## Notable Achievements in the Materials Research Division as compiled by Lance Midgley

## Introduction by David Jellie

As part of the celebration on 8 May 2024 marking the end of the Head Office and the adjacent laboratory building, I invited staff who worked in these premises to submit their memories of their time working there.

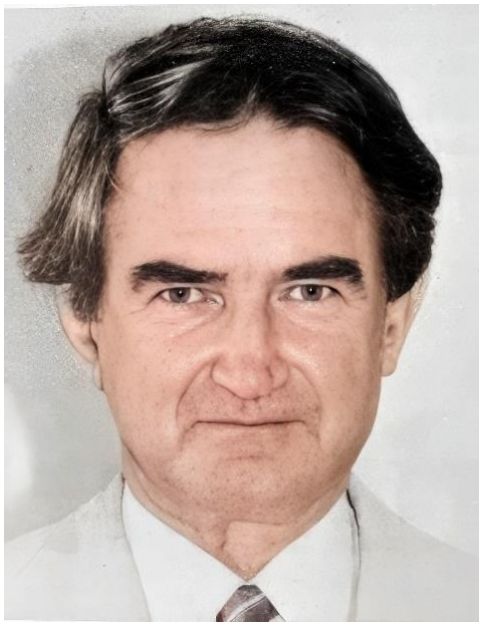
Lance Midgley rose to this challenge and produced the history of notable achievements described below. During his career, Lance worked in the materials area for over 21 years including 3 years as the manager of the department. A significant memory he has of the Materials Research Division (MRD) and its successor named departments is of the technological achievements made by staff in the materials area which addressed problems being experienced by the organisation at that time. In the main, these achievements were made possible through a well-funded Research & Development program.

He has listed the following 47 notable achievements in the MRD since its inception. He is conscious of the likelihood that some achievements, worthy of listing, may have been overlooked and he apologizes for any oversight. I suggest if there are any others, or any corrections to the current list, please contact me and, with Lance's assistance, I can update the list.

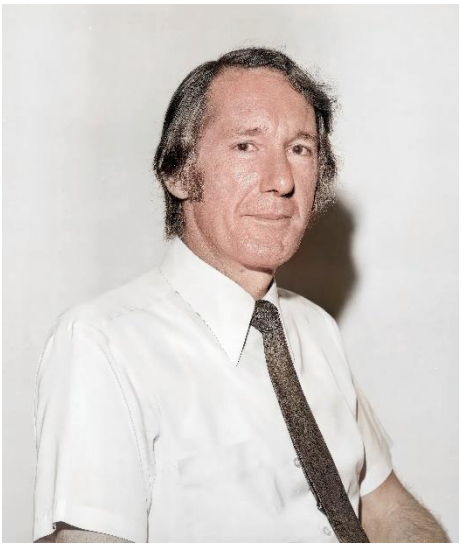
We have tried to include photographs of the people involved at the time of their achievement, but this has been difficult, so some of them are contemporary. Some of the photos were also of poor quality but with the help of Phil Symons, they have been enhanced using several Apps. Further, a photo of Bill Sherwin was taken at a revelry of some type and is not really appropriate for the gravitas of the list. However, I asked Lance to include it in recognition of his contribution. After all, he is entitled to a bit of fun.

Before I get to Lance's list and in keeping with the farewell celebration theme, I thought it worthwhile to include a list of the ten Materials Research Engineers (MRE's) who led the Division/Department since its establishment in 1948 to its current resting place within the Department of Transport and Planning.

Alf Gawith 1948- 1970



Dr David Currie 1970 - 1976



Peter Lowe: 1976 - 1982

John Bethune: 1983 – 1988

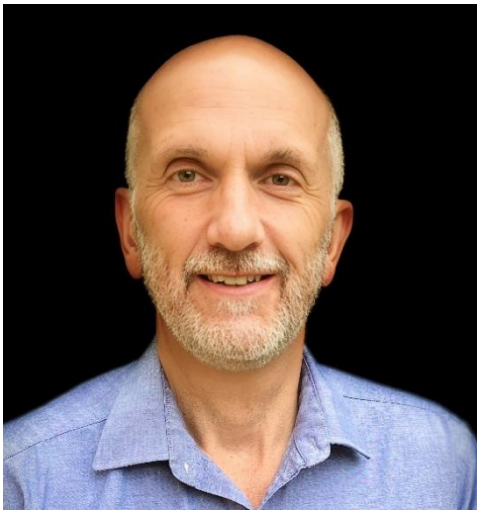
Colin Roy – 1988 – 1990

Bob Meggs: 1990 – 1997

Lance Midgley: 1997 - 2000

Steve Brown: 2001 - 2004

Praveen Reddy: 2005 – 2013



Andrew Papacostas: 2013 – 2022

A separate story on the "History of the Materials Research Division" summarised in chronological order from its inception to its final resting place is being prepared for a future edition of the Newsletter.

Lance has listed the following notable achievements:

**Alf Gawith** and **Clem Perrin**, in 1945, developed a California Bearing Ratio (CBR) design chart for thin bituminous-surfaced granular pavements building on the pioneering design charts of the California State Highway Department.

This was a major advance in Australian pavement engineering and was in common use until the 1960s. At that time, the chart was amended to include the effect of traffic loading and rainfall – refer to Technical Bulletin No. 21. The CBR test which is a measure of the strength of subgrade support is still used today in the design of pavements.

Clem Perrin – 1969.

**John Scala** in the mid-1950s designed and developed the Dynamic Cone Penetrometer Test (DCP) used to assess the consistency and strength of subgrade soils. The DCP consists of a 16 mm steel rod, to which a steel cone with a 20 mm base diameter and 60° cone tip is attached.

The DCP is driven into the soil by a 9 kg hammer with a falling height of 510 mm. In testing, the DCP is held vertically to the surface of the soil to be tested, and two operators are required.

One person holds the device, lifts the hammer to the stop and drop the hammer freely onto the anvil to drive the DCP into the soil and another on is required to record the readings.

John Scala - 1991

The accumulative number of blows and penetration depth is recorded during the operation. The relationship between the penetration depth and number of blows is correlated to an estimate of the insitu CBR of the soil, an important factor in pavement design and construction. A few years later, John developed a Static Cone Penetrometer Test. Both tests are now described in VicRoads Technical Bulletin No.40.

**Alf Gawith** designed the new Head Office laboratory building and **Keith Moody**, Alf's deputy (Assistant MRE), oversaw the construction of the building. The new premises were completed in 1963 and most of the 49 staff operating out of the laboratory in Drummond Street, Carlton moved into the new premises at Kew.

Dr Keith Moody – Circa 1960s

**John Bethune** introduced Full Depth and Deep Strength Asphalt pavements into VicRoads' practice in the early 1970s. A Full Depth Asphalt Pavement is constructed directly over the subgrade and a Deep Strength Asphalt Pavement is constructed over a stabilised subbase. The major advantages of these types of pavements are:

(a) they require a much shorter construction period than a conventional pavement,

(b) they are about half the depth of a conventional pavement, thus sometimes reducing the cost of services relocation,

(c) for urban roads, they require less maintenance and lasts longer than a conventional pavement of similar cost.

**John** also in the 1970s, imported from the USA the concept of adding crumbed rubber to bitumen used in bituminous spray sealing and asphalt pavement construction. Crumbed rubber is produced from recycled car and truck tyres which have been shredded to produce small particles free from cord, wire, fluff and other deleterious material.

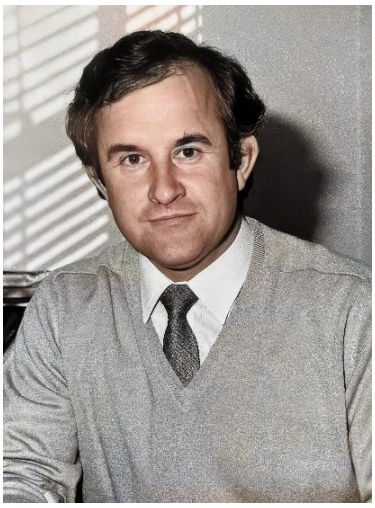
Crumbed Rubber Seals are designed to produce elastic membranes for the reduction and control of cracking particularly in an existing pavement from reflecting through the esealed surface. By adding crumbed rubber to conventional asphalt improve the properties of durability, temperature resistance, fatigue cracking and rutting resistance.

In the early 1970s, following the collapse of the King Street Bridge in 1962, **Roy Gilmour**, **Jim Webber, Peter Balfe** (see photos below) and **Bill Pinches** carried out dynamic load testing of large, welded, high-strength steel beams at temperatures as low as minus 20$^{o}$C. The purpose of the testing was to provide confidence in the brittle fracture resistance of the steel being used to construct the West Gate Bridge.

The testing successfully demonstrated that the welded steel would have satisfactory toughness to resist brittle fracture at temperatures that could be reasonably anticipated in Melbourne.

Roy Gilmour – 1983

Jim Webber – circa 1970s



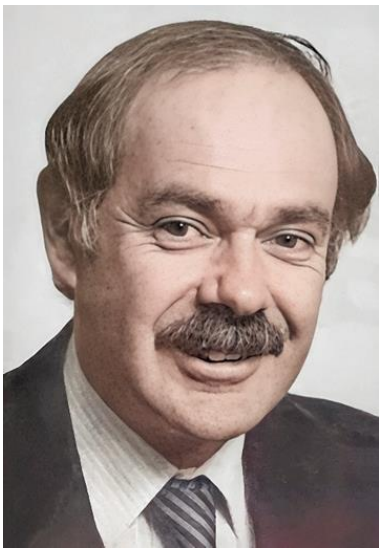
Peter Balfe - 1990

**Roy Gilmour** developed a process of friction welding large sized stud shear-connectors to steel beams to replace the block and loop type of connectors in use at that time. While this development was adopted for a period, manufacturers of the alternative problematic arc stud welding connectors increased the size of the studs that could be attached to steel beams, and the friction welding process was phased out for economic and practical reasons.

**Roy** also conducted tests on slip base light poles using a remotely driven passenger-less car to validate the torque force required to tighten the hold down bolts. The tests validated American standards regarding the levels of tightening required to ensure that poles disengaged when a collision occurred.

**Roy** also developed a consumable guide for the electroslag welding process to weld thick tension and compression flanges of bridge girders

**Bruce Phillips** was assigned (in 1973) to research and propose a surfacing system for the redesigned structure of the West Gate Bridge following its collapse in 1970. The new bridge design required the application of a 50 mm layer of asphalt applied directly to the top of the steel box girder section of the bridge. Such a pavement structure (asphalt on steel) had not been constructed before in Australia.



Bruce Phillips – 1976

The principal issues were the difference in the flexibility of steel and normal asphalt layers. In cooler climates (such as in Europe and U.S.A) a mastic asphalt worked well, but at higher temperatures (such as in Australia and New Zealand), the asphalt became fluid and distorted. Bruce undertook a literature search, and a worldwide study tour of bridges seeking a solution which was found in San Francisco, where a new development (epoxy/bitumen asphalt) was found.

The system was tested locally and adopted for surfacing of West Gate Bridge in 1978 - with an expected life of 20 years. The pavement has been repaved twice subsequently.

**Bruce Phillips** won the inaugural Australian Road Research Board (ARRB) Director's prize in 1976 for developing an artificial aggregate from crushed bricks which produced high skid resistance properties. Such aggregates were applicable at locations such as approaches to pedestrian crossings and intersections, where conventional aggregates did not have sufficient skid resistance for use to address concerns.

**Harold Taskis** and **David Ford** in the early 1970s, identified crop/tree dieback from unwashed plant (graders, dozers, etc.) carrying soil contaminated with a fungus know as *Phytophthora Cinnamomi* when being transported between road construction jobs.

Once infected soil is introduced into new locations, it can rapidly spread throughout the environment. A VicRoads instruction was subsequently issued that plant must be washed before transportation.

Harold Taskis – Circa 1970s

**Alan Griffiths, David Veith** and **Mechanical Branch,** in the 1970s, developed and built the Pavement Strength Evaluator (PaSE) (see below) based on the French Lacroix Deflectograph.

The vehicle was purposely built with a standard dual tyred rear axle legal load of 8.2 tonnes to accurately measure the downward movement of the pavement between the rear wheels by a sophisticated electro-mechanical system.

The vehicle travels at a speed of 2-4km/h and takes readings at intervals of 4-7 metres in both wheel paths giving a continuous strength profile of the pavement. Electronic sensors attached to the measuring beams measure deflections to the nearest 0.01mm and are recorded in digital format on and on-board computer. The information obtained from these readings is an important input used by engineers in the design of pavement treatments.

Alan Griffiths - 1982

David Veith – 1990


Pavement Strength Evaluator (PaSE)

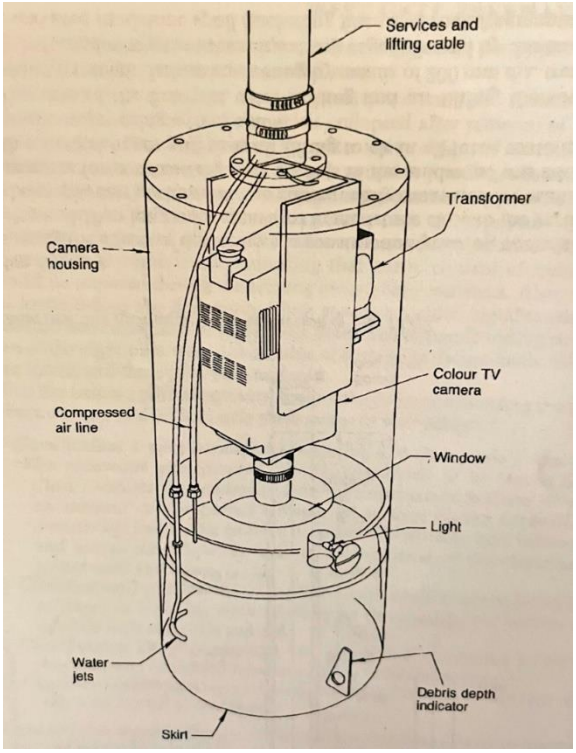

Cone Penetrometer Testing Vehicle

**Jim Holden** in the 1970s led a team of **Alan Griffiths, David Veith, Ron Lilly** and **Mechanical Sub-branch** in developing the **Cone Penetrometer Testing (CPT) vehicle,** which was used to identify soil characteristics in foundation investigations. Alan and Ron designed the mechanical and hydraulic drive which was built in the MRD workshop. David designed and built the control and data gathering electronics and Mechanical Sub-Branch designed and built the body.

Dr Jim Holden - 1990

**Jim** and **David Veith** developed the Socket Inspection Device (SID) utilising remote video technology, to verify the cleanliness of the bases of the 60+ metre deep bored and rock socketed piles for the West Gate Freeway through South Melbourne. The piles were constructed using bentonite to maximize the stability of the sockets before casting concrete.

The design assumptions relied on end bearing at the base of the piles as well as friction between the piles and the rock over the depth of the sockets. It therefore became necessary to inspect the cleanliness of the bases before casting concrete. SID enabled this inspection and with its amenity, procedures were developed to assist in the cleaning of the bases by air lifting.




Socket Inspection Device

**Jim, David Veith** and **Ron Lilly** developed the Electrical Skin Friction Cone Penetrometer used to evaluate and classify sub-surface materials particularly in soft silty-sandy materials which exist in the South Melbourne/Port Melbourne area. The information gained is an important input into the design of roads and bridges in such difficult locations – refer to VicRoads Technical Note No. 24.

**Jim Holden** in the 1980s, with the assistance from staff from the RCA Survey and Mapping Division, developed a methodology for stable Permanent Survey Marks (PSMs) constructed in expansive clay soils. It had been found that the previously used PSMs were progressively being jacked upwards by up to 40 mm when installed in these soil conditions. This led to claims being received from contractors arising from unstable benchmarks. The basic methodology involved installing a stainless-steel rod inside a stainless-steel sleeve that penetrated the clay subsoil which was then anchored in the bedrock below. Movements less than 1 mm were achieved.

**Jim**, along with two others outside of VicRoads, won the 1996 ARRB Director's Prize for the development of a new construction method for vertical moisture barriers beside highway pavements. The role of these barriers is to stop the seasonal lateral migration of moisture to and from the subgrade beneath the pavement, a significant factor causing pavement cracking and loss of shape. The barrier also prevents the invasion of plant roots – refer to VicRoads Technical Note No.13.

**Peter McDonald** and **Richard Evans** developed design methods for rock socketed piles in weathered basalt for the West Gate Freeway – South Melbourne Section. These methods provided confidence for bridge designers to meet the tight design tolerances for the elevated superstructure.

Peter also investigated improved methods for the design of laterally loaded piles which lead to significant savings for foundations for noise attenuation walls subject to wind loading.

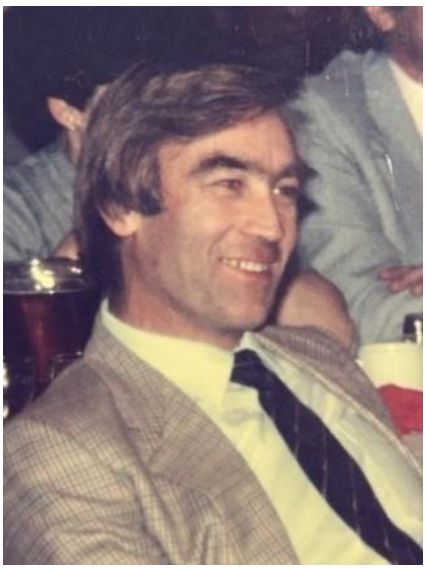
Peter McDonald – 1990

**Peter** and **David Jellie** (Project Manager of the West Gate Freeway) in 1992 were joint recipients of the "Baker Medal" awarded triennially by The Institution of Civil Engineers in the UK in recognition of services to the significant developments in design and construction practices for the foundations used on the West Gate Freeway Project – South Melbourne Section.

David Jellie - 1988

**Adrian Williams** developed design methods for socketed piles founded in weathered mudstone – a very different treatment to that for weathered basalt.
VicRoads sponsored Adrian to undertake a PhD at Monash University to develop the design method, and his input was pivotal to the socketed pile designs that were finally adopted for the mudstone.

Adrian's work was crucial to the foundation designs for the West Gate Freeway Project.

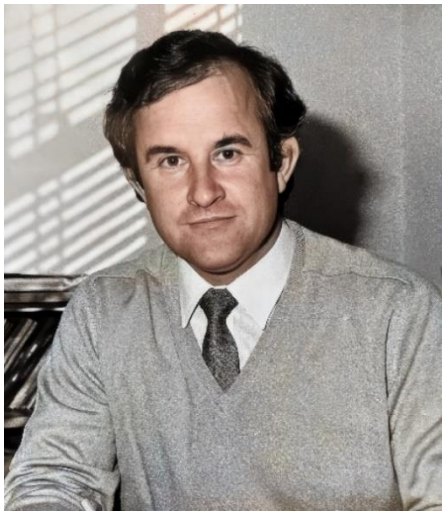


Dr Adrian Williams – Circa 1980s

**Peter Balfe** led a team investigating the correlation between instrumented Dynamic Pile Load testing and Static Pile Load testing for several hundred concrete piles on the West Gate Freeway Project. These piles were 1.5 m in diameter and extended down to a maximum depth of 65 m through silt and gravels and socketed into the underlying mudstone and basalt foundations.

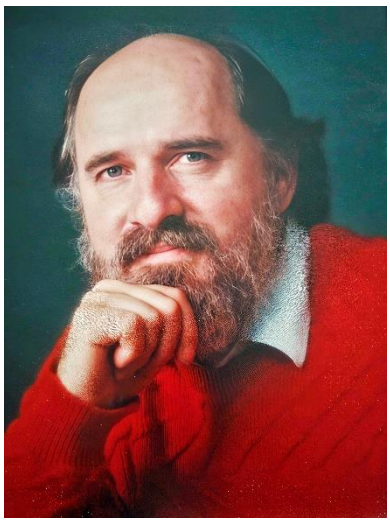
During construction, doubts developed about the strength and integrity of the socketed foundations due to the discovery of remnant bentonite on the socket interface of the pile and the rock. Previously, testing of such large piles traditionally required very expensive and time-consuming static load tests.

The investigation surpassed expectations, proving that the dynamic test results could be relied on which led to major cost and time savings on the West Gate Freeway Project and on many subsequent projects. The computer modelling and testing analysis was mainly undertaken by **Sam Plesiotis** and **Julian Seidel,** assisted by **Russell Brown** and **Ivan Haustorfer.**



Peter Balfe – 1990

Sam Plesiotis – circa 1980s



Russell Brown - 1991

Ultra lightweight Expanded Polystyrene (EPS) was used as fill in embankment construction in the 1980s over weak ground at various sites where Coode Island silt existed in the South Melbourne area during construction of the West Gate Freeway Project.

**Russell Brown** in 1995 further refined the use of EPS in the repair of a significant number of landslips which occurred in the Otway's within a couple of months. These landslips mostly occurred where road formations had been constructed as sidling cut and fill. The method is described in VicRoads Technical Note No. 25. Over the next 10 years, the method was used to repair over 300 slips**.**

**Barry Fielding** in the 1970s developed an Aggregate Durability test method in basalt source rocks. The test involves the measurement of the proportion of fines produced after several cycles of immersing a sample in boiling ethylene glycol.

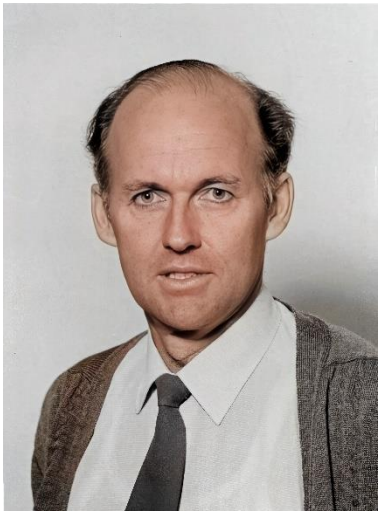
This test assesses the physical degradation of the sample primarily due to the swelling of clay minerals, especially smectite in basalt. A sound basalt rock type should have an index value of at least 94, with values between 90 and 93 considered marginal. Less than 90 is considered unsound. The method formed the basis of the Accelerated Soundness Index Test now published as an Australian Standard Test - AS 1141.29.

Barry Fielding - 1990

**Kelvin York** in 1976 co-authored with **David Currie** the authoritative Standard Specification Section 812 for Crushed Rock Base and Subbase pavement materials of the CRB, a specification of distinction at that time.

**Kelvin** in 1986 introduced the Nuclear Gauge density testing method into VicRoads procedures that replaced the IPCADD (In Place Coarse Density Device) previously developed by Keith Moody – a procedure for measurement of compaction in granular pavement construction.

**Kelvin, Simone Servais** and **Andrew Walker in** 1988 developed a calibration procedure for Nuclear Density/Moisture Gauges at the Mulgrave Laboratory.



Kelvin York - 1990

Simone Servais circa 1980's

Andrew Walker – Circa 1980s

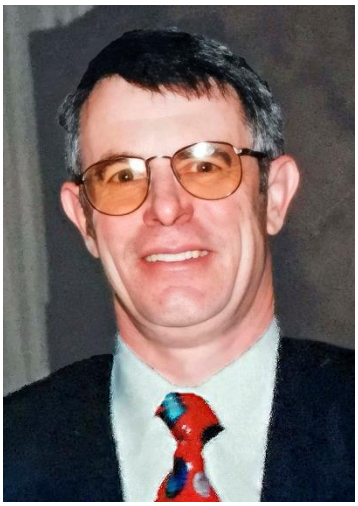
**Kelvin York** in the early 1980s prepared a document providing guidance for the conduct of carrying out pavement investigations in a uniform manner so that relevant design parameters are consistently and accurately obtained.

Parameters such as pavement strength, surface condition, surface and sub-surface drainage condition, pavement layer depths and descriptions, subgrade strength, and sampling for laboratory CBR testing.

This document was subsequently modified and reformatted to bring it in line with other Technical Bulletins produced by VicRoads MRD staff.

The updating was predominantly carried out by **Ken Mitchell** assisted by **Lance Midgley, Graham Foley, Andrew Papacostas**, **Ross Paul** and **Gerry Turner** – refer to VicRoads Technical Bulletin No. 40 issued in 1995.

Graham Foley – 1983



Ross Paul – 1997

Gerry Turner – Circa 2000s

**Ross Paul** in 1997 presented an authoritative paper to the 10th AAPA International Flexible Pavement Conference on the history of the development in design and construction procedures used for deep strength asphalt pavements.

This type of pavement had become almost exclusively used on urban, heavy-duty freeway construction, particularly in the Melbourne Metropolitan area. The paper covers how the design procedures evolved from an empirical procedure using granular equivalency coefficients to a full mechanistic procedure as greater knowledge of the structural properties and performance of pavement materials became available.

In preparing the paper Ross was assisted by Bill Brown, David Simpson and Darren Von de Lippe from MTD and staff from the ARRB.

**Barry Bromham and Dom Meadley** (see below) in the 1970s researched the use of super plasticisers in high strength concrete thereby dramatically changing the practices in the precast industry by enabling steam curing to be reduced from 10 hours to about 2 hours.

**Barry and Dom** in 1982 introduced rubber capping of concrete test cylinders providing a more efficient and less hazardous method than the alternative of sulphur capping. They also introduced the use of 100 mm diameter x 200 mm in length concrete test cylinders which, in 1986, was accepted as an Australian Standard (AS No.1012) saving multiple backs strains with over 100,000 cylinders being tested each year.

Barry Broham - 1983

Dom Meadley - 1986

**Dom** in 2008, as presented with a Standards Australia Meritorious Contributions Award for his 33+ years' work with the Soils, Asphalt, Aggregates and Earthworks committees.

**David Anderson**, in the late 1970s, studied for his master's degree in Transportation specialising in pavements. The study was undertaken at the University of California at Berkeley, USA and supervised by Professor Carl Monismith.

His research required him to run more than 250,000 computer analyses, usually near midnight when the University's computer was available. David concluded that the difference between the maximum deflection and the deflection at an offset of 200 mm ($d_0$-$d_{200}$), which he termed the Curvature Function, was considerably superior to other candidate parameters in estimating asphalt strain.

David Anderson - 1982

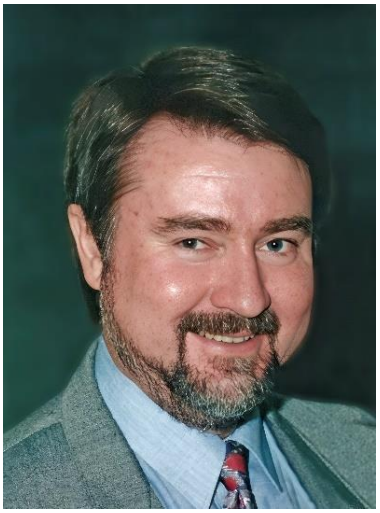
This work significantly rationalized the CRB's approach to Asphalt Overlay design and ultimately was adopted into the Austroads Pavement Design Guide procedure. In 1987 David along with four other State Road Authority pavement experts updated the NAASRA (now Austroads) "Guide to the Structural Design of Road Pavements" that incorporated a mechanistic approach to pavement design. This approach was a major change in the design of flexible pavements with bound layers such as asphalt over the empirical design charts used to design such roads as the Mulgrave Freeway in the early 1970's.

**Bill Sherwin**, in 1979, produced "Technical Report No 67, CRB Asphalt Mix Design - The State of the Art".

The report identified numerous MRD staff who contributed to improving asphalt mix design including **Alf Gawith** (1938), **Ollie O'Flynn** (1950s and 60s), **Alan Ratnarajah** (1961), **Bill Sherwin** (1962), **J Morris** (1963), **Brian Head** (1967/68), **M Jordan** (1974), **Maurice Herzfeld** (1974) and **Bruce Phillips** (1974 and 1976).

Bill Sherwin – circa 1980's

**Lance Midgley,** when working on the Hume Freeway- Seymour to Euroa Project in the late 1970s and early 1980s, together with **John Jobson,** sourced the use of a slightly plastic granitic sand as an additive to the crushed rock being produced at a Hornfels quarry that had been established at a VicRoads nominated site on private farmland in Avenel.



Lance Midgley - 1986

John Jonson - 1983

The mixture achieved a much better grading which significantly reduced its permeability, improved cohesion and compatibility but more importantly, eliminating the brittle nature of the previously used mixture on the failed Hume Freeway – Wallan to Broadford Project.

The principle of this modification together with other features adopted on the project, such as specifying and achieving higher pavement compaction levels and increased frequency of pavement density testing with results assessed on a statistical analysis, were subsequently incorporated in VicRoads' standard specifications – refer to VicRoads standard specification Section 812.

In 1988, **Lance** reported (refer Technical Repot No. 77) on the innovative pavement construction techniques over expansive clay subgrades adopted on the Western Freeway - Melton Section. Such techniques were aimed at minimising the swelling and shrinkage characteristics of such materials.

In the past where conventional construction methods were used, premature loss of pavement shape occurred adversely affecting the ride quality of the pavement. These techniques together with close attention to landscaping plantings (none in central median) has led to improved pavement performance based on monitoring over the past 40 years.

The concept of these techniques form part of a procedure now incorporated into VicRoads practices – refer to VicRoads Code of Practice No. RC 500.22.

**Lance Midgley** in 2023, was presented with a National Transport Research Organisation (previously ARRB) Lifetime Contribution Award for his contribution in the field of pavements for over 20 years. This included amongst other achievements, 10 years representing VicRoads on the Austroads Pavement Research Group, (3 years as Chair), leading the initiative with John Bethune to produce Austroads/AAPA Work Tips, and the issue of several papers at National Conferences including "Best Practice for the Preparation of New Granular Pavements for Thin Bituminous Surfacing" published as VicRoads Technical Report No. 209.

**John Hanks** and **Kel York** in circa 1980 developed statistically based acceptance testing 'procedures for roadworks (lot testing), now incorporated in VicRoads specifications and adopted by all other Australian road authorities.

John Hanks – 1982

**Walter Holtrop** and **Chris Starr** (from Horsham Division) in the 1980s led the development of the Surfacing Inspection Rating Procedure (SIRP), a fundamental input for determining the need and priority for resurfacing.

The procedure involves a visual assessment of the following conditions for a Sprayed Seal Surface: Extent of cracking, Loss of Aggregate (Stripping), Extent of Patching, Assessing Binder Condition (Oxidation), Loss of Binder, and Loss of Surface Texture. A similar procedure was developed for asphalt surfaces. Both procedures are described in VicRoads Technical Bulletin No. 50.

Walter Holtrop – 1990

**Elmer Nyoeger,** the CRB's petrologist, developed a test (early 1980s) identifying secondary minerals in basalt more commonly known as "green basalt". This type of rock significantly breaks down when exposed to the elements and was a contributing cause leading to the failure of the asphalt used in rehabilitation work following the earlier failure of the Wallan – Broadford Section of the Hume Freeway. The test formed the basis of the Secondary Minerals Content in Basic Igneous (Basaltic Type) Rocks now publish as an Australian Standard Test - AS 1141.29.

Elmer Nyoeger - 1982

**Geoff Jameson** in 1990 reported on the results of the Mulgrave Accelerated Loading Facility (ALF) trial aimed at evaluating the fatigue characteristics of asphalt and cement treated crushed rock, both of which are required to design deep strength asphalt pavements.

ALF enables the simulation of heavy vehicle trafficking on pavement structures providing rapid and cost-effective evaluation of the pavement being tested. The purpose of the trial was to obtain information about the fatigue characteristics of asphalt and cement treated crushed rock, both of which are required to design deep strength asphalt pavements.

Geoff Jameson – 1986

This need was highlighted when a mechanistic approach to the design of such pavements was adopted for Melbourne in the late 1980s. This followed the publication of the 1987 NAASRA Pavement Design Guide: A Guide to the Structural Design of Road Pavements.

This 1987 Guide included presumptive fatigue relationships based on overseas research and there was an urgent need to validate the relationships for use under Australian conditions. The results from the trial indicated that a reduction in the thickness of Deep Strength Asphalt pavements could be made making them a more cost effective and the favoured structure for use in Melbourne.

The paper was reported in the Proceedings of the 1992 ARRB Conference held in Perth.

ALF at the Mulgrave Site – 1991 post trafficking

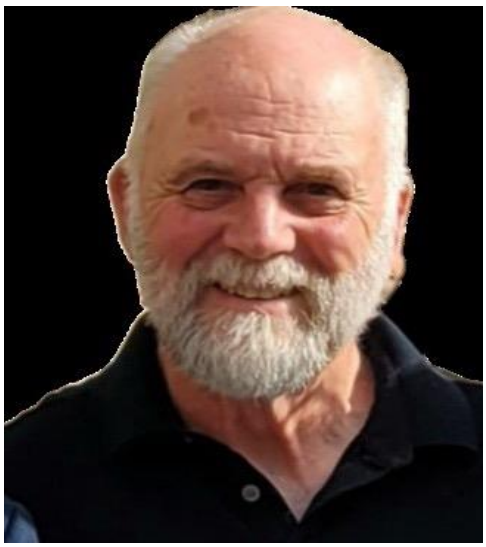
**Geoff** in 1993, updated the then CRB Pavement Design Guide (Technical Bulletin No. 31 issued in 1980) as a supplement to the NAASRA "Guide to the Structural Design of Road Pavements" issued in 1987 – see David Anderson above. TB31 was based on empirical and equivalency procedures and needed to be updated to align with the new Austroads Guide. The Supplement was known as Technical Bulletin No. 37 – VicRoads Guide to Pavement Design.

**John Esnouf,** in 2017, championed the introduction of the forward moving, front of vehicle, aggregate spreading system for sprayed bituminous sealing work.

This significant development followed concerns regarding the hazard associated with the traditional reverse moving vehicle aggregate spreading system.

It arose following a serious accident where a VicRoads' workman was run over by a reversing truck. Private contractors have adapted this innovation resulting in reduced accidents and improved quality of construction.

It also reduces the quantity of aggregate required, thus preserving valuable quarry resources.



John Esnouf - 2024