

SEMINAR
MATERIAL EVIDENCE
Conserving historic building fabric
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FLOORING
Asphalt flooring repair
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NSW
Heritage
Office

About the Speaker

David McBeath is a conservator specialising in architectural, industrial and rural heritage conservation. He has 24 years practical experience gained as an apprentice in fitting and turning, working in the rail and shipyards at his trade, and has worked as a conservator at the Powerhouse Museum. With further tertiary study, he now carries out surveys and advises government departments, architectural firms and community groups on the conservation of materials.

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Asphalt Tile image

David McBeath

Asphalt is everywhere. It is the curse of urban landscapes along with concrete but it still has some unique features that have been used historically in terrace backyards, factory floors, tennis courts, railway platforms and to graze children's knees in school playgrounds.

In Sydney, some excellent early examples of sheet and block asphalt survive.

Asphalt paving blocks measuring 250 mm. sq. x 125 mm were used in London in the 1830's¹ for roads and similar hexagonal blocks have been recovered from East Sydney Technical College. In the 1830's the Champs Elysees was paved with asphalt blocks 300 mm thick.

Asphalt and bitumen has been used in Australia since the early 1800's. The earliest recorded usage of these materials is found in convict work schedules from Tasmania, where it was used to coat timber blocks for town road construction.

During the 1880s, asphalt was laid at Kirkbride Hospital, Rozelle, Sydney, where it was used for the external footpaths and internally on utilitarian floors such as laundries, kitchens or cellars. The particular mixture used at this site was commonly used at the time and will be discussed later in this paper.

The verandah floors of Gary Owen House, situated in the grounds of Kirkbride Hospital, have also been covered with hexagonal asphalt cobble stone blocks similar to those at Darlinghurst Gaol, Victoria Barracks and the Lancer Barracks at Parramatta.

Laid asphalt has a life span of about forty years. Maintenance usually involves replacing or overlaying the asphalt regularly. Consequently, there are few intact original examples of laid asphalt. It is therefore important to retain as much as possible of examples such as those at Kirkbride Hospital. Remarkably, after more than one hundred years, Kirkbride still has the original asphalt paths in situ, although in various states of repair. The longevity of the asphalt is partly due to the paths being situated undercover with pedestrian use only. While the age of the asphalt at Kirkbride is remarkable it is very difficult to repair these original asphalt paths. The conservation of such examples will be dealt with later in this paper.

¹ Lilley, A. A Handbook of segmental Paving. Chapman & Hall pg.10

Characteristics of Asphalt

- Laid asphalt basically varies in five main factors:
 1. Percentage ratio of bitumen to aggregate
 2. Graded or ungraded aggregate sizes.
 3. Type of bitumen.
 4. Type of aggregate.
 5. Method of laying the asphalt.

Within these five variables, countless types of asphalt can be produced depending on the conditions the asphalt must endure.

- Most modern asphalts have a maximum binder content of 8% bitumen.
- Asphalt slowly turns from a black to a grey colour over time. This is caused by oxidation of the mixture and the cross lining of the binder to form a crystalline and brittle structure.

Historical notes

Since the 1880s asphalt has been used to provide a cheap non-slip surface for various types of traffic.

Prior to the 1880s, pitch obtained from Europe and Britain was exclusively used by the military for tanking and waterproofing magazines.

It was not until an Anglo-American consortium opened up the supply of tar and pitch from Trinidad (Lake Asphalt) that pitch became commercially available worldwide². In the 1880s, Australia imported tar and pitch from Lake Asphalt, Trinidad, to use as the binder in asphalt. Tar and pitch were also produced as a byproduct of town gas production from bituminous coal.

Tar is no longer used in the production of asphalt as it has dangerous and carcinogenic properties in its molten and volatile state.

Conservation of paving asphalt

This leads us to determine how to save intact the asphalt paths. What cannot be saved should be replaced in a traditional manner as is still practised today.

² The Trinidad pit is open again and the information is available on the internet.

The only method to conserve historic asphalt is to maintain a good housekeeping regime.

As a general rule the maintenance of edges or kerbing is critical. The edges of asphalt must be contained as they will break off over time.

Degradation of historic asphalt can be due to several environmental conditions including:

- Degradation due to the ingress of rain.

This will generally occur in areas where the asphalt has continual dripping or flow of water and the aggregate is dissolved out of the mix.

- Wear from foot traffic

This will generally occur in areas where the asphalt has continual tracking over the same area.

- Wear from furniture

Caused by indenting (rutting) from repeated use of chairs or other objects in the same position, where the legs distort or gouged ruts in the asphalt

- Earthworks

Replacement or installation of services beneath the path with the asphalt repaired in other materials.

- Distress

This is caused by ground movement and climatic extremes or poor preparation and failure of the base.

- Weed and plant growth

The roots cause the asphalt to distort and crack.

- Solvents

Solvents such as petrol will dissolve the binder causing the aggregate to fall away.

Renewal

Analysis and historical research is the only method for reproducing asphalt with accuracy in order to determine the mix proportion, type and size of the aggregates.

When considering renewal, the paving area should be mapped in order to obtain a clear understanding of what can be retained and what must be replaced. This will also provide an indication of the expected costs.

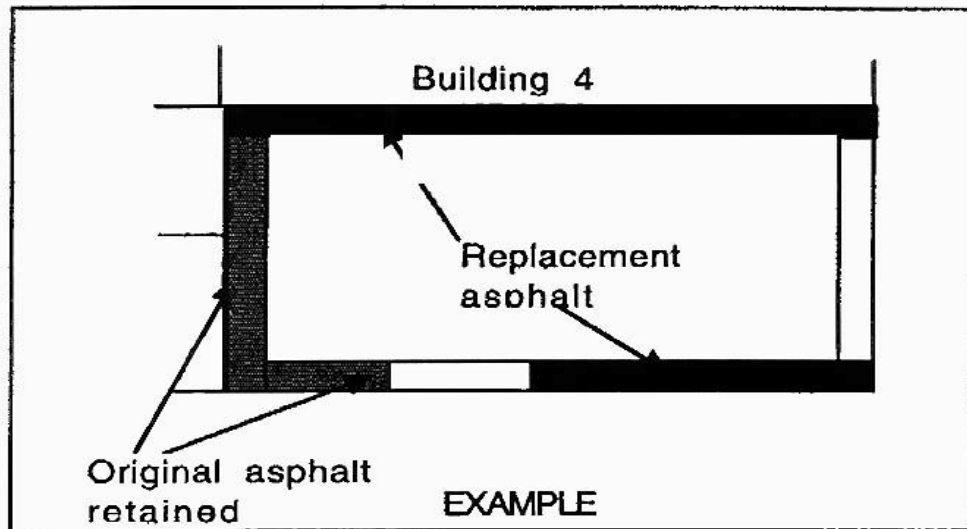


Diagram 1

Often local aggregates are used which would not be available or delivered unless specified.

Asphalt must be laid on a well prepared surface for it to last its full potential life span.

A number of studies have been conducted for the Sydney Harbour Foreshore Authority and the Sydney City Council mainly identifying material types in generic terms and positions where it has been found. This has resulted in what is called a “Heritage mix” produced by Boral Pty Ltd . This is a dense graded asphalt in which carborundum is added and it can be seen in Sydney footpaths in the Rocks area. It is identified by the sparkle of the carborundum in the sunlight.

The selection of a replacement asphalt should consider the following items:

- Where failure of the original material is caused by the substrate or base, it will be repeated in time by the new material unless the substrate is repaired.
- If new asphalt is laid over the original in places there will be a height variations
- The skills and cost of laying new asphalt in sections as the original may be cost prohibitive.
- The original mix is not an industry standard and will have to be specially batched.
- Colour variation in the repair compared to the original may destroy the qualities of what is being saved.

This may entail a method of lessening the pedestrian traffic using the paths with the original asphalt and maintaining the roofs and drainage. The best areas should be retained until their complete failure.

Aggregate and filler to be used in the mix:

The sand selected should have an affinity to the binder and the following criteria should be considered in the selection:

- Cleanliness
- Moisture content
- Porosity
- Shape
- Plasticity

Test Results

Test results in this report were carried out by National GTS.Laboratories in accordance with RTA test method T 607.

Case Study: East Sydney Technical College

Hexagonal Paving Blocks

Dense Graded Asphalt
Tar content 8.2%

Sand and Filler Analysis

The grading analysis has determined the following aggregate.

% passing 4.75 mm. sieve	100
% passing 2.36	82
% passing 18	54
% passing 600 µm	36
% passing 300 µm	- 25
% passing 150 µm	16
% passing 75 µm	10

The hexagonal blocks could be reproduced with a standard dense grade mix with the exception of using tar replacing it with a cold emulsion binder

The use of a cold emulsion allows for one week of working time to press the blocks. Hot bitumen is applied and pressed above a designated temperature to bind the mix.The mould should be constructed of metal. The material is produced similar to hand pressed bricks. (See Diagram 2)

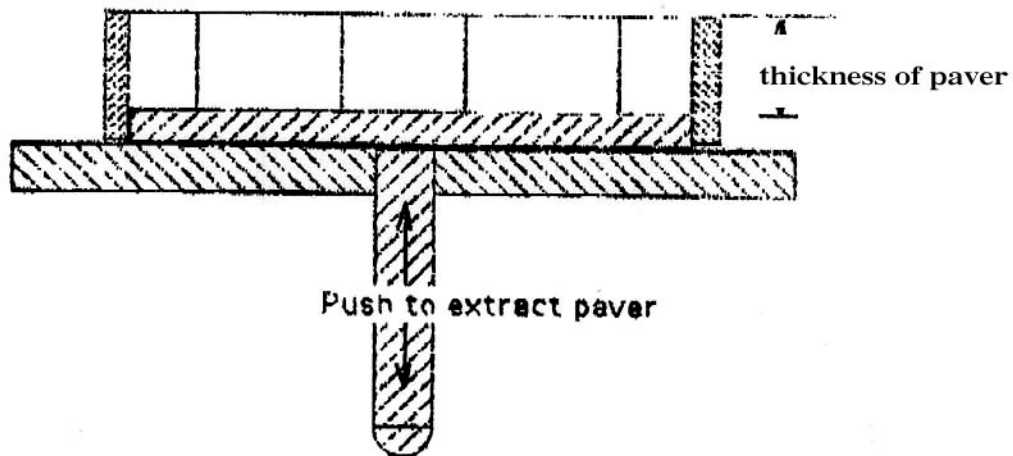
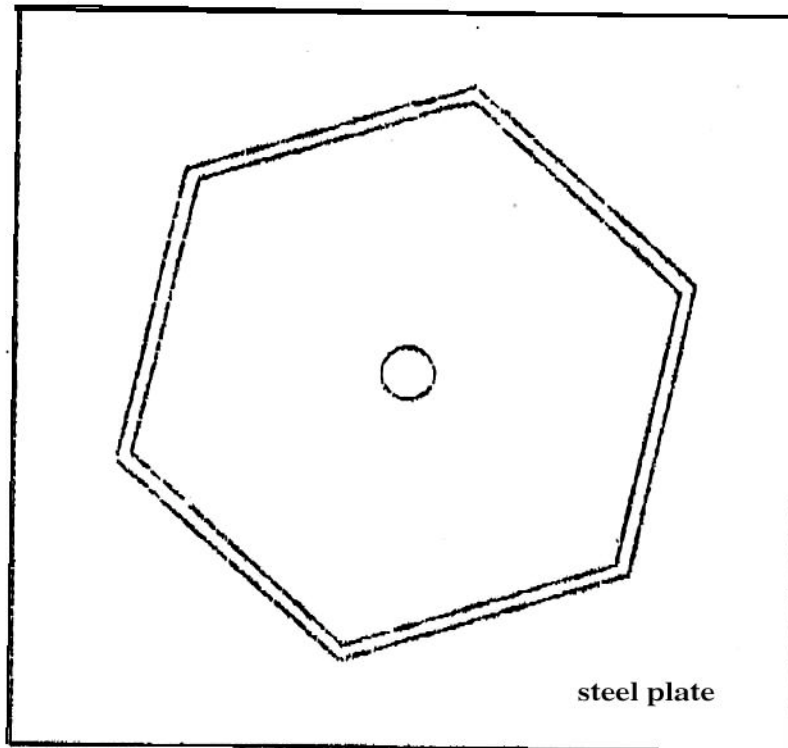


Diagram 2

All components should be lightly covered with dieselene as a release agent. The mould is then filled with the mix and hand pressed with a mallet until a uniform compaction is reached. The paver is then pushed out and stored until the mix has set.

The lower moulded face of the paver becomes the exposed surface when laid.

There would be a set up period of trial and error while quantities and measures are established and a uniform paver could be reproduced.

Case Study: Kirkbride Hospital
Gap Graded Sand Asphalt

Kirkbride Hospital at Rozelle was designed by James Barnett in the 1880's. Asphalt sheet was used for the covered walkways between the wards of the hospital and wherever safely possible, it has been retained.

The asphalt is a gap graded sand mix and has been laid in all verandah paths in sections that are undercover.

It is my assessment that the best treatment is large, continuous section replacement using the original mixture and segmenting where the condition of the asphalt is poor, and large section retainment with no treatment where the asphalt is in good condition.

This can be seen in the most severe sections at Building 4 where the verandah has been removed, but smaller areas can be seen where the verandah is leaking.

When originally laid, this was a black pathway banded by sandstone kerbing and walls. This is mentioned because the worn, mellow grey surface that is now seen was once pitch black in colour, significantly changing the aesthetic qualities and highlighting the perimeters of each wing of the hospital when new. The surface once had a fine texture but it is now worn smooth.

New, fine aggregate is always being exposed as the asphalt wears down. Pedestrian traffic will dislodge or polish the larger aggregate to a smooth surface.

Sand and Filler Analysis

The grading analysis has determined the following aggregate.

% passing 4.75 mm. sieve	100
% passing 2.36 "	99
% passing 1.18 "	87
% passing 600 µm	69
% passing 300 µm	60
% passing 150 µm	32
% passing 75 µm	45.5

The analysis shows us the grading and the reason for the very dense appearance of the asphalt, with nearly half of the mixture passing a 75µm. sieve as a filler.

The aggregate is washed river sand and the filler is a stone dust obtained from quarrying the sandstone used to build the hospital.

The stone for Kirkbride was quarried on site and the quarry now forms the 9 million litre underground reservoir beneath the buildings.

This style of mix is very stable due to the stiffness created with the fine aggregate but requires a harder binder and must be worked and compacted while hot.

When compared with densely graded mixes of the same nominal size, gap graded asphalt:

- requires more binder
- is more prone to rutting at high temperatures
- is more easily placed by hand
- has lower texture depths³

The ratio of binder to aggregate in the asphalt is 11.1 %. This is extremely high with most modern asphalt produced today being a maximum of 8%.

It has been laid in sections across the verandah path. This may be due to technological restrictions in the late 1800's, by virtue of the recipe of the mix or by the heating capacity of the crucible.

The measurements of each section of asphalt is 2300 mm.x 892 mm. X 20 mm. Each section has the cubic capacity of 40.94 litres or 9.0055 gallons, at 11.1 % pitch content. This works out to be exactly one (1) gallon of pitch per section of asphalt. This probably means that the recipe is determining the size of the segments that can be seen on the paths of the covered walkways.

The mixture would have been heated and mixed on site as the mixture had to be very hot when laid.

The sections of asphalt have been laid and hand rolled in sections between the wall and the sandstone kerbing.

- A steamroller would not fit under the verandah.
- The average thickness of the asphalt is 20 mm..
- It has been laid on a concrete or a compacted sandstone base. Slate has been used in places to fill shallow voids under the asphalt.
- The asphalt when laid is black in colour. When it has oxidised with age, it turns the grey colour that can be seen on site.

³ N.A .A .S.R.A. Guide to the selection of bituminous surfacings of pavements 1985 pg. 5

Treatment

As the Kirkbride block will soon be fully occupied, the asphalt paving requires repair. Several areas can be retained but with an increase in pedestrian traffic these areas will eventually fail.

If the original asphalt is not at least 95 % intact, it is too old to be relied upon to be repaired. I have found no other method other than those mentioned above that could be applicable in this situation.

Where the material is not so old and degraded, a method of enrichment could be used which may be effective on the roads within Kirkbride.

There are six options available to pursue for the re-use and repair of the paths:

- No treatment

If 100% of the section is without serious defects (Major cracks or missing areas of asphalt)

- Crack repair

To fill voids within minor cracks with a liquid bitumen.

- Complete replacement with identical material.

Where there are missing sections of asphalt and cracks.

- Overlaying

This should only be carried out if the substrate is sound and in continuous lengths.

- Replacement with another material

A policy decision that should refer to the Conservation Plan.

- Reproduce the original mix

In this case, the 'No Treatment' and 'Reproduction of the original mix' options were selected and undertaken successfully by the Department of Public Works & Services. Kirkbride is now open to the public.

Relevant Australian Codes

AS 1141 Aggregate Porosity

AS 1289 Methods for testing soils for engineering purposes.

AS 1348 Road Engineering

Terminology

Many terms are used for asphalt and its ingredients and often several different terms will be used in reference to the same thing. To avoid confusion I have included a list of terms and their meanings as used in this paper.

Asphalt - a mixture of bitumen and aggregate also referred to as asphalt concrete or in American publications as bitumen.

Bitumen- the binder in asphalt, produced as a refined byproduct of oil.

Base-the structural layer under asphalt.

Tar- the binder in asphalt produced as a refined byproduct of bituminous coal. No longer produced, as it is carcinogenic in its volatile state.

Pitch- a natural mined product often with a high clay or fine mineral content.

Course aggregate- 10 mm. or greater aggregate.

Fine aggregate- mineral particles in asphalt passing a 4.75 mm. sieve.

Filler- a fine mineral powder to reduce voids and increase stability of the binder, it passes a AS 75 μm sieve.

Dense Graded-evenly distributed aggregates from coarse to fine, with a low void content.

Gap graded- where the aggregate is uniformly graded from coarse to fine filler in the mixture leaving no voids with close texture.

Open Graded-where the aggregate is of consistent size allowing a void to exist.

Slurry sealing- an application of a mixture of bitumen emulsions, water, fine aggregate, and filler, applied with a squeegee used for resurfacing suburban streets.

Surface enrichment- a light application of bitumen to an existing bituminous surface, to increase the binder content. (Industry uses this for conserving asphalt, this should not be confused with the general heritage use of the word conserve)

Sand asphalt-a well graded sand used for tennis courts and low speed traffic zones as a skid resistant surface, The sand is sacrificial so the asphalt retains the skid resistance rather than the surface being polished.

Block asphalt- blocks pre formed to a regular size and laid like pavers.

Sheet asphalt- modern finely graded aggregate up to 6.7 mm. used in footpaths compacted while hot.

Tack coat - an adhesive layer to ensure that the substrate and asphalt bind.

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