ABSTRACT

This paper presents an account of engineering experience related to road construction materials, particularly coral detritus, used in road construction and maintenance in Western Samoa during the period July 1975 to July 1978. The performance of some coral pavements is discussed and a summary of test results presented. The experience was gained in the course of an Australian development assistance project which was undertaken to assist in upgrading the equipment, facilities, procedures and technology of the Samoan Government for road construction and maintenance. The investigations of the Project's materials laboratory resulted in the development of a large centralised hard rock quarry for production of high grade crushed aggregate and encouraged an extensive use of coral detritus for road pavements. Both results have contributed towards development of a locally oriented technology and the reduction of road construction and maintenance costs.

INTRODUCTION

Western Samoa is a small island country in the mid South Pacific. Like other small island communities, its development is hampered by problems associated with isolation, population growth, limited land area and a shortage of natural resources. It became independent in 1962. The Government realises the necessity for outside assistance, both financial and technical, and makes good use of international aid. Emphasis is being placed on agricultural development to provide a basic export income and thus high priority is given to road development.

In early 1975, a five-year bilateral technical development program was initiated as the 'Western Samoan-Australian Workshop and Road Maintenance Project' by the Governments of Western Samoa and Australia. Its aim was to upgrade and extend the road system of Western Samoa. The Snowy Mountains Engineering Corporation (SMEC) was commissioned by the Australian Development Assistance Agency (now the Australian Development Assistance Bureau) to direct the work.

It was intended to modernise and rationalise the Public Works Department's (PWD) equipment fleet and to train PWD personnel (SMEC 1974). Emphasis was placed on supplying new construction machinery, and establishing workshop facilities, a spare parts procurement system and maintenance procedures for plant and equipment. However, it was soon realised that local construction materials technology development was required if best use were to be made of the equipment and facilities.

In this paper, the development of a locally appropriate materials technology is described briefly. Materials investigations into the engineering use of coral, which forms an important part of that technology, are described in more detail.

BACKGROUND

Being a young country, Western Samoa has an insufficient number of technically trained and experienced local personnel to implement its public works program. Some managerial staff are contract officers from other countries, while volunteers from America, Japan, New Zealand and Australia fill many positions as architects, surveyors, engineers and draftsmen. Foreign aid also contributes expatriate staff to specific projects. Contract periods are usually from one to two years.

The varied origins and experience of the staff, and the associated lack of continuity, causes disjointed technological build-up. Engineering practice tends to be based on the experience of the current staff and not on local experience or conditions. The use of specifications, methods and materials appropriate to overseas countries may not directly affect the cost to Samoa if a project is fully funded from aid finances, but it has not been uncommon for the country to pay from its own resources for errors arising from unsuitable methods and designs.

During recent years, the building or upgrading of major roads has been financed by soft international loans. The Government-owned Special Projects Development Corporation (SPDC) performs large project construction, and its contracts are supervised on behalf of the financing authority and the Government by an independent engineering consultant. The PWD executes smaller-scale road construction and routine maintenance under an annual grant.

Previously, crushed lava was utilised for base and sub-base materials on major roads. Quarrying and crushing operations were very expensive because of the geological conditions (Kear and Wood 1959), the lack of sufficient quarry investigations and plant maintenance problems. The crusher...
products were relatively soft and had a high fines content. Large-sized sealing aggregate was sometimes used to compensate for its tendency to break down under traffic. The glassy nature of the rock and associated dustiness caused problems with bitumen adherence.

The growth in population and the associated increased demand for land led to a greater reluctance to release land for the purpose of providing adequate road reserves or material sources. The frequent opening of new quarries initiated legal problems, royalty claims, poor public relations and sometimes sabotage of equipment. These difficulties were avoided to some extent by crushing surface boulders collected manually from the countryside. The high production rate of the dredge and the consequent reduction of durability in some applications. The abundance of coral sand in concrete. These investigations showed that a satisfactory concrete could be made using coral sand and dolerite coarse aggregate.

Several important streets in Apia were cement stabilised. Maintenance of a good surface in the main street of Apia had been difficult due to the fact that it overlaid a swampy alluvium. The importance of this street justified the cost of stabilisation, but in other streets on well-drained lava formations cement was evidently used in a bid to overcome shortages of skilled workmen and equipment.

DEVELOPMENT OF MATERIALS TECHNOLOGY

It was decided that a more appropriate, or improved, local materials technology would reduce many of the engineering problems caused by the political and sociological aspects of the Samoan life style. This included:

(a) the development of a large, permanent, centrally-located quarry which would eliminate many of the current quarrying difficulties;
(b) the use of coral detritus, which existed in the lagoons, as a cheaper and more even quality material for roads; and
(c) the establishment of a reliable aggregate industry and an improved concrete technology.

ALAFUA QUARRY

An engineering geologist, brought in by the Project, discovered a large deposit of dolerite at Alafua near Apia (Braybrooke 1976). This material was sound, dense, hard rock and promised a solution to the problems of quarrying in geologically complex lava rocks. A site was selected for quarrying and reserves of rock were investigated for quality and quantity. An area of 12 ha, containing sufficient rock for 50 to 100 years supply, was reserved by the government. Equipment was provided for drilling, blasting, loading and transporting the rock. An existing crushing plant was overhauled and recommissioned. Procedures for the procurement, storage, security and use of explosives were improved. PWD staff were trained in all aspects of quarrying and aggregate production.

AGGREGATE SUPPLY

The rock quarried at Alafua Quarry is excellent for coarse aggregate for road sealing and concrete production. It is unsuitable for sand production because of the high cost of crushing it to sand sizes. The existing deposits of natural volcanic rock sand in rivers and on beaches were becoming depleted and the only alternative at that time appeared to be the crushing of soft or partly-weathered lava rocks.

During the first year of the Project the cutter-suction dredge 'Palolo' was refitted. This vessel had carried out major harbour dredging tasks, but deterioration of the pontoons and mechanical equipment required it to be rebuilt. The Project provided a welding supervisor and some materials and components. The dredge was recommissioned in November 1975 and used for stockpiling coral detritus at Apia for landfill and minor road surfacing.

The high production rate of the dredge and the abundance of coral detritus prompted investigations into the possibility of using coral sand in concrete. These investigations showed that a satisfactory concrete could be made using coral sand and dolerite coarse aggregate.

Some limitations to its use were thought advisable owing to the cellular and relatively weak nature of the coral and the consequent reduction of durability in some applications. The abundance of coral ensured that shortcomings in the properties of concrete produced in this way would be compensated for by the reliability and low cost of supply. These investigations are described in another paper (Vines 1980).

USE OF CORAL FOR ROADS

The use of coral detritus as a road and airfield paving material has only been sparsely reported, mostly from experience of military construction forces in the Pacific region during the Second World War. Its use
in Western Samoa had been intermittent, often producing doubtful results. Imported technology had mostly favoured the use of crushed rock pavements, which were very expensive.

It was decided that the Project should test and demonstrate various aspects of construction and performance of coral pavements in a field trial. This work showed that excellent roads can be made of coral. Because of the uniqueness of this material, the investigations and results are described here in some detail.

**SOURCES OF CORAL**

The coral is mined by a dredge located on a bank of coral detritus at Mulinuu Peninsula, near Apia. Much of the material is fragile and sticks with an aspect ratio of 3 to 6 are common. Fragments are full of tiny holes and passageways and are highly absorbent.

The rotating cutting head of the dredge produces a maximum particle size of about 150 mm. The material is sucked up and pumped ashore where it is thrown out of the delivery pipe in a fan-shaped fountain to fall in a pile. The water drains off quickly, taking most of the fines away, and the larger particles remain. The pile is pushed out into a horsehoe-shaped bund by a bulldozer and loaded into trucks from the outer face with a front-end loader; this process mixes the material very effectively into a well-graded soil.

The dredge, however, is not the only source of coral. An American company constructed a site for a luxury tourist hotel in the lagoon at the eastern edge of Apia during the early stages of this Project. The building of the hotel has been deferred, awaiting better air transport facilities for tourists, but the construction methods used for the site are of interest.

The site is an artificial island in the lagoon and is linked to the land by a causeway. Spoil for construction was obtained by excavating coral from the lagoon floor. A bund was built and dewatered by powerful pumps. The material was ripped and excavated by a Caterpillar DB bulldozer, then picked up by scrapers and transported to the site. Excavation reached about 5 m below sea level.

The coral was variably hard and brittle and highly permeable in places, as would be expected from the manner of its deposition. The presence of many small springs in the bottom required the pumps be operated 24 hours per day. The material was dumped, spread and rolled on the site. The resulting fill was very hard and strong. The bulldozer tracks left little impression on the surface.

Material from the construction area was used in small quantities for the East Coast Road but was not as good a basecourse as the Mulinuu dredged material, due to the coarse nature of the grading. However, it was excellent as a sub-base material.

A dragline, working continuously to stockpile material at several sites around the coast, could satisfy most rural requirements. A separate winning operation near Apia is needed to provide urban requirements.

**VAITELE ACCESS ROAD TRIAL**

The need for an access road was realised during construction of the Project workshop complex in a coconut plantation near Apia. The road was about 700 m long and passed through the new industrial zone. It would be required to carry considerable traffic, including a large proportion of heavy vehicles. It was decided to build this road with coral as a field trial.

Eight hundred and fifty-five truck loads of coral were hauled about 7 km from the dredge stockpile. The material was compacted with a 3.5 t vibrating sheepfoot roller augmented by a vibrating smooth drum and a rubber-tyred roller. Most of the coral was placed in a very wet condition, though it tended to drain quickly. The compaction process tended to slurry the material, bringing the finer particles to the surface. The smooth drum roller broke up excessively large particles and the rubber-tyred roller compacted the coral to a fine-textured hard and smooth surface.

Field and laboratory testing was performed soon after construction to gather data on the properties of the coral (Vines 1976). Field density tests were made at 50 m intervals on each lane, and particle size gradation tests were performed on samples of compacted soil taken at each point. Laboratory compaction tests allowed comparison of density achievements in the field with the Modified AASHO standard of compaction. CBR tests were made in the laboratory on samples compacted to the various degrees of compaction achieved in the field. The results of this testing are summarised in Table I.

| Table I. |

Benkelman beam pavement deflection tests were performed on both lanes at 10 m intervals; the results are summarised in Table II.

**PROPERTIES OF CORAL PAVEMENTS**

**Coral Gradation**

The particle size distribution tests showed the coral to be rather coarsely graded, the major deficiency being in the fines content. This varied from 0 to 4 percent smaller than 0.075 mm throughout the upper

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AUSTRALIAN ROAD RESEARCH, Vol 10, No. 1, March 1980
TABLE I

SUMMARY OF LABORATORY TESTING

<table>
<thead>
<tr>
<th>Test</th>
<th>Average Value</th>
<th>Range</th>
<th>No of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRY DENSITY (t/m³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Compaction</td>
<td>1.852</td>
<td>1.422-2.225</td>
<td>26</td>
</tr>
<tr>
<td>Laboratory Compaction (Max. DD)</td>
<td>1.927</td>
<td>1.770-1.955</td>
<td>10</td>
</tr>
<tr>
<td>MOISTURE CONTENT (per cent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field (at time of Field Density Test)</td>
<td>13.9</td>
<td>11.1-15.5</td>
<td>25</td>
</tr>
<tr>
<td>Laboratory Compaction (Optimum)</td>
<td>16</td>
<td>14-18</td>
<td>10</td>
</tr>
<tr>
<td>STRENGTH — Laboratory CBR (per cent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 95% of Maximum Dry Density</td>
<td>130</td>
<td>47-236</td>
<td>17</td>
</tr>
<tr>
<td>at 90%-95% of Maximum Dry Density</td>
<td>120</td>
<td>79-169</td>
<td>4</td>
</tr>
<tr>
<td>at 90% of Maximum Dry Density</td>
<td>70</td>
<td>35-67</td>
<td>5</td>
</tr>
<tr>
<td>PARTICLE SIZE GRADATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samples from road (compacted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum size (mm)</td>
<td>38</td>
<td>19-38</td>
<td>25</td>
</tr>
<tr>
<td>% of Total sample passing 9.5 mm</td>
<td>68</td>
<td>34-83</td>
<td>25</td>
</tr>
<tr>
<td>% of 20 mm max. sample passing 2.36 mm</td>
<td>49</td>
<td>24-65</td>
<td>25</td>
</tr>
<tr>
<td>passing 0.425 mm</td>
<td>14</td>
<td>6-26</td>
<td>25</td>
</tr>
<tr>
<td>passing 0.075 mm</td>
<td>1.3</td>
<td>0-4</td>
<td>25</td>
</tr>
<tr>
<td>Samples from Stock (uncompacted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum size (mm)</td>
<td>75</td>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>% of Total sample passing 9.5 mm</td>
<td>55</td>
<td>24-71</td>
<td>8</td>
</tr>
<tr>
<td>% of 20 mm max. sample passing 2.36 mm</td>
<td>59</td>
<td>48-70</td>
<td>8</td>
</tr>
<tr>
<td>passing 0.425 mm</td>
<td>20</td>
<td>9-30</td>
<td>8</td>
</tr>
<tr>
<td>passing 0.075 mm</td>
<td>3</td>
<td>1-6</td>
<td>8</td>
</tr>
</tbody>
</table>

150 mm of pavement but was probably much higher in the soil close to the surface. The specific gravity appeared to be about 2.5.

Tests on compacted and uncompacted material failed to show the degree of breakdown which occurs during compaction, but crushed coral could be seen on the surface after the sheepfoot and smooth drum rollers had passed. The action of these rollers on loose material was to reduce the surface course material to a small size; the usual specification grading is to a maximum size of 20 mm and the vibrating rollers had no trouble in crushing 150 mm lumps to conform.

It was readily apparent that slurring of the material allowed a very smooth surface to be developed by improving the particle size gradation in the upper part of the layer. In performance, the coral ravelled under traffic only where it was coarsely graded. Obviously a higher percentage of fines would improve the cohesion and dry strength.

Dust was not found to be a nuisance because the clay and silt-sized particles were washed out during dredging.

Coral Density

The high density attained in the coral fill was readily apparent during testing; the material was very hard to dig through. The desirability of using vibrating rollers was obvious, as the sheepfoot roller failed to penetrate the fill after two passes.

The testing indicated that high densities can be obtained in the field over a wide range of moisture contents. This is possibly due to the brittle nature of coral which allows particle breakdown during compaction to improve the gradation. It is also possibly explained by the high capacity of coral particles to absorb water that is in excess of compaction requirements. Note that density testing was done after construction was completed and the moisture content had stabilised; actual moisture contents during placement were generally higher than the test figures indicate.

It is doubtful whether the compaction test is the best basis for compaction control of coral. Although compaction curves could be obtained in the laboratory with an apparently valid density-moisture relationship, the nature of the material and the efficacy of vibration and high moisture content indicated that CBR or other strength tests would be a better measure for construction control. In any case, it was easy to obtain high strength that it seems pointless to persevere with density testing as an index of strength.

During mechanical breakdown of rollers on other roads, it was found that construction traffic (mostly trucks) compacted 150 mm layers of coral to an acceptable density and strength.

Coral Strength

The high CBR values even at densities of 90 per cent of modified AASHO compaction standard indicate the excellent strength and suitability of coral for road pavements. The Benkelman beam deflection tests showed that pavement deflections were of the same order as for well-built roads made with a crushed rock base.

During the trials, much discussion was engendered by the hard, smooth concrete-like appearance of the surface. It was popularly believed that coral had self-cementing properties, generally attributed to the presence of lime. No facilities were available for testing this. However, close examination showed that below a 1 mm crust the pavement material was not significantly or recognisably cemented. The very high material strength is apparently obtained by mechanical means: failure of coarse particles during compaction improves the gradation and thus the frictional grain contact, slurring of the wet material
TABLE II

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Chainage From Gate (m)</th>
<th>No. of Tests</th>
<th>Mean Deflection (mm)</th>
<th>Standard Deviation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-100</td>
<td>15</td>
<td>1.14</td>
<td>0.26</td>
</tr>
<tr>
<td>2</td>
<td>100-200</td>
<td>18</td>
<td>1.30</td>
<td>0.43</td>
</tr>
<tr>
<td>3</td>
<td>200-300</td>
<td>31</td>
<td>1.24</td>
<td>0.51</td>
</tr>
<tr>
<td>4 &amp; 5</td>
<td>300-400</td>
<td>31</td>
<td>1.02</td>
<td>0.43</td>
</tr>
<tr>
<td>6</td>
<td>400-700</td>
<td>37</td>
<td>0.96</td>
<td>0.25</td>
</tr>
</tbody>
</table>

VINES, FALCONER — CORAL AND VOLCANIC ROADS IN WESTERN SAMOA

reduces pore volume close to the surface, thus raising cohesion; and leaching of residual salt and other soluble solids to the surface tends to seal the surface pores and may provide a slight temporary cementing effect. Softening of the surface under traffic in sustained wet weather and the formation of slight erosion rivulets also indicated that the coral was not significantly cemented.

Although the authors believe that cementation may contribute to the strength of compacted coral sands, they consider the main contributing factors to be mechanical. It is, however, worthwhile to cite the observations of other writers.

Bowers (1944), in discussing coral airstrips, mentioned an example from Woodlark Island, an island off the Eastern end of Papua-New Guinea.

In the matter of repairs after bomb hits coral surpasses other materials to a notable degree. An example is the excellent airstrip on Woodlark Island, which received a string of six 125 lb anti-personnel bombs in a row almost exactly along the centreline. At the same time a similar string fell alongside the runway on an area that had been cleared but not graded. Craters in the latter case were twenty to thirty feet wide and about six feet deep because they penetrated before exploding. Craters on the runway were so small that all six were filled and repaired with less than a truckload of coral.

In his book, Tales of the South Pacific, James A. Michener described the building of an airstrip at Konora with coral. In this story one of the characters asserts that the coral polyp lives for several days in the excavated material; if the fill is watered with salt water it would continue its coral construction, thus cementing the grains together and raising the strength. This is a colourful but typical lay explanation for the high strength of coral pavements. However, the use of sea water to partially cement finely-divided coral may be a possibility. The Vaitele Access Road trial certainly showed salt efflorescence after a long dry period and the surface was very hard and strong.

Steams (1944) concluded that moisture is an important agent in the bonding process:

Many of the runways are sprinkled with sea water to hold the dust, thus aiding cementation. Sea water is already saturated with lime, but upon evaporation leaves its salts in the interstices of the runway. Consequently coral deposits with large interstices or with small proportions of fines, cement slowly if at all, unless vehicles are run over them to increase the percentage of fines by attrition. The rate of evaporation, the humidity and the rainfall became factors in islands where this treatment is used. If the rainfall is low the salts, chiefly sodium chloride, accumulate in the coral interstices and deliquesce, thereby keeping the surface moist. Moisture is an important agent in the bonding process.

The surface of the Vaitele Access Road remained damp for months.

Beaven (1963) considered it safer not to presume on any gain in strength due to chemical cementation:

In reporting the high strengths which can be developed by compacted coral, several observers suggest that the material has self-cementing properties, presumably due to the solution and redeposition of calcium carbonate. (The cementation of calcareous sands is a recognised phenomenon in the formation of limestone rocks.) Others believe that the strengths are entirely a function of the mechanical properties of the material. Quantitative evidence is needed and in its absence it is safest for the engineer not to presume on any gain in strength due to chemical cementation.

TRIAL SEALS

During construction of the Vaitele Access Road it became apparent that the use of coral could reduce the cost of the major East Coast Road by reducing the need for crushed 'basecourse'. However, some doubts were raised as to the adherence of bitumen to a coral surface. It was decided to test-seal parts of the road using various methods to find a suitable procedure.

Trial sections of about 100 m each were sealed in the following manner:

(a) Section 1 was primed with cationic emulsion and covered with lava crusher fines. This amounted to a primer seal. Hot-sprayed bitumen with crushed lava rock screenings constituted the final seal.

(b) Section 2 was lightly scarified and 10 to 15 mm of crusher fines (passing 10 mm) were rolled into the surface. This was then primed and sealed as in Section 1.

(c) Section 3 was armoured as in Section 2 and sealed without priming.

(d) Section 4 was armoured with 20 mm lava aggregate, then primed and sealed as in Section 1.

(e) Section 5 was sealed immediately over the coral surface.

The remaining length of road, about 300 m, was left unsealed.

The sealed surfaces were inspected early in the wet season in November 1976. There were no potholes or breaks in the seal, though there was some evidence that the sealing aggregate tended to
strip from the bitumen when wet. The poor quality of the stone was evidenced by the amount of material which was being crushed under traffic.

In June 1977 the sections were inspected again. Section 3, where the road was armoured with crushe
dust but not primed before sealing, had developed five potholes during the preceding dry season. These were caused, probably, by shortcomings in the
terpoint and an inadequate thickness of bitumen. Priming also would have been beneficial. There was little to choose between the appearance of the five sections and no significant difference could be discerned in the adhesion of the seals to the various surfaces. It appeared that the most economic method of sealing, i.e. directly onto a hard coral sur-
face, was feasible.

By June 1978 one more pothole had developed in Section 3; otherwise the pavement had not suffered
damage from the increasingly heavy traffic. However, Sections 4 and 5 had lost their seal in places, without
pavement damage. This was apparently due to
shortcomings in the sealing technique and screen-

ings; bitumen stripping of the lava aggregate left the
bitumen unprotected from the traffic.

Section 1, the primed and sealed coral surface,
appeared to withstand the trial best, though better
control of bitumen cover and a higher quality of ag-
gregate would undoubtedly be preferable. Section 5,
in effect, was a single coat seal, but performed
surprisingly well. A second coat would have been
preferable.

It is worth noting that coral has been tried as an
aggregate for bituminous sealing but Samoan ex-
perience tends to confirm that reported by Beaven
(1963).

On Cocos Island 3/4 in to 3/8 in coral gravel screen-
ings spread at 1 yd³ per 55 yd² over a cutback bitu-

ten showed poor resistance to wear under light traffic
(fifty vehicles/day) and after five months use the bitu-
men coating was exposed. The coral showed ex-

cellent adhesion to the bitumen and there was no
difficulty with ravelling, so it proved suitable for use
on a runway where the low resistance to abrasion was
of less importance than on roads.

**PERFORMANCE OF UNSEALD SURFACE**

Soon after construction of the Vaitele Access Road
an automatic traffic counter was installed. This was operated for more than a year, during which time it
recorded about 120,000 vehicles. Ninety-five per
cent of these were light vehicles — mostly unladen
pick-ups — and the rest unladen trucks, graders, etc. This was estimated to represent about 225 B-1 ESAL.
The traffic flow increased to between 500 and 600
per day.

Later, a sand-screening plant was set up in the
Workshop Complex and on some days up to 100
loaded trucks (representing 0.8 to 1.2 ESAL each)
now pass over the road. The average annual daily
traffic loading was estimated in September 1978 at
12 ESAL. A brewery, power pole and stores yard,
march factory and cigarette factory have been built
along the road and the design traffic loading of 20
ESAL per day will probably be exceeded in a year or
two. The road came into operation in May 1976 early
in the dry season.

Much of the wear on this surface occurred during
the first month when recompacted thin layers, mostly
coarse soil from the grading and trimming operation, peeled off or were eroded. A few potholes
developed, but these tended to remain shallow and
slowly became larger depressions rather than deep
holes. At the beginning of February 1977 the effects
of the wet season were apparent, but the surface
had not become exceedingly rough, as did other
roads constructed with volcanic soils. At the end of
March 1977 about 20 potholes were filled with coral
by hand. These were watered well and trodden down.
Within two days the positions of these holes could
not be found as the traffic quickly compacted the soil.
An accelerated rate of wear occurred during a period
of light rain in May 1977 even where the surface had
been very smooth and hard. The road was graded
during July 1977. No time during the period did the
road become very rough and even at its worst could
still be traversed comfortably at 80 km/h.

The worst wear was experienced on one wet day
when more than 100 loads of coral were hauled in to
the screening plant. This resulted in the formation of
shallow potholes, but no general collapse of the sur-
face. There appeared to be some healing of the
roughness as the road dried out and a week later
grading restored the smoothness.

Experience with the unsealed section showed
conclusively that coral will form excellent gravel
roads with very low maintenance costs if constructed
properly. Under Samoan conditions it would appear
to be feasible to leave roads unsealed with less than
600 to 1000 veh/day. provided that drainage and
dust are not problems and simple routine mainte-
nance procedures are followed.

**CONCLUSIONS**

The construction and performance of the Vaitele Ac-
cess Road showed conclusively that pavements built
with coral detritus in Western Samoa have significant
advantages over pavements constructed with other
materials.

Coral is abundant, cheap to excavate with
dredge or dragline, requires no crushing or screen-
ing, and does not involve alienation of land for borrow
pits and quarries. Construction of a high strength
pavement is easy; quality control does not require
careful management of the soil moisture content and
compaction by construction traffic may be sufficient,
though rollers are desirable.

The use of coral, rather than volcanic materials,
contributes to reduced maintenance and repair of
plant and equipment, less energy requirements due to
less use of equipment, a lower level of manpower
skills, easier maintenance of unsealed surfaces and
less need for bituminous sealing.

AUSTRALIAN ROAD RESEARCH, Vol. 10, No. 1, March 1980
REFERENCES


Mr. Vines has worked in the materials investigation and testing field since 1940. He worked on the Kiewa and Snowy Mountains Hydroelectric Schemes until 1971 when he joined the Snowy Mountains Engineering Corporation at its inception. Since then he has spent five years on road construction projects in South East Asia and the South Pacific, and is currently Materials Investigation Officer on a road construction and training project in Bangladesh. Mr. Vines particular interests are construction field trials, experimental blasting and the practical development and application of materials technology.

Graeme Falconer completed his B.E. (Civil) degree at the University of Sydney in 1969 under a Cadetship with (then) Commonwealth Department of Works. After serving Comworks in New South Wales and Papua-New Guinea he joined the Snowy Mountains Engineering Corporation (SMEC) in 1972. He is at present SMEC's Project Manager on the Chengi Valley Corridor Development Project in Bangladesh. Graeme occasionally works in Australia and has served overseas assignments in Western Samoa, Papua-New Guinea, Indonesia, Malaysia, The Philippines, Thailand, Bangladesh and Pakistan. Graeme's primary professional interest is in road engineering materials and his experience has been predominantly with roads, highways and airfield engineering (feasibility study, investigation, design, specification, contract preparation and supervision, and supervision of construction and maintenance by day labour) with some civil and structural engineering. When there is time and facilities are available he enjoys squash and tennis but smokes too much.