

CHAPTER  
SEVEN

# Preseal Preparation



## Chapter 7 Preseal Preparation

7.1	Introduction	223
7.1.1	New or Unsealed Pavements	223
7.1.2	Existing Sealed Pavements	224
7.1.3	Pretreatment Seals	225
7.1.4	Timing of Preparation	225
7.2	Preparation for First Coat Seals	225
7.2.1	Granular Aggregate Basecourses	225
7.2.2	Stabilised Pavements	231
7.3	Preparation for Reseals	233
7.3.1	Investigation	233
7.3.2	Drainage and Shoulder Repairs	234
7.3.3	Pavement Repairs	236
7.3.4	Surface Texture Repairs	245
7.3.5	Removal of Deleterious Matter	253
7.4	References	255

Previous page: Preparing the basecourse of a road for sealing by compacting it with a steam roller, c1910.  
Photo from Alexander Turnbull Library, Stefano Francis Webb Collection (ATL G-4032-1/1)

# Chapter 7 Preseal Preparation

## 7.1 Introduction

This chapter explores the why, what, when, where and how of preseal preparation for both first coat seals and reseals, because the life and performance of any chipseal or other surfacing treatment is very much dependent on how well the preliminary preparation work of the existing surface is carried out. Preseal preparation is also known as 'preseal repairs' and 'prep'.

The goals for such preparation work can be summarised as follows:

- To maximise effective life for the new seal and ensure adequate seal performance throughout its life;
- To ensure adhesion of the new seal to the existing surface over all the seal area;
- To improve the riding quality by levelling uneven surfaces, including adjustment of service covers.

To achieve these goals, preliminary preparation works are carried out on any pavement area being readied for chipsealing or other resurfacing. The preparation works can be separated into two distinct categories, each with its own requirements and methodologies. They are:

- Basecourse preparation for first coat chipsealing of a new pavement (frontispiece);
- Surface repair, digout repair, and other preparation for the resealing of an existing pavement.

### 7.1.1 New or Unsealed Pavements

For new or unsealed pavements being readied for first coat chipsealing, preseal preparation includes the final sweeping of the unsealed surface to remove any soft layer of aggregate fines that have collected on top of the compacted basecourse (Figure 7-1). Removal of this fine layer is important to ensure adhesion of the sealing binder to the aggregate surface of the basecourse. If the fines are not removed, the new chip will 'punch' into this layer and the seal will flush.

First coat seal preparation will also include repairing surface defects such as variable or open-textured areas, loose aggregate or water-saturated areas, all of which are detrimental to the performance of a first coat seal.



Figure 7-1 The basecourse for State Highway 2 in Cook County, Gisborne, was swept clear of loose aggregate and other detritus by this rotary broom mounted in front of a tractor (with solid wheels and tyres), in the 1920s.

Photo courtesy of John Matthews, Technix Group Ltd

### 7.1.2 Existing Sealed Pavements

For existing sealed surfaces, pre-seal preparation is most likely to involve surface and structural (base) repair works in some form.

As discussed in Chapters 3, 4 and 5, the decision to re-seal a road or street section and the likely preparation required for it will have been made by identifying and measuring surface and other defects (using RAMM<sup>1</sup> Road Condition Rating Surveys, Treatment Selection and Validation inspections).

In addition to repair of obvious surface failures, e.g. potholes, minor cracking, edge-break repairs and other defects, pre-seal preparation can include pavement repairs and subsoil drainage works, minor shape correction and smoothing of uneven surfaces, adjustment of service covers, joint sealing, or isolated pavement rehabilitation works.

The inspection and renewal of catchpit and other road surface drainage structures (including kerb and channel (K&C)) before re-sealing is also important to avoid digging up the road a few years after a re-seal has been laid. Needless to say, co-ordination with providers of

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<sup>1</sup> RAMM – Road Assessment and Maintenance Management system.

underground utilities (communications, power, drainage, etc.) is important to ensure that planned maintenance of their services is carried out before the road is resealed.

The defect types and common repair methods used in pre-seal preparation works outlined briefly in Section 3.11 are covered in detail in this Chapter 7. For repair of seal failures that occur soon after construction of new reseals, see Chapter 12.

### 7.1.3 Pretreatment Seals

Chipseals must be applied to a uniform sound base layer, and treatments that can be used to achieve this, e.g. pretreatment seals such as texturing seals, are discussed in Section 7.3.4. Many methods of texturing are available for reinstating surface texture or for reducing the variation in texture of a surface before chipsealing, some of which do not include sealing (e.g. high pressure water treatments).

### 7.1.4 Timing of Preparation

When to carry out pre-seal preparation works is very much dependent on the type of preparation. Before first coat sealing, most preparation works for the basecourse are carried out in the days immediately preceding the day of sealing, and right up to the day of sealing.

Before resealing existing sealed surfaces however, pre-seal repair works should be carried out well in advance of the resealing date. Any minor surface repair, patching, or shape-correction works using asphaltic mix should be carried out at least 3 months in advance to allow time for the asphalt to cure and harden. Otherwise the new chipseal will be subject to faults caused when sealing over a soft substrate (see Section 4.7.4.1). Any minor repair, e.g. pavement rehabilitation, rip and remake, or stabilising, and first coat sealing areas, should be completed at least 9 months before resealing. A timetable for the various pre-seal repairs is presented in Table 7-1.

## 7.2 Preparation for First Coat Seals

### 7.2.1 Granular Aggregate Basecourses

For roads with medium to heavy traffic, granular aggregate basecourse material should comply with TNZ M/4:2003 specification, and should be constructed in accordance with TNZ B/2:1997 specification (Figure 7-2).

Table 7-1 Timing of pre-seal repairs.

Maintenance Treatment	Desirable Time of Completion Before Resealing
<b>Repair of edge breaks, patching, or smoothing using:</b>	
Cold mix with fluxed bitumen	>9 months
Cold mix with cutback bitumen binder	>9 months
Cold mix with bitumen emulsion binder	>9 months
Asphalt	>9 months
Slurry surfacing	>9 months
<b>Crack filling using:</b>	
Bitumen emulsion	2 months
Cutback bitumen products	6 months
Hot application bitumen products including PMBs	2 months
<b>Corrective treatment of flushed chipseal surfacings and patches using:</b>	
Chips only	2 weeks
Solvent chip treatments	2 to 6 months
<b>Maintenance of shoulders and longitudinal drains:</b>	
Before resealing	2 weeks
After resealing	2 weeks
<b>Line marking before resealing:</b>	
	6 months
<b>Miscellaneous</b>	
Weed and lichen removal (chemical means)	1 week (or as recommended by manufacturer)
Lichen removal (mechanical)	Pre-seal sweeping
Water cutting/blasting	6 weeks

7



Figure 7-2 Preparation of basecourse for chipsealing has changed a great deal in the last 80 years. Left: A steam roller compacts a new basecourse on State Highway 2 near Manutuke, Cook County, Gisborne, in the 1920s. Photo courtesy of John Matthews, Technix Group Ltd  
 Right: A basecourse to comply with the TNZ B/2:1997 specification is prepared on the Alpurā A2 section of State Highway 1, Auckland in 1999. Photo courtesy of Philip Muir, Works Infrastructure Ltd

The TNZ B/2 specification requires a high standard of compaction to densify the base (98% Maximum Dry Density (MDD) for basecourse and 95% MDD for sub-base material), and to obtain a situation in which the material is dried back to a saturation level of less than 80% before sealing. Saturation is calculated from the moisture content and solid density of the aggregate in the following formula detailed in TNZ B/2.

$$\% \text{ saturation} = \frac{\text{dry density} \times \% \text{ water}}{1 - \frac{\text{dry density}}{\text{solid density of the particles}}}$$

Failure to meet these two criteria is likely to result in an unstable base that will rut or shove, and lead to flushing. Immediately before sealing, density and water content can be checked by a Nuclear Density Meter (NDM) or other appropriate test method to ensure compliance.

Of equal importance for the success of the first coat seal is the final basecourse finish for which TNZ B/2 has the following requirement:

*The basecourse surface finish, as distinct from the surface shape, shall be such that when swept, it presents a tightly compacted, non-glazed, clean stone mosaic surface that will not ravel as a result of sweeping. The standard of sweeping shall be sufficient to remove all loose aggregate, dirt, dust, silt and other detritus matter.*

This latter requirement is frequently not met, perhaps because no clear test method is available to measure it, but what is intended is quite clear however. Essentially the surface should be almost entirely composed of clean stone particles, large enough to be visible to the naked eye and with fine lines of a ‘mortar’ of the finer sand and silt-sized particles between each chip (Figure 7-3).

The term ‘stone mosaic’ is a misnomer that dates from the period when most basecourse compaction was carried out by a static (not a vibratory) steel-wheeled roller (frontspiece). These rollers tended to cause the larger surface stones to be pushed into a flat surface alignment, so the surface looked like a mosaic of different sized flat tiles. Because steel-wheeled rollers tend to crush the stones to fine dust, modern practice is to do most compaction with vibrating steel rollers, finishing with a few passes with the vibration off, then tightening the surface with a mix of rubber-tyred rolling and trafficking. This leads to a surface having appreciable macrotexture once the surface has been swept to produce the desired clean stony surface.

This type of surface finish can be very difficult to achieve, especially when constructing the basecourse in a situation where it is not possible to divert the traffic. Unfortunately this is the usual situation for most rehabilitation works on two-lane roads.

The reasons for setting such a demanding requirement in TNZ B/2 are to prevent formation of layers of fines, as follows:

- *Formation of a layer of fines:* when a basecourse surface is covered by a layer of fine sand- and silt-size particles, the surface is far weaker than the body of the basecourse that has been constructed to the TNZ M/4 specification. (Paradoxically such a surface may be very hard when it is dry before sealing, but in moist conditions, the layer sucks up water like a sponge, becoming saturated and very soft.)
- *Formation of a wet layer of fines:* all sealed bases will ‘sweat’ very quickly under the seal in New Zealand conditions. A slippery ‘carpet’ of wet fines forms and the first coat seal applied over it is not satisfactorily anchored to the basecourse surface. The first coat seal can often be rolled up like a carpet.

In both cases, the seal binder eventually penetrates and binds the dust layer but this cannot be guaranteed. Long term, the adhesion of the seal coat to a basecourse with a dusty surface will always be inferior to that of a basecourse complying with TNZ B/2 (like those shown in Figure 7-3), as a permeable layer will remain under the sealed surface.



Figure 7-3 Basecourses prepared for first coat sealing from aggregates that are characteristic of different parts of New Zealand, after they have been prepared by sweeping.

Photos in clockwise order from top left are from the West Coast; Napier, Hawke's Bay; the Rotorua–Waikaremoana area; State Highway 1 near Palmerston North; by courtesy of Les McKenzie, Opus; Laurence Harrow, Opus; Norman Major; and Lindsay Roundhill, Opus, respectively.



### 7.2.1.1 Causes of Basecourse Failure

The consequences of having the soft layer of fines on top of the basecourse are:

- Poor adhesion of the seal to the base, putting greater stress on the seal under traffic and resulting in chip loss and loss of waterproofing.
- A permeable layer of fines that initially tends to soak up binder, and lowers the ability of binder to hold on to the sealing chip. The chips may punch down into the wetter layer of fines, resulting in binder rise and flushing.
- Excess fines forming a permeable layer under the seal. These fines can wet up over a large area with water infiltrating through tiny defects in the seal. The increased amount of water seeping into the basecourse can lead to potholes, sometimes called 'blowouts' as they appear to be caused by water pressure from beneath blowing holes in the seal.
- Frost-susceptible silt layers aggravating frost damage. Silt is easily damaged by frost, especially if directly under the seal coat. Most silt layers are thin however, and the effect of frost heave is not large scale, but over time the seal can totally delaminate from the basecourse, with more water entering each freeze-thaw cycle until the surface is totally disrupted.

### 7.2.1.2 Remedies for Basecourse Failure

To avoid these detrimental effects, any build-up of fines on the basecourse surface must be removed before sealing to achieve the desired stony surface. To achieve this, the following steps are taken:

- Spreading (or gritting) the final compacted surface with, ideally, clean Grades 5 or 6 sealing chip (although some surfacing engineers have used chips as coarse as Grades 4 and 3).
- Trafficking the surface for one or several days, depending on the traffic volume.
- To speed up the process, rolling for a pass or two to punch in the clean chip and break up the 'cake'.
- Grinding the loose chip by traffic to remove any caked-on fines.
- Drag-brooming to keep the grit in the wheelpaths.
- Careful traffic control to ensure that the full pavement width is trafficked.
- Final mechanical sweeping immediately before sealing to remove only the thin layer of loosened dust and loose chip.

Another option is:

- Watering and mechanical sweeping which can remove the material, but the basecourse will then have to be dried out before sealing. The gritting and trafficking procedure as described above can remove the fines with less water but may take longer.

When constructing a basecourse under traffic, wet weather can result in failures, e.g. potholing (Figure 7-4) of its actual surface. The problem will be much worse where there is a thick cohesive layer of fines on the base surface. If potholing does occur, the base must be scarified usually with a grader to below the base of the potholes, regraded and re-compacted. Any attempt to merely fill the potholes by grading AP20<sup>2</sup> material into them and rolling, will result in poorly compacted spots that will be revealed as depressions in the surface shortly after the new seal is opened to traffic. Hence it is better to drag broom to keep the surface intact (or 'hold the surface') in order to avoid pothole formation.



Figure 7-4 Even when chipsealing was less common, failures soon after pavement construction occurred, as they may do today. Here this road works team repairs a non-compliant section of freshly compacted pavement in the main street of a small New Zealand town in the 1920s.

Photo courtesy of John Matthews, Technix Group Ltd

<sup>2</sup> AP20 – all passing 20 mm sieve.

On lightly trafficked roads, softer cheaper aggregates may be used for chip instead of harder material complying with TNZ M/4. However these materials tend to break down under the rollers and produce more surface fines. As much as is possible, these fines should be removed to achieve a stone-mosaic surface. If this is not possible without breaking up the soft stone particles to fines, consider adjusting the first coat binder to enhance the penetration and binding of the fines. Some surfacing engineers advocate the use of slow break emulsions for this situation.

## 7.2.2 Stabilised Pavements

As an alternative to constructing pavements with granular aggregate material such as quarried M/4 basecourse, old road pavements are commonly stabilised in situ (Austroads 1998). This involves ripping or breaking up and pulverising the existing basecourse pavement (and seal layers as applicable to the site), then mixing in a stabilising agent such as lime, Portland cement or other proprietary products.

The aim of the stabiliser is to bind the finer soil particles (including silt and clay particles). The intention is not to create a rigid concrete slab pavement but simply to improve the basecourse aggregates to perform as much as possible like a well-graded basecourse.

General design and construction of stabilised pavements will vary widely depending on the existing material type and make-up, and the stabilising agent chosen. However the following information relating to preparing the surface of the stabilised pavement to ensure good adhesion of the seal coat will apply in all cases.

### 7.2.2.1 Causes of Stabilisation Failure

Stabilised bases can shed their seal coats, because lime- and cement-stabilised basecourse materials have relatively high fines content. If the fines have been bound and waterproofed by the stabiliser, achieving the stone-mosaic surface is not quite as important, provided that the stabilisation reactions have occurred throughout the entire depth of the basecourse and to its very surface well in advance of resealing.

Where full depth stabilisation is not achieved, and these fines have not been well bound and waterproofed by the stabiliser, they can cause the repair or seal coat to fail prematurely through the same mechanism that regular basecourses with a layer of fines on top would fail, as described in Section 7.2.1.

Portland cement is a relatively quick-acting agent, but if its normal setting reaction with water is interrupted it will not attain full strength. Just as concrete will not achieve full strength if it dries out before curing is completed, the surface layer of fines of a cement-

stabilised base will never achieve full strength if it dries out before the setting reaction is well advanced. It will subsequently break down under traffic forces, which results in the seal being bonded to only the layer of dust that has formed on the basecourse surface.

### 7.2.2.2 Remedies for Stabilisation Failure

For the above reasons, the basecourse must be kept at or near the optimum moisture content from the time the cement is first made wet by contact with the basecourse or by initial compaction watering, until the time it is sealed.

In addition, if optimum performance is to be achieved, over-watering must be prevented because it dilutes the cement mortar. It is therefore desirable to apply the seal as soon as possible after stabilisation.

Lime stabilisation or other proprietary products (such as those based on steel-mill slag) react to water less quickly than Portland cement. However, as with cement, these products usually also rely on water being added to the mixture of stabilising agent and basecourse material to ensure reaction with the fine material.

If for any reason the stabilising agent does not react or is not fully cured, a build-up of unstabilised fine material on the surface is likely. This fine material or dust layer must be removed before first coat sealing.

The problem of a layer of dust on the stabilised basecourse surface can also arise if:

- the stabilising agent or cement content is too low to bind the fines;
- very soft, coarse- and medium-sized aggregates are used without enough strong cement and fines mortar around them to bind and protect them;
- the surface of the base is over-watered or unexpected rain occurs, diluting the cement mortar and lowering its strength;
- surface shaping or trimming is attempted after the stabilisation agent has cured.

Provided good stabilisation construction practices (including any recommendations from the supplier) are followed during construction, very little unstabilised or loose fine material should remain on the compacted base surface. Sweeping should be as light as possible, and only enough to remove loose material. Sealing should follow as soon as the loose material has been swept off to prevent excess drying of the surface and/or the formation of additional fines caused by traffic action.

## 7.3 Preparation for Reseals

The actions required to prepare existing surfaces before resealing are now discussed. The desirable timing for carrying out and completing the repairs is listed in Table 7-1 (Section 7.1.4).

### 7.3.1 Investigation

Preseal preparation before resealing may fall into any of the three following categories:

1. Drainage and shoulder repairs;
2. Road pavement (surface and base) repairs; and
3. Top surface texture repairs.

Determining the amount and type of repairs that are necessary requires careful and detailed inspection of the area to be resealed.

In today's road construction and maintenance environment, the person carrying out the inspection, mark-out and recording of preseal repairs may be an employee of the local council or other road controlling authority (RCA), an engineering consultancy, or a roading construction company. Whoever the person works for, they are to carry out a preseal inspection during which they will consider the following questions and then programme the relevant repair solutions accordingly:

1. Do the drainage facilities work effectively?
2. Are road shoulders and adjacent verges in need of attention?
3. Is there edge rutting or edge break?
4. Are there potholes, shallow shear failures, cracks or cracked areas in need of repair?
5. Are there service trenches showing signs of settlement or requiring joint-sealing, pre-levelling or structural repairs?
6. Are there manholes and other utility service covers that require adjustments to be level with the proposed surface?
7. Are there depressions, wheel-ruts or other pavement deformations that require pre-levelling?
8. Are there areas of uneven surface texture, chip loss or flushing?
9. Are there flushing and bleeding spots?
10. Is the cement grouting of road bases on concrete roads intact, and are tree roots likely to lift concrete bases?

11. Check vehicle crossings:
  - Do vehicle crossings cause scraping of car towbars, exhausts or other fittings?
  - Are slot crossings clear or blocked?
12. Are subsoil drains (under the channel or the pavement) needed?
13. Is the surface permeable?
14. Are there weeds or other deleterious matter (mud, dust, moss, lichen, etc.) that have to be removed?
15. Are K&C effective with no high lip at channel edge or isolated sunken lengths of channel?
16. Are there any water-ponding areas on the surface?
17. Are K&C and other related drainage structures in poor condition?

Typical solutions for pre-seal repairs are covered below in Sections 7.3.2 to 7.3.5.

## 7.3.2 Drainage and Shoulder Repairs

### 7.3.2.1 Off-road Drainage

Moisture is the main enemy of road pavements and impacts significantly on the performance of both the pavement and of any surface treatment.

Drainage from the surface, and beyond and away from the pavement base, must be unobstructed to ensure optimum performance.

Because cleaning, repairing, modifying or constructing new drainage channels (whether they are open-cut earth drains, roadside water tables or formed concrete channels, or K&C) all involve heavy construction machinery, any sealed surface may be damaged. New chipseals which are very tender, and thus more prone to damage within the first few months after sealing, are most likely to be damaged in this way.

Therefore any drainage repairs, major cleaning, or other works should be undertaken well before resealing works are carried out.

### 7.3.2.2 Shoulder Repairs (including Edge Rutting)

Shoulders and feather edges, as well as supporting the pavement, also need to be of the correct shape to promote rapid run-off of surface water (see Figure 3-1).

If that is not correct, water can get under the pavement layer by infiltration from the adjacent shoulder. More often than not this is also the area closest to the wheelpath that is on the outside edge of the pavement. In that position, it is subject to maximum loading.

#### *Causes*

A shoulder not flatter than 12:1 is recommended because too flat a shoulder will slow down run-off. Where shoulders are grassed, compost will accumulate as a result of repeated mowing and will form a lip which prevents rapid run-off and often causes water to run parallel to the centreline or to pond on the surface in low areas. Depending on climatic conditions, this material needs to be removed regularly (every two or three years), and definitely before a surface treatment is applied.

Edge rutting (i.e. the formation of a channel parallel to the edge of the seal) also causes water to run or pond close to the edge of the trafficable surface. It can also be a danger to traffic if allowed to become so deep that the wheels of a straying vehicle get trapped in the rut. Edge rutting also promotes the development of edge break (see Section 7.3.2.3).

#### *Remedies*

Shoulder grading, dressing and, where appropriate, build-up with extra aggregate material or removal of surplus material is often necessary before re-surfacing. Grass should be removed from the edge of the seal before resealing because long grass becomes limp from the heat of the reseal bitumen, then falls onto the new surface, contaminating and weakening the seal.

### 7.3.2.3 Edge Break

Edge break is the loss and/or breaking away of existing bituminous surfacing material at the outside edge of the sealed surface.

#### *Causes*

Edge break often occurs where the surfaced width is too narrow, on insides of tight curves with a lack of pavement support (caused by edge rutting or too steep a shoulder), or where moisture has weakened the outside edge.

It can also occur when a previous reseal has not been properly lapped onto an adjacent concrete K&C, or dish channel (i.e. a shallow U-shaped channel).

#### *Remedies*

To prevent a rapid increase of the edge break, which creates discomfort to the travelling public and affects the overall integrity of the pavement and to ensure a uniform width of carriageway, edge break needs to be repaired before a new surface treatment is applied.

Repair methods will differ depending on the defect size, location (in relation to the nearest supply of materials), and the maintenance contractor's plant and resources (as dictated by the relevant maintenance contract).

In urban areas, edge break is typically repaired by reinstatement with hot mix (i.e. asphaltic concrete).

In rural areas, basecourse and first coat seal using a binder of emulsion or cutback bitumen, cold mix, or hot mix may be used.

### 7.3.3 Pavement Repairs

Repairs, commonly called 'digouts', may be required on sections of the road pavement, either to the basecourse or to the surfacing layers.

#### *Causes*

If the structural layers of the pavement are weak or have washed out, they need to be strengthened by digout and replacement.

Causes of these defects are outlined in Chapter 3.11, but most pre-seal defects are caused by loss of waterproofing and ingress of water. This may be either through cracks, potholes or wash out, and they affect the lower structural layers of the pavement, not the surfacing.

#### *Remedies*

Any of several pavement and/or surface repair methods may be suitable for any particular defect noted for repair. The particular method will relate to depth or type of basecourse failure, available resources and materials, location and traffic loading, and an RCA's current practice and contractual requirements. Detailed below are the more common or typical defects and possible repair types:

#### 7.3.3.1 Cracking

A good understanding of the cause and type of cracking is essential for effective treatment of the defect. Read Sections 3.11.2, 4.3 and 4.7.3 which outline the typical causes of cracking including fatigue of the seal, structural damage, and environmental effects.



If the symptoms are not carefully analysed to ascertain the causes, the treatment of those causes may be inappropriate and will result in an ineffective reseal.

Before jumping to the conclusion that crack repairs are needed, it is important to remember that some minor cracking can be a normal end-of-life condition for a seal on an otherwise sound pavement.

In such a case the reseal is applied specifically to fix and seal the cracks. Hence if an area does not need shape or drainage repairs, there is no need to repair any minor cracking before resealing.

#### *Causes*

In addition to cracks caused by fatigue, structural damage, binder ageing and oxidation, some environmental effects that cause cracks which have not been discussed in previous sections include:

- effects of moss and lichen;
- heave from plant growth, frost or chemical effects;
- surface cracking caused by tree roots, if trees were planted closer to the road than their height. If the trees are to be retained, then their roots may need to be cut between the road and trees, with a purpose-built deep cutting saw or ground knife.

Cracks that are discoloured by fines pumping up from the basecourse indicate that water has penetrated through the surface and into the base. The pavement will have weakened, and loss of shape, localised rutting, or potholing may have occurred. These areas require repair before resealing.

#### *Effects*

Cracked pavements are not waterproof. Ingress of water into pavements significantly reduces their strength and pavement failure will ultimately result. Premature cracks in asphalt surfaces generally mean weak base materials and high deflections.

#### *Remedies: Treatment of structural layers*

Where the pavement base or the subgrade has obviously become unstable and a surface treatment is not an appropriate repair, localised pavement or subgrade rehabilitation will be required. This could involve:

- removal and replacement of the affected pavement and/or subgrade layers (i.e. digouts);

- in-situ stabilisation of the base layer (see Austroads 1998);
- granular overlay (see Austroads 2004a) with a sufficient depth of material (though this is not practical on urban roads with K&C);
- subsoil drainage installation in association with any of the above;
- re-surfacing of the treated area with a first coat seal or asphaltic concrete layer.

Where only the basecourse or surfacing layers are likely to have been affected, the treatment may be limited to drainage improvements in conjunction with shallow repair methods such as rip and remake, in-situ stabilisation, or scarify and surface repair.

Even if the treatment does not totally fix the problem area, the person overseeing the pavement repair must be sure that it will not compromise the expected life of the proposed reseal about to follow.

*Remedies: Treatment of surface layers*

Where cracking is *hairline* (<1 mm wide) and affects less than 5% of the pavement, a normal reseal using chipseal with a chip size that gives a binder application rate of greater than 1.5 ℓ/m<sup>2</sup> may be appropriate.

Where crack widths are *narrow*, about 1 to 5 mm, bandaging or a SAM<sup>3</sup> seal is used. In the bandaging technique the hot binder is poured on to the cleaned pavement and then spread with a metal tool to make a 'bandage' 2-3 mm thick and 75-100 mm wide (Figure 7-5). If using a SAM, binder application rates in excess of 2 ℓ/m<sup>2</sup> will be required. Binder applications of more than 3 ℓ/m<sup>2</sup> using a PMB (polymer modified bitumen, see Chapter 8.4) with a two coat Grade 3/5 seal have been successful without subsequent bleeding and tyre pick-up.

However, where crack widths are 3 mm or wider, the hot PMB of the SAM can flow into the crack, resulting in only a thin film which cannot form a good membrane over the crack. Therefore wider cracks should be filled with special filling materials before the PMB membrane is applied.

On 5 to 15 mm-wide cracks, bandaging is advisable on surfaces that are laid hot. If the surface is laid cold, or laid on a cold surface, 'crack filling' is used. In crack filling, the crack is cleaned or routed, primed and then carefully filled to the top with the crack-filling binder. This gives support to the crack edges.

<sup>3</sup> SAM – Stress Absorbing Membrane.



Figure 7-5 Filling a large joint crack using the bandage technique.

Courtesy of Austroads Sprayed Sealing Guide (2004b)

*Wide cracks* (>15 mm) are generally filled. In some applications, e.g. bridge decks, the bottom of the joint is filled with foam plastic to obtain the best width to depth ratio, and to stop the hot binder flowing down through the joint.

*Large joint cracks* or cemented-pavement slab cracks (of greater than 2 mm width) should be separately treated by joint bandaging or other linear crack filling methods.

Crack repair methods, e.g. bandaging and crack filling, are known collectively as 'crack sealing'.

Cracks with no signs of pumping, or only minimal pumping and no other failure, can be resealed. However, ensure at the time of reseal design that binder application is at a high enough rate to fully crack-seal the pavement surface.

Cracks with signs of pumping are generally caused by structural defects which must be remedied before any surface sealing can be done.

*Reflective cracks* can be treated effectively using these methods, but even after a successful repair some of the more severe reflective cracks may re-occur. Normally any such reflective cracks would be narrower and less extensive than those that had occurred on the initial defective pavement.

Opinion varies on the minimum binder application rate (regardless of traffic volumes or chip size) to waterproof a cracked pavement surface by sealing. Most sealing practitioners work within a range of 1.0 ℓ/m<sup>2</sup> and 1.5 ℓ/m<sup>2</sup> as a minimum amount of binder if crack sealing is a key reason for the planned reseal.

*Very extensive* pavement cracking, where crack filling is not an economic option, or the cracks are narrow but extensive and cannot be filled with a normal chipseal with a higher bitumen application rate, the use of a PMB (e.g. SAM or SAMI<sup>4</sup>), or a geotextile (fabric) seal can be an economic alternative to pre-seal repairs. More information about use of PMBs in SAM and SAMI seals is in Section 8.4.

#### *Precautions when Crack Sealing*

In areas where traffic may stop or park the bandage should be covered. This is normally done by applying a layer of small chip, such as Grade 5.

In areas subjected to high traffic volumes, the bandage can be peeled off the surface by tyre action. In these areas the covering of the whole pavement with a chipseal can protect the edge of the bandage. Although the resulting pavement may look unsightly because the bandage reflects through the chipseal, this technique has given seal lives in excess of 10 years.

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If the surface surrounding the crack is dirty then a primer should be used to ensure a good bond. When crack sealing on concrete, it is recommended that a primer always be used, as recommended by the manufacturer of the crack-filling material.

On wider cracks the width of the crack will change with temperature. For example, in summer, crack widths will be narrower than in winter due to the expansion of the surrounding material. Therefore crack filling normally should be carried out in cooler weather when the cracks are larger, but without overfilling so that the binder will not squeeze out when the crack narrows in warm weather and be picked up on tyres.

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<sup>4</sup> SAMI – Stress Absorbing Membrane Interlayer.

### 7.3.3.2 Depressions, Wheel Ruts and Similar Deformations

#### Causes

Depressions, wheel ruts and similar deformations usually form in inadequate pavements that have been weakened, for example by the ingress of water (see Section 3.11). Pavements with these deformations need to be investigated to ensure they meet the standards for roughness set by many RCAs. If the road surfaces do not meet these standards, they require maintenance. Most surfacing treatments are expected to last at least 10 years, and this is a long time to live with an uneven surface.

#### Effects

As a general rule, the following faults need to be attended to before a re-surfacing treatment is applied.

- Deformations that affect safety, such as wheel ruts, which could cause:
  - vehicles to track;
  - bitumen to pond during resealing, creating a longitudinal flushed wheelpath (because chip along the sides of the rutting where application rate is low will pluck off, while chip along the trough will be 'drowned' with flushed binder).
- Deformations that hold water which could:
  - infiltrate the pavement layers through a permeable surface;
  - cause splashes that, especially in high speed situations, could reduce visibility for both oncoming and following traffic;
  - potentially cause aquaplaning;
  - freeze or cause splashes that could freeze;
  - cause ponding of bitumen when resealing and show as isolated bleeding or flushing areas later.
- Sudden change in the superelevation of a curve needs to be considered as a reason for repair, especially in high speed environments. This is distinct from a general out-of-shapeness through the whole of a curve which, normally, is fixed by an area-wide treatment such as shape correction.
- Intersecting roads or side roads which are not correctly constructed and interfere with the normal crossfall on the road to be re-surfaced. This situation will cause an uncomfortable ride in most situations and can be dangerous in high speed environments. It will require careful consideration to rectify the fault.

- Sunken service trenches, often found in urban situations but not necessarily isolated to those areas, need to be repaired and/or levelled.
- Low or high service covers are often the cause of a rough, uncomfortable ride and should be considered for adjusting to match the proposed surface or, as a minimum, for rectification by smoothing the surrounding area to improve the riding qualities.
- Low areas, either as isolated depressions or as a form of rutting alongside surface water channels which prevent surface water from running into the channels, need to be rectified. This fault often occurs in urban areas alongside K&C.

If such faults are not fixed, after some time water may find its way into the pavement causing a weak area. This may develop into a shear failure or may accelerate any edge break as previously discussed.

#### *Remedies*

Treatments will include pavement digout and replacement, or other methods of strengthening and should be carried out before chipsealing. Innovative treatments for ruts include filling ruts with slurry (Figure 7-6), or dry chipping a rutted area before chipsealing (Figure 7-9).

Type 4 slurry is suitable for treating wheelpath rutting (Figure 7-6). Longitudinal trenches up to 40 mm deep can also be effectively repaired, resulting in a surface that can be resealed with minimal risk of chip embedment in subsequent seal coats. This work is usually carried out with a specialised rut box, designed to deposit the larger chip in the deepest part of the rut and the fines on the edges. This ensures a very smooth ride with excellent transitions and smooth edge tapers which do not ‘fret’ (or ravel). This has been used successfully in the South Island but not so much in the North Island.

### **7.3.3.3 Potholes, Shear Failures and Weak Areas**

#### *Causes*

Potholes form when patches of the pavement surfacing are lost and the underlying basecourse is exposed.

Their formation is briefly covered in Sections 3.11 and 7.2.1.1. Weak areas which can lead to potholes or depressions can usually be located by the presence of some surface distress, and cracking is often its first sign. While repairing such areas, the cause of the distress should also be attended to.

Moisture in pavements, whether through the surface, from the side (from poorly constructed drainage channels), or from below (by subsoil water or capillary rise), is usually the cause of these surface defects.



Figure 7-6 These ruts have been filled with slurry, after which the entire surface will be chipsealed.  
Photo courtesy of Barry Gundersen, Gundersen Consulting Ltd

### *Remedies*

Potholes and shear failures (explained in Section 4.7.4.2), and broken surface areas need to be repaired in preparation for sealing. Potholes may be repaired by digouts, either to the basecourse or just to the surfacing layers.

To avoid subsequent flushing and/or bleeding, the surface texture of repairs must match the texture of the adjacent surface as closely as possible.

Weak areas can sometimes be detected by carrying out a series of Benkelman Beam<sup>5</sup> or other relevant tests. Those familiar with this test and interpretation of its results can, by plotting a curve of a series of readings at a particular point, determine whether a weak zone exists in the upper pavement layers or is deep-seated.

A penetrometer<sup>5</sup> is another relatively simple instrument used to identify weak subgrade conditions which can lead to weak pavement layers.

The Falling Weight Deflectometer (FWD<sup>5</sup>) can be used to assess overall pavement strengths and strength characteristics.

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<sup>5</sup> See Glossary for explanations of these instruments.

In summary, when there is doubt about the appropriate treatment, some further investigation may be required before embarking on a particular type of repair for potholes and other failures caused by pavement weakness.

#### 7.3.3.4 Rough Surfaces

##### *Causes*

Isolated rough areas (sometimes known as ‘wash boarding’) need to be fixed where the level of roughness is unacceptable, especially if they occur in areas where resealing is required. They can be caused by traffic, e.g. by braking vehicles, but can be caused by other deformations as discussed in Section 7.3.3.2. They may occur because the pavement is nearing the end of its life.

##### *Effects*

Such areas cause either an uncomfortable ride for the motorist or unacceptable effects on the environment, e.g. an empty stock truck travelling over a rough area in an urban situation can generate unacceptable noise.

##### *Remedies*

Smoothing with a mix material is not always possible where the areas are small and they do not cover a complete lane width. Often smoothing only changes the pattern from many small irregularities to two or more larger ones. If that is the case, removal and replacement of the offending area may be required. This repair may be in the form of rip and remake (or recycle or stabilise), and apply a first coat seal, or hot mix asphalt re-surface.

If high roughness is the result of the pavement nearing the end of its useful life, road re-construction such as pavement smoothing or Area-Wide Pavement Treatment (AWPT) should be considered.

If the area of pre-seal works (as a % total reseal area) and/or cost of reseal works (as a % of reseal cost) is so high that it is more economical to reconstruct, then pavement smoothing or AWPT should be considered. See Chapter 5 for more details on economics and asset management.

Where the area of roughness occurs on an asphaltic concrete surface which is to be resealed, and sufficient quantity of work is available to warrant bringing in a milling machine, milling-off of the offending area can be very effective. Some texturing before sealing may then be required.



## 7.3.4 Surface Texture Repairs

For chipseal treatments to work successfully, they must be applied to a uniform sound base layer. Sections 7.3.2 and 7.3.3 describe repair methods to form a sound base. This Section 7.3.4 focuses on achieving a uniformly textured surface on which a reseal is applied.

Four separate categories require consideration when determining if the existing top-surface texture is suitable for resealing. They are:

- Chip loss (also called stripping);
- Flushing (binder has risen up the chip leaving minimal texture depth);
- Uneven texture (e.g. repair patches with a different texture to the surrounding surface);
- Permeable surfaces.

### 7.3.4.1 Chip Loss

#### *Causes*

Repair of chip loss on an existing surface is essential before re-surfacing. The cause of chip loss or 'stripping' of new seals usually relates to insufficient binder application, high stress (e.g. caused by turning traffic), dirty chip. (See Sections 12.6.3 and 12.6.4 for repair of chip loss early in a chipseal's life.)

Chip loss can also be related to ageing when it is much more likely to relate to bitumen hardening or embrittlement, or to a site-specific condition or event that has affected the otherwise normally performing chipseal. Shaded areas, such as under- or overpasses and bridges, large cut-faces, or near large trees, are more prone to chip loss as the seal ages. The seal may also be damaged by heavy machinery, e.g. during slip clean-up work after a major storm event, or at stock crossings.

#### *Effects*

Lack of pre-treatment of any chip loss areas before resealing may lead to either early flushing or further chip loss. The difference in macrottexture will also affect the surface ride and roughness.

The surface texture is also likely to differ from the surrounding seal, thus making the determination of an appropriate area-wide binder application difficult.

If the application rate is determined for an area that still retains chip, it will result in over-application in areas devoid of chip and thus result in flushing. If the rate is determined on the smooth texture where chip loss is apparent, then it will be insufficient for those areas with existing chip. This low application rate will lead to early chip loss of the new seal.

### Remedies

The areas with chip loss either will have to be repaired before sealing the whole area, or different rates will have to be applied to affected parts of the area.

If the height difference between the chip loss area and the surrounding seal is obvious, repair will be required. This will involve re-spraying of binder and rolling in new chip. The replacement chip size is carefully selected to ensure that the post-repair surface texture and level closely match the surrounding seal. For example, a repair area in an old Grade 2 chipseal may require finer Grade 4 chip to make the surface levels match. The binder application rate will be based on the Grade 4 ALD and reduced to account for any free binder at the surface in the chip loss area (Figure 7-7).

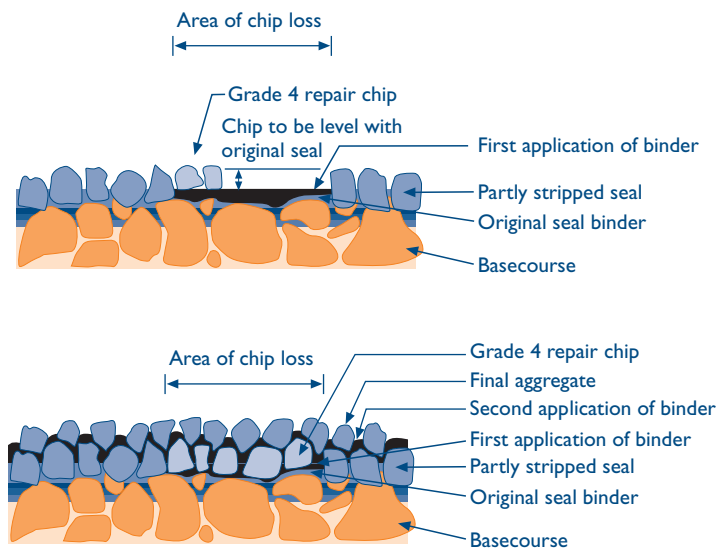


Figure 7-7 Method of matching areas of chip loss with surrounding surface levels. Top: Area of chip loss to be repaired. Bottom: Completed repair of area of chip loss.

Where the chip loss is intermittent and/or the height difference between the stripped area and surrounding seal is minimal (<5 mm), removal of excess or free binder from the stripped areas is recommended before making a pre-seal repair using fine chip, if fine chip is the chosen repair method.

A high pressure water treatment, as discussed below in Section 7.3.4.2, is the recommended repair method in this situation.

### 7.3.4.2 Flushing

Flushing creates a smooth pavement surface caused by excess binder rising to the surface for various reasons. Where the existing surface has flushed to the extent that the selected surface treatment cannot cope with the difference in surface texture or the quantity of surplus binder, the surface will need to be rectified.

#### *Causes*

Flushing can occur in isolated areas, often where repairs have been carried out, where the chips have either been pounded into unstable underlying repaired areas, or the quantity of binder needed to waterproof the work has been misjudged. It can also be quite general, for instance where all the wheelpaths have flushed (Figures 7-8 and 7-9).



Figure 7-8 A surface in which the wheelpaths have flushed. Note evidence of vapour venting (many small circles of bitumen) on the surface. Photo courtesy of Mark Owen, Transit NZ



Figure 7-9 Dry chipping a flushed area before chipsealing the entire surface. Clockwise from top left in order of construction: Original surface marked out to show area to be dry chipped. Top right: Dry chip laid in wheelpaths. Bottom right: Binder is laid lane by lane over the dry chip. The next step is to lay the chip over the binder as for a conventional reseal. Bottom left: The completed surface.

Photos courtesy of Lindsay Roundhill, Opus

7

### Remedies

Various repair methods are available to deal with surface flushing. Some are directly applicable to preseal preparation works, and others are more suitable as a resurfacing alternative to standard resealing.

Flushing treatments suitable for preseal preparation include:

- high pressure water treatments;
- rolling in new chip after applying:
  - a bitumen cutter such as kerosene or mineral turpentine, although bear in mind this technique can cause flushing later, as explained in Section 4.7.4, or
  - a very light coat of heavy cutback bitumen.

Flushing treatments suitable as resurfacing alternatives are:

- sandwich seal;
- OGPA (Open-Graded Porous Asphalt); or
- SAM (Stress Absorbing Membrane) seal.

Sandwich seals and OGPAs can accommodate the excess binder in voids within the new layer.

Flushing occurs not only on chipsealed surfaces, and asphaltic concrete surfaces can suffer from the same trouble (Figure 7-10). Careful attention is needed to identify the cause of the problem before deciding on the next treatment, and whether or not any pre-treatment is required.



Figure 7-10 Flushing which has reflected through an asphaltic concrete surface.

Photo courtesy of Les McKenzie, Opus

‘High pressure water treatment’ is a collective term for water blasting and water cutting (Figure 7-11) which are relatively new techniques to New Zealand. Both use jets to direct very fine streams of water at the road surface.

- Water blasting uses a water pressure of approximately 15 000 psi at high volumes;
- Water cutting uses ultra-high pressure (up to 36 000 psi) but at low volumes, as the very high speed of the water provides the desired cutting action.

Many practitioners believe water cutting has advantages over water blasting and should be used where the equipment is available. Whichever is used, such high pressure water treatments can cause damage and reduce waterproofing if used incorrectly. Both techniques are capable of restoring macrotexture on a chipseal (Figure 7-12), although this may be more difficult to achieve on flushed PMBs.

These high pressure water techniques have replaced the pavement burner treatment which was phased out recently because of environmental concerns. A total ban on all



Figure 7-11 A road surface undergoing high pressure water treatment as a repair for flushing.

Photo courtesy of Les McKenzie, Opus

pavement burning came into effect in August 2004 as part of the National Environmental Standards (NES) relating to air pollutants, regulated under the RMA. The NES (2004) will override any existing permits or consents to use the pavement burner. Therefore road network managers will have to use other binder removal techniques for road maintenance and repair, e.g. these high pressure water treatments.

*Water cutting* is claimed to be more effective in restoring microtexture than water blasting. Skid resistance testing using the British Pendulum Tester (BPT), showed an increase in BPN (British Pendulum Number) directly after water cutting in a Fulton Hogan research project (Dr B. Pidwerbesky, pers.comm. 2002). However determining if the improvement in microtexture (and hence skid resistance) is associated with the removal of bitumen from the chip, or if the chip surface itself is being refreshed, is difficult. The life of the improvement in microtexture from water cutting is part of a current research project.

*Water blasting* uses much greater volumes of water than water cutting. On older surfaces this water can penetrate the seal layers and damage the upper basecourse, and also disrupt the seal to basecourse adhesion.

For small-scale operations, such as treating flushed patches in an otherwise sound seal, a small truck-mounted hand-lance system may be used. However, as required in TNZ P/26:2003 specification, the high pressure water equipment is to incorporate a collection system to uplift the removed detritus at the time of operation from the road surface.



Figure 7-12 A chipseal that is seriously flushed and requires restoration of texture. Left side shows flushing several millimetres thick above the original chip surface, exacerbated by many layers of grit that have been applied to mop up bleeding binder. Right side shows the same seal after water blasting. The original surface with adequate texture depth has been restored.

Photo courtesy of Les McKenzie, Opus

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The detritus of excess binder, grit and dirt must be collected and removed, and not make a mess of the roadsides, run into stormwater drains, or remain on the sealed surface to become re-attached to it. Self-contained machines have integrated vacuum pick-up systems to cope with these conditions. Using equipment without an integrated pick-up system needs screens to block the scattering of detritus, and sediment traps in drains.

For a generally soft surface and other area-wide flushed areas, the entire surface needs to be treated. To do this, purpose-built truck-mounted systems are used that can treat a wide strip of road surface evenly in each pass.

#### 7.3.4.3 Uneven Texture

In an existing seal, isolated areas of texture that vary significantly from surrounding areas need to be pretreated before resealing.

The treatment for uneven texture is a 'texturising seal'. A texturising seal is used to prepare a surface for a reseal by reducing texture variation. It differs from a voidfill because in some cases it will reinstate texture and not just fill in the gaps between chips. It may be applied to only isolated areas within a reseal site to either fill texture or reinstate texture. The necessity for and amount of preseal texturising required depend very much on the reseal type that is selected.

Texturising involves either:

- filling existing deep-texture areas, e.g. road seal edge or centreline, where the chip is not normally trafficked, or
- reinstating texture, e.g. over an asphalt patch surface repair or trench line cut into a chipseal.

Texturising is usually limited to only those areas that are significantly different to most of the existing seal. Texturising should not be mistaken for voidfilling (see Section 3.7.9 for definition and use of a voidfill seal).

A texturising seal is a localised, situation-specific chipseal, involving a binder spray coat followed generally by a coat of Grade 5 or 6 chip. As it is likely that texturised areas will be covered by a reseal, careful attention must be given to selecting a suitable spray rate. The spray rate must be enough to ensure chip adhesion but not so much that flushing or bleeding results.

The normal reseal spray design algorithm is based on the voids between existing chip crowns being filled with binder. For texturising of deep-textured areas, the new chip will sit between the existing stone crowns. Therefore the texturising seal spray rate will need to be reduced.

Careful consideration should also be given to the binder type used. Heavily cutback bitumen should be avoided as the diluent content will most likely not have evaporated off before any subsequent reseal. The trapped diluent will soften the reseal binder and cause premature flushing or bleeding. Where available, emulsion is recommended for use as the binder in the texturising seal.

#### 7.3.4.4 Permeable Surfaces

Just as variable texture surfaces require pretreatment before chipsealing, so do permeable or porous surfaces. Typical permeable surfaces requiring pretreatment will include OGPA (also known as friction course or OGA, open-graded asphalt) and OGEM (Open-Graded Emulsion Mix) (described in Section 3.9.1).



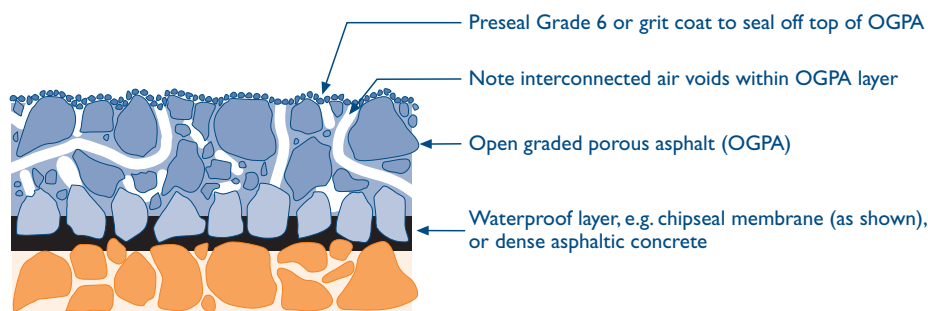


Figure 7-13 A permeable or porous surface, such as an OGPA or OGEM, requires pretreatment with a preseal Grade 6 or grit coat to prevent excess absorption of binder in the reseal.

As these open-graded mix surfacings are porous by design and have a large percentage of voids, they will readily absorb the reseal binder unless some pretreatment is carried out.

While these materials become less permeable with time because of traffic densification and choking of voids with road dirt and other deleterious materials, the voids remaining at the end of the useful life of the mix-surfacing will require treatment before chipsealing as they still absorb more binder than a non-porous road surface. A constant water-head test is used by some RCAs to determine the effectiveness of the drainage properties of the OGPA, and whether the surface is porous or clogged up.

The preseal treatment for permeable surfaces involves sealing off the top of the porous layer to prevent the binder from the reseal from being drawn down into it (Figure 7-13).

One treatment option involves spraying the permeable surface area with an emulsion binder (as a light application only), and then spreading a fine chip (Grade 6), grit or coarse sand over the sprayed surface area. The area is then rolled or trafficked to close off and tighten the surface ready for resealing.

Another option is a two-coat final surfacing using an emulsion binder (without the need for a preseal Grade 6 coat). The risk of failure is high when sealing over a porous surface without pretreating with a preseal Grade 6 coat or grit, because the amount of binder which will be 'sucked up' is unknown. The repair of the resulting failure is very difficult.

### 7.3.5 Removal of Deleterious Matter

To ensure adequate adhesion of the reseal binder to an existing surface, all contaminants, dust, organic and other deleterious matter must be removed first.

If removing deleterious material is the responsibility of the re-surfacing contractor, this responsibility should be clearly communicated to them, e.g. in the contract documents. They will need to make considerable extra effort to carry it out, and if they have been informed, they can plan for it and avoid unnecessary delays at the time of sealing.

Some treatments such as chemical weedspraying will need to be carried out well in advance of the reseal works because they may take time to become effective. This activity should be programmed a few weeks or months in advance of the re-surfacing treatment.

Using large quantities of chemicals for weed spraying is environmentally unfriendly, affecting road users, local residents and stormwater. Its use should be considered carefully and consultation with public or affected land owners must be undertaken. Run-off from sprayed areas must be controlled so that it does not contaminate the stormwater.

Use of weedkillers may not be appropriate in urban areas, and other treatments should be considered instead. Some authorities have found a light application of lime to be as effective and economical. Steam treatments have also been used. These treatments and final sweeping with rotary brooms may be carried out immediately before sealing. Hard sweeping with appropriate steel-wired brooms (without chemical treatments) may be useful for surface preparation in some situations, and may be all that is needed.

Lichen removal by aggressive brooming may be necessary on low traffic volume roads before a reseal treatment. The hot cut-back bitumen of the reseal will, in most cases, burn and kill any remaining lichen, so the binder will readily adhere to the existing stone below.

Emulsion chipseals and slurry seals do not adhere well in areas affected by lichen and in some cases have been observed to even accelerate the lichen growth. Therefore pre-treatment is essential in these situations.

Vehicles may pick up metal and debris along unsealed roadways and private drives, and then track this material across intersections and entrances onto newly sealed main roads. If this is likely, sealing some distance back along the unsealed road in the approach to the intersection should be considered. Then the tracked material should fall off the tyres before the intersection. The cost involved in extra sealing is low compared to the damage that the material will cause to the new seal.

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