaltic concrete for resheeting work at North Belmont.	Boral Road Surfaces	$47,097.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and lay up to 950 t of 10 mm asphaltic concrete for resheeting work between 2 km south of Belmont to Charlestown.	Bitupave Ltd	$33,031.00
State Highway No. 10	Pacific Highway. Shire of Port Stephens. Supply and lay up to 1400 t of 10 mm asphaltic concrete for resheeting work between 18.8 and 20.7 km north of Newcastle.	Bitupave Ltd	$48,482.00
State Highway No. 10	Pacific Highway. Shire of Great Lakes. Supply and delivery of up to 1230 m³ of 14 mm crushed sealing aggregate precoated to stockpile sites between 93.0 and 129.0 km north of Newcastle.	Gloucester Shire Council	$20,844.00
State Highway No. 10	Pacific Highway. Shires of Great Lakes and Port Stephens. Supply and spray up to 100,000 litres of Class 160 bitumen at various locations between 53.2 and 130.0 km north of Newcastle.	Shorncliffe Pty Ltd	$33,000.00
State Highway No. 10	Pacific Highway. Shire of Lake Macquarie. Supply and lay up to 870 t of 20 mm asphaltic concrete for extension of dual carriageways between Docker Street and 304.8 m south of Soldiers Road, Marks Point.	Boral Road Surfaces	$30,058.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Surface preparation and protective coating of steelwork on bridge over entrance to Lake Macquarie at Swansea.	K.G.B. Painting Contractors (K. & G. Bradica Pty Ltd)	$25,866.00
State Highway No. 10	Pacific Highway. Shire of Nambucca. Supply and delivery of non-plastic granular fill material to a site at Bellwood Creek.	Fortescue Motor Pty Ltd	$44,400.00
State Highways Nos. 10 and 12	Pacific and Gwydir Highways. Supply, heat, haul and spray to 575,000 litres of Class 160 bitumen in North Eastern Division.	Shorncliffe Pty Ltd	$149,340.00
State Highways Nos. 10 and 12	Pacific and Gwydir Highways. Supply, heat, haul and spray up to 660,000 litres of Class 160 bitumen in North Eastern Division.	Boral Road Surfaces	$21,738.25
State Highway Nos. 10 and 16	Pacific and Bruxner Highways. Supply, heat, haul and spray up to 1,250,000 litres of Class 160 bitumen in North Eastern Division.	Boral Resources (N.S.W.) Pty Ltd	$283,050.00
State Highway No. 16	Bruxner Highway. City of Lismore. Protective treatment and repainting of steelwork on bridge over Richmond River at Ballina Street, Lismore.	Kada Painting Contractors Pty Ltd	$89,812.70
Main Road No. 503	Shire of Singleton. Supply and delivery of up to 4000 m³ of A1 base course gravel for reconstruction of various lengths of failed pavement and widening of narrow cutting on existing alignment 80.0-92.0 km south of Singleton.	G. J. Pierce	$20,000.00
Main Road No. 617	Foreshore Road. Municipality of Botany. Supply and deliver ready-mixed concrete to Foreshore Road.	Ready Mixed Concrete Industries	$605,410.00 (estimate)
Main Road No. 617	Foreshore Road. Municipality of Botany. Steel fixing for reinforced concrete pavement on Foreshore Road.	E.V.F. Hema	$46,800.00
Secondary Road No. 2081	Shaftesbury Road to Ryedale Road. Municipality of Ryde. Construction of West Parade underpass retaining wall at Eastwood.	Thiess Bros. Pty Ltd	$409,634.00
Various	Supply and application of thermoplastic road marking material at various locations throughout the South Western Division.	Shorncliffe Pty Ltd	$36,684.50
Various	Sealing and base courses on various roads in the Central Western Division	Western Washed Sands and Aggregate Pty Ltd	$69,610.00

Two aerial views showing the road improvements and the extensive widening of the bridge which carries The Horsley Drive over the Main Southern Railway Line at Fairfield (see article on pages 68-69).


WALTONS