THE USE OF CONCRETE SEGMENTAL PAVING FOR CONSTRUCTION OF AN AIRCRAFT LANDING AIRSTRIP ON THEVENARD ISLAND, WESTERN AUSTRALIA

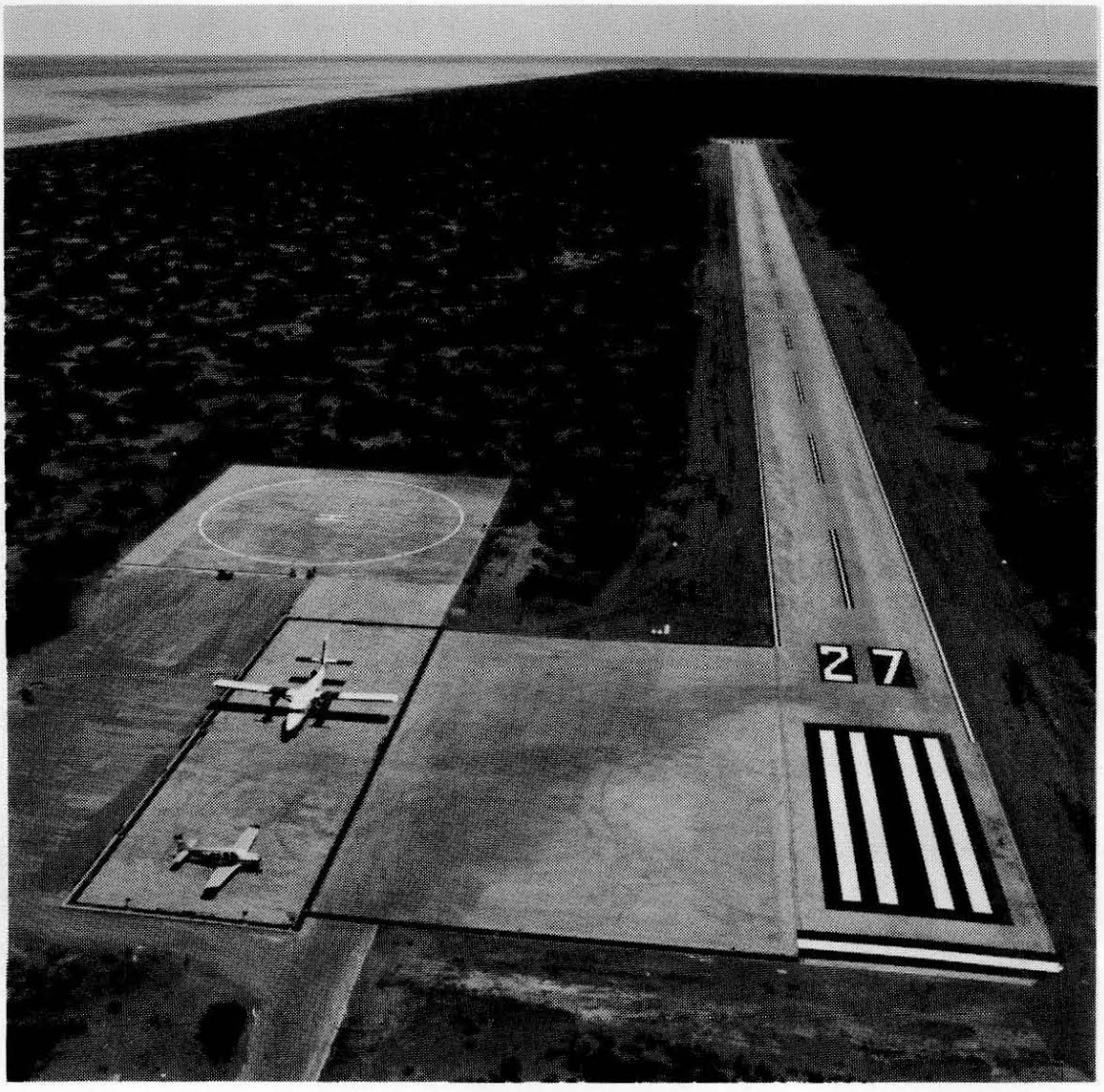
I. Muir
Boral Masonry, Perth, Australia

Summary

Construction of a 1 km long aircraft landing runway was completed using concrete segmental pavers in March 1995. The runway measures 1km long by 20m wide and including parking aprons the overall project consisted of 26,000m² of concrete segmental paving.

This paper will give an outline of the history and background to the design of the airstrip with particular focus on the reasons a concrete segmental pavement was specified instead of other surface mediums.

Economic factors, environmental impacts, construction details as well as manufacturing and laying times will also be discussed.



Location

Thevenard Island is located 1,400 kms north of Perth and 25 kms offshore from Onslow in the North West of Western Australia.

Thevenard Island is a flat sandy island approximately 5 km by 1km wide. The client, West Australian Petroleum Pty Ltd (WAPET) is engaged in the development of the Roller and Skate oilfields approximately 20 kms west of Onslow, Western Australia. WAPET have existing oil and gas separation, water treating and tanker loading facilities on the island and operate existing offshore production platforms which deliver production to Thevenard Island.

History of Original Airstrip

The existing airstrip at Thevenard Island used to service WAPET facilities was constructed in 1990. The original airstrip pavement was constructed by stabilising the institu sand with approximately 6% cement.

This surface suffered from a combination of weather erosion and wear from the impactive and abrasive effect of landing aircraft. In an attempt to arrest these problems, the surface was treated with a bituminous primer seal consisting of a primer binder and a fine aggregate seal. This treatment had some effect regarding the wear effect, but did not produce a long term solution.

The airstrip continued to deteriorate to a point that it created a serious hazard to users. Continued scouring of the surface caused pot holing requiring continual maintenance work.

In consideration of the importance of the airstrip to WAPET's operation on the island and the hazards that it created it was decided that extensive upgrade works to the strip were required.

Pavement Evaluation

Fraser Worley Pty Ltd, Consulting Engineers, Perth, Western Australia were engaged by WAPET to investigate the pavement alternatives available to achieve their requirements as well as being compatible with the sensitive environment of the 'C' Class Reserve of the Island (see environmental conditions, page 4).

Preliminary designs were prepared for six options. These were:-

* Steel matting
* Prime and two coat seal
* Cement stabilised sand
* Asphaltic concrete
* Reinforced concrete
* Concrete segmental paving.

Each option was considered on the basis of the following:-

* Technical performance
* Maintenance requirement
* Durability
* Constructability
* Cost
* Environmental impact.

Through liaison with various bodies including the Civil Aviation Authority (CAA), Conservation and Land Management (CALM) and WAPET, specific design evaluation criteria was developed and included:-

* Design life of 15 years.

* Construction period of approximately 6 weeks.

* Low maintenance (minimal post-construction disruption).

* Low environmental impact (meet environmental regulations of "C" class nature reserve).

* Comply with CAA guidelines for night operation.

Through the evaluation process a short list of 4 viable options was developed.

The four options deserving further evaluation were:-

* Cement stabilised sand
* Prime and two coat seal
* Asphaltic concrete
* Concrete segmental paving.

Evaluation Conclusions

Evaluation indicated concrete segmental paving to be the most technically suitable option. The pavement provides high strength and durability yet remains flexible. The initial capital outlay for this option was AUD$2.4 million. Concrete segmental paving was further supported as it has been used successfully in the construction of roads previously on Thevenard Island.

The cement stabilised sand and prime and two coat seal required the least initial capital outlay of AUD$1.1 million and AUD$1.5 million respectively. Technically, however both these options require regular maintenance to maintain the integrity of the surface.

The asphaltic concrete option is anticipated to out-perform both the cement stabilised sand, and prime and two coat seal but would still require some maintenance. The initial capital outlay for this option is AUD$1.9 million.

After final consideration of these alternatives it was decided that concrete segmental paving presented the most attractive option.

Primary factors in concrete segmental paving were:-

* High durability
* Low maintenance ie. minimal future disruption
* Ease of transport to site
* Environmentally "friendly" solution
* Structural integrity already proven on road construction on Thevenard Island.

Environmental Considerations

One of the most important reasons that concrete segmental pavers were used for the construction of the airstrip were the environmental benefits this paving allowed.

Due to the isolated location and harsh climate, Thevenard Island is inhabited by a number of rare and unique flora and fauna. Inhabitants on the island include a rare native mouse and Acacia Coracea plants, both of which are found solely in the region. Additionally the island is a nesting ground for sea turtles and surrounding waters are filled with an abundance of marine life.

In order to help preserve Thevenard Island relatively "pure" environmental state it has been classified as a "C" class nature reserve. With this classification strict environmental regulations are applied to all work carried out on and around the island.

Particular to this contract a number of restrictions were in place for consideration both in design and construction of the airstrip. Environmental considerations on the island relating to the construction include but were not limited to:-

* import and export of plant and materials
* containment of possible contaminates
* containment of works within limits of construction
* rehabilitation of disturbed areas
* conservation of soil fertility
* rehabilitation of airstrip lease following useful life of airstrip.

Environmental Advantages of Concrete Segmental Paving

Owing to the fragile nature of the environment it is most important that possible contaminates are not brought onto the island. Two possible vehicles for the introduction of natural contaminates include:-

* Mud and vegetation imported on wheels and underside of plant and machinery
* Import of seed and vegetation contained in natural bulk materials.

By designing the use of concrete segmental paving as the basis for construction of the airstrip this drastically reduces the risk of contamination to the island.

Rehabilitation

A great advantage of the choice of pavement type used for this contract is its ability to be readily removed following completion of WAPET operations on Thevenard Island. Should the useful life of the airstrip expire, rehabilitation of the airstrip could be carried out leaving little or no impact on the environment.

Concrete segmental pavers have the advantage that they can be picked up, repacked on pallets and shipped back to the mainland. The cost of this operation could be offset against the resale value of the pavers.

Rehabilitation of the sub-base pavement could be readily performed by pulverising the cement stabilised sand in preparation for vegetation regrowth.

In total this operation would come at a minimal cost to the principal in comparison to a similar operation being carried out on more conventional pavement types.

Manufacture

Manufacture of the concrete segmental paving was by Boral Besser Masonry Pty Ltd, Jandakot, Perth, Western Australia.

26,000m² or 1.04 million Boral Interpave shape Type A nibbed paving units were supplied for construction of the airstrip and parking apron.

The ability from Boral to guarantee manufacture and supply of 1.04 million paving blocks over a 4 week contract period in November/December 1994 was a prime consideration to avoid any delay in construction.

Special packing of paving was required for a journey to site of some 1,425 kms from the Jandakot factory. Two packs were strapped on a pallet and transport was by truck some 1,400 kms to Onslow. The paving units were then transported by barge the 25 kms to Thevenard Island.

Due to the growth of paving units caused by mould wear, every pack was individually labelled and numbered in sequential order for identification on site and assist in the ease of laying by ensuring similar size of pavers were placed together.

For this unique contract a quality system was developed to ensure paving units were dimensionally checked every 4 hours with regular mould changes to achieve a dimensional tolerance of ± 0.5mm which resulted in trouble free laying, allowing the project to be completed 1 week earlier than schedule.

Paving units were manufactured in accordance with the Concrete Masonry Association of Australia Specification for Concrete Segmental Paving Units - MA20.

Testing of paving units was performed on each daily production run to ensure the client's requirements were adhered to.

Construction

Malavoca Pty Ltd, Perth, Western Australia were the main contractor for the airstrip upgrade works.

Pavement Design

Detailed description of the pavement used for this project is as follows:

As a medium for the upgrade works to the existing airstrip concrete segmental paving was chosen. In this solution, concrete segmental pavers were laid on a 30mm sand base overlaying a 150mm cement stabilising sand sub base. The sub base utilised the existing base where it made the required grades pavement thickness criteria. In other areas the stabilised sub base was reconstructed. A description of the construction process is as follows:

(i) *Sub Base*

The sub base for the concrete segmental paving was constructed from a combination of new and existing cement stabilised sand. It was proposed to use an optimum amount of the existing stabilised sand airstrip pavement as a sub base for the paving. To this end the design profile for the new pavement was formed around a line of best fit over the existing pavement.

Classification of the pavement was carried out based on the criteria that the pavement would fit into design profile and maintain minimum required pavement thickness. Through this process the existing pavement was divided into areas classified for either reconstruction and profile works.

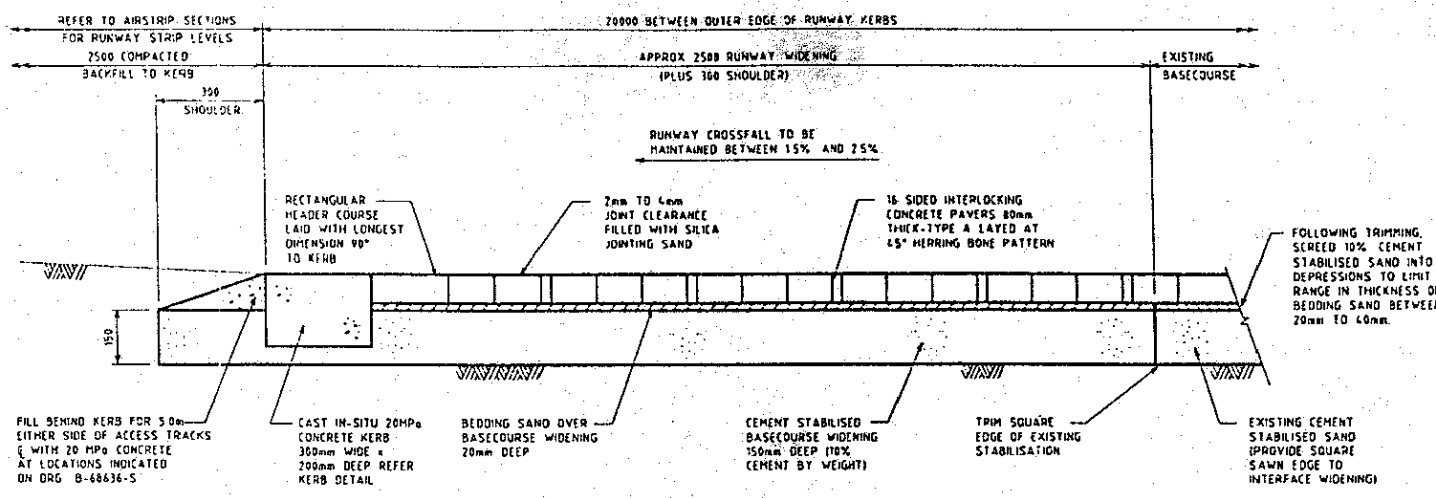


Fig 1. Typical pavement cross-section.

Reconstruction - Existing pavement which did not meet the design criteria for pavement sub-base was reconstructed. Sub-base reconstruction was carried out by a process of:

* pulverisation of the existing pavement
* 10% cement restabilisation of a 150mm layer of sand
* compaction; and finally
* graded to the design level

Profiling - Existing pavement which met the design criteria for pavement sub-base was profiled to the design grade. Profiling was carried out using a Wirtgen 1900DC profiling machine.

(ii) *Extruded Concrete Kerbing*

To act as an edge restraint for the segmental pavement a 300mm by 200mm extruded concrete kerbing was trenched in place around the perimeter of all pavement areas.

(iii) *Concrete Segmental Paving*

Following kerb and sub-base preparation Boral Interpave shape type A pavers were laid on a loose spread nominal 30mm thick sand bed. Compacting was completed using plate compacters and joints filled using clean imported jointing sand.

Laying Procedure

Laying of the segmental pavement was performed by Challenge Brickpaving, Perth, Western Australia.

Bedding sand was excavated from the island and screeding was performed by hand. The paving was laid manually using a team of 26 block pavers and labourers.

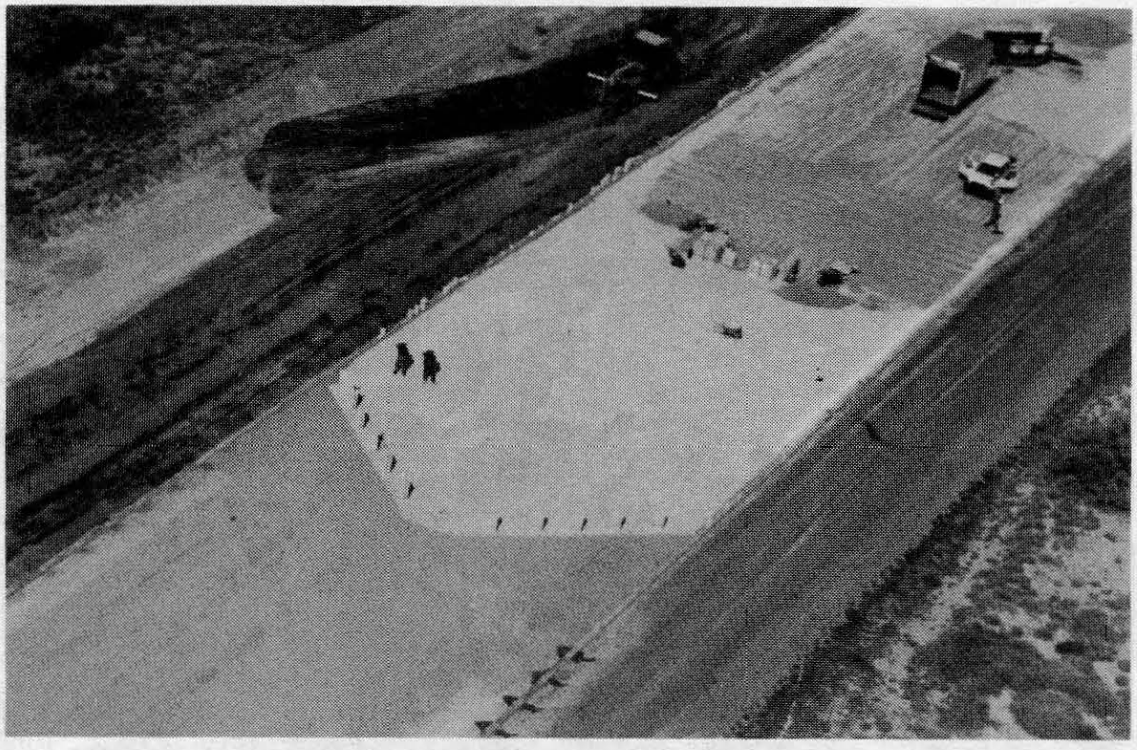
The paving was laid in a 45° herringbone pattern to the centre line of the airstrip with surveyed height levels being marked every 20 linear metres along this centre line.

Pavers were transported to the laying face by forklift and placed in position for laying with the use of pack barrows.

Strict quality control measures were in place to ensure the joint width of 2-4mm was adhered to. Pavers from adjacent pack numbers were used in sequence to ensure exact sizes were used together and assist with ease of laying.

The pavers worked 10 hour shifts from 6am to 4pm when the temperature was in the 35-39°C range. When the temperature reached between 40-45°C the shift was broken in half - 4am-10am and then 5pm-10pm under floodlights.

The laying was completed in 21 days with an average daily rate of 1,238m² and a highest rate of 1,800m² per day.



Concluding Comments

As a first of its kind in Australia and the Southern Hemisphere it was imperative that Boral supplied a dimensionally accurate paving unit, and manufactured on time.

The ability to manufacture a quality assured product that, for this project, achieved a dimensional tolerance of ± 0.5mm which in turn resulted in trouble free laying allowing the project to be completed 1 week ahead of schedule.

The construction of the airstrip was achieved to the complete satisfaction and delight of the client and design engineers who have a durable and uniform surface which will give trouble-free service for many years.

The unique nature of this project, that it is a landing strip rather than an aircraft hardstanding apron has assured increased interest in concrete segmental paving.

It is a great advert for Boral and the concrete segmental paving industry, and will undoubtedly lead to future interest in this type of construction around the world.