MAIN ROADS

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"BECAUSE"

A few decades back, a wedding wasn't a wedding unless a soloist sang the popular song "Because" at the reception. Weddings, love songs and singers have all changed in style over the intervening years.

The "because" of roads has been more enduring and its surprising to find that Governor Macquarie's reasons for embarking on major road improvements 170 years ago in 1811 are stated (with due allowance for his more formal language) in much the same terms as we would use today:

"The Construction and Preservation of safe and commodious High-ways is a matter of great and general Importance, and tends greatly to increase Commerce, and promote Civilisation." A year previous, Macquarie claimed that a better road from Sydney to the Hawkesbury would "afford great Facility to the Farmers, Graziers, and other Inhabitants to bring their Grain, Cattle and various other Produce to the Public Market."

But the "raison d'être" of roads has not always been so lofty. If we go beyond our own colonial history, we find that the basic reason behind road developments was quite different. Speaking at the opening of the new bridge at Walgett (see article on page 48), the Minister for Roads, Hon. Harry Jensen, put it this way: "One of the oldest known paved roads was constructed in Egypt around 2700 B.C. We may certainly question the benefit to the community of that particular road since its function was to allow the movement of the many thousands of huge granite blocks which went to build the great Pyramid of Cheops. These blocks were hauled by teams of unfortunate slaves and it was, perhaps, the first occasion in history when a Weight of Loads Inspector might have been a welcome sight!"

Mr. Jensen also referred to the prowess of the ancient Romans as road builders. Their engineers and labourers constructed over 80000 km of excellent roads, radiating to every corner of the Empire. While the initial motivation behind that mighty enterprise may seem a little dubious, being based on military conquest and the enrichment of Rome, it nevertheless facilitated the spread of Christianity throughout Europe.

Military considerations can also be seen in the "because" behind gabion walls, which have their origins in the siegecraft of the late 1600's (see page 57).

Roads certainly still enrich our society, but road building is no longer pursued in the harsh relentless style of the Egyptians, the Romans or the colonial days here in New South Wales. As Mr. Jensen summarised it so succinctly in his speech at Walgett: "It is the people of New South Wales who are her greatest asset . . . and roads exist primarily in our society to serve the needs of people".

That's the best "because" about roads that we've heard for a long time. If we could put it to music, it would be worth singing about.

BRIDGE OVER THE CLARENCE RIVER NEAR ASHBY

For many years Maclean Shire Council and residents of the cane-growing Ashby-Tullymorgan area on the western side of the Clarence River were anxious to improve access across the river to Maclean and Harwood (site of the region's sugar mill). The small, timber, four vehicle ferry which linked Ashby to Maclean operated on one drive cable only, because of the danger presented by snagging on two rock bars on the river bed, and was therefore limited to carrying loads not exceeding 10 tonnes. The only ferry-free route between Ashby and Maclean was via Lawrence, Tullymorgan and Chatsworth, a distance of some 40 km.

Between 1965 and 1974, a series of investigations was carried out to evaluate possible bridge sites in the area. However, due to lack of funds, the Public Works Department instead offered Maclean Shire Council a subsidy for the purpose of buying a replacement ferry vessel.

In 1974, the Department of Main Roads assumed responsibility for the distribution of Commonwealth finance to Councils for selected works, through Rural Local Roads Funds. On examination of the Ashby problem, the Department decided that there would be serious difficulties involved in improving the ferry service. A new ferry vessel would be extremely expensive and the alternative, a Departmental vessel which could be modified and strengthened to accept heavy cane haulage trucks, was not then available. Nor was the site itself suited to accommodating a large, heavily loaded ferry, and the water was too shallow at other possible sites to allow for any alternative location. Finally there was the fact that the roads on the Ashby side of the Clarence River were unsuitable for classification, and finance could not be allocated to ferries on non-classified roads. The case for a bridge was now very strong, particularly since automation was coming to the sugar cane industry in the region and it was foreseen that the days of barge transport — the grower's traditional means of carrying their cane to the Harwood Mill — were numbered.

In 1975 Maclean Shire Council proposed two alternative sites for bridge works:

(1) A bridge (E on map) over the Back Channel to Warregah Island to link with the Warregah Island Bridge (F on map) to Chatsworth Island. This proposal also involved the construction of bridges over Ashby Channel (G on map) and Sandy Creek (C-D on map).

(2) A bridge from the northern end of Ashby Island across the North Arm of the Clarence River to Harwood Island. This bridge (JK on map), particularly, would facilitate cane transport to Harwood Mill.

In 1976 the New South Wales Government undertook to construct two bridges in the region, one in the lower Richmond area, the other to be over the lower Clarence. Both would replace ferries and construction costs would be met from Rural Local Roads Funds.

On the basis of this undertaking, the Department of Main Roads initiated a comprehensive review of the various ferry, bridge and road proposals in areas affected by cane haulage. The study involved field investigations and informal discussions with Councils in the Tweed, Richmond, Clarence and Hastings River Valleys.

This review showed that the Ashby Ferry did in fact head the priority list, especially as automated cane harvesting was due to start later in 1977 and the ferry would have been unable to carry the 30 tonne cane trucks bound for the Harwood Mill.

The Department of Main Roads then prepared estimates for three alternative schemes to replace Ashby Ferry with a bridge over the Clarence River. These proposals were as follows:

Proposal 1 (BHGDEF on map)
A bridge over Back Channel (estimated cost $631,800) which would connect by road across Warregah Island to the bridge over the North Arm of the Clarence River onto Harwood Island, plus an additional bridge over Ashby Channel (estimated cost $312,000) and connection to existing roads on Ashby Island.

Bridges	$943,800	
Roads	$406,900	(2.9 km construction plus approaches)
Total	$1,350,700	

Proposal 2 (BCDEF on map)
The same bridge over Back Channel (estimated cost $631,800) connecting by road with the Warregah Island Bridge to Harwood Island. Construction also required to connect with Murrayville Road which is generally above flood level, plus a small bridge over Sandy Creek (estimated cost $93,600).

Bridges	$725,400	
Roads	$479,400	(4.6 km construction plus approaches)
Total	$1,204,800	

Proposal 3 (BHJK on map)
The existing road on Ashby Island to be extended to a point near the northern tip of the island and a bridge to be built across the North Arm of the Clarence River to connect with Watts Lane on Harwood Island, all approach roads being subject to flooding.

Bridges	$1,638,000	
Roads	$ 457,000	(1.1 km construction plus approaches)
Total	$2,095,000	

Foundation details revealed that the North Arm site had very soft marine sediments overlying weathered rock at a considerable depth. The Back Channel site, on the other hand, had very firm strata lying close to the surface providing a suitable foundation for relatively short driven piles, and was thus by far the superior of the two bridge sites. Therefore, although proposal 3 would provide a more direct route for cane haulage, this was out-weighed by the

Back Channel bridge and Sandy Creek bridge in the lush green cane district of Maclean. The bridges and approaches will serve the Ashby-Tullymorgan cane-growing area.

foundation difficulties at North Arm and also by the expense of the longer bridge.

The second proposal was more suitable due to the shorter total length of bridging required. Roadworks could be staged following completion of the bridge over Back Channel. Traffic would travel north along the Martins Point Road and then south along the Pacific Highway (State Highway No. 10), a distance of 14.4 km. Following the proposed replacement of the bridge over Serpentine Channel, cane transports would have access to Harwood via Watts Lane, saving a further 2.4 km.

Back Channel Bridge preferred

A detailed economic evaluation was carried out by the Department in January, 1978. This study assessed the annual differential road user benefits for each proposal and compared these with the differences in construction costs, to yield the marginal or differential rates of return on capital investment. This evaluation confirmed in all respects that the Back Channel Bridge and the associated route of Proposal 2 were economically to be preferred.

On 4 April 1978 the adoption of Proposal No. 2 involving a bridge over Back Channel, a bridge over Sandy Creek and road construction for a length of approximately 4.6 km was approved.

Maclean Shire Council was advised that the Department would meet the full costs of design and construction of the Back Channel Bridge and the replacement bridge over Sandy Creek, and also the full cost of constructing a two lane gravel road necessary to directly connect the Back Channel Bridge with the existing road system. Council would be responsible for survey and design for all roadworks between the Tullymorgan Road and Warregah Island Bridge (CDEF on the map) and the cost of road improvements to Murrayville Road.

Tenders for the construction of the 205 m Back Channel Bridge were advertised on 25 July 1979 and closed on 5 September 1979, the successful tenderer being Citra Constructions Ltd.

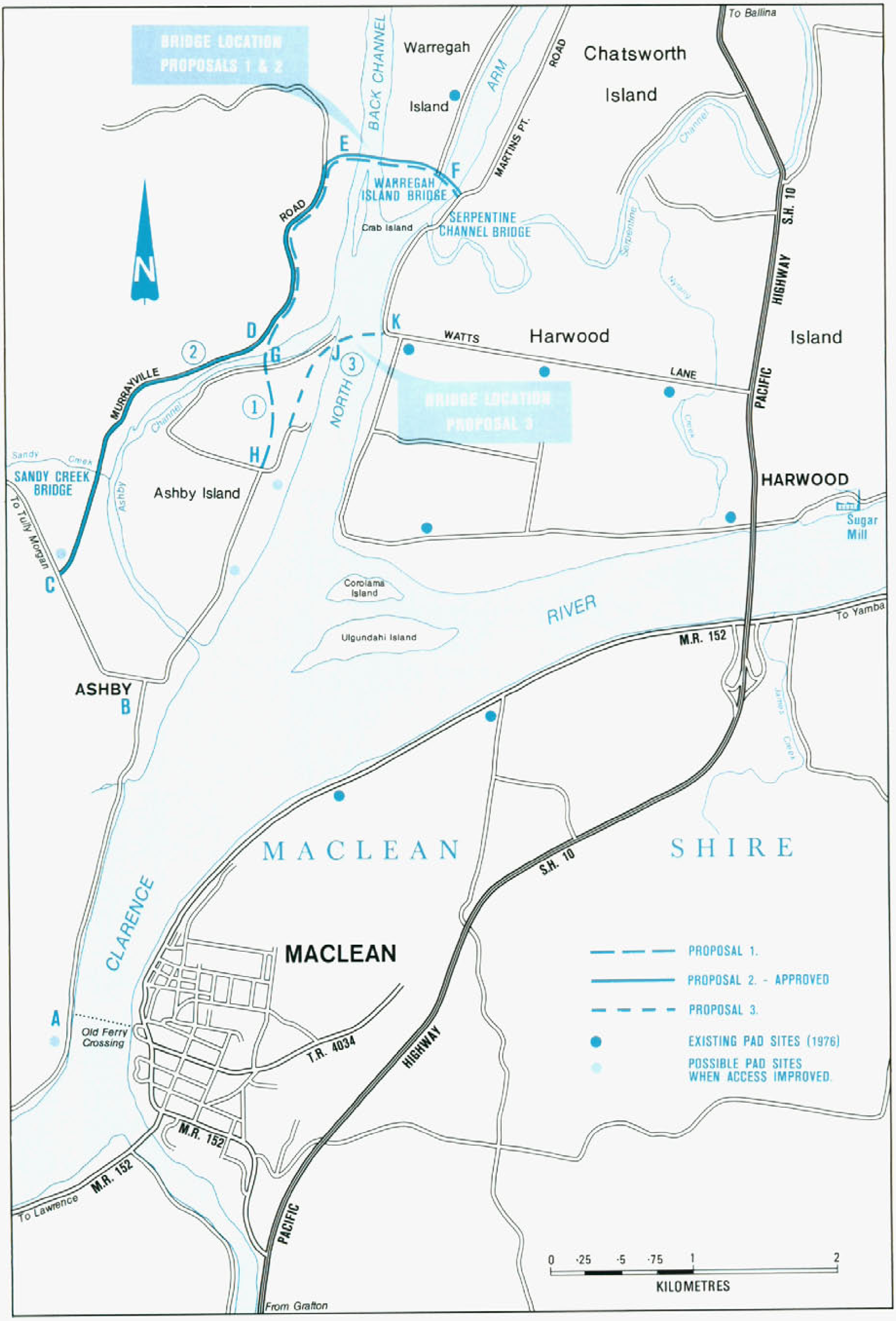
Design details

The Back Channel Bridge is an eight-span prestressed concrete broad flange girder bridge on driven steel pile foundations. The length is approximately 205 m almost entirely over water, with six central spans of 25.5 m and two end spans, each measuring 25.8 m. The overall width of the bridge is 7.8m with a two lane carriageway 6.8 m wide between kerbs, with traffic barriers consisting of steel railings mounted on concrete parapets provided on each side.

The level bridge deck provides vertical clearance of 1.0 m above the highest known flood level which occurred at Maclean in 1890.

Foundations

Foundation bores taken along the bridge centreline, indicated weathered sandstone, siltstone and shale layers, with bands of clay and coal, overlain by silt and clay. It was initially considered that large diameter cast-in-place piles, socketed into sound rock, would provide the most suitable foundations for the structure. However, a detailed examination of the foundation bores indicated that sound rock level was variable and difficult to define and so the bridge has been supported by rolled steel H piles driven to refusal. With these piles, the selection of



BRIDGE LOCATION PROPOSALS 1 & 2
BACK CHANNEL
Warregah Island
ARM
MARTINS PT. ROAD
Chatsworth Island
To Ballina
WARREGAH ISLAND BRIDGE
SERPENTINE CHANNEL BRIDGE
Crab Island
MURRAYVILLE ROAD
N
WATTS LANE
Harwood Island
NORTH
BRIDGE LOCATION PROPOSAL 3
PACIFIC HIGHWAY S.H. 10
Sandy Creek
SANDY CREEK BRIDGE
To Tully Morgan
Ashby Channel
Ashby Island
HARWOOD
Sugar Mill
Coroiama Island
Ulgundahi Island
RIVER
M.R. 152
To Yamba
ASHBY
MACLEAN SHIRE
S.H. 10
CLARENCE
MACLEAN
Old Ferry Crossing
T.R. 4034
HIGHWAY
M.R. 152
To Lawrence
PACIFIC
From Grafton
PROPOSAL 1.
PROPOSAL 2. - APPROVED
PROPOSAL 3.
EXISTING PAD SITES (1976)
POSSIBLE PAD SITES WHEN ACCESS IMPROVED.
0 ·25 ·5 ·75 1 2
KILOMETRES

contract levels was less critical, as the piles could be readily adjusted on site by cutting, or by welding on additional lengths.

The tops of the piles are encased in a 0.6 m diameter concrete jacket, to a distance of 2.0 m below surface, as a protection against corrosion.

The concrete end posts at the ends of the bridge barriers provide a smooth connection between the approach guardrail and the bridge traffic barriers, and will also serve to delineate the ends of the bridge, from a driver's viewpoint.

Superstructure

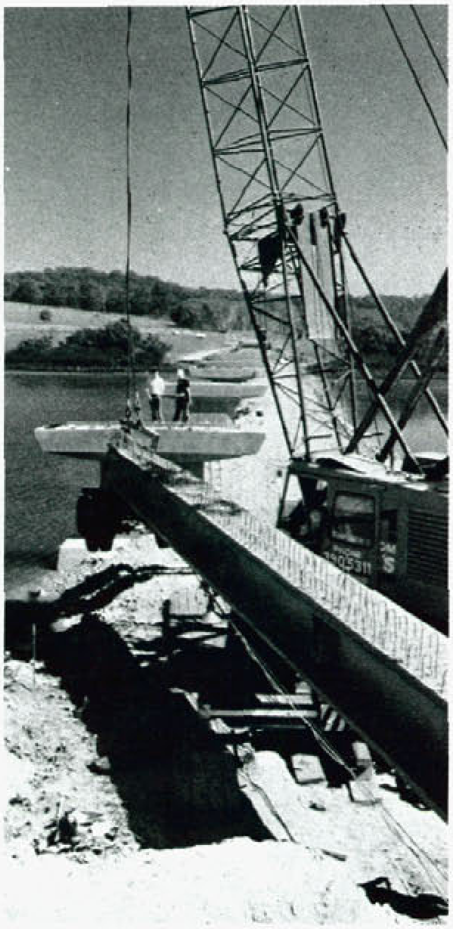
The superstructure spans are all simply supported and consist of seven broad-flanged prestressed concrete girders acting compositely with a reinforced concrete deck.

The girders are pretensioned and are detailed for the use of either normal or low relaxation 15.2 mm prestressing strand. They have been placed so that the lower flanges are 100 mm apart, and these spaces are filled with cast-in-place concrete. This arrangement employs the minimum number of girders in the superstructure cross section to satisfy loading requirements.

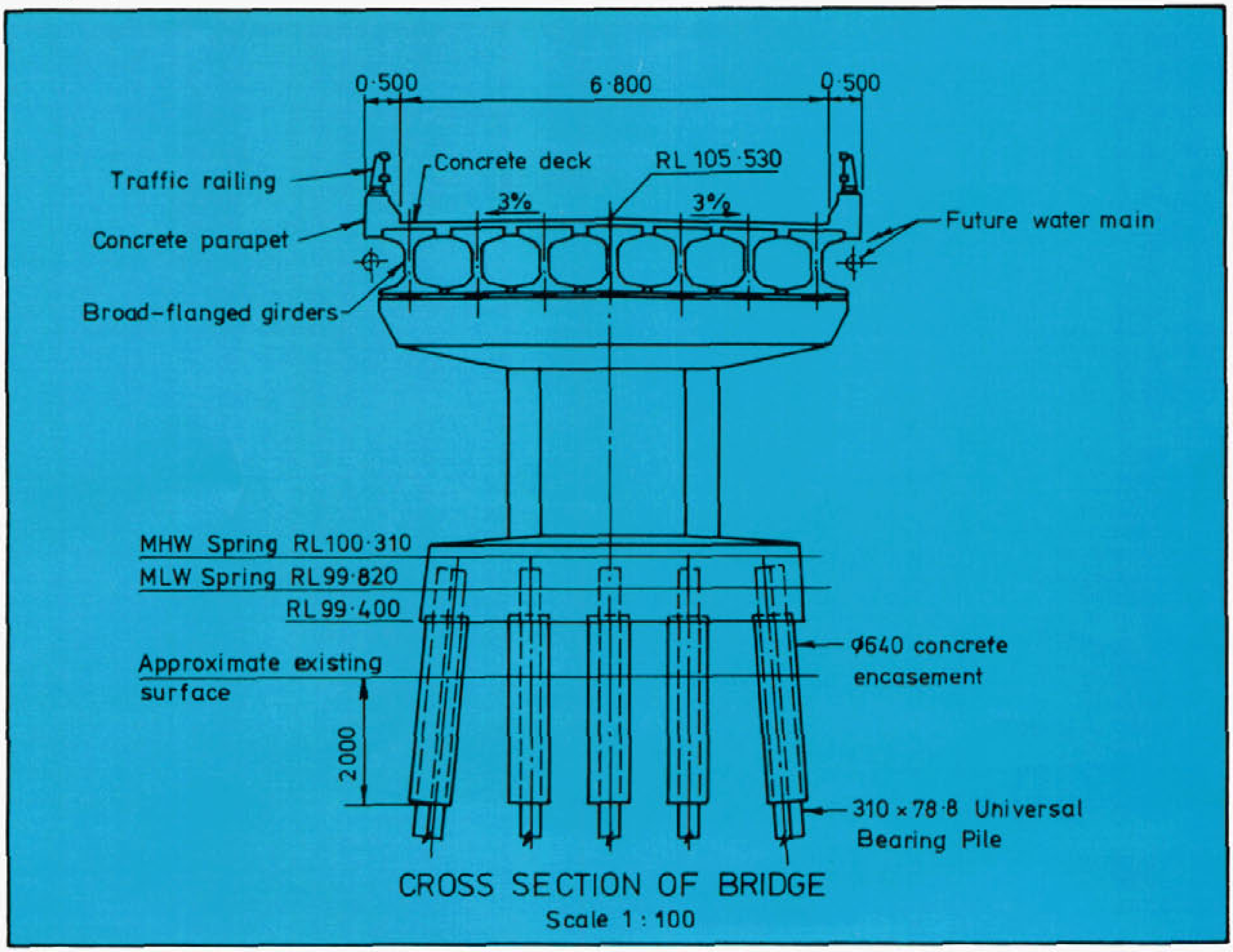
The top flanges of the girders are narrower than the bottom flanges and these spaces are also filled with cast-in-place concrete. The girders are transversely tied together by a system of intermediate and end cross girders with no reinforcement protruding into the concrete. Five post-tensioned concrete intermediate cross girders and two reinforced concrete end girders are provided for each span. The intermediate cross girders are detailed for either a high tensile bar system or a multi-strand system to allow the Contractor some flexibility during construction.

The superstructure is supported on laminated elastomeric bearings at the piers and abutments. Rotation and longitudinal movements are thus permitted but transverse movement is restrained by a system of 20 mm diameter galvanised steel dowels cast in the concrete between the bearing locations.

Because the bridge will be used by heavily loaded cane trucks, it was decided that a concrete wearing surface similar to that on the Warregah Island Bridge, would be



The first of the seven prestressed concrete girders being lifted into position.



CROSS SECTION OF BRIDGE
Scale 1 : 100

more suitable than asphaltic concrete. This means also that the girders can be made composite with the deck to carry the bridge's live loading. Transflex — 150C expansion joints are provided at both pier and abutment locations.

The traffic barriers flanking the carriageway complete the superstructure. Ferrules are cast into the underside of the concrete parapet sections of these barriers to provide for possible future attachment of watermains.

As a finish to the superstructure, fascia panels were considered but it was decided that the off-form surface of the girders themselves would provide an equally attractive final result at considerable cost saving.

Construction

Citra Construction Ltd., who submitted the successful tender for the bridge, began construction work in January 1980.

The approximate quantities of materials used were:

Driven steel piles	1153 m
Concrete Class 40 MPa in girders	580 m^3
All other concrete including pile encasement	610 m^3
Reinforcing steel	140 t
Prestressing tendons	40 t

The bridge was completed in August 1981 at an estimated cost of $810,000. After the completion of the approach roads by Council, the bridge was opened to traffic on 4 September 1981. ●

MECHANISED CANE HARVESTING

Harwood is the last of the three New South Wales sugar mills to convert to fully mechanical cane harvesting (the others are at Condong and Broadwater). Automation brings considerable savings to growers and to the N.S.W. Sugar Milling Co-operative Ltd who took over operation of the mills from CSR in 1978.

In the mechanised system, cut-up pieces of harvested cane are delivered into buggies of 6 or 7 tonne capacity which travel alongside the harvesters. As the chopped cane moves along the machine's conveyor, blasts of air blow out much of the extraneous matter. Full buggies tip their load into a 20 tonne container which, when full, is taken by semi-trailer to the mill.

The use of several containers at each grower's delivery point enables cane to be stored so that pick-ups and deliveries can be made throughout the day and night. The mill operates 24 hours a day throughout the cane season which is approximately June to December.

1. Trash is blown into the air as the mechanical harvester loads cut cane into a wire container on the buggy. 2. When full, the buggy tips the cane into a 20 tonne container sitting on a prepared gravel surface. 3. The massive loaded container is winched up onto the semi-trailer's chassis which slowly lowers as the container is drawn forward. The total weight of the truck is now between 30 and 35 tonnes. At the mill the chassis will be elevated again to allow cane to slide out of the back of the container. (Information and photographs by courtesy of CSR Limited.)

F4 — WESTERN FREEWAY PROGRESS

The planned route of the F4 — Western Freeway extends for approximately 50 km, from the inner western suburb of Concord to Blaxland in the lower Blue Mountains. It runs generally parallel to, and on the northern side of Parramatta Road between Concord and Parramatta, then on the southern side of the Great Western Highway to the Nepean River.

Land use along the route ranges from densely populated urban areas to industrial estates, cultivation and grazing. The landform is generally flat or undulating.

Construction history

Construction of the F4 began in the late 1960's and by mid-1974 a 24 km length between Dog Kennel Road, Prospect and Russel Street, Emu Plains was in use. At the same time attention was being directed to the eastern end of the freeway and in 1971 construction began between Saleyards Creek, Homebush and Berry Street, Granville. This mainly involved construction of bridgeworks to carry the freeway over existing roadways. Twelve bridges had been completed by mid-1977, and construction of the formation was well in hand.

This favourable rate of progress was soon curtailed. The need to complete the Warringah Freeway extension to Willoughby Road, the Bondi Junctin By-pass, and lack of funds, led to the suspension of work between Homebush and Granville from May, 1977 to September, 1978.

With the Warringah Freeway extension completed, work resumed at Homebush and following the completion of the Bondi Junction By-pass, the Western Freeway Construction Office re-opened in January, 1979.

Proposed programme for completion

To take advantage of the completed work and to relieve congestion on Parramatta Road, priority was given to the length between Young Street, North Strathfield and Silverwater Road. After consultation with Concord, Strathfield and Auburn Councils, this work was commenced. It involved completion of pavement and drainage work on the through carriageways, construction of on-loading and off-loading ramps at Silverwater Road and construction of a connection from Parramatta Road to the Freeway at Young Street, North Strathfield.

This length is expected to be in service in late 1982. It is intended to complete the full length between Concord Road and Hawkesbury Road, Mays Hill by early 1986. Work is planned or in progress as follows.

Concord Road, North Strathfield to Silverwater Road, Silverwater

Work is in progress, including the construction of a major viaduct over the Northern Railway and Powells Creek at North Strathfield. Construction of a bridge at Underwood Road and a cable-stayed steel box-girder pedestrian overbridge at Pomeroy Street will be required before this length is opened to traffic by 1983.

Silverwater Road to Berry Street, Granville

Roadworks are in progress on this length. Work is in hand on construction of the major bridge over Duck River at Auburn, which is expected to be completed during October, 1981, and on the bridge to carry Stubbs Street, Auburn over the freeway, which is expected to be opened to traffic in August, 1981. Bridge structures are being constructed at Deniehy Street, Wentworth Street and Kay Street before opening to traffic, expected late in 1983.

Berry Street, Granville to Church Street, Parramatta

Design of this length, including a major crossing of the Western Railway at Harris Park, is in hand. It is expected that construction work will be undertaken between 1983 and 1985.

Church Street, Parramatta to Hawkesbury Road, Mays Hill

Construction work is in hand, earthworks are well advanced and a new pedestrian underpass is in use at Peggy Street, Mays Hill. The bridge over Burnett Street, Merrylands has been completed. Other structures required include bridges over the freeway at Pitt Street, Merrylands

The 366m long viaduct over the Northern Railway and Powell Street under construction during September, 1981.

and Coleman Street, Mays Hill. A pedestrian bridge over the freeway at Franklin Street, West Parramatta has been constructed, and widening of the existing bridge over A'Becketts Creek in Church Street is in progress. An additional bridge over A'Becketts Creek, carrying the freeway on-loading ramp from Parramatta Road is in progress, and is expected to be completed early in 1982.

In an article entitled "Current Construction of the Western Freeway" in the March, 1975 issue of *Main Roads* (Vol. 40, No. 3, pp. 83-87), details of the design and construction at that time were given. The following information up-dates some areas covered in that issue and describes current major works.

Construction of continuously reinforced concrete pavement Marlborough Road to Silverwater Road

The freeway pavement has been constructed in continuously reinforced concrete (C.R.C.P.) underlaid by 100 mm of lime stabilised fine crushed rock and 150 mm of crushed sandstone on the natural weathered shale subgrade.

The concrete pavement was 200 mm thick, reinforced longitudinally by 16 mm diameter coldworked deformed bars at 150 mm spacings. Additional longitudinal reinforcement was provided at construction joints which were located no less than 300 m apart.

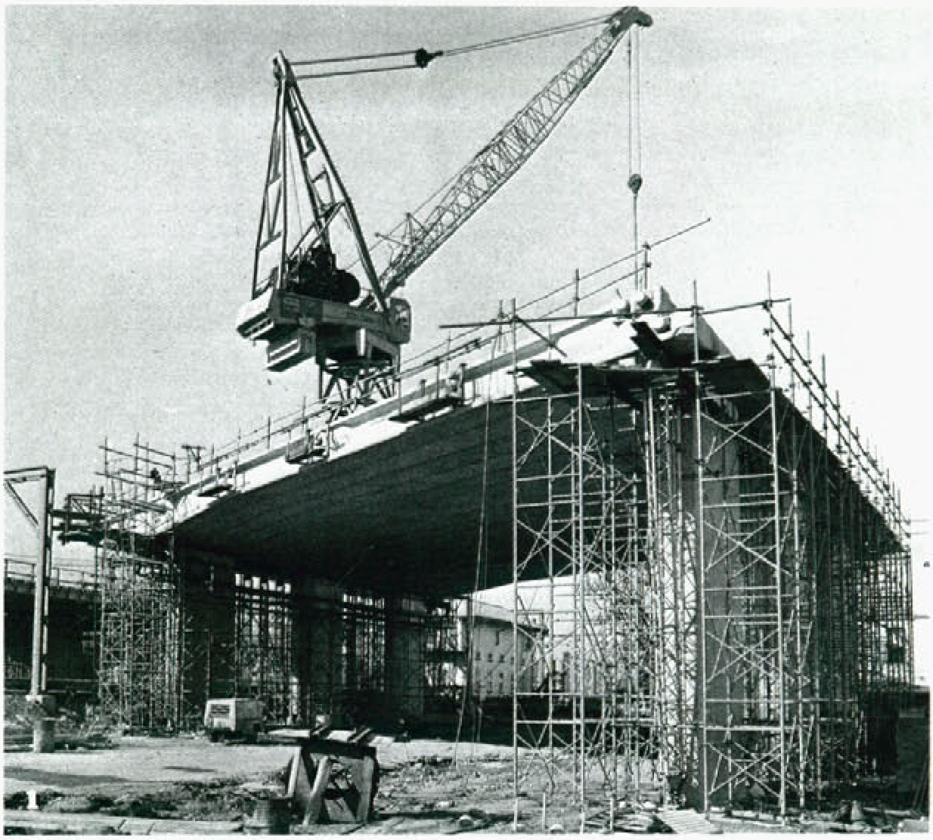
The 12 mm diameter transverse reinforcement supported the longitudinal reinforcement in position, but played no part in the pavement design.

Apart from construction joints, the C.R.C.P. had transverse joints only at fixed structures. Anchor beams embedded in the formation provided restraint against movement of the pavement. Three anchor beams at 12 m spacings were provided in advance of bridge abutments.

To obtain uniformly spaced and controlled transverse cracking, the mix design provided concrete of consistent strength.

The cement concrete specified for use at Homebush was designed to achieve a compressive strength of 35 ± 5 MPa at age 28 days. Improved workability of concrete was achieved by incorporating water reducing and air-entraining agents.

However, tight control was maintained on concrete air content and slump. These were specified at $4 \pm 1\%$ and 55 mm $\pm$ 15 respectively for hand-placed concrete. The opportunity was taken to construct a length of pavement using a fly-ash concrete mix having a specified compressive length of 30 ± 5 MPa.



Tenders for construction of 3000 m of dual carriageway in C.R.C.P. were invited on the basis that either mechanised slip-forming or conventional fixed side forms could be used during pavement construction. The successful tenderer, Friend and Brooker Civil Engineering Pty. Ltd. elected to use fixed side forms. The

1. The 12 span viaduct consists of 186 precast bridge girders (September, 1981).
2. Continuously reinforced concrete pavement being constructed during October, 1979, between Marlborough Road and Silverwater Road.

2

The dual carriageways looking eastward from King Avenue, Lidcombe as at September, 1981.

contractor used 8 m long steel forms supported by pins driven into the compacted pavement base courses.

Concrete was discharged directly into the forms, where it was worked and compacted in place using immersion vibrators and vibrating screed boards. The fresh concrete surface was wood floated and subsequently a 2 mm deep transverse surface texture was applied by broom. Application by spray of a chlorinated rubber curing membrane completed the concreting operation.

Saleyards Creek to Marlborough Road

The C.R.C.P. on this length of freeway was constructed by McGregor Construction Australia Pty. Ltd., using the McGregor CPP 60 slipform paver.

The concrete specification was similar to that used for the hand-placed length, with the following variations to provide for the special requirements of concrete placed by extrusion.

	Hand-Placed Mix	Extruded Mix
Strength	35 ± 5 MPa	35 ± 5 MPa
Slump	55 ± 15 mm	30 ± 15 mm
Surface Texture	2 mm	1.5mm

The costs of both types of pavement construction were comparable ($23.00/m²) but on this project the hand-placed pavement gave a marginally better roughness value after construction (50 counts/km vs. 61 counts/km).

Bridge over the Northern Railway and Powell Street at North Strathfield

Location

The viaduct at North Strathfield is located at the eastern end of the freeway section now under construction and runs almost parallel to Parramatta Road. It is comprised of twelve spans of precast, prestressed concrete girders with post-tensioned cross girders. The main span crosses the Northern Railway near North Strathfield Station with a minimum clearance of 6.44 m. The viaduct, which is 366 m long from the eastern abutment at Queen Street, North Strathfield to the western abutment just short of Powell Street, Homebush, was designed by engineers of the Department of Main Roads. The deck cross-section which is 20.5 m wide between kerbs, will accommodate twin carriageways of two 3.7 m wide traffic lanes separated by a 1.8 m wide median. Shoulders 1.95 m wide are provided alongside each carriageway.

Foundations

The site of the viaduct is underlaid by sound hard shale at depths which vary from 6.5 m to 10 m below the existing surface. The substructure is founded on 1.2 m diameter cast-in-place reinforced concrete piles socketed 2-3 m into sound rock.

Maximum pile loads are 325 tonnes for abutments and 365 tonnes for piers.

Substructure: Abutments

The western spill-through abutment is supported on 28 piles, cast in two rows. The eastern wall abutment is supported on 14 piles in two rows. The front row of piles in both abutments is raked forward at 1 in 5.

There is provision for future duplication of the viaduct on the northern side. Partial construction of the abutments for this duplicate structure was included in the work.

Piers

There are eleven reinforced concrete piers, each founded on six piles and a pilecap. All piers (except Pier No. 8) consist of three 4.5 × 1 m rectangular columns with a tapered corner detail. The column heights vary between 9.4 m and 10 m. Pier No. 8 incorporates a cantilevered headstock supported on two rectangular columns.

Superstructure

The superstructure consists of 186 precast, prestressed concrete bridge girder forming the twelve spans of the viaduct. There are four distinct girders types varying in length from 24.5 m to 37.7 m and in mass from 25 tonnes to 51 tonnes. The girders for Span 11, directly over the Northern Railway, incorporate lightweight aggregate to reduce the mass to span-length ratio.

Design of the viaduct was arranged so that construction of Spans 10-12 could proceed independently of the nine western approach spans.

After post-tensioning the deck girders will be erected and integrated into the superstructure by casting and post-tensioning cross girders and in-situ concrete between the girder flanges. The wearing surface of the viaduct will be asphaltic concrete.

Construction proceeded under a series of separate contracts. Individual piers were built as each site became available.

The bridge over the Northern Railway at North Strathfield is estimated to cost $6.2 million. It is expected to be completed in May, 1982.

Bridge over Underwood Road

The bridge to carry the Western Freeway over Underwood Road, North Strathfield is comprised of three spans of precast, pretensioned I-beams, with a composite reinforced concrete deck.

The site is underlaid by sound hard shale about 7 m below the existing surface. The substructure is founded on 1.2 m diameter cast-in-place reinforced concrete piles socketed into sound rock. Abutments are supported on ten piles, consisting of pilecaps, five spill-through counterforts with headstocks. The Piers consist of four rectangular columns with reinforced concrete headstocks.

Construction of the substructure was carried out under Departmental direct control. Supply and delivery of pretensioned I-beams was arranged by subcontract. The estimated cost of construction is $900,000.

Pedestrian bridge over Western Freeway at Pomeroy Street, North Strathfield

The design of the pedestrian bridge, prepared by Departmental Engineers, calls for a two-span, cable-stayed, steel box girder bridge 67.6 m long. The box girder and steelwork for the 30 m high support tower were fabricated at the Department's Central Workshop.

Footings were completed earlier this year, and erection of the prefabricated structure will be undertaken by Departmental direct control. The pedestrian bridge is estimated to cost $200,000 and is certain to be a feature of the completed freeway.

Bridge over Freeway at Stubbs Street, Auburn

The superstructure consists of a continuous in-situ voided slab, post-tensioned longitudinally, with short cantilevers carrying two footways. Service ducts are provided in both footways. The bridge has four spans, 16 m, 24.1 m, 24.1 m and 11 m, is 17 m wide and is on a 3.21% grade. Grille type bridge railings were installed on the outer edges of the footways, and street lighting standards located on the eastern side of the bridge.

The footings of Abutment A and the three piers bear directly on the ground. Abutment B is supported on piles. Each pier consists of two blade columns. Part of the formwork for these blades was textured to give a special finish.

The Concord Road, North Strathfield to Silverwater Road, Silverwater section is expected to be opened to traffic by 1983 (September, 1981).

Work by Enpro Constructions, as Contractors to the Department, was completed on 9 February 1981 at a contract price of $555,000.

Bridge over Duck River at Auburn

The 300.2 m long bridge carrying the Western Freeway over Duck River at Auburn consists of nine spans of precast, post-tensioned segmental girders which vary from 27.4 m to 36.6 m. The bridge alignment is on combined horizontal and vertical curves.

The deck cross-section, which is 20.2 m wide between kerbs, will accommodate twin carriageways of two 3.7 m wide traffic lanes separated by a median 1.8 m wide. Shoulders 1.8 m wide are provided alongside each carriageway. The bridge was designed by Departmental engineers.

Foundations and substructure

The site of the bridge is underlain by sound hard shale at varying depth and the foundations, designed accordingly, consist of cast-in-place reinforced concrete piles or spread footings as appropriate. Maximum pile loads are 254 tonnes for piers and 102 tonnes for abutments.

The deck is supported on three reinforced concrete columns at each pier. Piers 1, 2, 3 and 6 are founded on cast-in-place piles and the remainder are on spread footings. The eastern abutment is a reinforced concrete anchor beam tied to the rock foundation by post-tensioned rock anchors. The western abutment is a reinforced concrete spill-through anchor beam on cast-in-place piles.

Superstructure

There are twelve segmental broad-flanged concrete girders in each span. Cast-in-place concrete at the top and bottom flanges of the girders will form a cellular deck structure. The deck is continuous throughout the length of the bridge, fixed at the eastern abutment and has provision for expansion at the western end. Spherical bearings are provided at piers and abutments with elastomeric bearings at stepped joints at pier 7 and in Span 8.

Construction

A tender for $2,930,141.00 was accepted from Citra Constructions Limited on 19 February, 1979. The contract period was 130 weeks.

Construction of the substructure is at an advanced stage, and deck construction proceeded from the fixed eastern end towards the western abutment.

Deck girder segments were manufactured off-site at a concrete casting yard. These were assembled and stressed on site and launched from the eastern abutment with the aid of cranes and launching trusses as required. Certain girders not resting on bearings were supported on falsework at the cross girder locations.

Cross girders were cast, followed by placement of in-situ concrete between the girder flanges. When the required concrete strength was attained, the cross girders were post-tensioned to complete the deck structure. The wearing surface will be asphaltic concrete.

Freeway bridge over Deniehy Street, Clyde

A contract for construction of the bridge to carry the freeway over Deniehy Street was awarded to Christie Civil Contracting.

At the bridge site, the freeway is on embankment. Placing and compaction of fill near the bridge were completed by the Department. The freeway centreline is on a 137 m (450 foot) spiral curve at the bridge, but all formwork except the southern parapet is to be set on the chord (i.e. all members will be straight except the southern parapet).

The superstructure consists of a continuous in-situ voided slab which was designed to be constructed and prestressed in two parts. On completion of stressing, a slab is to be cast to join the two parts into a single superstructure. Short cantilevers carry part of the shoulders and the parapets. The bridge has three spans 11 m, 22 m, 11 m skewed at 8° to the centreline of Deniehy Street.

In a future stage of construction when the westbound carriageway is built, the southern parapet will be demolished for construction of the final median.

The substructure is supported on cast-in-place concrete piles. The abutments are spill-through type and each pier consists of two tapered blade columns.

Services are provided for by the placing of three P.V.C. pipes in the northern parapet and wing walls. The Contract price for construction was $470,500.

Freeway bridges over Wentworth Street, Clyde and Duck Creek

Design and construction are due to be completed by early 1983.

Widening of bridge in Church Street, Harris Park over A'Becketts Creek

The existing two-span bridge in Church Street over A'Becketts Creek is being widened on the upstream side. This will provide additional traffic capacity at the complex junction of the Great Western Highway with the Western Freeway.

Design was undertaken by the Department. The work is expected to cost $300,000.

On-loading ramp bridge over A'Becketts Creek

Construction by A.A.M.M. Constructions Pty. Ltd. is in hand for this work, at a tender price of $350,255. Completion is expected in early 1982.

Bridge over Freeway in Pitt Street, Merrylands

Designed by Conbsultants Taylor and Pty. Ltd., this bridge is being constructed by Enpro Constructions Pty. Ltd. at a tender price of $767,735. Completion is expected in October 1981.

The structure is a single span, cast in-situ, post-tensioned concrete box girder bridge. During construction a side-track around the site was used by traffic to minimise inconvenience.

Pedestrian bridge at Franklin Street, Parramatta West

Construction by Christie Civil Contracting was completed at an approximate cost of $110,000. The three-span cast in-situ reinforced and prestressed concrete bridge, provides access to the nearby West Parramatta Public School for children whose homes are south of the Freeway.

Freeway bridge over Burnett Street, Merrylands

The Burnett Street bridge superstructure consists of a three-span continuous post-tensioned slab voided in the middle span. The deck incorporates a dowelled contraction joint along the bridge centreline for the full length of the bridge. Fixed bearings are provided at Pier 1. All other supports provide for movement of the superstructure.

The bridge centreline is on an 800 m radius vertical curve and on a 700 m radius horizontal curve. To provide a minimum clearance of 4.9 m under the bridge it will be necessary to lower Burnett Street.

The substructure of the bridge — abutments on cast in-situ reinforced concrete piles and six-column piers on spread footings — was constructed by Departmental direct control.

Tenders were invited for construction of the deck and work was completed by Enpro Constructions Pty. Ltd. at a tender price of $449,565. A side-track around the bridge site is in use by Burnett Street traffic. Construction of the bridge deck and subsequent lowering of Burnett Street were facilitated by this removal of traffic from the bridge site.

The 300m long bridge over Duck River at Auburn is aligned on combined horizontal and vertical curves (August, 1980).

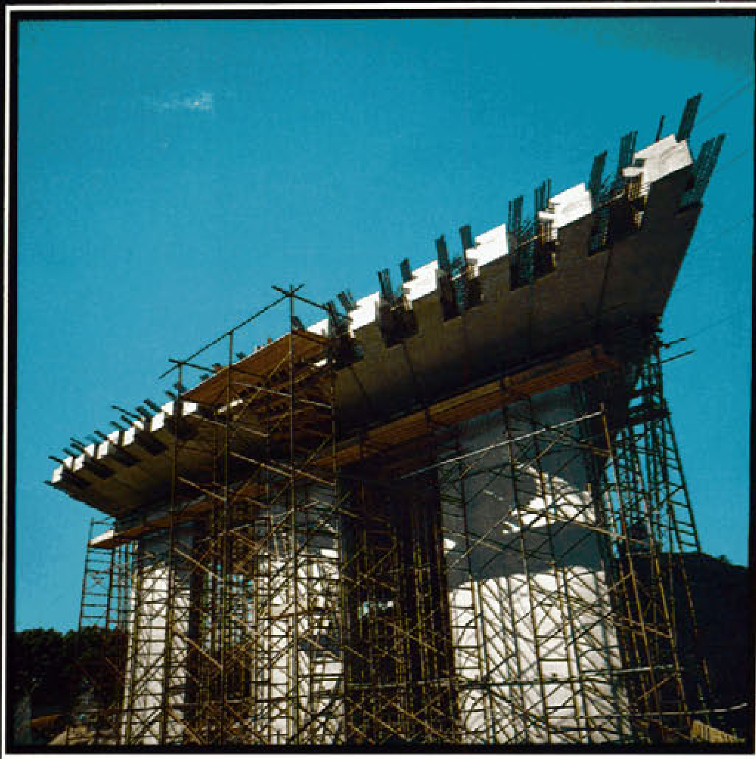
Bridge over Freeway in Coleman Street, Mays Hill

Designed by Consultants Taylor and Herbert Pty. Ltd. Construction by contract was awarded to Citra Constructions Ltd. at a tender price of $749,595. This work is expected to be completed in January 1982.

The design calls for a three-span prestressed concrete box girder bridge of in-situ concrete. Piers consist of 500 mm thick in-situ reinforced concrete walls. The footings of the piers form a thrust block to resist the combined effects of the vertical forces from the piers and inclined tie forces used to hold down the ends of the bridge deck, by means of prestressed concrete ties.

A feature of the design is that the ends of the deck merge into the approaches at each end of the bridge. The prestressed concrete ties from the ends of the deck to the pier footings restrict the amount of vertical movement at the ends of the deck. A side-track for traffic was provided around the bridge site at Coleman Street. ●

The bridge over Duck River at Auburn under construction as at September, 1981. Inset: The 366m long viaduct over the Northern Railway line at North Strathfield.



The BCT . . . a forgiving guardrail terminal

The following article is adapted from a paper presented by Mr. R. Troutbeck of A.R.R.B., and Mr. R. N. Field and Mr. P. J. Duncan of the Department of Main Roads, New South Wales, at a recent A.R.R.B. Conference. The paper summarised information on the Michie and Bronstad terminal, including some information on trial installations by the Department.

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The approach end of a guardrail is a formidable roadside hazard. Actual accidents and full scale crash tests have indicated that most end designs fail to provide the same protection as the rest of the guardrail. Vehicles have been speared on guardrail terminals fitted with *fish-tail* end wings. Where an end is ramped to ground, such as in the *Texas twist* design, it tends to prevent spearing, but can cause high speed roll-overs.

An acceptable guardrail terminal, therefore, should:

- anchor the steel W-beam so that the tensile strength in the main portion of guardrail is used when the rail is hit
- minimise vehicle deceleration
- minimise the risk of the vehicle's passenger compartment being speared
- minimise vehicle damage, and
- be economical to construct and to maintain

What is a BCT?

M. E. Bronstad and J. D. Michie at the Southwest Research Institute, Texas, U.S.A. have developed a guardrail terminal design* which meets all of these requirements. Bronstad and Michie called their design a Breakaway Cable Terminal or BCT.

The diagrams on this page show the BCT design. The important features of this design are:

- two timber posts installed in concrete footings
- 60 mm holes drilled in the posts approximately 100 mm above the ground
- an enlarged end section, called a *Bullnose*, and
- a cable connecting the W-beam to the first post.

How does it work?

If an errant vehicle hits the terminal head-on, the first and second posts weakened by the drill holes shear, allowing the guardrail to buckle. The bullnose increases the "vehicle to barrier" contact area, distributing the impact loading. The BCT can be struck head-on with a very low probability of the vehicle being speared, or of the vehicle stopping with drastic decelerations.

If the guardrail beyond the BCT is hit, the tensile force developed in the W-beam is transferred to the soil through the anchor cable and the concrete footing. Therefore the BCT ensures that the total guardrail installation retains the same vehicle redirecting characteristics along its entire length.

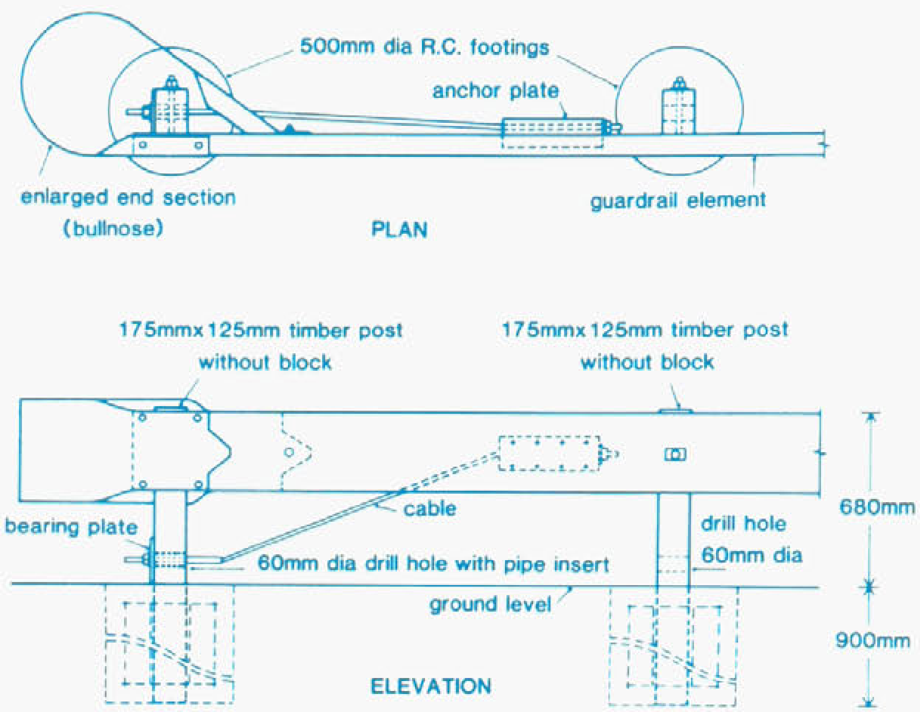
Has the BCT been tested?

Bronstad and Michie used one and two tonne passenger vehicles to crash test the BCT. The vehicles were crashed into the guardrail at various points ranging from head-on terminal impacts to impacts along the guardrail. When impacted head-on by two tonne vehicles, the terminal broke away with minimum decelerations. Head-on impacts by the lighter one tonne vehicles resulted in higher decelerations, but were still considered survivable for occupants wearing seat belts.

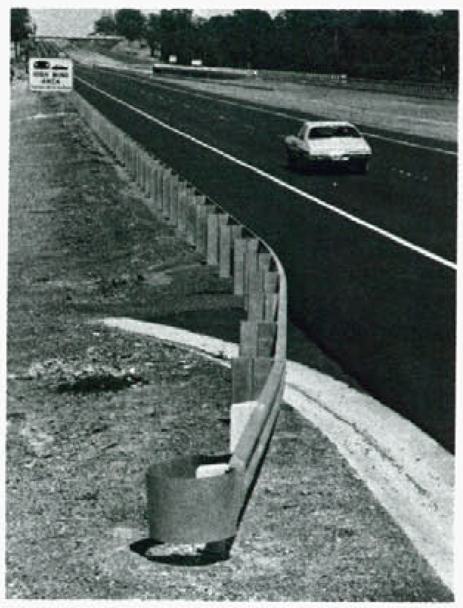
When the guardrail was impacted a few metres beyond the terminal, the anchor held and the guardrail successfully re-directed the vehicles. The results of these tests have been reinforced by extensive field tests in the United States. Thirty American States have now adopted the BCT as a standard terminal.

Installation for Australia

The BCT is recommended for use on both rural and urban roads in Australia. Although the average Australian car is



An installation of a BCT on the F5 — South Western Freeway.



lighter than its American counterpart, a BCT will still operate better on impact than a conventional guardrail terminal.

The BCT's performance depends on the post footings, as they must have sufficient strength for the wooden posts to shear. Bronstad and Michie consider that their footing design is suitable for most soil types. If footing details are changed, however, they suggest that they should be pendulum-tested.

All guardrails should be flared to offset the terminal for increased safety. The BCT is no exception. Flaring also means that the terminal will be loaded eccentrically if impacted at the end. This improves the BCT's performance. Bronstad and Michie warn that *"Significant modification or deviation from proven details is discouraged, unless verified by full scale testing"*.

Its use and cost

If the end of a guardrail is within the "clear zone"[1], a BCT should be used. For consistency it should also be used if the end of the guardrail is outside the clear zone, in which case the bullnose need not be used.

As the number of errant vehicles depends largely on traffic volumes, priority for installation of the BCTs should go to higher volume roads.

Timber post BCTs have been installed by the Department for between $300 and $350. An alternative slip base steel post BCT designed by Bronstad and Michie, still being evaluated in New South Wales, is likely to cost less than $750 installed.

[1]The "clear zone" is the roadside area where a driver has a high probability of recovering control of an errant vehicle, if the area is kept clear of obstructions. A strip of ground 9-10 m from the edge of the pavement is desirable.

. . .

The Department has now approved the provision of BCT's on both new and existing guardrails. On existing guardrails, priority is to be given to those lengths of guardrail which have a history of vehicle impacts. BCTs have now been installed at more than one hundred locations throughout New South Wales, primarily along the F5 — South Western Freeway. ●

** Bronstad and Michie developed the BCT under the National Co-operative Highway Research Program (NCHRP) sponsored by the American Association of State Highway and Transportation Officials (AASHTO) in co-operation with the Federal Highway Administration (FHWA).*

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"SUPER-SPAN" ON F3 — SYDNEY-NEWCASTLE FREEWAY

The horizontal ellipse "Super-Span" now carries the deviation of Old Tuggerah Road under the F3 — Sydney-Newcastle Freeway. ***(For details see article on p. 54.)***

1. The underpass is large enough to accommodate two 3.4m traffic lanes with a vertical clearance of over 5.5m. 2. Shape control during plate erection was a critical factor, as the "squatting" of the completed shape could not exceed 2% of the structure's span. 3. Organic materials beneath the superspan were removed to depths of up to 5m and were replaced by compacted crushed sandstone.

WELCOME ADDITION AT WALGETT
NEW CROSSING OF NAMOI

On 18 June, 1981, the new bridge over the Namoi River at Walgett was opened by the Hon. H.F. Jensen, Minister for Local Government and Minister for Roads.

The bridge is situated near the junction of the Namoi with the Barwon River, hence the Aboriginal name "Walgett", which means "meeting of the waters". "Barwon" is derived from an Aboriginal word meaning "wide stream", while "Namoi" denotes a species of acacia.

The surrounding tree-dotted landscape is given principally to fat lamb-raising, wool production and wheat growing. The bridge is a vital link between the stock stations in the north and the markets in the south ... as well as a northern gateway to Walgett.

Along the Castlereagh Highway

The new bridge forms part of the Castlereagh Highway (State Highway No. 18), which, for much of its length, runs parallel with and close to the Castlereagh River.

The river was named by Surveyor-General John Oxley after Viscount Castlereagh who, at the time of its discovery by Deputy Surveyor-General George Evans in 1818, was Secretary of State for the Colonies and Leader of the House of Commons.

The Castlereagh Highway commences at Gilgandra, where it connects with the Newell Highway and the Oxley Highway. It runs for 343 kilometres in a north to north-westerly direction to the Queensland border near Hebel.

The country through which it passes is mostly pastoral in character. Settlement along its route was prompted, primarily, by the desire of the pastoralists for new and more extensive pastures for their rapidly increasing flocks and herds.

There is some uncertainty as to the date settlement of the Castlereagh River area actually began, but by 1840 several large runs had been established. By 1848 settlement along the river extended from the present locality of Mendooran in the south to that of Walgett in the north.

In the early stages of settlement, and especially in the sparsely settled districts, it was necessary for travellers to keep as close as possible to the rivers or streams, which guaranteed water supplies during their journeys.

Situated on the banks of the Castlereagh River, the 'Canamble' station of James Walker became, in the mid 1800s, a converging point for the early settlers and overlanders, and therefore the natural centre of the surrounding plains. Walker's properties covered a large extent of country bordering the river and the tracks formed by the movement of cattle, and later sheep, between his stations, laid the foundations of the route which was to be named, nearly 100 years later, the Castlereagh Highway.

In 1885 a map was prepared by the Postal Department to show the postal stations, mail roads and the telegraph lines in New South Wales. The route of the mail road running northwards from Gilgandra through Curban, Gulargambone, Coonamble, Walgett and Angledool to the Queensland border, was almost exactly that now taken by the Castlereagh highway.

A scheme of classification of Main Roads in New South Wales was adopted in 1928 and, as a result, the road now called the Castlereagh Highway was classified as a Trunk Road. In 1938, it was reclassified as a State Highway and in 1954 it received its name.

The old timber bridge

The original bridge was built in 1897 and crossed the Namoi River approximately 800 m from the centre of Walgett. Here the river is neither tidal nor navigable and the deck of the structure, as soon became apparent, was about 1.5 m below flood level.

The bridge was meant to serve a very different size and style of community to the one that it serves today. The bridge was of the timber beam and truss variety, 121.3 m in length. It consisted of two 9.0 m spans, seven 10.7 m spans and one central span 27.43 m long of Allan Truss construction. The width between kerbs was 4.57 m with a footway on the downstream side.

Over the years, various adjustments and repairs to the bridge became necessary. In 1961 and again in 1966, sheeting and repairs costing over $12,000 were carried out. In 1970–71, two piles were replaced at a cost of $13,000.

In 1973 the failure of a downstream truss chord caused the deck to sag to such an extent that the bridge became temporarily untrafficable. The truss was replaced by a Bailey Bridge truss which allowed the deck to be pulled back to grade. In 1976, the upstream truss also deteriorated and had to be reinforced by the installation of a second Bailey Bridge truss at a cost of over $10,000.

It was apparent that the structure was failing under the increased loading of heavy modern traffic and was nearing the end of its economic life. Sight distance to either side of the bridge was limited over the "hogged" centre spans and vehicles were frequently entering the single lane structure from each side with the ensuing result of one having to back off.

Meanwhile, a new 30 000 tonne wheat silo was nearing completion in Walgett (it was opened in 1977). It would be handling produce from some 20 000 — 25 000 hectares sown to wheat and due for harvesting that season. The resulting traffic would be 20 wheat trucks per hour, in both directions, travelling over the Namoi River Bridge.

With plans for a new structure well advanced, the Department decided to improve traffic and safety conditions at the old bridge by installing traffic lights and warning signs, until the new bridge was completed. The temporary lights went into service in 1976.

The long-awaited replacement

On 9 August 1978, the Commissioner accepted a tender for the construction of a new bridge on an improved alignment of the Castlereagh Highway just downstream of the old bridge. The successful tenderer was A.R. Dickinson Construction Co. Pty. Ltd., of Tamworth.

The new bridge is 146.4 m long and has an overall width of 12.0 m, with a carriageway 9.2 m wide between kerbs and a footway, 1.55 m wide, on the upstream side. The superstructure comprises eight 18.3 m long simply supported spans of precast prestressed concrete broad flanged girders with cast-in-place reinforced concrete deck.

Prior to placing the deck concrete, transverse Macalloy bars were post tensioned in ducted intermediate cross girders. The girders in each span were positioned on individual elastomeric bearing pads. In addition, cross girders were cast across the ends of the girders and accommodated fixed dowels which protruded from the piers and abutments.

These restricted movement of the bearings to those limits imposed by expansion and contraction of the superstructure.

Provision in each intermediate cross girder was made for three 32 mm diameter Macalloy bars which were each tensioned to 600 kN using an electrically powered hydraulic jack.

The piers comprise single columns and cantilevered headstocks, founded on precast reinforced concrete piles. There are fourteen piles supporting each pier.

The 350 mm square piles penetrate 10 m into alluvial clay and rely on end bearings and wall friction for support. The overall heights of the piers vary from 6.0 m to 11.4 m above the pile caps.

The abutments are spill-through buttress type, founded on ten precast reinforced concrete piles. They were initially constructed to the underside of the headstocks to allow the Department to place fill to that level before the contractor continued with pouring the headstock. This ensured the best compaction of the fill and also provided access at deck level for construction purposes.

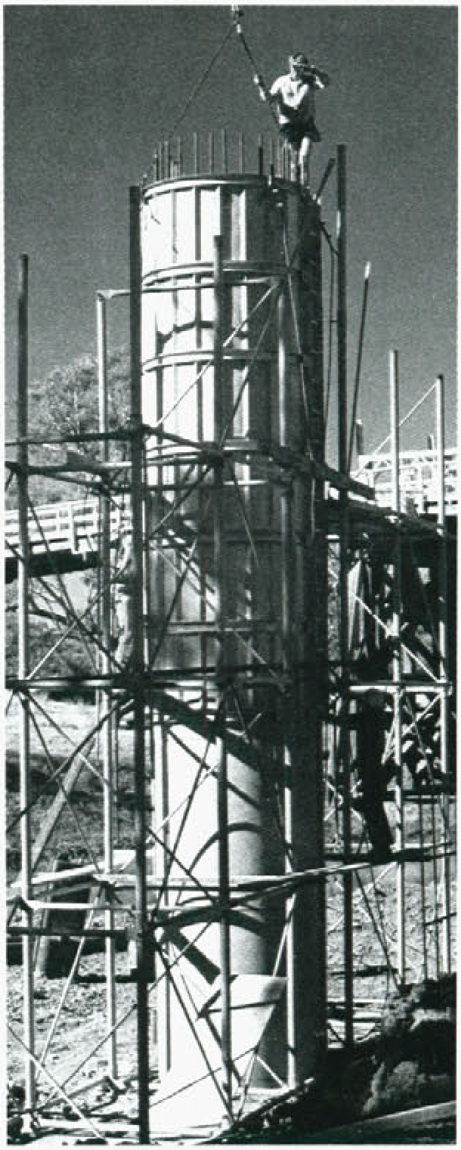
In the past, floodwaters have reached the deck girders at the abutments of the old bridge, leaving no clearance in major floods. The new bridge has approximately 1.0 m minimum clearance above the high flood level, and the north eastern approach is designed to act as a floodway during the high flood level flows. The improved sight distance of the deck minimises the likelihood of accidents.

Lighting of the bridge was provided by the Namoi Valley County Council on lamp standards provided through the Department. The cost of this lighting installation has been borne by the Department, while electricity costs will be met by Walgett Shire Council.

The construction of the new bridge and its approaches was supervised by Departmental personnel from the Department's Central northern Divisional Office at Bourke, under Divisional Engineer, Mr. Max Foster.

The new bridge was constructed at a total cost of approximately $873,234.00. It not only provides for road-users and pedestrians but also cattle and sheep. More than 25,000 cattle and 30,000 sheep used the old bridge to cross the Namoi River annually. This stock is driven across on foot in approximately 20 separate herds per year. The footway of the new bridge is separated from the carriageway by a traffic barrier, which with the wire gate provided on the footway, will protect any pedestrians who happen to be crossing the bridge at the same time as stock being driven across on the hoof.

1. Piers are comprised of single columns with cantilevered headstocks. Each pier is supported by 14 piles. 2. The eight span superstructure provides a 9.2 m wide carriageway, plus a 1.5 m footway on the upstream side.



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(Full page) The new bridge has a clearance of approximately 1.0m above high flood level. (Inset) The old single lane timber bridge over the Namoi River was often congested.

Closing words from the opening

In welcoming guests to Walgett, to see the new bridge opened, Councillor Alan Friend, President of the Shire of Walgett, referred first to the Acting Commissioner for Main Roads, Mr. Bruce Loder, who was Chairman and host of the official opening.

"Mr. Acting Commissioner, I knew you had considerable talents in having created for us this beautiful bridge, but to create such a beautiful day on which to open it, is quite remarkable and I must compliment you on both achievements!

I feel that it is a good omen, with this green feed forcing its way through the ground and everything so different to what it was only a couple of weeks ago. Perhaps, this is the start of a new era, an exciting era for our district. The old bridge has done a tremendous job and has brought us to this point quite successfully. Now it just cannot cope, even if it was in good shape, with the traffic that passes over it.

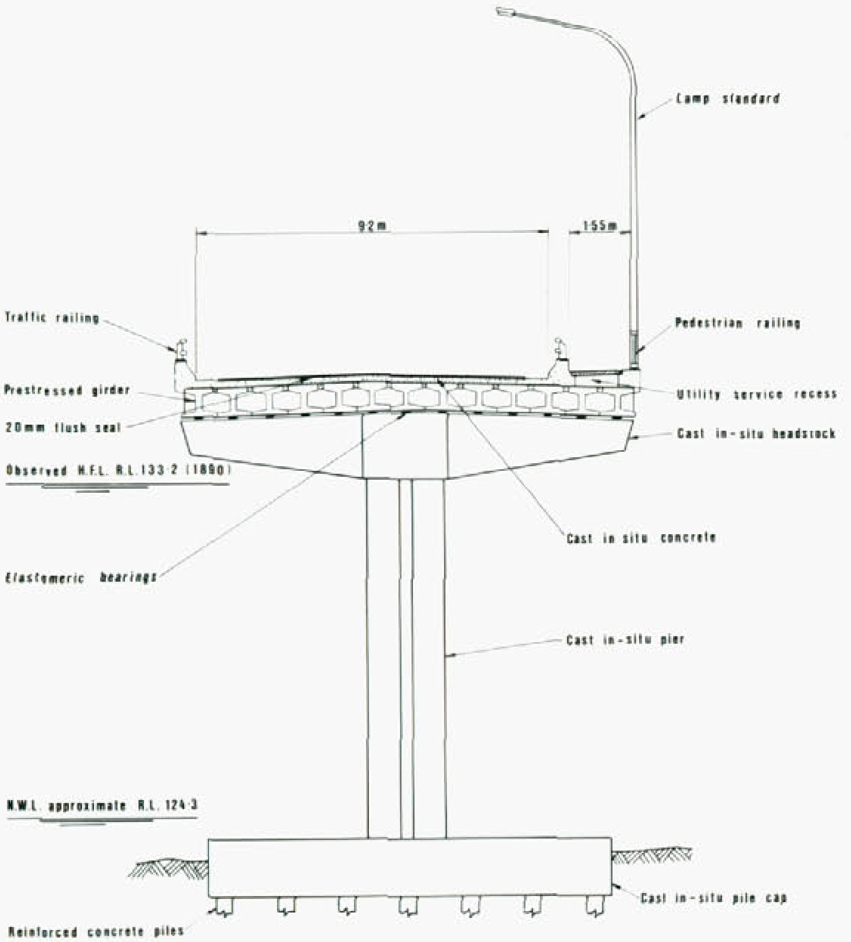
So, really it is a great day for Walgett and I hope that you all feel likewise and have great confidence in our future."

Mr. Wal Murray, State Member for Barwon, emphasised the road problems faced by country people who do not have sealed routes on which they can depend throughout seasonal changes.

"We have just had the disaster of the dry and we have gone into the immobility of the wet. We have seen greater damage, I believe, in the last two and a half years of dry than we saw in the floods. We have seen the loss of the binding on the roads, roads that were terribly rough and because of the dry unable to be graded. Now we have moved from that situation to a bog-hole situation over the last few weeks."

Concerning the new bridge, Mr. Murray reflected on a matter of "pleasant regret".

"Actually, I will be a little sorry to see the old bridge go because in the whole electorate of Barwon, there are only two sets of traffic lights. One of them is here and the other one is at the Boolooroo Bridge over the Gwydir River at Moree, in a very similar situation. The prospects of the Boolooroo Bridge being completed towards the end of the year are very reasonably good, so, we will go back to the old days of Barwon and we won't have one set of traffic lights in the whole of the electorate! Rather a fascinating thought and one that we can conjecture upon for quite a while."



CROSS SECTION OF BRIDGE

0 1 2 3 4 5 6

DIAGRAM 1

In his opening remarks, Mr. Harry Jensen, Minister for Roads, spoke of his delight in being present to open the Bridge.

"To encounter country people in their own area is always a warming experience, because the immediate friendship and goodwill that emanates from country peopole is an inspiring thing to enjoy.

One also develops a better appreciation of the problems of people who live in centres distant from the major centres of population. It is in these country areas that one fully appreciates the importance of our roads and bridges to the communities they serve. The roads throughout our agricultural and pastoral areas serve several functions. Not only are they the arteries from which our vital primary products flow from farm to market, not only do they provide the pathways for our valuable raw material resources to be transported for processing or export, they also allow the supply of many goods and services to rural and farming communities. They play no small part in improving communications to and from and between many sparsely settled regions of our State.

Thus by bringing better connections with our centres, the main roads network helps to lessen the sense of isolation for many rural communities. With improved opportunities of access to schools, hospitals and shopping centres, together with community and cultural activities, life in the sparsely populated regions of the State becomes easier, safer and a great deal more lively and stimulating.

I was delighted to hear the references to the old wooden bridge. For valiant men came out into the countryside and hewed the trees and built the structure that has recently carried loads far greater than that for which it was intended. Any community that lacks a sense of obligation, not only to the people but to the things of the past, lacks an important element of our humanity. To have an appreciation of the things which were, creates at least one of the attributes necessary in order that the generations who succeed us will remember the things that we did."

This article will in a small way permanently record for posterity at least some of what was said and done at Walgett on 18 June 1981, as well as the preceding months, to provide a new crossing of the Namoi. ●

A previous article on the Castlereagh Highway appeared in the March 1961 issue of the Main Roads Journal. Reprints of this article may be obtained from the Department's Public Relations Section.

"SUPER-SPAN" UNDERPASS ON F3 AT KANGY ANGY

The first 1.3 km of the F3 — Sydney-Newcastle Freeway north of Ourimbah Creek crosses low-lying grazing land. This area is subject to flooding from Kangy Angy Creek and the backwaters from Ourimbah Creek. The route of the F3 in this location crosses three (unclassified) gravel roads which serve local farming and grazing communities.

Two of the local roads, Valley Road and Old Maitland Road, have been closed at the freeway boundaries. In order to maintain access to these communities, a grade-separated intersection allows a third road, Old Tuggerah Road, to pass safely beneath as the freeway rises toward a major cutting through the Blackbutt Range. This necessitated a slight deviation of Old Tuggerah Road.

When designing the grade-separated intersection, two options were considered. The first of these was the construction of twin bridges to carry the freeway over Old Tuggerah Road. The flow of Kangy Angy Creek was to be contained within one span whilst the deviation of Old Tuggerah Road would be constructed at a higher level in a more northerly span.

The second consideration was to construct separate structures for the flow of the creek and for vehicular access under the freeway. A three cell 3 by 2.75 m box culvert was proposed on a diversion of the creek, and a "Super-span" horizontal ellipse shaped corrugated steel pipe structure was proposed to accommodate the two lane vehicular underpass. This second option was chosen due to its lower estimated cost.

It's all in shape

The shape of the structure is not a true ellipse, but rather two large radius (6.78 m) top and bottom arches joined by two smaller radius (2.77 m) side arches. This provides a maximum width of 10.69 m and height of 7.42 m. The larger width provided by this shape offers obvious advantages over a circular structure, especially when used as a vehicular underpass.

This particular underpass is large enough to accommodate two 3.4 m traffic lanes with a vertical clearance of over 5.5 m. The shape also offers structural advantages. The smaller radius of the sidewalls makes them more stable than the larger radius walls on a circular structure of the same horizontal span. Necessary compaction of the backfill is therefore less likely to cause buckling of the plates.

A key design factor for the "Super-span" structures is the use of reinforced concrete thrust beams. These are cast on the assembled structure at an appropriate time during backfilling. They are positioned on each side of the top arch at its junction with the side wall, their steel reinforcement connected to the corrugated steel plates.

The thrust beam reinforces the top arch at the point of critical buckling and distributes the concentrated live loads, particularly those of earthmoving and compaction equipment during construction. This is done by transferring the thrust in the top arch into the well compacted soil against its vertical face.

In August 1977, an order was placed with Armco Australia Pty. Ltd. to supply and deliver the materials. The hot dipped galvanised plates were to be 6 mm thick. The order comprised 363 plate segments and 28,235 nuts and bolts, giving the unit a total weight of 166 tonnes. The cost of the components, including 20 weeks' supervision on site during erection was $140,056.95.

A tender from Smiths General Contracting Pty Ltd of Newcastle for an amount of $167,270 for the erection and backfilling of the structure, was accepted by the Department in December 1977.

Erection procedure

It is important that the structure be supported on bedding material of uniform bearing capacity, to ensure that sections of the structure are not excessively loaded. As the underpass partly lay over the old bed of Kangy Angy Creek, it was necessary to remove organic materials to depths of up to 5 m. The latter material was replaced with compacted crushed sandstone, giving a foundation of uniform bearing capacity. This foundation was provided over the full length of the underpass and for a width of approximately 55 m along the freeway route, minimising possible future settlement in the region of the Armco structure. The excavation and replacement work was also undertaken by Smiths General Contracting Pty Ltd for a total cost of $108,600.

The structure was erected on a thin sand base shaped to the profile of the first two bottom plates. Erection was carried out in accordance with Armco's "Standard multi-plate procedures" for which the company provided a plan detailing the erection sequence. This allowed for sub-assemblies of side and top plates to be joined together on the ground prior to crane erection.

Control and supervision

Shape control during plate erection was a critical factor. The specification required each plate to be within 75 mm of the true shape at any time and provided dimensions of the chords at seams on the junctions of top, bottom and side arches to assist in this control. The "squatting" of the completed elliptical shape could not exceed 2% of the span of the structure, which in this case, was 214 mm. To achieve these dimensional tolerances it was essential to install temporary 19 mm diameter horizontal tie bars at mid height from side-wall to side-wall, as erection proceeded. The tie bars were spaced approximately 9 m apart along the barrel of the structure.

The contractor chose to erect the whole structure by sub-contract before backfill-

1. Pouring of the reinforced concrete thrust beams was a critical operation. 2. Air-operated hand-tools were used during compaction.

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ing. This required a considerable amount of hand compaction under the bottom haunch of the pipe, where the work could only be undertaken by special air operated tools. This tedious and expensive hand compaction could have been avoided if the bottom plates had been placed on a shaped bed, or if the backfill had been placed progressively, as each row of bottom plates was erected. In the latter case, fill would also have to be placed inside the plates to counterbalance the weight of the backfill in the early stages. For this reason, the shaped bed construction method is preferred.

Hand compaction was specified for a distance of 0.5 m from the structure and for a depth of 1 m over the top arch of the structure.

The select backfill was crushed sandstone with a plasticity index of less than 12 and a maximum particle size of less than 75 mm. This material was to be placed in layers not exceeding 200 mm loose thickness over the full length and width of the backfill area, before compaction commenced. Each layer had to be balanced on each side of the structure to avoid eccentric loading, which may have caused buckling.

The proper synchronisation of placing the crushed sandstone, plant compaction and hand compaction was therefore an essential feature of backfilling operations.

Dimensional checks on the shape of the structure were undertaken as each additional metre thickness of backfilling was reached. Plumb bobs were suspended from the crown of the top arch and from each thrust beam position. This enabled the Department's supervisors to readily detect any movement of the structure during backfilling. As backfilling passed mid-height, there was a slight reduction in the "span" width of the Armco, accompanied by a slight reduction in the deflection of the top arch. All movements were within the specified tolerances.

Critical supply

The pouring of the reinforced concrete thrust beams, once the backfill reached the top of the side-wall, was one of the most critical operations in the contract. To minimise the possibiliy of distorting the structure with the wet concrete (which weighed over 250 tonnes) the beams on each side of the structure were poured concurrently from the mid-point of each beam outwards to each end. The specification required the entire 1015 mm deep beam to be built up in layers of 0.25 m to 0.3 m, over its full length.

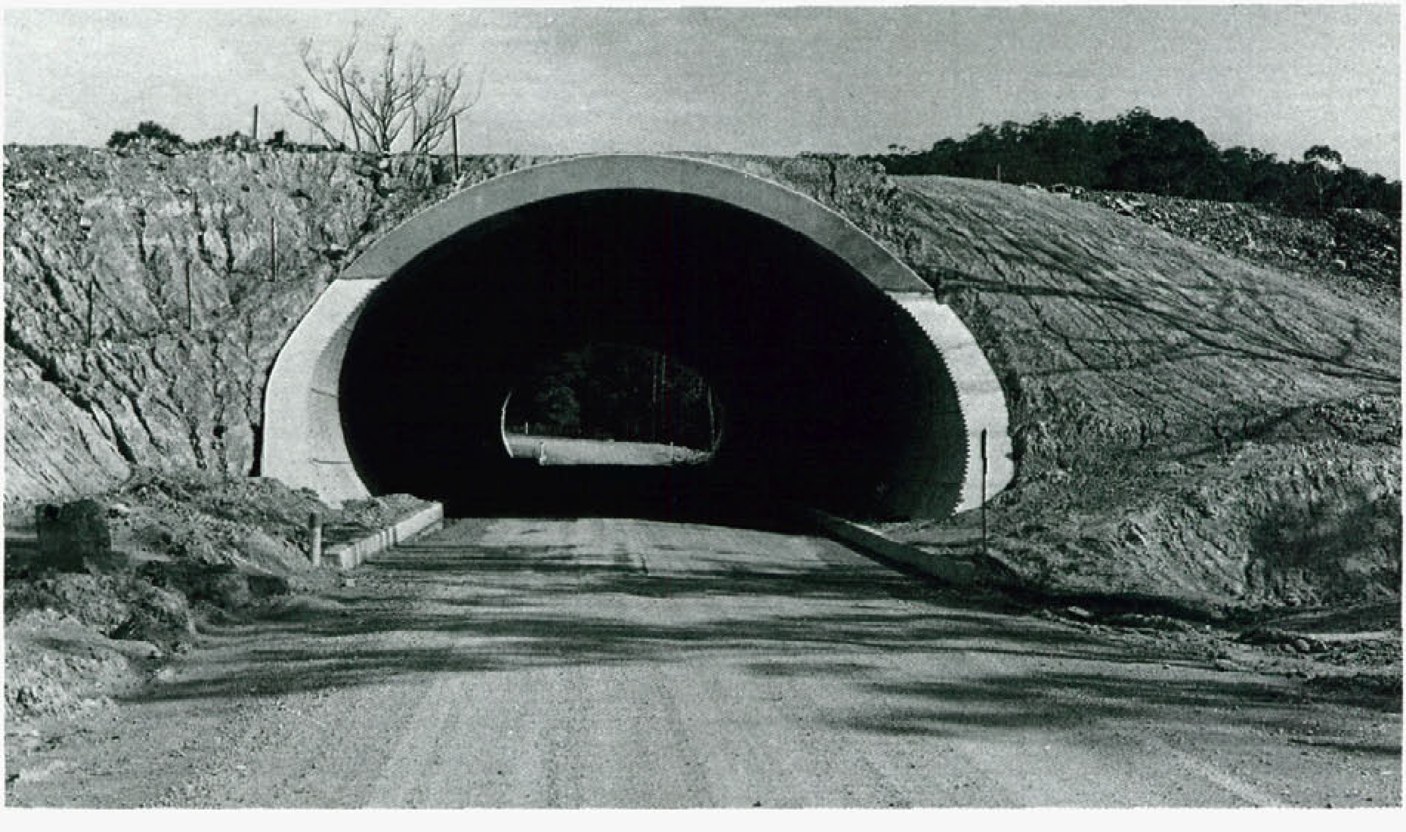
Twelve transit mixers were used to maintain supply during the 120 m^3 pour. At the start of the pour, two mixers were positioned back to back at the mid-point of each beam, so that four mixers could discharge uniformly along the two beams. The total operation was completed in six hours.

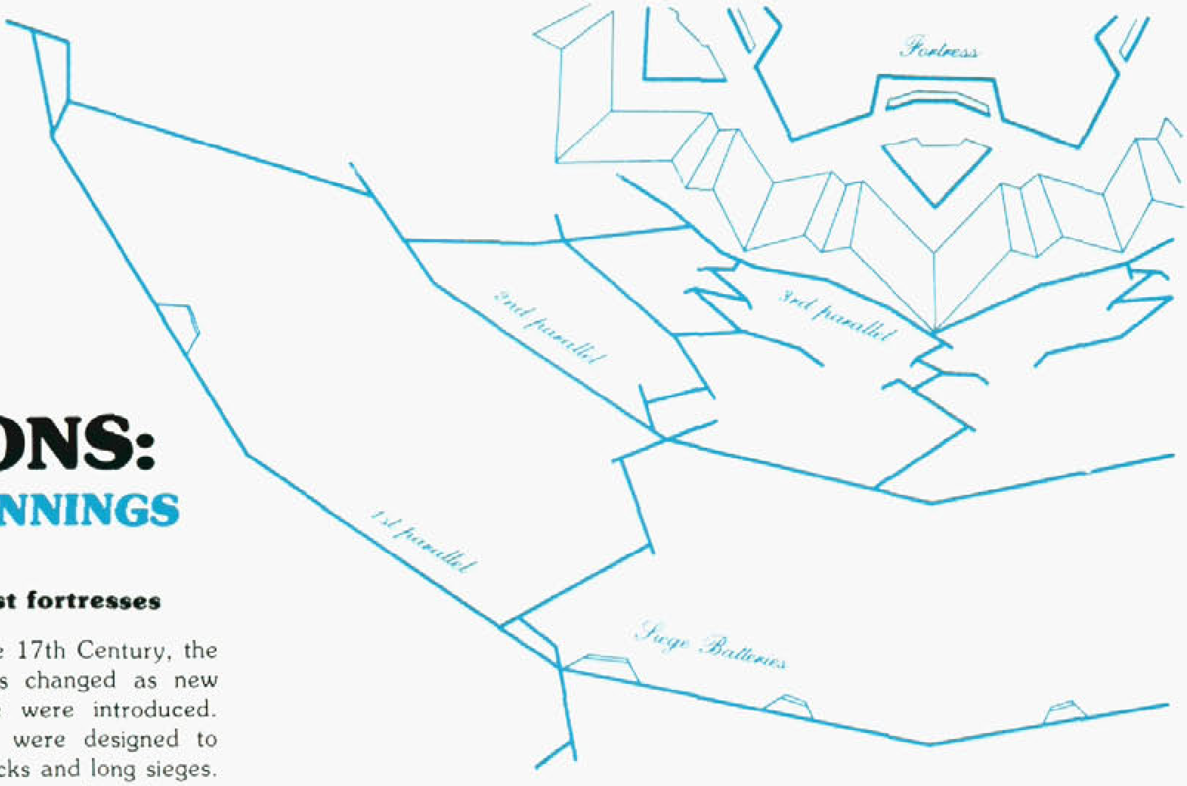
On 30 April 1979 backfilling had been completed to a depth of 1 m over the crown. The reinforced concrete collars over the ends had also been completed. This underpass is the longest "Super-span" structure in New South Wales.

The Department has since constructed the deviation of Old Tuggerah Road through the underpass. A concrete pavement has been provided through it between the freeway boundaries. The deviation was opened to traffic on 11 August 1979.

Additional earthworks over the top of the "Super-span" were undertaken by Dostal and Co. Civil Engineering Pty Ltd as part of the contract for earthworks, drainage and stabilisation from Ourimbah Creek to Cobbs Road (84.5 km to 87.38 km north of Sydney). Landscaping of the entrances to the underpass will be carried out as soon as the earthworks in this vicinity have been completed. ●

Landscaping will be carried out as soon as earthworks in the vicinity have been completed.





GABIONS:
THE BEGINNINGS

Siege craft against fortresses

Across Europe in the 17th Century, the fortification of towns changed as new methods of warfare were introduced. Bastioned fortresses were designed to withstand fierce attacks and long sieges. One of the foremost to cast his influence over these new battle techniques was the French Marshal Sebastien de Vauban.
Vauban, born in 1633, became a cadet in a cavalry regiment in 1651, and in 1652 was employed in the construction of fortifications at Clermont-en-Argonne. Shortly after this he was present at the siege of St. Menehoud, so that within a short time of enlistment he had been exposed to both sides of the science he was to make his own. In the following year he was given a commission and placed in charge of both repairing fortifications and leading siege attacks against towns held by the Spanish. In 1655 he was given the rank of 'Engineer-in-Ordinary to the King' to Louis XIV and soon revitalised the whole business of conducting a siege.

Up to this stage, the usual practice was for the attackers to arrange themselves in a circle around the objective, to prevent supplies of food or reinforcements reaching the besieged. Artillery was brought up facing the walls and opened fire at as short a range as possible in order to create and expand a breach in the wall. Once the breach was sufficiently large, it was then charged by the infantry. This assault was generally an undisciplined rush, with the object of being in early for the subsequent looting, if one was lucky enough to survive the fight.

Then came Vauban's "sap and parallel" trenching system. Since the range of guns was around 600 m, the first move after the attacking forces had established themselves was to set up batteries to withstand the fort's artillery. As this artillery was reduced, the trenches had to be advanced so that the guns could be taken and the troops prepared in safety for their attack. The Vauban system, which long served as a model for armies, was known as the approach by parallel lines. Its first use was at the siege of Maastricht in 1673. Here, Vauban completed the capture in 13 days.

Vauban placed his engineers just behind his heavy siege artillery, where they dug a trench parallel to the fort's walls. While the duel was in progress, approach trenches were dug in zigzag form so that the batteries of the fort could not sweep down their length.

From these approaches, a second parallel trench was dug closer to the fort. These trenches were about 3 to 4 m wide and 1 m deep, and the earth from the excavation was thrown forward to form a parapet. Again, the approaches were pushed out, but now they came within musket range of the fort. Specially trained men called sappers dug slowly ahead under shelter of a gabion pushed forward on wheels.

Finally, the third parallel was dug, from which the sappers dug their way up the slope towards the walls. The breaching batteries were then established in full view of the fortress, which usually soon surrendered.

As musketry increased and face to face conflicts became more hazardous, it was found necessary to protect the besiegers' batteries. This was most often achieved by piling gabions (wickerwork cages filled with earth) in front of the guns. The trenches were also screened by gabions.

The military use of gabions extended beyond the 18th century, but by that stage their application to civil engineering works was more widespread. The earth filling was surpassed by rock, but the principle of a cage filled with a stable material has continued through the ages.

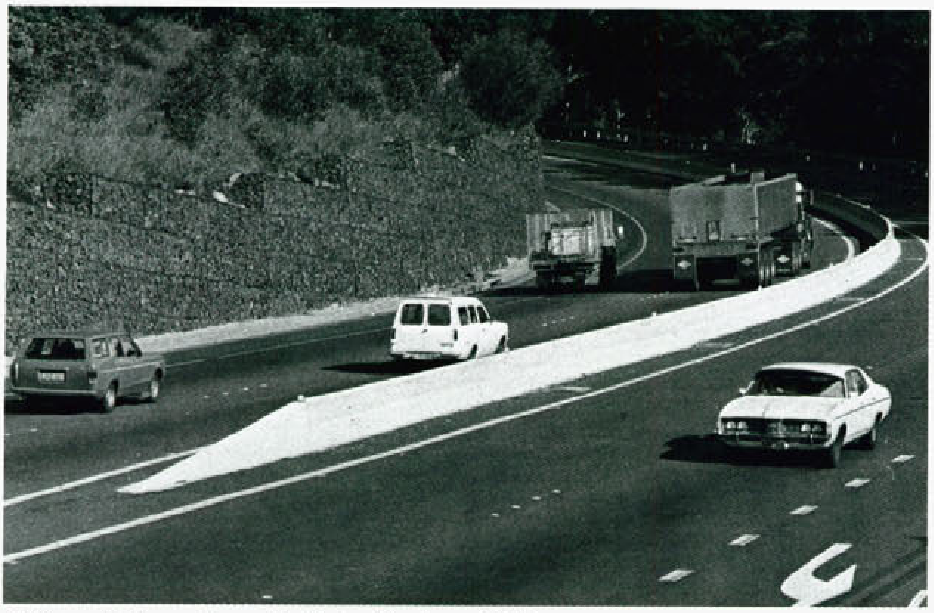
* * *

Although the principle of gabions is centuries old, it was not until the late 1960s that the modern baskets became commercially available in Australia. These were woven wire baskets imported from Italy. From 1977, two locally manufactured baskets, one a woven mesh and the other a welded mesh, also came onto the market.

Three weirs built on the Snowy Mountains Highway at Rules Point were the first gabion structures built by the Department of Main Roads. Erected in early 1973, the structures took the form of drop weirs and energy dissipators at three large corrugated metal pipe culverts. They are still in good condition after eight years service.

To date around 50 gabion and mattress works have been installed throughout the State. These vary from inlet and outlet protection for small culverts to huge retaining walls. They have been used mostly on new construction work, although appreciable use has been made in restoration work following flood damage and land slips.

The use of gabions is related to special needs and the availability of suitable rock.



Gabion retaining walls on Mt. Ousley Road near Wollongong.

They are widely used in the Bega-Snowy Mountains areas, for example, as suitable rock is readily available and the crumbly granite country poses many problems which lend themselves to gabion-type solutions.

Rock size

Consistent, durable rock of the correct size is essential for gabion and mattress work. The supply of suitable rock is often a key factor in determining the economic feasibility of gabions over alternative types of construction. The baskets are filled with rock during construction and it is important that they remain filled.

This is vital for works subjected to stream flow. Where rock is lost from the baskets (that is, sucked out by stream flow), this generally leads to other problems.

Movement of rock within the baskets, distortion of the basket and structure shape, and increased vulnerability to snagging by debris all may reduce the protective effect. Loss of rock from the baskets can be due to the use of undersize rock and the breaking down or contamination of the rocks.

For dry works the rock size is less critical. In order to use undersize or excessively variable sized rock, two different methods can be employed. In some locations, the outside faces of the walls have been hand-packed with large rocks, which have kept the undersize rocks away from the unsupported face. The exposed face of a toe-wall on the Alpine Way was lined with galvanised protection fencing mesh, permitting the use of 65 mm rocks which had been acquired for other works since abandoned. With welded mesh baskets, and within the range of meshes available, it is generally possible to choose a mesh size to suit the available rock size.

The durability of the rock has to match the expected life of the gabion structure. Shale, which was used in small quantities on two jobs, started to break down in only a matter of months. Sandstone, which was offered at an appreciable saving for walls on Mt. Ousley Road, was rejected after inspection due to its poor durability.

Standard testing of rock samples is usually carried out to check the microdurability of rocks. Tests include the Los Angeles Test, the Sodium Sulphate Test, the Wetting and Drying and Wet and Dry 10% Fines Test.

Road embankment support

Sizeable gabion walls were built at the bridge carrying the Hume Highway over the main southern railway line at Ettamogah, north of Albury. One of the crib walls which originally supported the road embankment collapsed after prolonged rain. Ineffective drainage and possible liquefaction of the fill material due to the vibration from fast trains, are thought to have caused the failure.

To provide a more effective drainage system, both walls were rebuilt using PVC coated, 4 m long gabions filled with diorite rock. They were founded on the concrete base which remained from the crib wall, and sloped backwards at 1 in 4. The new walls vary in height between 2 and 9 m, and are 30 m long.

A 200 m long gabion wall was used to stabilise a cutting failure on the Snowy Mountains Highway, just east of the Monaro Highway. The cutting failure is known as *White Slip* because of its light colouring. The cutting was in highly weathered granite which scoured readily. Overlying the granite is a cap of basalt, and at the junction, a line of springs. At one highly saturated location, failure started and spread progressively by saturation and slumping of the weak kaolinised granite.

This wall varies between 1 and 4 m in height and is 200 m long.

At another location cuts at 1:1 in granite talus, which occurred at the toe of the cut on the Summit Road at Charlotte Pass, proved unstble and slumped under the freeze/thaw action which takes place during winter. Gabion toe-walls 1 to 2 m high were provided and the batters were flattened to 2:1. This eliminated the problem and also provided for more effective re-grassing of the batter slopes, of primary concern within the Kosciusko National Park.

Granite rock used on this project was spoil from the Snowy Mountains Hydro-Electricity Scheme tunnel excavations.

Road embankment batters

Gabion walls have been used by the Department in a variety of ways to solve geometry problems. Toe walls have been provided to contain road embankments within existing road reserves, and to keep batters out of creeks. In other situations, small walls have been used at the tops of embankments where roads have been raised. In one case, the headwall of a reinforced concrete box culvert was extended upwards by using a 3 m high gabion wall.

For many decades the traditional protection of road embankment batters from scour at bridge abutments has been by stone pitching. Over recent years, the availability of stones of the required size, and the cost and expertise of labour in placing the stones, has resulted in a search for other methods. Of the alternatives tried, gabion mattresses have been found very successful and this method is becoming widely adopted.

Mattress protection work has recently been completed, on two causeways on the Castlereagh Highway, 56 km north of Walgett. The causeways total 850 m in length, and are separated by a length of raised embankment which includes two bridges. The road batters at the bridges are likewise being protected by mattresses. The galvanised mattresses, with their long edges parallel to the road, are being used on the downstream side only, to prevent scour.

Embankments, generally with 1.5 to 1 batters, have been protected with mattresses in a number of locations. The protection of downstream batters against scour from floods overtopping the road is the most common application. In one case, the *upstream* batters have been protected against wash from fast, highly jetted flow from a road culvert immediately upstream of the embankment.

Stream protection and culverts

In conjunction with the construction of the F6 — Southern Freeway at Wollongong, the alignment of American Creek was improved, and nearby Byarong Creek was deviated over a considerable length to join with American Creek. Flows in the long concrete structures were calculated to occur at supercritical velocities. Considerable turbulence and high flow velocities were expected to continue beyond the concrete aprons. As a result, 200 m of American Creek and sections of Byarong Creek were protected with mattresses.

Protection of Fairy Creek at Bodes Bridge on the Princes Highway at Wollongong was also achieved with mattresses. Realignment of the creek, which eased the sharp bend, was carried out in conjunction with the widening of the bridge. Mattresses were then applied to both the unstable banks (in cut and fill) and the bed of the creek.

Gabion and mattress works on culverts range from headwalls, wingwalls and aprons to training walls, drop weirs and energy dissipators. New road alignments often cross meanders and bends of small streams. Usually a single straight culvert is provided, with small deviations of the stream required at one or both of its ends. Gabions and mattresses lend themselves readily to curved training walls and channel lining. Flow velocities often increase in regular channels and in culverts, and small drop weirs and stilling basins made of gabions are ideal for dissipating excess energy.

These points are well illustrated by a project on the Princes Highway south of Bega. The new channel was lined with mattresses, and two 1 m gabion drops were provided. At the outlet of the pipe culvert, velocities were reduced by a 1.5 m high gabion check weir, which formed a stilling basin.

Mattresses have the great advantage of providing flexible surface protection which does not break up even after major settlement or distortion. However, careful consideration still needs to be given to the edges of any works which are exposed to stream flow. Mattresses are more prone to problems than gabions because they are shallow in depth, and are often placed on slopes or used in stream situations.

Mt. Ousley Road walls

The largest gabion work carried out by the Department is the series of retaining walls on the Mt. Ousley Road near Wollongong. These walls form one of the largest gabion wall projects in the southern hemisphere.

As it winds its way from the top of the Illawarra escarpment to the coastal plain below, Mt. Ousley Road traverses a most unstable talus slope intersected by coal seams. When the road was widened, the side of the slope was cut into, rather than adding to the embankment loads on the talus. Where the talus was cut, it had to be supported by a retaining wall.

Whichever wall type was adopted, it needed to be flexible to cater for varying foundation conditions, permeable to allow free drainage, and suitable for heights of up to 11 m. The wall also needed to be constructed with minimum disruption to

Tenders Accepted by Councils

The following tenders (in excess of $20,000) for road and bridgeworks were accepted for the three months ended 31 December, 1980.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
Auburn	Main Road No. 190	Reconstruction of Joseph Street, Lidcombe.	Borham Mixed Concrete	$70,000.00
Bland	Main Road No. 371	Construction and bituminous sealing 5.3 to 9.9 km and 10.8 to 23.6 km on Tallimba — Ardlethan Road.	Allen Bros. Asphalt Ltd	$29,790.30
Blayney	Various	Supply and spray bitumen on various roads.	Emoleum (Aust.) Ltd	$22,548.93
Boorowa	Main Road No. 248	Construction of bridge over Five Mile Creek.	Mundey Constructions	$71,170.00
Brewarrina	Various	Bituminous sealing of various roads.	Spraypave Pty Ltd	$35,321.00
Cabonne	Main Road No. 377	Manufacture, supply and driving of steel castings for foundations of Platts Bridge over Long Gully, 17.7 km west of Cudal.	Emoleum (Aust.) Ltd	$22,548.93
Coolah	Trunk Road No. 62	Construction of bridge over Talbragar River 40.65 km east of Dunedoo.	Dallas Civil and Building Pty Ltd	$131,715.60
Cootamundra	Various	Supply and spraying of bitumen on various roads.	Canberra Asphalters	$57,607.85
Crookwell	Various	Supply and spraying of bitumen on various roads.	Canberra Asphalters	$29,972.00
Goulburn	State Highway No. 2 and Main Road No. 256	Bituminous sealing and resealing.	Allen Bros. Asphalt Ltd	$22,300.00
Hastings	Main Road No. 112	Reconstruction and bituminous surfacing of road from 20.0 to 21.7 km south from Oxley Highway.	C.T.K. Engineering Pty Ltd	$231,420.00
Jerilderie	Main Road No. 321	Supply and delivery of C 160 bitumen.	B.P. Australia Ltd	$31,717.35
Lockhart	Various	Bituminous sealing of trunk and ordinary main roads — Maintenance and Improvement Programme.	Emoleum (Aust.) Ltd	$25,016.12
Mudgee	Various	Bituminous surfacing and resealing of various roads within Council's area.	Polson and McKinley Pty Ltd	$107,135.75
Mulwaree	Various	Supply and spraying of bitumen within Council's area.	Allen Bros. Asphalt Ltd	$34,902.14
Queanbeyan	Trunk Roads Nos. 51 and 52	Pressure grouting and joint sealing of concrete slabs.	Monier Ltd	$24,238.00
Wade	Various	Bituminous sealing on rural, local and shire roads.	Allen Bros. Asphalt Ltd	$114,640.94
Wakool	Various	Bituminous resealing work on various trunk and main roads in the Council's area.	Allen Bros. Asphalt Ltd	$167,730.80
Wakool	Various	Supply and delivery of aggregate for various trunk and main roads in the Council's area.	Lake Boga Quarries	$34,493.87
Waugoola	Various	Supply and spray bitumen on various roads in Council's area.	Allen Bros. Asphalt Ltd	$51,802.60
Wollondilly	Various	Supply and laying of asphaltic concrete — County of Cumberland Maintenance and Improvement Programme.	Bitupave Ltd	$66,347.68
Wollondilly	Various	Supply and laying of asphaltic concrete — Country Maintenance and Improvement Programme.	Pioneer Asphalts Pty Ltd	$82,475.20
Yarrowlumla	Various	Bituminous resealing works proposed under 1980-81 Rural Local Roads Programme.	Canberra Asphalters	$46,953.68

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 March, 1981.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
Armidale	Rural Local Road	Bridge over Dumaresq Creek at Markham Street.	Moggill Pty Ltd	$201,247.00
Auburn	Secondary Road No. 2096	Supply of 5 MPa mixed concrete and 5 MPa pump-mixed concrete for reconstruction on Wellington Road.	Farley & Lewers	$47,000.00
Bingara	Main Road No. 133	Construction of two 3 span prestressed concrete bridges, 33.5 m long over Pallal and Five Mile Creeks, west of Bingara.	Dallas Civil & Buildings Pty Ltd	$452,620.00
Bombala	Trunk Road No. 93	Construction of bridge over Racecourse Creek, 4.3 km south of Bombala.	Hunt Constructions Pty Ltd	$397,957.00
Bombala	Trunk Road No. 93	Construction of bridge over Saucy Creek, 5.6 km south of Bombala	K. E. Bottom	$868,744.70
Gilgandra	Rural Local Road	Construction of bridge over Marthaguy Creek, 0.6 km north of Oxley Highway.	Dallas Civil & Building Pty Ltd	$93,459.10
Mulwaree	Various	Bituminous sealing of roads in Council's area.	Allen Bros. Asphalt Ltd	$34,902.14
Murrumbidgee	Main Road No. 321	Bituminous resealing.	Emoleum (Aust.) Ltd	$119,452.39
Narrabri	Trunk Road No. 72	Bituminous spraying.	Spraypave Pty Ltd	$21,420.00
Tumbarumba	Various	Bituminous sealing and resealing of various roads in Council's area.	Allen Bros. Asphalt Ltd	$110,558.74
Wagga Wagga	Various	Bituminous sealing of main and trunk roads in Council's area.	Boral Road Surfaces	$31,597.95
Wakool	Trunk Roads Nos. 67 and 94	Bituminous sealing works in connection with the construction of bridge approaches at both Kyalite and Gleesons bridges.	Allen Bros. Asphalt Ltd	$69,963.39
Wingecarribee	Various	Bituminous sealing works on main and tourist roads in Council's area.	Emoleum (Aust.) Ltd	$36,153.28
Wingecarribee	Various	Supply of aggregate for main and tourist roads in Council's area.	Blue Metal and Gravel Ltd	$20,237.11
Yallaroi	State Highway No. 12, Trunk Road No. 63 and various Local Rural Roads	Supply, heat, haul and spray C160 bitumen.	Emoleum (Aust.) Ltd	$131,035.85

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, 1980.

Road No.	Work or Service	Name of Successful Tenderer	Amount
F3 — Sydney — Newcastle Freeway	City of Gosford. Repainting girders of bridge over Hawkesbury River.	I. Mondello	$134,600.00
F3 — Sydney — Newcastle Freeway	Shire of Wyong. Construction of two 3 cell 3 m × 1.8 m reinforced concrete box culverts at 94.7 and 94.8 km north of Sydney.	A.A.M.M. Constructions Pty Ltd	$170,831.20
F3 — Sydney — Newcastle Freeway	Shire of Wyong. Manufacture and delivery to site, unloading and stacking of precast, pretensioned concrete trough girders for new twin bridges over Deep Creek at bridge sites 89.01 km, 89.35 km and 89.5 km north of Sydney.	Structural Concrete Industries Pty Ltd	$599,964.00
F3 — Sydney — Newcastle Freeway	Shire of Wyong. Driving of steel piles and construction of substructures for new twin bridges over Deep Creek at 89.5 km north of Sydney.	Ermani Constructions Pty Ltd	$257,372.00
F4 — Western Freeway	Municipality of Strathfield. Reconstruction of stormwater channel at Underwood Road, Homebush.	Roach Industries Pty Ltd	$171,632.00
F4 — Western Freeway	Municipality of Holroyd. Construction of bridge over Freeway at Pitt Street, Merrylands West.	Enpro Constructions Pty Ltd	$767,735.00
F4 — Western Freeway	Municipality of Strathfield. Manufacture, deliver, unloading and erecting of bridge girders for new bridge over Underwood Road, North Strathfield.	Humes Ltd	$110,864.00
F4 — Western Freeway	Municipality of Holroyd. Construction of bridge on Coleman Street over Freeway at Mays Hill.	Citra Constructions Ltd	$749,594.00
F6 — Southern Freeway	City of Wollongong. Repainting of bridges over Flagstaff Road and Berkeley Road, Unanderra.	Mondello Bros.	$37,178.00
State Highway No. 2	Hume Highway — Shire of Gundagai. Construction of bridge over Snowball Creek, 8.0 km south of Gundagai.	John Evans	$138,698.00
State Highways Nos. 2 and 15	Hume and Barton Highways. Various council areas in Southern Division. Supply of 1000 t of 10 mm asphaltic concrete.	Allen Bros. Asphalt Ltd	$29,600.00
State Highway No. 5	Great Western Highway. Shire of Blaxland. Construction of twin bridges over Farmers Creek at 1.15 km west of Lithgow.	Hornibrook Group (Southern Division)	$759,078.00
State Highway No. 5	Great Western Highway. City of Greater Lithgow. Construction of bridge over Meadow Flat Creek, 29.8 km west of Lithgow.	Eodo Pty Ltd	$198,110.93
State Highway No. 5	Great Western Highway. City of Bathurst. Protective treatment and repainting of Denison bridge over Macquarie River at Bathurst.	Gardner Bros. Pty Ltd	$57,478.00
State Highway No. 8	Barrier Highway. Shire of Central Darling. Construction of four bridges over the Talyawalka Flood Plain at 11.59 km, 11.83 km, 12.81 km and 13.14 km east of Wilcannia.	L. M. Robertson Civil Engineering Pty Ltd	$1,262,597.00
State Highway No. 9	New England Highway. City of Maitland. Supply and lay of up to 700 t of 10 mm dense graded asphaltic concrete at reconstruction work between 16.3 and 17.3 km west of Maitland.	Boral Road Surfaces	$34,006.00
State Highway No. 9	New England Highway. City of Maitland. Supply and lay of 800 m^3 of 30 MPa ready mixed concrete to reconstruction work at intersection with Melbourne Street, East Maitland.	Blue Metal and Gravel (North)	$41,760.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 12000 m^3 of selected subgrade material to reconstruction work between 34.9 and 35.8 km west of Maitland.	W. A. Shearer	$22,200.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 6000 m^3 of sub-base gravel to reconstruction work between 34.9 and 35.8 km west of Maitland.	Les Tinkler Earthmoving	$20,940.00

traffic. Gabion walls were eventually selected.

The five walls vary in height between 2 and 11 m and have a total length of 650 m and a total volume of 14 800 m^3. The base of the walls is stepped to suit the road grading as well as the profile of the rock (where encountered), and the top is stepped to suit the topography. The steps in the front face are generally 0.3 m but vary from wall to wall, one wall having a straight profile. The walls are founded largely on talus, though one wall straddles a rock ridge and another is interrupted by a concrete drop structure.

They are made almost entirely from 4 x 1 x 1 m gabions, laid with the longest side parallel to the face, with the joints on successive layers staggered (as in brickwork). At the ends of each layer, 2 m long gabions have been used to provide flush ends. The gabions are PVC coated to resist corrosion, due to their proximity to both the ocean and heavy industry.

A strong waterproof membrane was laid under the foundations of the wall to minimise seepage into the ground below the wall. At the rear of the wall a sub-soil drain carries away all water that filters down through the wall and the backfill. During construction of the first wall, high sub-surface flows from the saturated talus were experienced. For all the other walls three sub-soil drains were installed instead of the intended one. Surface run-off from the road pavement is kept away from the wall by a concrete kerb and gutter at its base.

The rock supplied was basalt (between 150 and 200 mm in size), from quarries near Albion Park. It was tested for sulphate soundness and Los Angeles abrasion, and proved most durable. Construction was generally carried out with a gang of seven men, an excavator and front end loader. The average output was 32 m^3 per day. The rock, placed by the excavator, was in turn fed by the front end loader. The rock in the front of the wall was hand packed, and some hand levelling of the rock was also carried out. When the wall height exceeded the reach of the excavator, an earth embankment was built in front of the wall for access, and was subsequently removed.

The walls were constructed without any major problems, at an average cost of $\$56/m^3$, with the cost of the rock at the site being $\$15/m^3$.

The main advantages of gabions, namely their flexibility, permeability, speed and simplicity of construction, the absence of foundations and their relatively low cost, together with their wide range of application, ensure them a permanent place in the Department's future activities. ●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1. 2. Roadbase spoil was used as backfill, and was placed in position by an excavator. When the wall height exceeded the reach of the excavator, an earth embankment was constructed for access and was subsequently removed. 3. Gabions: the principle of a cage filled with a stable material is centuries old.

Tenders Accepted by the Department of Main Roads

Road No.	Work or Service	Name of Successful Tenderer	Amount
State Highway No. 9	New England Highway. City of Maitland. Supply and laying of 1000 t of 10 mm asphaltic concrete to reconstruction and channelisation of intersection with Melbourne Street, East Maitland.	Hawkins Asphalt Pty Ltd	$48,200.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 4000 m^3 of Class A base gravel to site of pavement strengthening and widening 12 and 13 km west of Singleton.	Archmar Investments	$20,000.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 12000 m^3 of selected subgrade material to reconstruction work between 34.9 and 35.8 km west of Maitland.	Les Tinkler Earthmoving	$41,760.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and delivery of up to 6000 m^3 of base gravel for reconstruction work between 34.9 and 35.8 km west of Maitland.	Reynold's Hiring Service Pty Ltd	$32,940.00
State Highway No. 9	New England Highway. City of Maitland. Supply and laying of 800 t of 10 mm asphaltic concrete to reconstruction work between Kaludah Creek and Harpers Hill, 13.7 to 15.6 km west of Maitland.	Boral Road Surfaces Pty Ltd	$38,864.00
State Highway No. 9	New England Highway. Shire of Singleton. Supply and laying of 1000 t of 10 mm asphaltic concrete to reconstruction work at Minimbah between 36.2 and 37.4 km west of Maitland.	Bitupave Ltd	$50,000.00
State Highway No. 10	Pacific Highway. Shire of Great Lakes. Supply and delivery of 1160 m^3 of 14 mm precoated sealed aggregate for flush seals south of Bulahdelah.	Quarry Industries	$23,635.00
State Highway No. 10	Pacific Highway. Shire of Great Lakes. Supply and spraying of 60000 l Class 160 bitumen for flush sealing between Bangalow Creek and Wootton.	Boral Road Surfaces	$24,304.00
State Highway No. 10	Pacific Highway. Shire of Great Lakes. Supply and spraying of 85500 l Class 160 bitumen for flush sealing south of Bulahdelah.	Boral Road Surfaces	$35,227.00
State Highway No. 10	Pacific Highway. Shire of Wyong. Supply and delivery of 10000 m^3 of selected subgrade to construction work between Vales Road and Saliena Avenue, Munmorah.	D. & J. Constructions Pty Ltd	$25,800.00
State Highway No. 10	Pacific Highway. Shire of Port Stephens. Supply and laying of 1000 t of 10 mm asphaltic concrete to construction work between Glenelg Street and Carpenter Street, Raymond Terrace.	Bitupave Ltd	$48,470.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and laying of 600 t of 10 mm asphaltic concrete to northbound carriageway at Highfields.	Hawkins Asphalt Pty Ltd	$28,380.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and laying of 750 t of 10 mm asphaltic concrete to southbound carriageway at Highfields.	Hawkins Asphalt Pty Ltd	$35,475.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and laying of 500 t of 10 mm asphaltic concrete to southbound carriageway at Belmont.	Bitupave Ltd	$25,550.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and laying of 520 t of 10 mm asphaltic concrete to northbound carriageway at Belmont.	Bitupave Ltd.	$26,572.00
State Highway No. 10	Pacific Highway. Shire of Port Stephens. Supply and laying of 74000 l Class 160 bitumen for flush sealing at Karuah.	Boral Road Surfaces	$31,765.00
State Highway No. 10	Pacific Highway. Shire of Tweed. Supply and laying of up to 3000 t of asphaltic concrete.	Pioneer Asphalts Pty Ltd	$126.540.00
State Highway No. 10	Pacific Highway. Shire of Tweed. Supply and laying of up to 1100 t of asphaltic concrete.	Pioneer Asphalts Pty Ltd	$50,710.00
State Highway No. 10	Pacific Highway. Shire of Byron. Driving and splicing of 36 steel piles for bridge over railway line at Tyagarah, 10.36 km north of Bangalow.	J. Parkinson	$48,084.10
State Highway No. 10	Pacific Highway. Shire of Coffs Harbour. Supply and delivery of bridge units to bridge over Coffs Creek, 0.3 km north of Coffs Harbour.	North West Prestressed Concrete	$24,540.00
State Highway No. 10	Pacific Highway. Shire of Nambucca. Supply and laying of asphaltic concrete at various bridge sites.	Pioneer Asphalts Pty Ltd	$23,100.00
Trunk Road No. 75	Shire of Dumaresq. Construction of bridge over Dyke River at Lower Creek, 93.35 km east of Armidale.	Bridge and Civil Pty Ltd	$573,831.00
Main Road No. 108	City of Newcastle. Surface preparation and protective coating of steelwork at the bridge over north arm of Hunter River at Stockton.	K.G.B. Contractors	$88,266.00
Main Road No. 157	Shire of Baulkham Hills. Widening of bridge over Cattai Creek in Showground Road, 3.5 km west of Castle Hill.	McGregor Constructions	$165,537.31
Main Road No. 164	Municipality of Manly. Construction of pedestrian bridge over Sydney Road at Balgowlah Boys High School, Balgowlah.	Adua Contracting Pty Ltd	$108,450.00
Main Roads Nos. 240 and 243	Shire of Coolamon. Bituminous sealing 27 km to 30 km west of Main Road No. 240, resealing under the 1980/81 Trunk and Main Roads Maintenance and Improvement Programme and resealing under the 1979/80 Traffic Facilities Programme.	Canberra Asphalters	$62,494.74
Main Road No. 503	Shire of Singleton. Supply and laying of up to 900 t of 10 mm asphaltic concrete for resheeting work between 33.6 km and 35.0 km south of Singleton.	Bitupave Ltd	$45,729.00
Main Road No. 503	Shire of Singleton. Supply and laying of up to 650 t of 10 mm asphaltic concrete for resheeting work between 35.6 and 43.3 km south of Singleton.	Bitupave Ltd	$33,280.00
Main Road No. 503	Shire of Singleton. Supply and laying of up to 800 t of 10 mm dense graded asphaltic concrete to resheeting work between 43.9 and 44.5 km south of Singleton.	Hawkins Asphalt Pty Ltd	$35,040.00
Main Road No. 503	Shire of Singleton. Supply and laying of up to 600 t of 10 mm asphaltic concrete for resheeting work between 46.5 and 47.6 km south of Singleton.	Hawkins Asphalt Pty Ltd	$26,280.00
County Road No. 5015	City of Parramatta. Construction of bridge over Toongabbie Creek east of Harris Road at Wentworthville.	Enpro Constructions Pty Ltd	$642,520.50
Alpine Way	Shire of Snowy River. Winning, crushing and stockpiling of crushed rock for reconstruction work.	Normans Plant Hire	$92,000.00
Wodonga Place	City of Albury. Supply, deliver and laying of up to 550 t of 20 mm asphaltic concrete and up to 250 t of 10 mm asphaltic concrete.	Allen Bros. Asphalt Ltd.	$38,525.00
Various	City of Newcastle and Municipality of Lake Macquarie. Supply and apply thermoplastic materials to pavement markings in these areas.	Linemarking Industries	$30,282.00

Road No.	Work or Service	Name of Successful Tenderer	Amount
Various	Cities of Blue Mountains, Greater Lithgow and Bathurst and Shires of Oberon, Evans, Coolah, Rylstone and Mudgee. Application of painted road marking materials.	Linemarking Services Pty Ltd	$47,926.00
Various	Various Council areas in South Coast Division. Thermoplastic linemarking of pedestrian crossings and holding lines at various locations.	Spraypave Pty Ltd	$22,035.00
Various	Shire of Wade. Bituminous sealing on various main and trunk roads.	Allen Bros. Asphalt Ltd	$49,987.87
Various	Shire of Wade. Supply of 1703 m^3 of 10 mm; 852 m^3 of 14 mm and 881 m^3 of 20 mm aggregate.	Farley & Lewers	$50,995.82
Various	Shire of Urana. Bituminous sealing and resealing of various trunk, main and shire roads.	Emoleum (Aust.) Ltd	$134,530.60

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 31 March, 1981.

Road No.	Work or Service	Name of Successful Tenderer	Amount
F3 — Sydney — Newcastle Freeway	Shire of Wyong. Construction of twin bridges over St. Johns Road at 93.5 km north of Sydney.	Civilbuild Constructions Pty Ltd	$460,533.95
F3 — Sydney — Newcastle Freeway	Municipality of Lake Macquarie. Construction of 2 cell 4.2 m × 4.2 m box culvert over Mannering Creek, 103.2 km north of Sydney.	Ermani Constructions Pty Ltd	$269,626.00
F3 — Sydney — Newcastle Freeway	Shire of Wyong. Construction of twin bridges over Buttonderry Creek at 96.7 km north of Sydney.	A.A.M.M. Constructions	$219,203.50
State Highway No. 1	Princes Highway. City of Wollongong. Manufacture, supply, delivery, unloading and stacking of pre-cast pretensioned concrete members for bridge over South Coast railway line in Flinders Street, North Wollongong.	Humes Ltd	$78,780.00
State Highway No. 1	Princes Highway. Shire of Imlay. Construction of new bridge over Merimbula Lake at Merimbula.	McDougall-Ireland Pty Ltd	$796,554.00
State Highway No. 2	Hume Highway. Shire of Yass. Construction of carriageway from Two Mile Creek to Dunderalligo Creek.	Thiess Bros.	$526,514.00
State Highway No. 2	Hume Highway. Shire of Gundagai. Supply, delivery and laying of asphaltic concrete at Sylvias Gap, 19 km south of Gundagai.	Canberra Asphalters	$68,414.40
State Highway No. 9	New England Highway. Shire of Singleton. Construction of bridge over Bowmans Creek, 16.1 km north of Singleton.	Civilbuild Constructions Pty Ltd	$419,453.93
State Highway No. 9	New England Highway. City of Maitland. Supply and laying of up to 750 t of 10 mm dense graded asphaltic concrete to reconstruction work between 13 and 15 km west of Maitland.	Bitupave Ltd	$38,700.00
State Highway No. 9	New England Highway. City of Maitland. Supply and delivery of up to 7000 m^3 of sub-base gravel to reconstruction work between 12.2 and 13.7 km west of Maitland.	Quarry Products Pty Ltd	$22,050.00
State Highway No. 9	New England Highway. City of Maitland. Supply and delivery of up to 7000 m^3 of base gravel to reconstruction work between 12.2 and 13.7 km west of Maitland.	Reynolds Hiring Service	$22,680.00
State Highway No. 9	New England Highway. City of Maitland. Supply and delivery of up to 1300 m^3 of selected sub-grade material to reconstruction work between 12.2 and 13.7 km west of Maitland.	Quarry Products Pty Ltd	$27,300.00
State Highway No. 9	New England Highway. City of Maitland. Haulage of 10000 t of slug skulls from B.H.P. Ltd, Port Waratah to construction site between Mitchell Ave. & George St., East Maitland.	J. T. & B. W. Johnson Pty Ltd	$31,000.00
State Highway No. 9	New England Highway. Municipality of Glen Innes, Shires of Guyra and Severn. Supply and delivery of bulk quick-lime for stabilisation works.	Newcastle Lime & Cement Co.	$32,427.50
State Highway No. 10	Pacific Highway. Shire of Hastings. Repainting of steelwork (including surface preparation and protective coating) on Dennis Bridge over Hastings River at Blackmans Point, 80.1 km north of Taree.	I. Mondello	$168,960.00
State Highway No. 10	Pacific Highway. City of Greater Taree. Supply and delivery of ready mixed concrete to Stewarts River bridge 37.8 km north of Taree.	B.M.G. Concrete	$63,063.00
State Highway No. 10	Pacific Highway. City of Greater Taree. Supply and delivery of ready mixed concrete to Stewarts River bridge, 37.8 km north of Taree.	K. & I. Concrete	$40,512.00
State Highway No. 10	Pacific Highway. Shire of Wyong. Supply and delivery of 400 m^3 of readymixed concrete to construction work between Vales Road and Saliena Avenue, Munmorah.	Pioneer Concrete Pty Ltd	$26,050.00
State Highway No. 10	Pacific Highway. Shire of Port Stephens. Supply and delivery of 2000 m^3 of fine crushed rock to construction work between Glenelg and Carpenter Streets, Raymond Terrace.	Blue Metal & Gravel (North)	$23,850.00
State Highway No. 10	Pacific Highway. Municipality of Lake Macquarie. Supply and delivery of 10000 m^3 of selected sub-grade material to construction of divided carriageways between Oxford Street, Gateshead and Warners Bay Road Charlestown.	A. Matthews Pty Ltd	$41,500.00
State Highway No. 10	Pacific Highway. Shire of Port Stephens. Supply and lay 300 t of 20 mm asphaltic concrete to construction work between Glenelg and Carpenter Streets, Raymond Terrace.	Hawkins Asphalt Pty Ltd	$42,984.00
State Highway No. 11	Oxley Highway. Municipality of Hastings. Driving of 33 precast concrete piles at Sarahs Creek Bridge, 16.8 km west of Port Macquarie.	M. F. & E. I. Crocker	$25,900.00
State Highway No. 11	Oxley Highway. Municipality of Hastings. Manufacture, supply and delivery of 12 pretensioned, precast concrete bridge girders for bridge over Sarahs Creek, 16.8 km west of Port Macquarie.	Humes Ltd	$37,296.00
State Highway No. 17	Newell Highway. Shire of Timbrebongie. Widening of bridge over Rays Creek, 29.8 km south of Dubbo.	G. & E. M. Tincknell	$62,825.13
State Highway No. 18	Castlereagh Highway. Shire of Coonamble. Construction of bridge over Castlereagh River at Coonamble.	Bridge and Civil Pty Ltd	$955,256.00
State Highway No. 19	Monaro Highway. Shire of Monaro. Widening of bridge over Colyers Creek, 71.5 km south of Canberra.	Hunt Constructions Pty Ltd	$123,594.00
Main Road No. 217	Municipality of Lake Macquarie. Fabrication, delivery to site, unloading and stacking of steel girders and safety screens for bridge over main northern railway line at Morisset.	Citra Constructions Ltd	$144,772.00
Main Road No. 256	City of Goulburn — Construction of bridge over Wollondilly River at Kenmore 3.0 km north of Goulburn.	Lumo Constructions Pty Ltd	$840,000.00
County Road No. 5033	City of Blacktown and Shire of Baulkham Hills. Construction of bridge over Toongabbie Creek at Pyes Crossing on Old Windsor Road, Seven Hills.	A.A.M.M. Constructions Pty Ltd	$239,979.90