A ROAD PAVEMENT FOR VERY RAPID CONSTRUCTION – 25 TO 35 YEARS OF SUCCESS

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Author Biography

39 years employed in senior engineering positions in three large Sydney Councils. Since 2003, has operated as a consultant for various Sydney Councils and as an agent for a Private Certifier (subdivisions). Experienced in all aspects of suburban civil engineering and management, with emphasis on road pavement design, non destructive testing, pavement condition evaluation, road construction & maintenance, and asset management. ritchiecivil@gmail.com

Introduction

Why This Paper

What was learnt from the early FDAC pavement design and construction, some 23 - 36 years ago, and the simple construction methods that were used, has largely been lost to successive generations of engineers and contract staff? The last of the engineers involved in six of those projects will all retire within the next 5 years and hence it is very important to pass on this knowledge. As a result, the author brought together the present Director City Assets of Blacktown City Council (Mr G Morgan who personally supervised the Newton Road project), the NSW RTA (3 of the above roads are now State Roads), and AAPA via Boral Pty Ltd, to meet the substantial testing costs of the FDAC pavements that were constructed between 1974 and 1987.

This paper presents and discusses the test results, and what we should all learn from the past and the present, to improve road construction techniques and reduce the detrimental effects of construction on motorists and the community in general (our customers).

History

In the late 1960 and early 1970 decades, Bankstown City Council engineers, in conjunction with Boral Pty Ltd (asphalt division – Bitupave Ltd) trialled different types of road pavement construction to reduce costs and shorten construction times. The subgrades were predominantly clay with 4 day soaked CBR = 3% (in situ CBR approximately 5%).

Full depth asphaltic concrete (FDAC) was suggested by Bitupave Ltd but the Council engineers were hesitant on this radical approach and chose to have a 150 - 200mm layer of road base placed over the subgrade with a 100 - 150mm layer of AC over the road base. These pavements though quick to construct, did not perform particularly well and were largely abandoned after a disastrous project in the main shopping centre (Fetherstone Street).

From the above experience, Blacktown City Council agreed with Bitupave Ltd to reconstruct one of their main shopping centre roads (Alpha Street) with FDAC in 1974 (proposed 225mm AC directly on the clay subgrade). This project was completed in one weekend, with only praise from the community, within budget, and post deflection testing proved the pavement met its design criteria (20 year ESA = $1.7x10^6$). Consequently, another road in the same shopping centre was reconstructed in 1976, in the same manner, with the same successful result (Flushcombe Road).

Interestingly, in the latter project, at about 2.00am Sunday morning, a 15m x 3m section of very poor subgrade was encountered – the tracked excavator got bogged, and with only AC available, the Council engineer was very concerned. The area was immediately excavated a further 150-200mm, AC 28 pushed in with the tracked,excavator, compacted with only the weight of the tracked excavator, left to cool, and then the road completed. The Council engineer discussed his concern on the Monday, and deflection testing of the entire reconstructed pavement was arranged after 3 months and found the problem area with slightly higher deflections. Deflection testing was repeated approximately one year later and no anomaly was found, ie the entire pavement was sound.

From these successes, FDAC construction was then used at this latter Council in all road pavement reconstruction on high traffic and high profile locations. The design and construction methodology is still used today with little change.

Construction Method Used

The general method used in the early days of FDAC and in all the test sections as detailed in Table 1 (Appendix A), was as follows:-

- Kerb & gutter reconstructed/constructed on an AC base (usually 100mm thick of AC28) – 2 to 3 weeks earlier than the weekend of the pavement construction or on larger projects in conjunction with the FDAC pavement)
- Weather predictions considered and a weekend selected where the weather was likely to be mostly fine
- Ensure the plant and equipment was in good order with back up for breakdowns and mechanics available
- Road closed to all vehicular traffic or at least in half widths
- Excavation with a tracked excavator
- Subsoil drainage laid where considered necessary (rarely used and often constructed with the kerb & gutter)
- Clay subgrade trimmed and compacted
- AC28 or AC40 base layer laid with a grader in 1-2 layers (total thickness of 110mm to 260mm plus), compacted with a two point steel vibratory roller. The AC would be laid as the pavement excavation progressed, ie the entire excavation was not completed before AC laying was commenced. 700T of AC laid in a 12 hour shift was not an unusual output and advice from the asphalt industry indicates that 1,000T would now be achievable.

  With FDAC pavements laid directly on the subgrade, grader laying is important as trucks delivering into an asphalt paver often damage the subgrade due to the heavy and frequent loading within the same wheel paths.
- AC20 or AC10 correction layer laid with a paver (30-50mm thick) – in the very first projects, two layers were used, but it was later found that only one was required
- On a weekend after all the base layer of AC had been completed, the final 30mm AC10 was laid with a paver.

The quality assurance (QA) procedure was as follows:-

- Kerb and gutter laid to a surveyed line and level
- All services and utilities marked
- Excavation depth checked with a tape or marked rod
- Visual check of the subgrade and deepening where appropriate to a depth judged by the Council site engineer (rarely required). No laboratory subgrade CBR or PI tests were carried out. On some occasions the subgrade CBR was ascertained by Dynamic Cone Penetrometer (DCP)

- AC depths checked with a marked heavy wire probe whilst the AC was hot
- Tonnage/area /depth relationship checked
- AC temperature taken at adhoc intervals and when a load seem to be standing for a long period
- Crown level checked with string line and tape from kerbs, and ‘ups’ painted on the AC layers to control added layers
- Compaction tests a few weeks after completion (2-3/project)
- No work-as- executed levels were taken on any layer as the kerb & gutter existed and had been checked for level during construction.

This QA approach was neither then, nor seen today, as a ‘rough’ or short cut procedure, but a practical, cost effective one.

TESTING METHODS

Deflection and Calculation of Pavement Life

Each road section was tested by a highly experienced consultant (Fugro PMS Pty Ltd) in November 2009, using a Falling Weight Deflectometer (FWD – 40Kn load), to the following criteria:-

- Each lane at 50m centres but staggered per lane
- Outer wheel path in each lane with some exceptions.

The author calculated the Equivalent Standard Axle (ESA) loading /lane using historical AADT data, % Heavy Vehicles (HV), ESA/HV relationship, and future traffic growth rates supplied by the respective road authority, for the following periods:-

- Construction date to 2009
- Additional loading from 2009 to 2019
- Additional loading from 2009 to 2029
- Additional loading from 2009 to 2059

The estimated ESA’s/lane for each road sections are detailed in Table 2 (Appendix B).

Fugro PMS used the above ESA data, the representative depth of AC from the site cores (see Table 5 – Appendix C), and their FWD test results (the 95th percentile deflection and mean curvature for each road section) to calculate the remaining lives using the ELMOD program (Evaluation of Layer Moduli and Overlay Design designed by Dynatest).

Coring and Testing of Pavement Materials

The NSW RTA in October 2009 and February 2010 took cores from five of the pavements sections (the exception was Alpha St – coring & testing done in 1997/1998 by Boral Asphalt) as detailed in Table 3 (Appendix B) and at the same time undertook DCP testing to ascertain the in-situ subgrade CBR.

TEST RESULTS

Subgrade

The results from the testing and the earlier testing on Aplha Street, found that the subgrade was silty brown, red & grey clays of high plasticity and was moist, typical of most of the western Sydney metropolitan area. The detailed results are indicated in Table 4 (Appendix C).

The DCP results were only in the clay layers not where there are ironstone nodules (in lower layers).

Asphaltic Concrete

See Table 5 (Appendix C) for the test results.

There was extremely little, if any, segregation of the AC at the interface with the subgrade, ie no deterioration of any consequence.

Deflection, Curvature, and Estimated Pavement Life

The test results are shown in Table 6 (Appendix C) and the Estimated Pavement Life in Table 7 (Appendix C).

Visual Condition and Work Done on Road Sections Since Construction

The author inspected each road section and the condition is indicated in Table 8 (Appendix C).

The work done on the road pavements since construction is indicated in Table 9 (Appendix C).

The large amount of heavy patching in Wallpark Avenue was due to a design error in that an insufficient thickness of AC (50-90mm) was placed under the new kerb & gutter (no road base was used as the kerb & gutter was constructed in conjunction with the FDAC road pavement). This caused the kerb & gutter to rotate and fail under the heavy loading in the kerb side lane, leading to failure of the adjoining road pavement. The failures commenced within approximately 5 years of construction.

COMPARISON OF ACTUAL CONSTRUCTION METHOD TO TODAY'S METHODS – TIME & COST

Actual Method Used For Construction of the Above Sections of Road

This is detailed in the Introduction under 'Construction Method Used'.

Today's Methods

The FDAC construction methods and quality assurance procedures now in common use by at least some State Road Authorities and major civil engineering consultants are as follows (personally encountered on two projects in 2008 and 2009::-

Construction

- 150mm - 300mm granular select or capping layer over the subgrade
- Primer seal
- 200mm bound road base layer of 2 – 5 MPa
- Primer seal
- 100 – 175mm FDAC utilising a heavy duty mix, with the depth varying with the ESA loading on the different roads, broadly based on the *AUSTROADS Pavement Design Manual (Design Chart EC13).*

The subgrade on the two projects that were observed was 3% and 15-30% respectively (in situ values).

Quality Assurance (QA)

- After excavation, Laboratory CBR tests (4 day soaked) on the subgrade, with no overlaying until the results are obtained
- After excavation, PI tests on the exposed subgrade (must be a maximum of 25), with no overlaying until the results are obtained. If the PI of 25 is exceeded, the pavement is deepened by a further 150-300mm (select material)
- Visual inspection of the subgrade and treatment of any soft areas
- Levelling of the subgrade by a surveyor
- Compaction testing of the subgrade and each pavement layer (including the AC layers), with no overlaying of the tested layer until satisfactory results are obtained
- Levelling of each pavement layer by a surveyor, including each AC layer.

One large contractor has verbally advised me that the above QA procedure adds approximately 10% to the project cost.

It should be noted that the local road authorities mostly do not use the same QA procedure and the use of select layers is quite rare.

However, the use of grader laid AC is now very unusual and not supported by some of the asphalt contractors with the major reason being that their present staff have never heard of or encountered AC being laid this way. The test results detailed above for the six 23-36 year old projects do not indicate any detrimental effect by the use of grader laid AC, ie quality is not compromised and was learnt from testing of the process some 35 years ago.

Comparison of Methods – Cost & Time

The costs indicated in Tables 10 & 11 (Appendix D) are for comparison purposes and should not be considered to represent the actual estimate for these and similar projects.

The estimated construction times are based on what occurred in the actual FDAC construction of the particular roads and the authors' extensive road construction experience for the comparison pavements.

For the deeper non FDAC pavements, there is no doubt that the actual costs would be costlier than the estimates due to service adjustments and delays due to wet weather.

As a further comparison, a 'standard' flexible pavement has been designed utilising the *AUSTROADS Pavement Design Manual (Design Chart EC19),* with the select layer thickness being based on 300mm if the 10 day soaked CBR < 3% and 150mm if > 3%.

Conclusion

From the test results and visual inspection, there is no doubt that the FDAC pavements, as constructed between 1974 and 1987 are performing well. Some may be eventually classified as 'perpetual' pavements.

At the time the six roads were constructed, the FDAC construction was approximately 15% more expensive than a 'standard' flexible pavement, based on unit rates, with no allowance for wet weather. However, the service to the community was worth every extra dollar for the FDAC pavement, due to the massive reduction in inconvenience and lost business.

The 15% cost difference is not evident today as can be seen in Tables 10 and 11, and in fact the situation is now reversed with the 'standard' flexible pavement being 5% - 54% more expensive. The reasons are as follows:-

a) Larger haulage distances for the excavated material due to the lack of disposal sites

b) Tipping costs did not apply prior to 1990 and the material was often used to create playing fields. The tonnage fee that typically applies today is substantial ($100/m^3 – outside normal working hours & $69/m^3 in normal working hours).

Taking into account how well the six pavements are performing, and considering the data in Tables 10 and 11, the following aspects of FDAC construction should be widely considered for all future high traffic urban road projects. This especially applies where short construction time is essential due to the detrimental effect of the construction on shoppers, motorists, business', and residents, and where public utilities, services, and stormwater assets are at high levels and can be damaged or require adjustment.

a) Why is a select or capping layer needed as a standard requirement? There are obvious occasions where it is required, eg on sand subgrades and where the subgrade is very poor (in-situ CBR say <3%).

b) Why is a road base (bound or unbound) required under the FDAC?

c) Why test the subgrade for PI during construction and apply a maximum figure of 25? It should be known from the initial pavement design testing and its relevance is questionable as noted from the PI's in Table 4 compared to how these pavements have successfully performed. This testing delays construction and allows wet weather damage.

d) Why automatically test the subgrade CBR after the subgrade is exposed as it delays the construction? Should only do this if it is obviously different to the design CBR and such can be easily ascertained by an experienced road construction engineer (say with > 5 years experience in this field). Small soft areas are locally excavated and the pavement deepened by using the most appropriate and accessible material at the time (remembering the problem may arise at 3.00am). Any major doubt can be easily put to rest with some rapid Dynamic Cone Penetration tests as is done at Brisbane City Council.

e) Why lay the AC in the base layers with a paver? Much faster construction using a grader – up to 700 to 1,000T/12 hour shift for approximately the same m^2 price (from the Schedule of Rates Contract as used to estimate the above cost comparisons). The cores and density results show no detrimental effect.

f) Why not use 28mm aggregate in the base AC layers? Allows for thicker layers and faster construction. There is no evidence from the 20 cores taken from the above six projects that segregation or water ingress at the interface with the lower AC pavement layers and the subgrade is a problem (remember that subsoil drainage was rarely provided). Brisbane City Council (the largest local government authority in Australia) is permitting 35mm aggregate.

g) At least in urban construction where levels are fixed, why level the subgrade and pavement layers? Simple tape measuring and 'wire' dips control the levels quite adequately and any minor variations in the base AC layer when laid via a grader, is taken up with a minor correction layer during the main construction period (by an asphalt paver) and prior to laying the final AC layer.

h) Why is compaction testing essential on every pavement layer during construction before allowing the covering of each layer? Place the onus on the contractor to obtain the compaction standard and core the completed pavement if necessary to obtain the actual compaction. It is not difficult to control compaction by knowing and monitoring the number of roller passes that is required to obtain the required compaction and/or use a Nuclear Densometer (by the contractor as specified at Brisbane City Council). The idea of passing on the responsibility to the contractor is not onerous as it is not difficult to obtain the compaction standard. A similar approach is used by some Councils for new subdivision roads constructed by developers, in that deflection testing of the *completed* pavement is required and if it fails, the developer/contractor must remedy the problem at his expense before the subdivision plan is released and /or the final progress payment is made.

i) Why not use FDAC pavements for all road construction and reconstruction on important and high trafficked roads in urban areas/busy intersections to speed the project and limit the detrimental effect on motorists, pedestrians, and business'? There would be some exceptions, but these would be rare. The above test results have shown long pavement life is obtained by this method, with extremely low maintenance.

j) Why not extend the life of waste disposal sites by reducing the excavated spoil (thinner pavements with FDAC pavements as detailed in the 'test' roads)? This also saves money on future projects as waste disposal sites are tending to be at greater distances.

Engineering design and construction is not all about the $ cost, it is just as much about the detrimental effect of the work on OUR CUSTOMERS (the general public). The engineers of Bankstown and Blacktown City

Councils learnt this in the mid 1970's. Why has it been forgotten?

The conclusion is left for the engineers of today and tomorrow, to ponder and perhaps arrive at the same reasonable decision the engineers of the 1970's and 1980's came to at two Sydney Councils.

References

ALPHA STREET – 24 hours to reconstruct the pavement', by a Mr Don Johnston of Bitupave Ltd, printed in the December 1974 The Shire and Municipal Record magazine.

Boral Asphalt asphalt cores and testing results – Dec 1997/Jan 1998.

Appendix A

Table 1

Tested Roads

Road Name	Section	No of Lanes	Construction Year	Pavement Construction Time
Alpha St Blacktown	Flushcombe Rd to Patrick St	4	1974	1 weekend
Flushcombe Rd Blacktown	Main St to Alpha St	3	1976	1 weekend
Newton Rd Blacktown	Main St to Flushcombe Rd	4 divided	1980	1 weekend
Prospect Highway Seven Hills	Best Rd to Federal Rd	6 lane divided, but northbound only FDAC	1982	1 week
Wallpark Ave Seven Hills	Prospect Highway to Burnie St	4	1986	5 - 6 weeks
Bungarribee Rd Blacktown	Flushcombe Rd to Lock St	4 divided	1987	3 weeks

For lengths and areas of the above road sections, see Table 3.

Appendix B

Table 2

ESA Loading

Road Name	Construction Year	ESA's/Lane			
		To 2009	2009 to 2019	2009 to 2029	2009 to 2059
Alpha St	1974	$1.6x10^6$	$0.5x10^6$	$1x10^6$	$2.4x10^6$
Flushcombe Rd	1976	$1x10^6$	$0.4x10^6$	$0.8x10^6$	$1.8x10^6$
Newton Rd	1980	$3x10^6$	$1.1x10^6$	$2.4x10^6$	$5.6x10^6$
Prospect Highway	1982	$4.7x10^6$	$2.9x10^6$	$6.3x10^6$	$1.6x10^7$
Wallpark Ave #	1986	$4x10^6$	$2.6x10^6$	$5.8x10^6$	$1.4x10^7$
Bungarribee Rd	1987	$3.7x10^6$	$2.2x10^6$	$4.6x10^6$	$1x10^7$

Table 3

Coring Details

Road Name	Approx. Road Section Length/Area (m/m^2)	No of Lanes	No of Cores	Comments
Alpha St *	210/2,520	4	4	1 core/lane
Flushcombe Rd	264/2,215	2 (one way)	2	I core for each through lane (2)
Newton Rd	407/5,000	4	4	1 core/lane
Prospect Highway Northbound Carriageway	203/1,900	3 as only northbound carriageway	4 in northbound carriageway	1 in median lane, 2 in centre lane & 1 in kerb side lane
Wallpark Ave	1,382/15,000	4	6	3 in kerb side lanes, and 3 in centre lanes
Bungarribee Rd	640/8,000	4	4	1core/lane

***** *This coring and testing was carried out by Boral Asphalt in 1974 on the subgrade and in December 1997/April 1998 on the AC.*

NB The coring locations were spread well apart in a longitudinal direction and were in the centre of the lane.

Appendix C

Table 4

Subgrade Test Results

Road Name	Test Site No	Field Moist. %	PI	4 Day Soaked CBR - %	10 Day Soaked CBR - %	DCP CBR - % (over first 300mm)
Alpha St *	NA	16.1	NA	3.1	Not taken	7
Flushcombe Rd	F1	19.4	40	1.0	0.5	8
	F2	22.0	39	1.5	1.0	6
Newton Rd	N1	16.7	60	1.5	1.0	23, min. 14
	N2	19.2	38	1.5	2.0	15
	N3	24.1	35	1.0	1.0	1.5
	N4	20.1	Road base			5
Prospect Highway	P1	19.9	33	1.5	1.5	7
	P6	27.6	Not taken			
	P7	18.5	Not taken			
	P8	13.7	Not taken			
Opposite c'way for comparison	P2	13.1	38	2.5	2.5	2.5
Wallpark Ave	W1	23.1	29	2.5	2.0	23
	W2	23.6	31	3.0	1.5	Not taken
	W3	24.8	46	4.5	4.5	29
	W4	14.0	26	1.5	0.5	23
	W5	12.5	18	5.0	3.0	19
	W6	11.0	15	6.0	4.5	15
Bungarribee Rd	B1	18.2	39	1.5	1.5	7
	B2	Trench	Utility trench			
	B3	24.9	40	1.5	1.5	12
	B4	20.1	45	1.0	1.0	26

* *This coring and testing was carried out by Boral in 1974 - 5 tests.*

The tests were carried out to the following standards; PI – AS 1289.3.3.1, CBR – RTA T117, DCP – RTA T161, and moisture – RTA T120.

Appendix C (Cont’d)

Table 5

AC Test Results

Road Name	Test Site No	Pavement Depth mm	AC Base Layer			AC Surface Layers	
			AC Type #	**Density t/m^3**	**Depth mm**	**AC Type**	**Depth mm**
Alpha St *	A1	250	40mm stone, 4.1% bitumen, 6.0% voids, 4000MPa, & 70.5^0C softening point.	Relative density – 98 to100% from 6 tests with average in situ voids of 7.5%.	125	20 & 10mm stone, 5% bitumen, 6.0% voids, 4100MPa, & 70^0C softening point	125
	A2	290			120		170
	A3	270			170		100
	A4	220			110		110
Flushcombe Rd	F1	270	28mm stone, 3.6% bitumen, and Pen. & 25^0 C = 9.	2.43	190	7 & 14mm stone	55mm – AC14, and 25mm – AC7 (a recent mill & fill).
Flushcombe Rd	F2	245	28mm stone, 3.0% bitumen, and Pen. & 25^0 C = 23.	2.42	165	7 & 14mm stone	50mm – AC14, and 30mm – AC7 (a recent mill & fill).
Newton Rd	N1	250	28mm stone, 2.6% bitumen, and Pen. & 25^0 C = 17,	2.44	155	10mm	95
	N2	330	28mm stone	2.45	260	10mm	70
	N3	250	28mm stone	2.39	225	10mm	25
	N4	250	20mm stone, 4.9% bitumen, and Pen. & 25^0 C = 11,	2.35	200	10mm	50

Appendix C (Cont'd)

Table 5 (Cont'd)

Prospect Highway	P1	350	28mm stone layer, 3.2% bitumen, and Pen. & 25^0 C = 20,	2.35	135 – AC28 140 – AC20	10 & 14mm stone	30mm – AC10, & 45mm – AC14
	P6	340	Not taken				
	P7	350	Not taken				
	P8	310	Not taken				
Wallpark Ave	W1	240	20mm stone	2.52	190	10mm	50
	W2	200	28mm stone, 3.4% bitumen, and Pen. & 25^0 C = 32.	2.51	145	10mm	55
	W3	200	28mm stone	2.45	135	14mm	65
	W4	290	28mm stone	2.40	190	10 & 14mm stone	50mm each stone layer
	W5	235	28mm stone, 4.1% bitumen, and Pen. & 25^0 C = 6.	2.47	115	10mm	120 in 2 layers of 45mm & 75mm
Wallpark Ave	W6	280	28mm stone	2.37	210	10mm	70
Bungarribee Rd	B1	270	28mm stone, 4.1% bitumen, and Pen. & 25^0 C = 19.	2.34	200	10mm	70
	B2	Trench	Not taken				
	B3	200	28mm stone, 4.2% bitumen, and Pen. & 25^0 C = 12	2.42	175	10mm	25
	B4	220	28mm stone	2.47	200	10mm	20

***** *This coring and testing was carried out by Boral in 1997/98. The 'Surface Layers' in Alpha Street were 75 – 130mm of AC20 and 25 – 40mm AC10.*

The bitumen content was obtained from the cores. Test cores were 150mm diameter (Standards; density – AS 2891.9.2, penetration – RTA T522, and bitumen content – AS/NZS 2891.3.1).

Appendix C (Cont'd)

Table 6

Deflection & Curvature Results

Road Name	No of Tests	95th Percentile Deflection mm	Average Curvature mm
Alpha St	16	0.59	0.06
Flushcombe Rd	5	0.39	0.06
Newton Rd	30	0.65	0.09
Prospect Highway (northbound carriageway)	12	0.30	0.03
Wallpark Ave	81	0.63	0.06
Bungarribee Rd	52	0.68	0.08

Table 7

Estimated Pavement Life

Road Name	Pavement Age Yrs	ESA Loading to Date	Remaining Life in ESA	No of Years Remaining Based on Table 2	Comment	Total Predicted Life incl Past Life (Yrs)
Alpha St	35	1.6×10^6	7.7×10^5	15	The design life for this pavement, in 1974 was 1.7×10^6 ESA's. Only 1 of 16 results is < 2×10^6, ie 'life' probably >40 years	>60
Flushcombe Rd	33	1×10^6	4.5×10^7	>50		>80
Newton Rd	29	3×10^6	1.2×10^5	1	Only 3 of 30 results are < 8×10^6, ie'life'probably >50 years	>50
Prospect Highway (northbound carriageway)	27	4.7×10^6	2.4×10^8	>50		>70

Appendix C (Cont'd)

Table 7 (Cont'd)

Road Name	Pavement Age Yrs	ESA Loading to Date	Remaining Life in ESA	No of Years Remaining Based on Table 2	Comment	Total Predicted Life incl Past Life (Yrs)
Wallpark Ave	23	$4x10^6$	$2.6 x10^6$	10	Only 7 of 81 results are < $1X10^7$, ie 'life' probably >40 years	>60
Bungarribee Rd	22	$3.7x10^6$	$5.9x10^5$	3	Only 4 of 52 results are < $5X10^6$, ie 'life' probably >20 years	>40

Table 8

Visual Road Pavement Condition

Road Name	% Environmental Cracks	% Structural Cracking	% Rutting	Overall Rating (out of 10)^
Alpha St	<1	nil	nil	8
Flushcombe Rd	<1	nil	<1 (minor)	9
Newton Rd	<1	<1	<5 (medium at signals)	8
Prospect Highway (northbound carriageway)	<1	nil	<1 (minor)	8
Wallpark Ave	1 - 5	1	<5 (medium at signals)	7
Bungarribee Rd	5	4 - 5	<1 (minor)	7

NB Excludes service/utility trenches and damage due to trees.

No potholes evident in any road section.

The 'Overall Rating' - 1 is failed, 10 is excellent.

^ *The overall ratings are based on the extent of all the defects and oxidisation of the AC. It should be noted that the author is highly experienced in visual evaluation of road pavements, having done such for over 4,000 roads (not sections), just over the past 4 years.*

Appendix C (Cont'd)

Table 9:

Work Done on Road Pavement Since Construction

Road Name	Approx Pavement Area – m^2	30mm Mill & Fill – Surface Renewal	Rutting Repair – 100mm Mill & Fill	Heavy Patching
Alpha St	2,520	1 within last 10 years and a new roundabout within last 5 years	nil	nil
Flushcombe Rd	2,215	1 within last 10 years	nil	nil
Newton Rd	5,000	1980	400 m^2 at signals in 2008	60 m^2 (1%) within last 10 years
Prospect Highway (northbound carriageway)	1,900	1 within last 10 years	100 m^2 within last 10 years	nil
Wallpark Ave	15,000	1 within last 10 years	nil	1600 m^2 (11%) of which 90% is in kerb side lanes – within last 10 - 20 years. See details below.
Bungarribee Rd	8,000	1 within last 10 years	nil	150 m^2 (2%) within last 10 years

NB No heavy duty AC has been used.

Appendix D

Table 10

Original and Today's Methods for FDAC – Cost/Time Comparisons

Road Name	Standards of 1970's & 1980's		Standards of Today (State Roads)	
	Construction Time incl Final AC layer at a later time	Estimated Cost $	Construction Time Weeks (allowing for QA delays)	Estimated Cost $
Alpha St	36 hrs over 3 nights	360,000	6	470,000
Flushcombe Rd	36 hrs over 3 nights	330,000	5	420,000
Newton Rd	48 hrs over 1 long weekend	750,000	10	900,000
Prospect Highway	20 hrs over 3 nights or 4 days	380,000	5	390,000
Wallpark Ave	25 normal working days	1,660,000	16 - 20	2,220,000
Bungarribee Rd	15 normal working days	870,000	12 -14	1,330,000

The costs in Tables 10 and 11 are based on the following:-

- No kerb & gutter, subsoils, and stormwater drainage are included
- A 20 year design life
- Based on four Schedule of Rates Contract rates from a large Sydney Council
- Based on 2009 unit rates
- No project management costs are included
- No services/utility adjustments are included
- No wet weather delays are included
- A haulage of 10km for the excavated material is included
- Non RAP (Recycled Asphalt Product) tipping charges with some allowance in the large projects for free tipping are included.

Appendix D (Cont'd)

Table 11

Standard Flexible Pavement – Cost and Construction Time Comparisons

Road Name	Pavement Composition	Construction Time Weeks	Estimated Cost $
Alpha St	70mm AC + 100mm DGB + 275mm bound DGS + 150mm select	6 - 7	410,000
Flushcombe Rd	50mm AC + 100mm DGB + 275mm bound DGS + 150mm select	5 - 6	360,000
Newton Rd	100mm AC + 100mm DGB + 260mm bound DGS + 300mm select	10 - 11	980,000
Prospect Highway	100mm AC + 100mm DGB + 260mm bound DGS + 150mm select	4 - 5	400,000
Wallpark Ave	100mm AC + 100mm DGB + 260mm bound DGS + 150mm select	20 - 22	2,200,000
Bungarribee Rd	100mm AC + 100mm DGB + 260mm bound DGS + 300mm select	13 - 15	1,340,000