PAVEMENT REHABILITATION

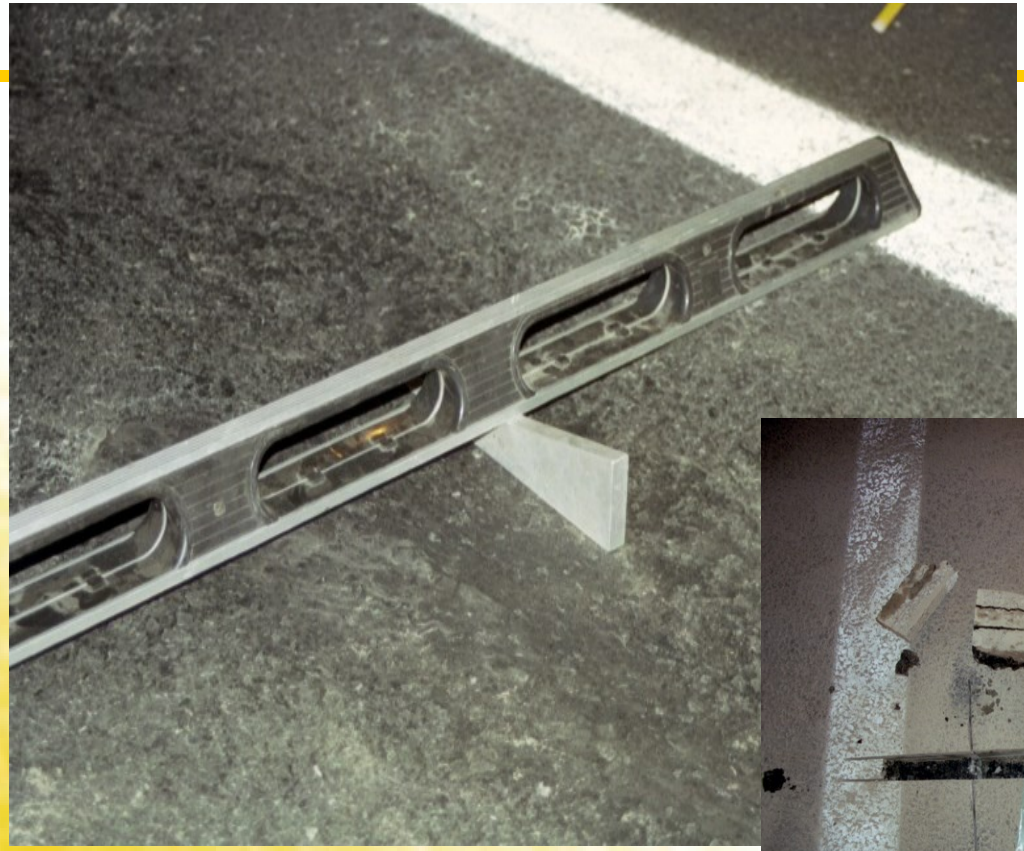
Why Rehabilitate?

- Sprayed seal (stripping, bleeding)
- Asphalt deformation
- Reflection cracking
- Fatigue cracking
- Failures in non-standard pavement materials
- Boxed-in pavements and other drainage problems
- Expansive clay subgrade

Why Rehabilitate? (cont)

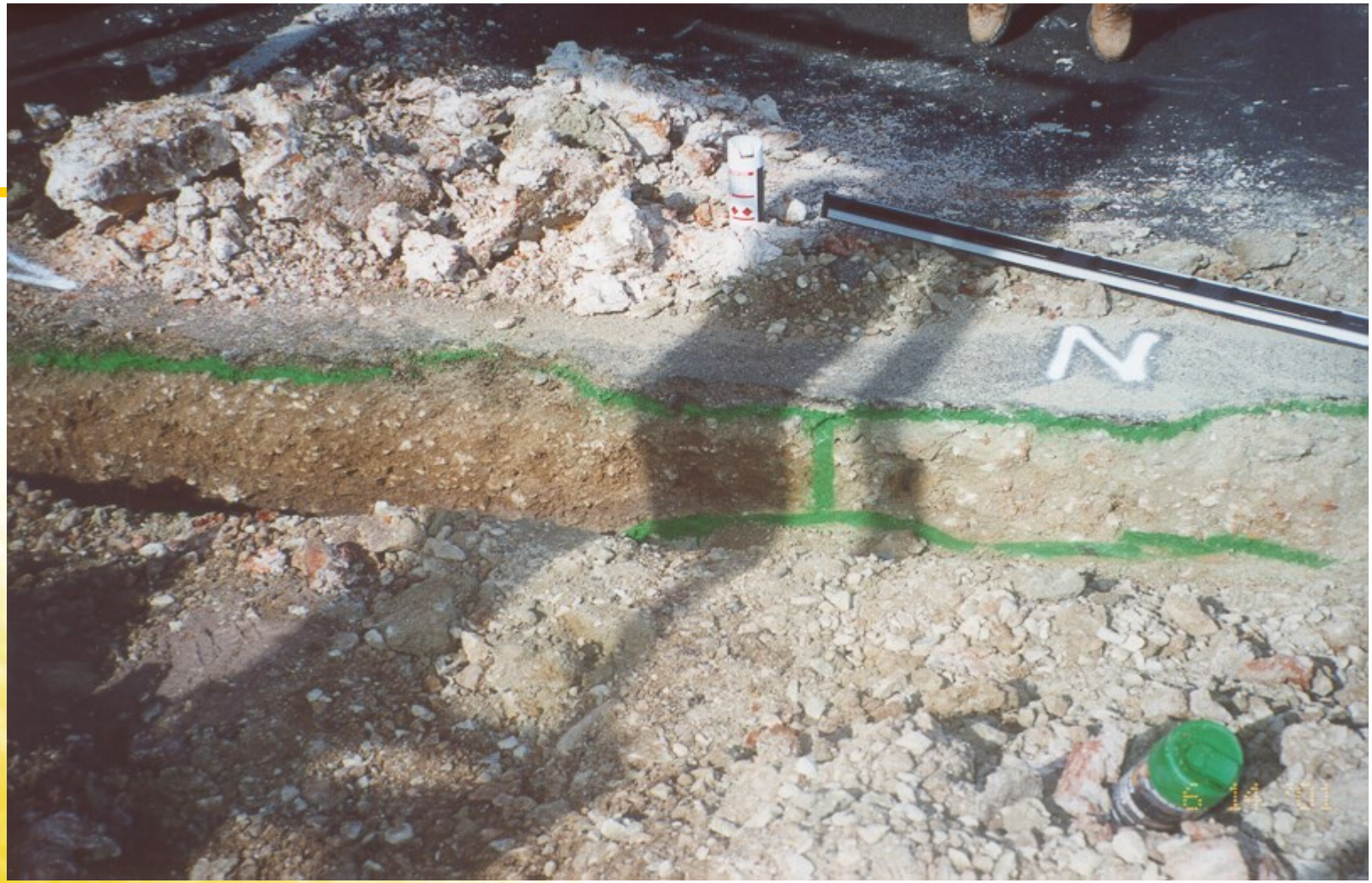
- Transverse, block cracking and pumping from Cement Treated Pavements
- Ageing of asphalt surfacings
- Surface oxidation of binder in sprayed seal surfacings
- In summary, should address restoration or improvement of:
  - Structural capacity and/ or
  - Serviceability

Asphalt Rutting/Stripping



- Pumping of fines in dense graded asphalt.

Boxed Construction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Asphalt Fatigue

Outer Wheel Path
Rut Holding Water

Single Overload Failures

Fine Graded High Bitumen Mixes - Excessive Rutting and Bleeding

Defects caused during construction

Early Pavement Failures

Typical OWP Failures

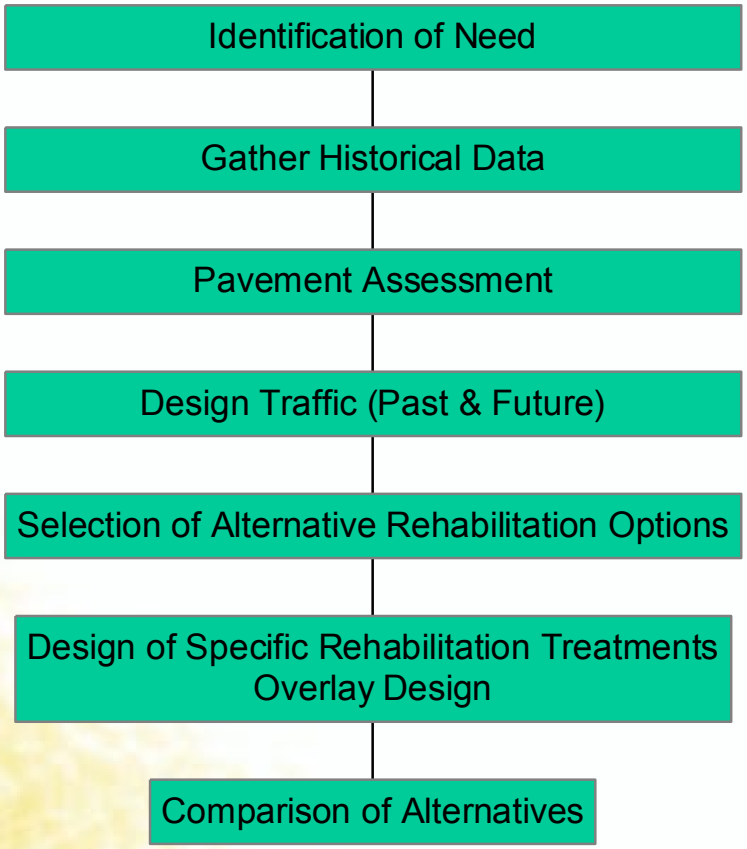
Typical OWP Failures

A typical highway of Western Queensland also showing undulating edges

- Premature Block Cracking


FLEAMARKET
SATURDAY

Pavement Rehabilitation Design System



Historical Information

- Original pavement design report
- Laboratory testing during construction
- Construction practice/problems
- As built pavement
- Year of construction
- Details of any major rehabilitation
- Previous investigations
- Underground services

Condition Assessment
(requires testing)

Mapping of:

- Roughness
- Geometric Properties
- Surface Texture
- Surface Defects eg. potholes
- Rutting
- Cracking
- Shoving
- Profile

Benefits of a Defect/Data Map

- Provides permanent record (quantity & location)
- Assists with subsequent evaluations
- Allows cross matching of condition states
- Saves return visits

Structural Assessment

- Structural response to load
- Pavement and subgrade properties
- Drainage

Structural Assessment - Materials Evaluation

- Thickness
- Sampling
  - Granular
  - Stabilised
  - Asphalt
  - Seals
  - Subgrade
  - Drainage

Structural Assessment

Testing equipment includes:

- Clegg Hammer
- Benkelman Beam
- Deflectograph (PAVDEF)
- Falling Weight Deflectometer

Structural Assessment - Beyond Deflection Testing

If the deflection response does not correspond to the pavement distress, the following properties should be determined:

- Layer density
- Insitu subgrade stiffness
- Thickness of insitu stiffness of pavement
- Grading, m/contents & plasticity of s/grade and pavements

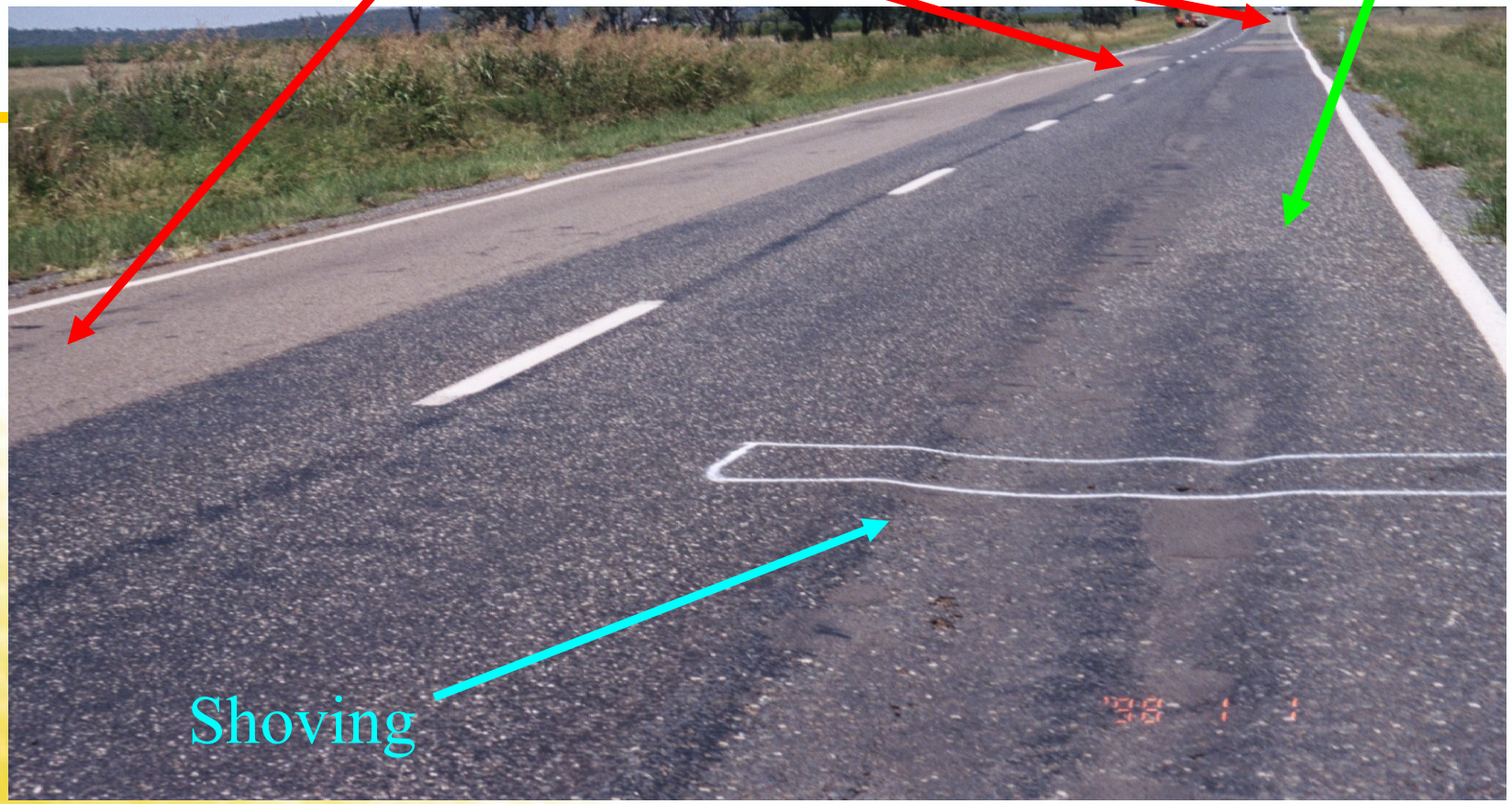
Summary

Steps required in evaluating pavement:

- **Search for pavement history/subsoil drain register/ recorded maintenance work**
- **Visual inspection**
- **Level of serviceability testing**
- **Assessment of Pavement Condition**
- **Pavement Testing for Structural Response to load (deflection survey)**
- **Determination of traffic pattern and past traffic**
- **Analysis of test data**
- **Verification of the pavement to ensure the condition of the pavement consistent with measured level of deflections.**

Extent of patching = light colour

OWP ruts



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Insitu stabilsiation

Granular Overlay

Asphalt Overlay

Treatments for Flexible Pavements

Strengthening treatments

If existing pavement is structurally inadequate for anticipated traffic, possible strengthening treatments include:

- structural overlays (granular, asphalt, concrete)
- insitu or plant-mixed stabilisation
- major patchings
- reconstruction

Transverse Crack (CT)

Possible Causes

- Reflection of a shrinkage crack or joint in an underlying base (commonly port-land cement concrete or cemented materials)
- Construction joint or shrinkage crack (due to low temperature or bitumen hardening) in asphalt surfacing
- Structural failure of portland cement concrete base

Block Cracking and Pumping

Joint and crack sealing

Method :

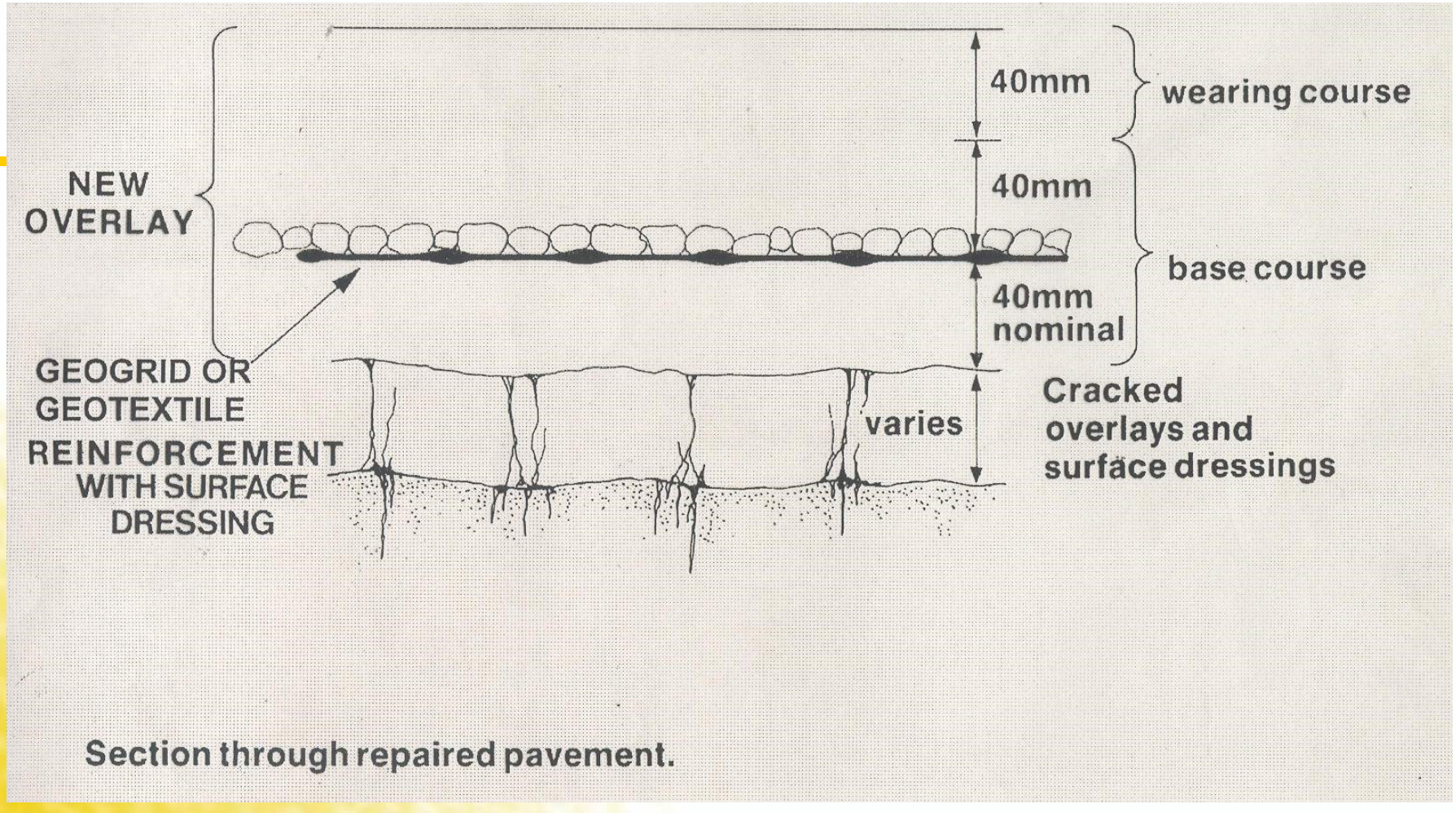
- clean cracks, then
- fill with rubberised bitumen emulsion or
- hot-poured polymer-modified bitumen

Appropriate use:

- temporary treatment to inhibit moisture ingress
- widely-spaced block cracking, longitudinal or transverse

Inappropriate use:

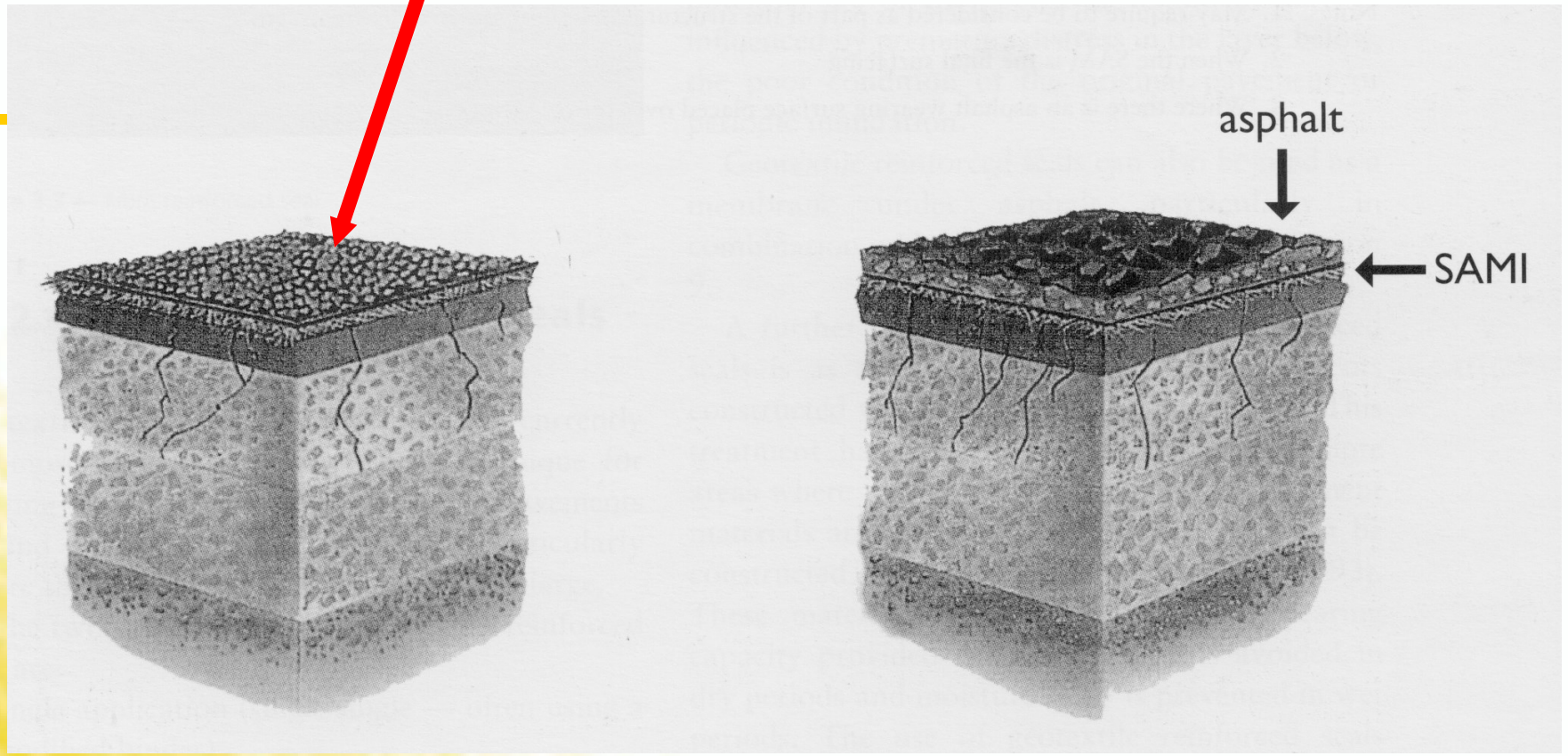
- closely spaced cracks



Section through repaired pavement.

Strain Alleviating Membrane (SAM)

Strain Alleviating Membrane Interlayer (SAMI)

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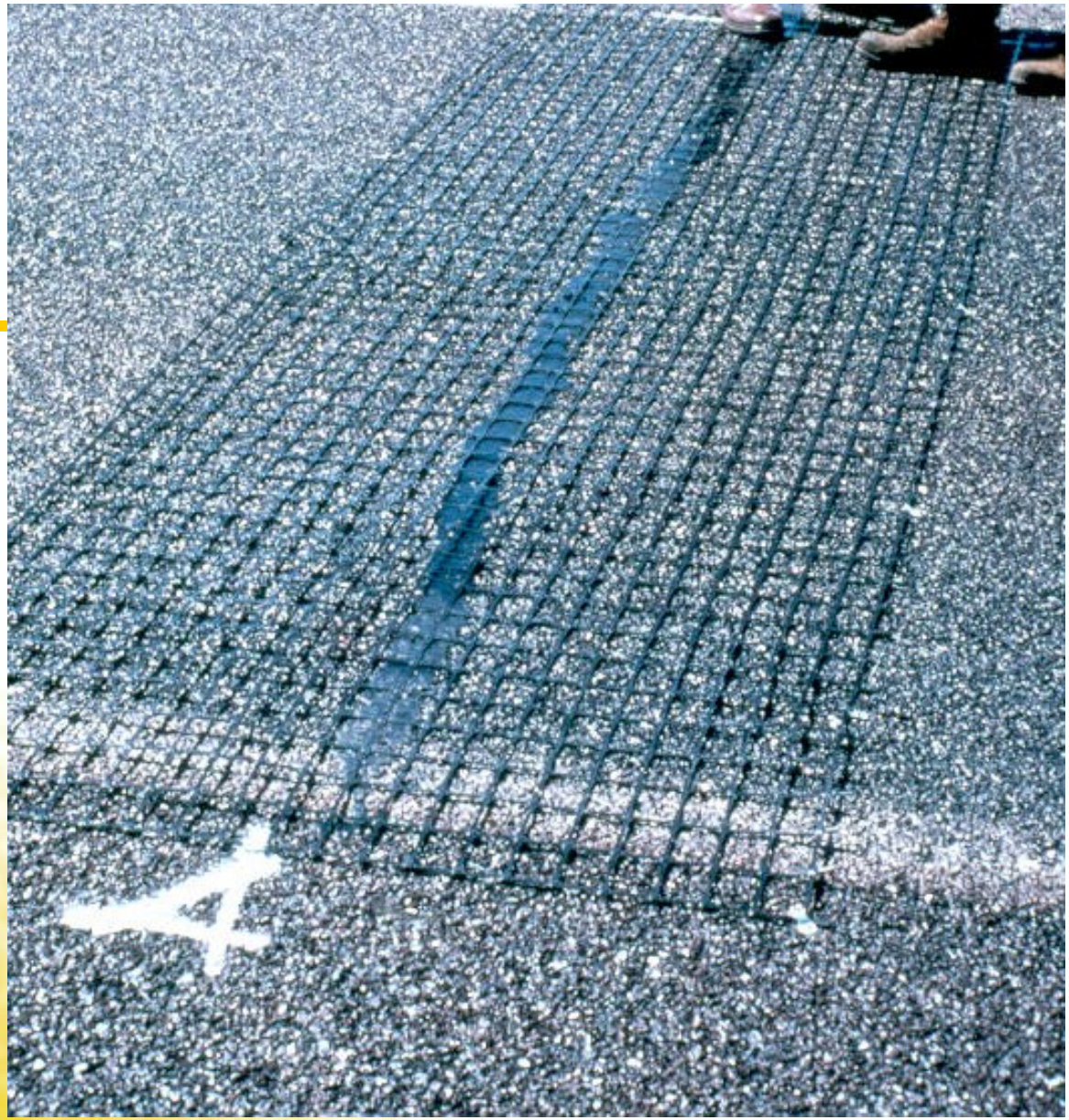

Treatments for Flexible Pavements

Treatments to correct shape

If pavement ride quality or shape needs to be improved, possible treatments include:

- remove and replace existing surfacing
- asphalt overlay, with and without regulation layer
- slurry surfacing
- asphalt or sprayed seal surfacing in combination with granular overlay
- reconstruction

Need to ensure check that pavement is structurally adequate for these treatments

Slurry seals and microsurfacings

Appropriate uses :

- non-structural overlay
- correct minor shape loss
- lower noise compared to sprayed seal
- for low speed skid resistance

Inappropriate uses :

- pavements with inadequate structural capacity
- pavements rut depth >15 mm and heavy traffic
- new primerseals incorporating cutback binder

Rut filling and correction

Treatments to Improve Drainage

- Drainage and moisture control is of fundamental importance
- Safety to road users
  - Aquaplaning/skid
  - Spray/visibility
  - Reduced width/vehicle stability
- Pavement performance
  - may mean difference between sound/failed
  - requires expedient corrective action

Treatments to Improve Drainage

- List of treatment options for drainage deficiencies

Table 4.1 Drainage Improvements

Condition	Treatment Options
Shallow and/ or silting table drains	De-silt or deepen drains
Moisture ingress from elevated shoulders and medians	Install subsurface drainage at the edge of pavement closest to the point of moisture ingress Seal shoulders and place impermeable material in median
Impermeable shoulders caused by boxed construction	Install subsurface drains through the impermeable shoulders
Water ponding in hollows in the pavement surface	Correct pavement shape
Infiltration from cuttings	Install sub-surface and surface interceptor drains at the base of the cut slope Provide a drainage blanket under pavement
Accumulation of moisture in sag curves	Improve crossfall in the low point of the sag
Moisture accumulation at changes of pavement type or thickness	Install subsurface drains along the junction to connect with edge drains


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Drainage improvements

surface drainage systems

- de-silt, deepen table drains
- remove blockages
- overlays to correct shape, crossfall
- improve capacity of system
- raise grade line

Drainage improvements

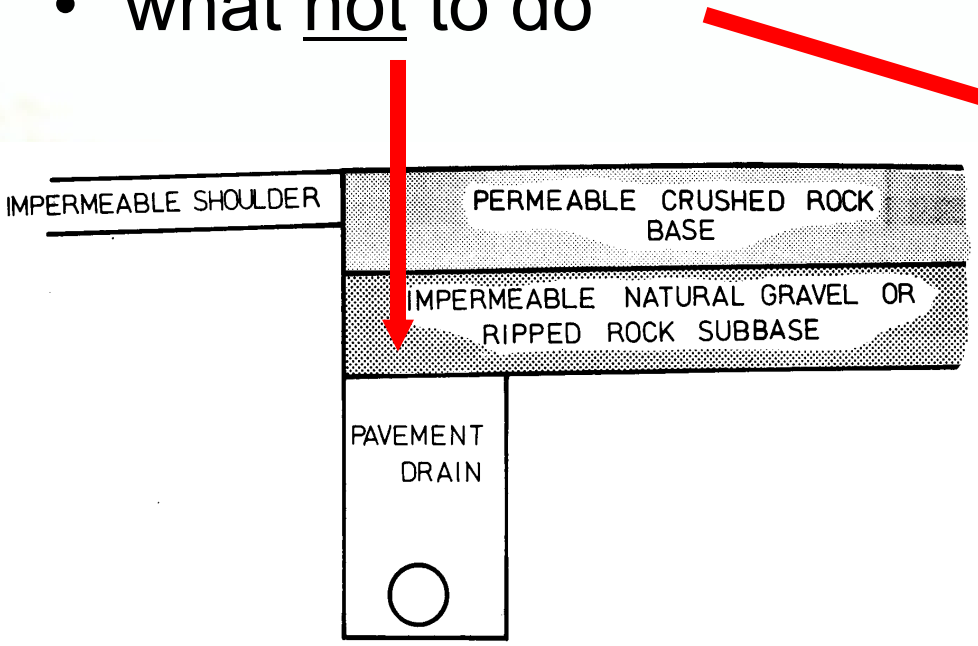
subsurface drainage

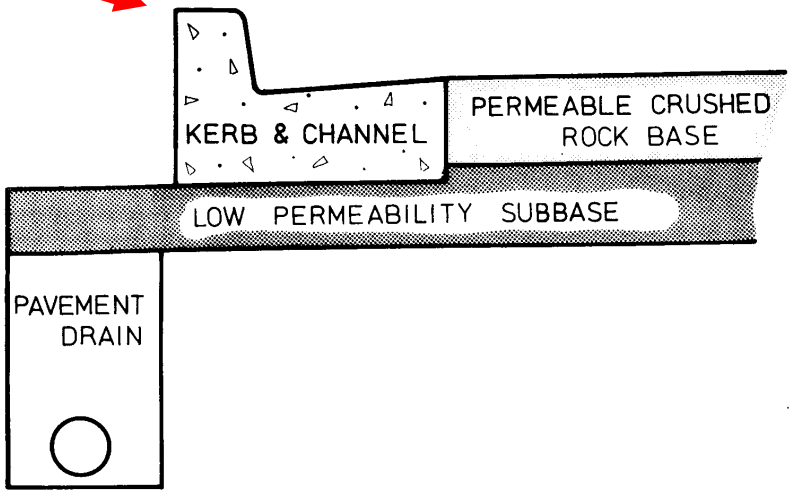
common practice in wetter areas & heavy traffic to construct subsurface drainage systems to:

– drain subgrade
– drain pavement materials
– intercept ground water

Subsurface drainage

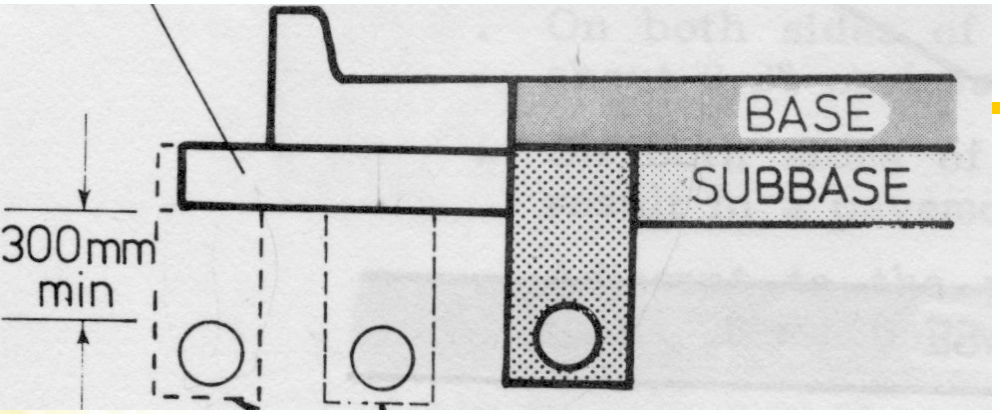
- in designing subsurface drainage systems consideration needs to be given to permeabilities of pavement layers and subgrade
- what not to do

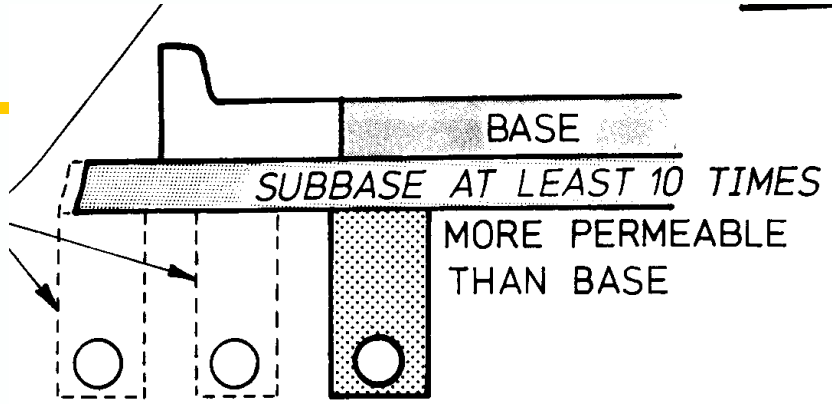


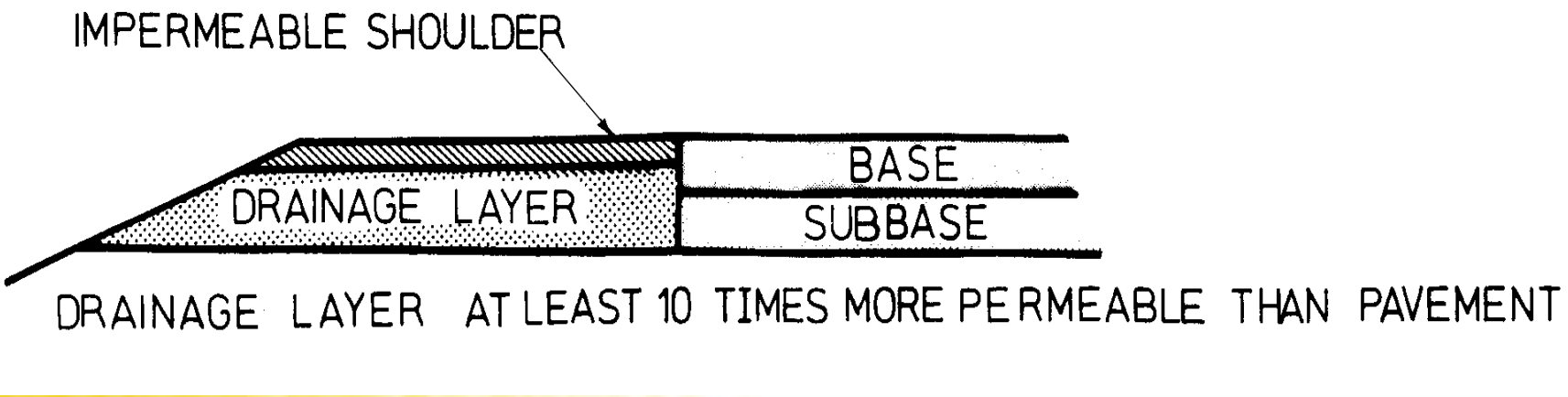


Subsurface drainage

- examples of satisfactory pavement drains







Drainage systems for surface

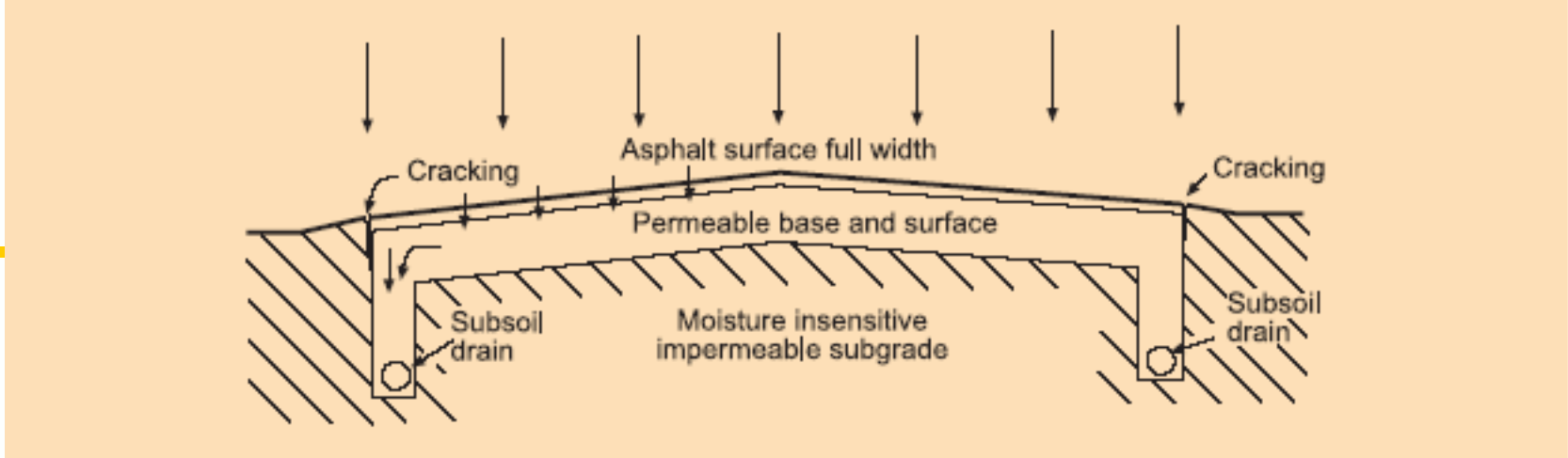


Figure 5.1(a) Drainage for surface infiltration (Gerke, 1987)

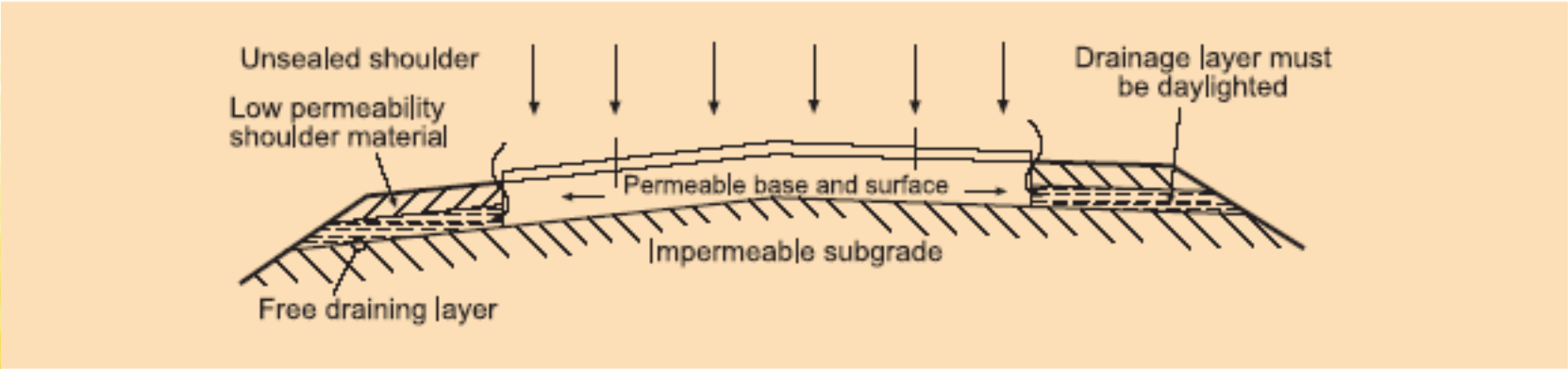


Figure 5.1(b) Drainage for surface infiltration (Gerke, 1987)

Drainage systems to lower water table

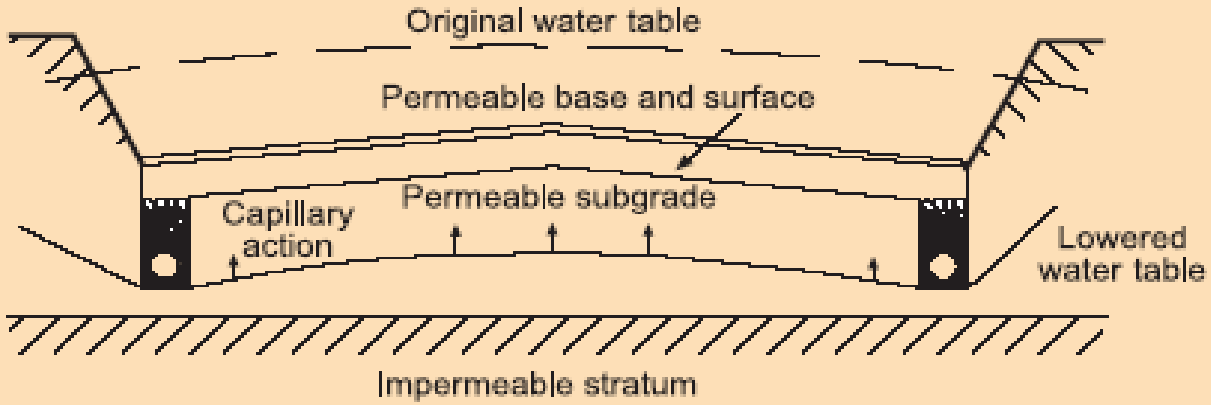


Figure 5.1(c) Drainage trenches to lower water table (Gerke, 1987)

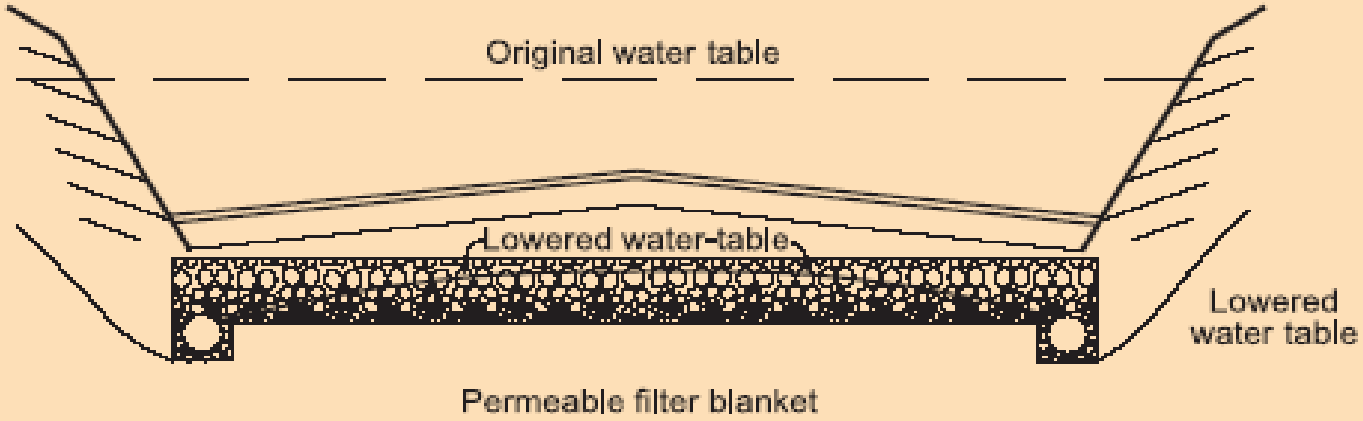


Figure 5.1(d) Horizontal filter blanket to lower water table (Gerke, 1987)

Drainage improvements

factors construction personnel should be aware of:

– need for stable, smooth free-draining working platform, no soft areas where water may pond
– avoid contamination of permeable materials
– excessive compaction may damage installed subsurface drains
– importance of inspecting and testing the pavement drainage system at end of construction

Design and Construction Considerations

Community Attitudes

- expectation that rehabilitation works will minimise impacts on local residents, businesses and road users
- In selecting a treatment need to consider :

⇒dust, noise, smell

⇒environmental impacts

⇒length of traffic delays, need for side tracks, detours

⇒scheduling of work, time of year, time of day

Design and Construction Considerations

Grade Line Restrictions

Limitation on modifying grade line is a major influence on treatment selection

- maintain bridge clearances
- urban kerb and channel levels, or intersecting roads

level constraints may require treatments like:

⇒ mill and replace existing asphalt

⇒ thin surfacings

⇒ insitu stabilisation

⇒ reconstruction

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Design and Construction Considerations

Road Geometry

consider the effect of possible treatments on road geometry

- Examples:

⇒a thick overlay may involve additional costs for raising the level of shoulders, adjacent verges, relocating guardrails & drains

⇒a widening may involve increasing embankment width, consider costs

Overlays

1. Grade Controlled Overlays:

- 1.1 Graded to High Spots
- 1.2 Cut/Fill
- 1.3 Full Cut

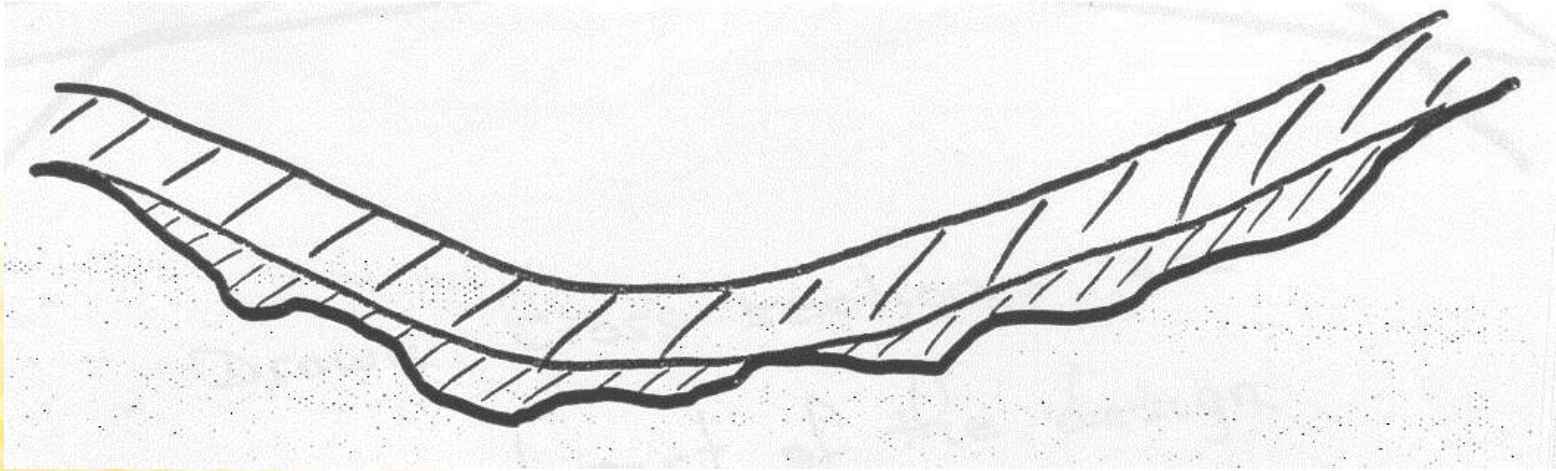
2. Non-Grade Controlled Overlays

3. Treatment of Existing Surface:

- 3.1 Scarify and Reshape

Overlays - Grade Controlled

1.1 Graded to High Spots



Overlays - Grade Controlled

1.1 Graded to High Spots

Advantages:

- Relatively simple design
- Minimal pretreatment

Disadvantages:

- Relatively poor rideability
- Excessive wastage of imported pavement
- Ponding

Overlays - Grade Controlled

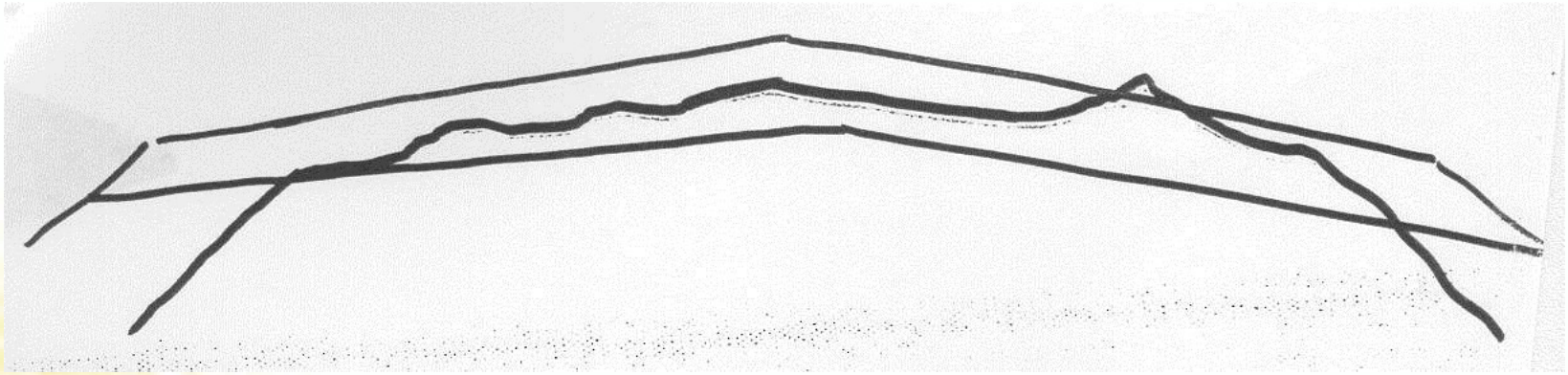
1.1 Graded to High Spots

Applications:

- High traffic
- Reasonable existing shape
- Conservative design where there may be considerable existing pavement thickness variations

Overlays - Grade Controlled

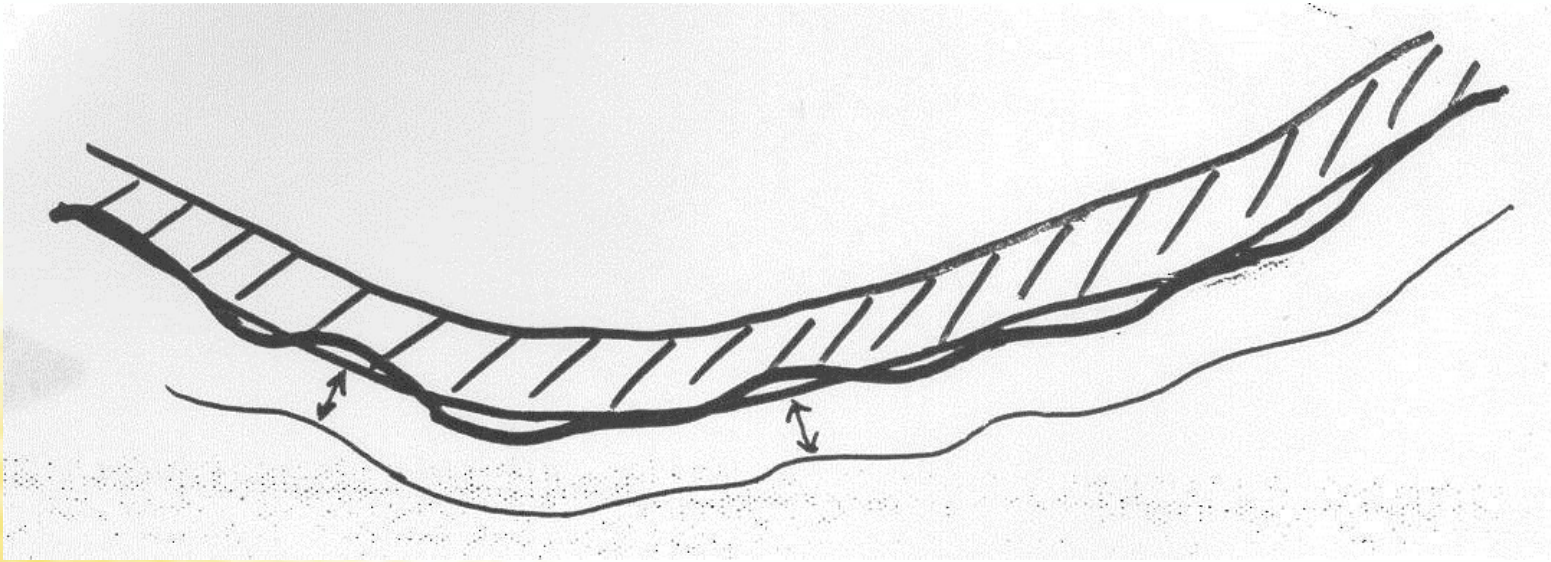
1.1 Graded to High Spots



Drawn cross sections are a crucial part of the design process.

Overlays - Grade Controlled

1.2 Cut/Fill



Overlays - Grade Controlled

1.2 Cut/Fill

Advantages:

- Minimal wastage
- Allows good rideability

Disadvantages:

- Extensive pre-treatment
  - Profiling
  - Stabilizer
- Traffic sensitive
- Frequent grade changes

Overlays - Grade Controlled

1.2 Cut/Fill

Applications:

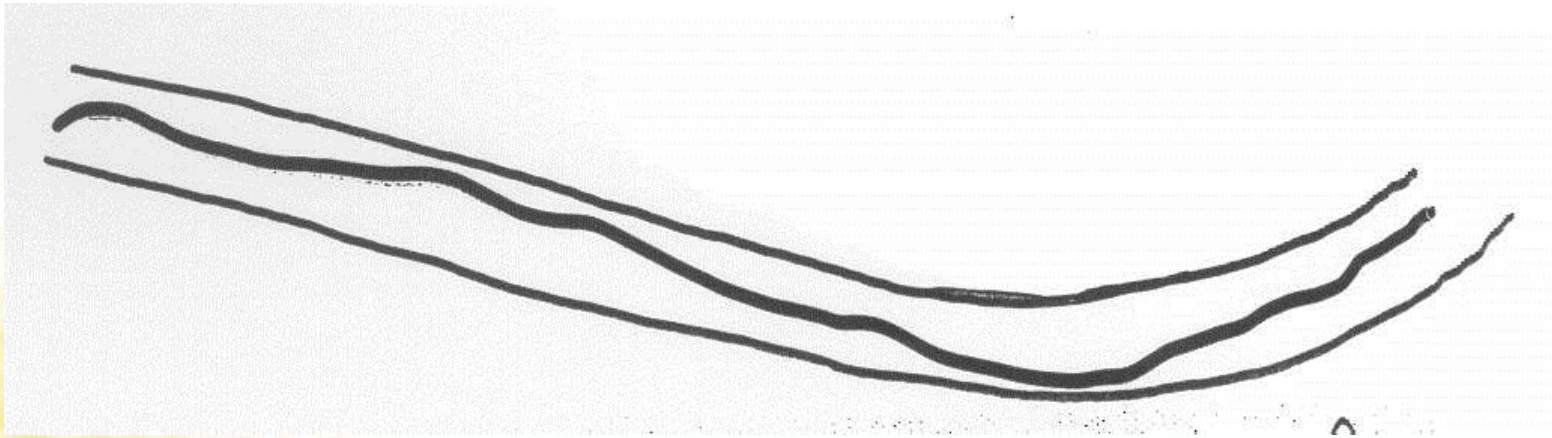
- Existing pavement out of shape
- High traffic (rideability)

Other Comments:

- Detailed knowledge of existing pavement thickness

Overlays - Grade Controlled

1.3 Full Cut



Overlays - Grade Controlled

1.3 Full Cut

Advantages:

- Uniform working platform → leads to good rideability

Disadvantages:

- Expensive
- Wastage of existing pavement
- Traffic

Overlays - Grade Controlled

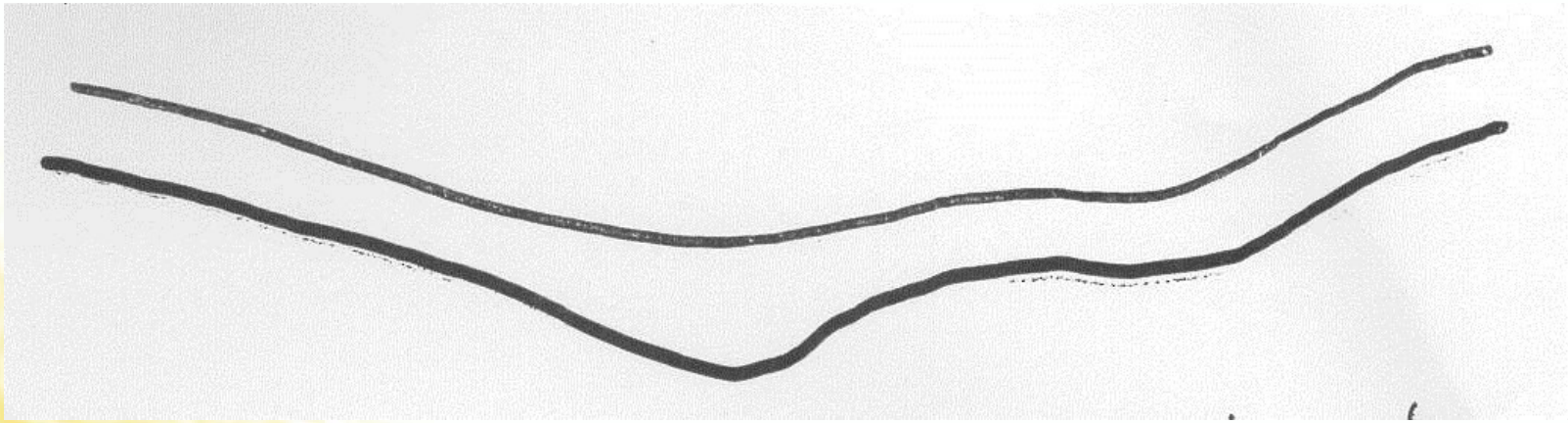
1.3 Full Cut

Applications:

- Inadequate existing pavement quality
- Height restrictions
  - Kerb and channel
  - Bridge and clearance
  - Rail Crossing
- Minimal increased cover required

Overlays – Non-Grade Controlled

2. Non-Grade Controlled



2. Non-Grade Controlled

Advantages:

- Minimal pretreatment
- Minimal wastage

Disadvantages:

- Lack of control
- Poor rideability

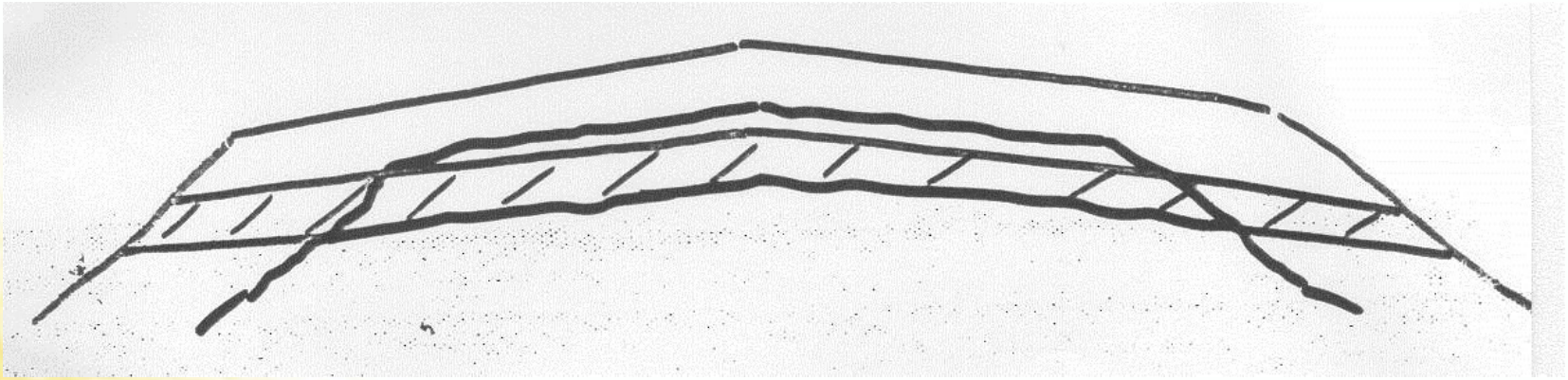
2. Non-Grade Controlled

Applications:

- Good existing vertical alignment
- Low traffic roads

Overlays – Treatment of Existing Surface

3.1 Scarify and Reshape



Overlays – Treatment of Existing Surface

3.1 Scarify and Reshape

Advantages:

- Maximum use of existing pavement
- Provides uniform full width pavement

Disadvantages:

- Uncertainty of reshaped pavement thickness ∴ conservative design
- Traffic control
- May require mixing with imported material to allow minimum thickness

Overlays – Treatment of Existing Surface

3.1 Scarify and Reshape

Applications:

- Best under side track
- Better suited to non-grade control

Design Issues

1. Widening to accommodate future overlay
2. Consider the merits and demerits of one side widening as against both sides. – Alignment
3. Boxing point – to avoid wheel path.
4. Improvement of existing subgrade if lime treatment is specified
   Issues – Suitability of lime – Capillary Rise
5. Strength of the existing pavement – lack of depth, poor quality
6. Selection of the subgrade strength both in the widening and under the existing pavement
7. Structural assessment using deflection/overlay design/Back Analysis
8. Case studies
9. Traffic issues – Tyre Pressure, ESA/CV
10. Overlay issues
11. Boxing to provide effective cover over expansive subgrade i.e.. 700-800mm above the untreated subgrade.
12. Seal design – Provide a full width seal as against only over the widening
13. Design to avoid crushed rock pavement on impermeable sub base.

Construction Issues

1. Shape correction scarify or rut fill – avoid bird baths.
2. Subgrade improvement with lime stabilisation / rock fill – issues
3. Construction under traffic – particularly granular overlay
4. Construction traffic
5. Extension of culverts and drainage structures

Specification/ Material Issues

1. Widening material to be ‘compatible’ with the existing material to avoid box type issues
2. Material specification local availability, Pour Pressures/DOS issues
3. Overlay material to be suitable for stabilisation

Maintenance & Rehabilitation Issues

1. ‘Boxed’ type design relies on the seal integrity – seal maintenance or resealing pavement
2. Insitu stabilisation

Flexible Pavement Surface Treatments

Common sprayed seal types :

- primerseals
- single & double coat seals and reseals
- SAM seals
- geotextile seals
- emulsion seals

Sprayed seals

Appropriate uses :

- extend pavement life by reducing water ingress
- provide a wear resistant surface
- correct surface deficiencies, eg cracking, ravelling, skid resistance

Inappropriate uses :

- pavements requiring shape correction or strengthening
- turning or braking traffic

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Design and Construction Considerations

Shoulder Sealing

- safety and pavement performance significantly enhanced by sealing shoulders
- Shoulders must be structurally adequate

Design and Construction Considerations

Construction under traffic

need to consider traffic management required for different treatment options

- Detours
- Night work
- Benefits – i.e. soft spots
- Risks - ravelling

Design and Construction Considerations

Risk and Design Sensitivity

- risk of premature distress may vary with treatment type due to differing sensitivities to variations in design parameters or construction factors
- if a design is sensitive to a factor
  - allow for over-design
  - reschedule to construct under lower risk conditions
  - exclude treatment

Design and Construction Considerations

Availability of Plant, Personnel and Material

- some treatments require specialised items of plant operated by skilled staff
- availability may influence viability of treatment
- testing and process control
- Establishment costs

Asphalt overlays

- application of a layer of asphalt to existing pavement
- prior to overlay may need to crack seal, cold plane or patch localised areas

Asphalt overlays

Appropriate uses :

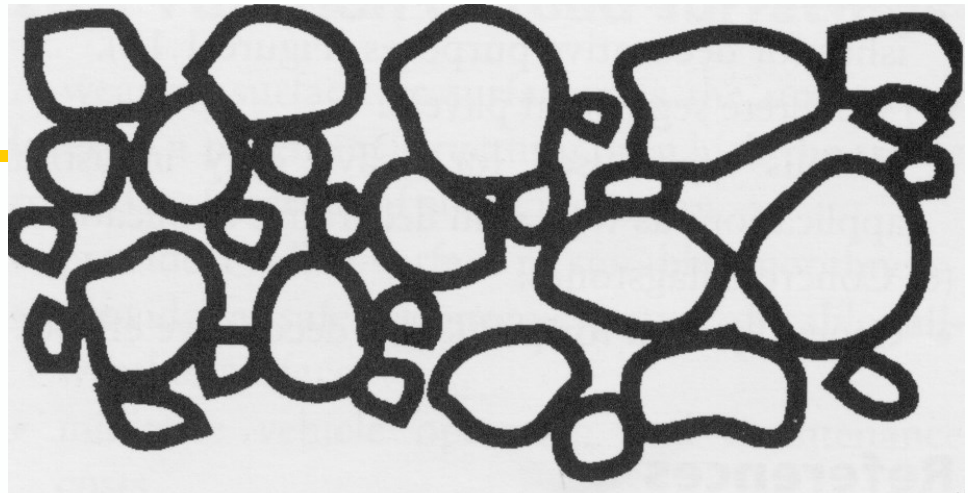
- pavements requiring shape correction
- pavements requiring strengthening
- improve noise or skid resistance

Inappropriate uses :

- over unstable bases/subbases
- where pavement levels cannot be increased, unless combined with cold planing

Open graded asphalt surfacings

- OGA is a coarse, gap graded mix, 18-23% air voids
- OGA has superior noise reducing and spray reducing properties
- as OGA is very permeable, not waterproof, if existing pavement is cracked need a seal or SAMI under the OGA



Ultra thin asphalt surfacings

Two major types

- thin OGA placed with a modified asphalt paver that applies a tack coat ahead of the asphalt
- modified, small sized, dense graded asphalt mixes

Ultra thin asphalt surfacings

Appropriate uses :

- minor shape correction of structurally sound pavements
- on cracked pavts in combination with a geotextile SAMI treatment
- to obtain reduction in noise and spray

Inappropriate uses :

- on pavements that require strengthening
- areas of high shear forces

Asphalt recycling

Plant Mixed Recycling

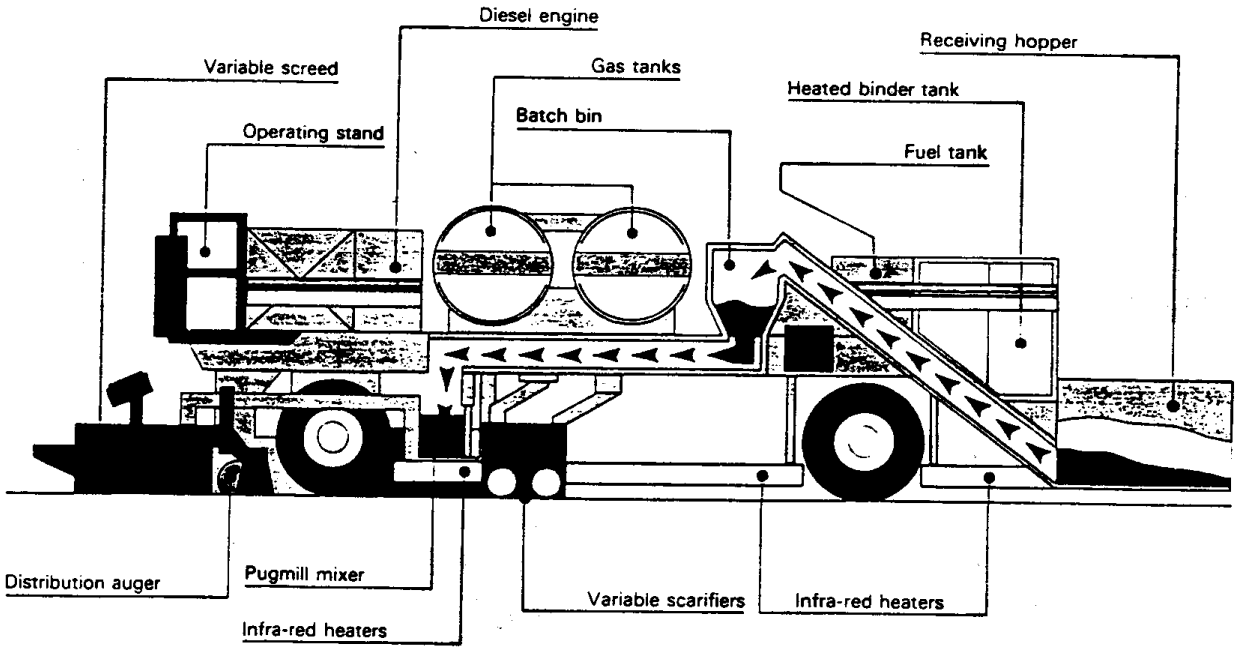
removal of asphalt and its re-use in new asphalt

Asphalt recycling

Hot In-Place Asphalt Recycling (HIPAR)

In a single pass, HIPAR equipment :

- heats and mills the surface
- mixes the millings with new aggregate, binder and rejuvenating agent to form a recycled mix
- lays and compacts the mix back onto the pavement



Asphalt recycling

HIPAR appropriate uses :

- rehab substantial lengths of major roads which are structurally sound
- restore surface shape, skid resistance
- rejuvenation of oxidised asphalt

HIPAR inappropriate uses :

- to treat reflection cracking in asphalt overlying a bound cementitious layer
- asphalt containing tars, some types of PMB or geotextiles

Asphalt recycling

Cold In-Place Asphalt Recycling

In a single pass, CIPAR equipment :

- mills the surface
- mixes the millings with rejuvenating agent to form a recycled mix

Appropriate uses

- light to moderately trafficked roads

Inappropriate uses

- pavts that require strengthening, if not used in conjunction with an overlay
- to achieve a high quality finish

Insitu stabilisation of granular pavements

- stabilisation provides a long-term increase in its load bearing properties
- stabilisation methods:

⇒ granular (mechanical)

⇒ cementitious

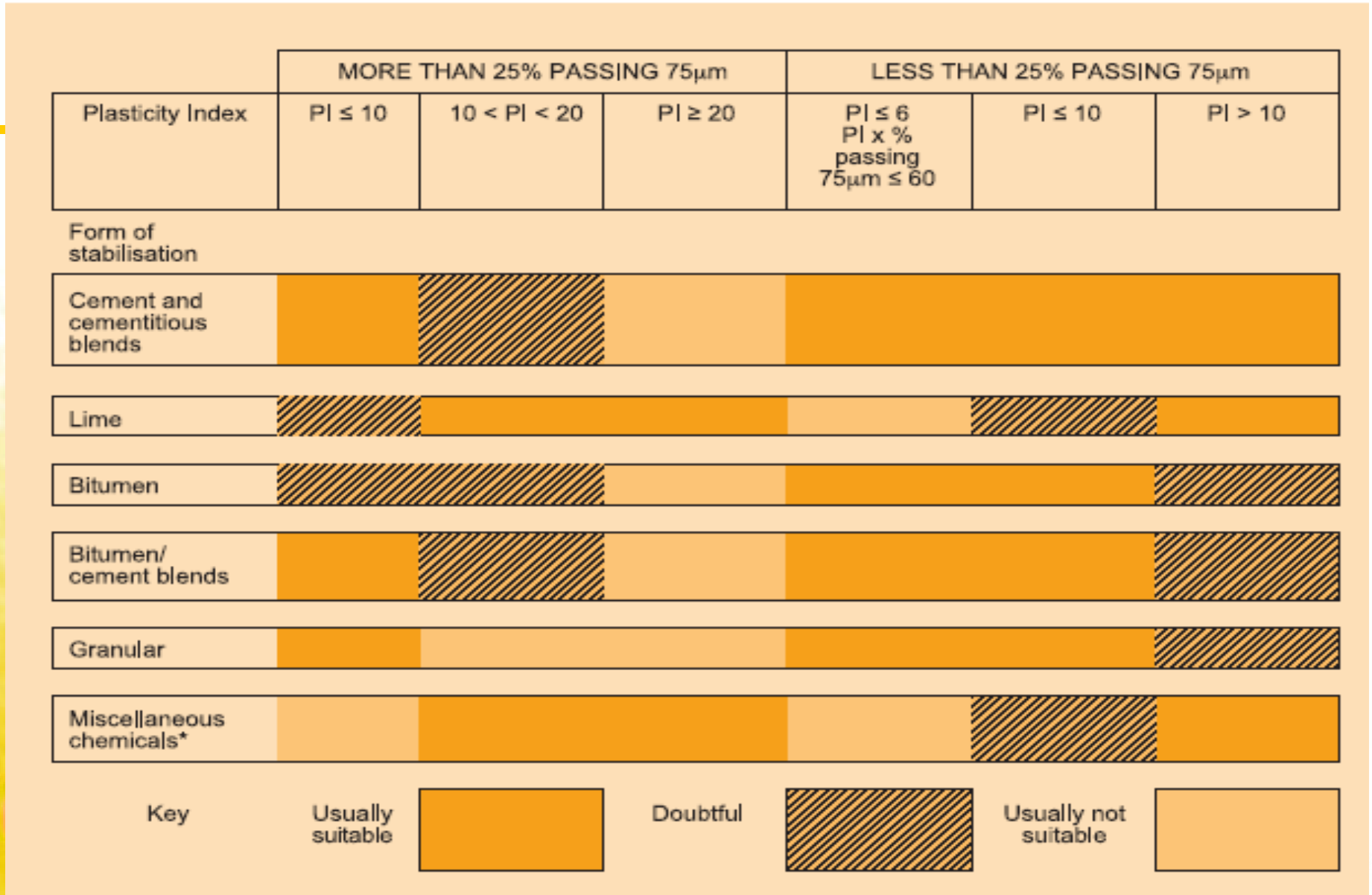
⇒ lime

⇒ bitumen

⇒ other chemical agents

Guide to selecting method of stabilisation

Table 5.1 Guide to selecting a method of stabilisation (Austroads, 1998)



Other chemical stabilising agents

- Organic, non-bituminous binders, lignosulphonates
- Electro-chemical stabilisers, sulphonated petroleum, enzymes lime stabilisation
- Dry Powdered Polymers, PVC, PVA

⇒DPPs preserve the strength of moisture - susceptible gravels without stiffening the pavement

⇒AustStab and APRG Technical Notes on DPPs

Concrete Pavement Treatments

- surface treatments
- joint treatments
- strengthening treatments

More fully discussed in RTA NSW *Guide to Maintenance of Concrete Pavements*

Crack and Seat with Overlay

- involves cracking pavement into 0.5m to 1m square sections, then rolling to push the cracked slabs into a stable position
- the C&S pavement is then strengthened with an asphalt overlay
- process creates blocks sufficiently small to inhibit thermal movement and hence reflection cracking, yet still retains some aggregate interlock

Slab stitching

process is used to retain aggregate interlock across joints, thereby maximising load transfer

its effectiveness relies on it being completed before the crack or joint has opened sufficiently to compromise load transfer

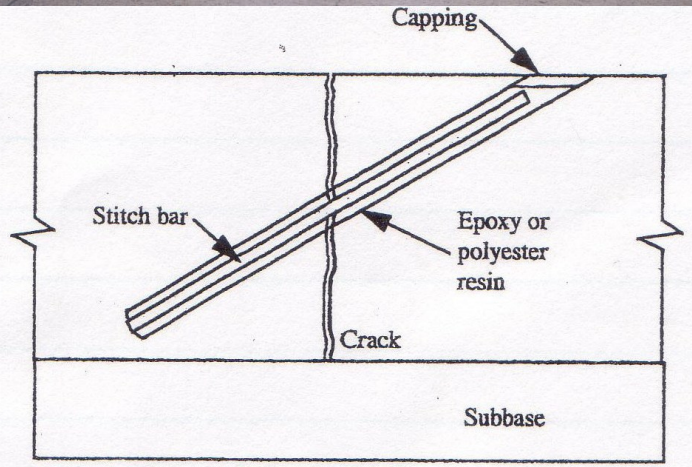


Figure 16 : Typical section of a stitched crack.

Full depth concrete patching

- involves removal of distressed concrete by full depth saw cuts
- installation of dowel bars to achieve load transfer across sawn joints
- placing & compacting concrete

Detailed descriptions of treatments

Compendium of Technical Notes in Appendix 5.1

- Australian Pavement Research Group 13
  www.austroads.com.au/aprg/index.htm
- APRG/AAPA Work Tip 39
  www.aapa.asn.au
- State Road Authorities 50

- Australian Stabilisation Industry Association 6
  www.auststab.com.au

Checklist for Solutions

Solutions - Strengthening

- Selective digout & reseal
- Overlays
  - granular
  - Asphalt
- Base course stabilisation
- Drainage
  - table drains
  - shoulder seal
  - subsurface drains
  - crossfall & flow path regulation
  - remove low permeability barriers

Solutions - Shape Corrections

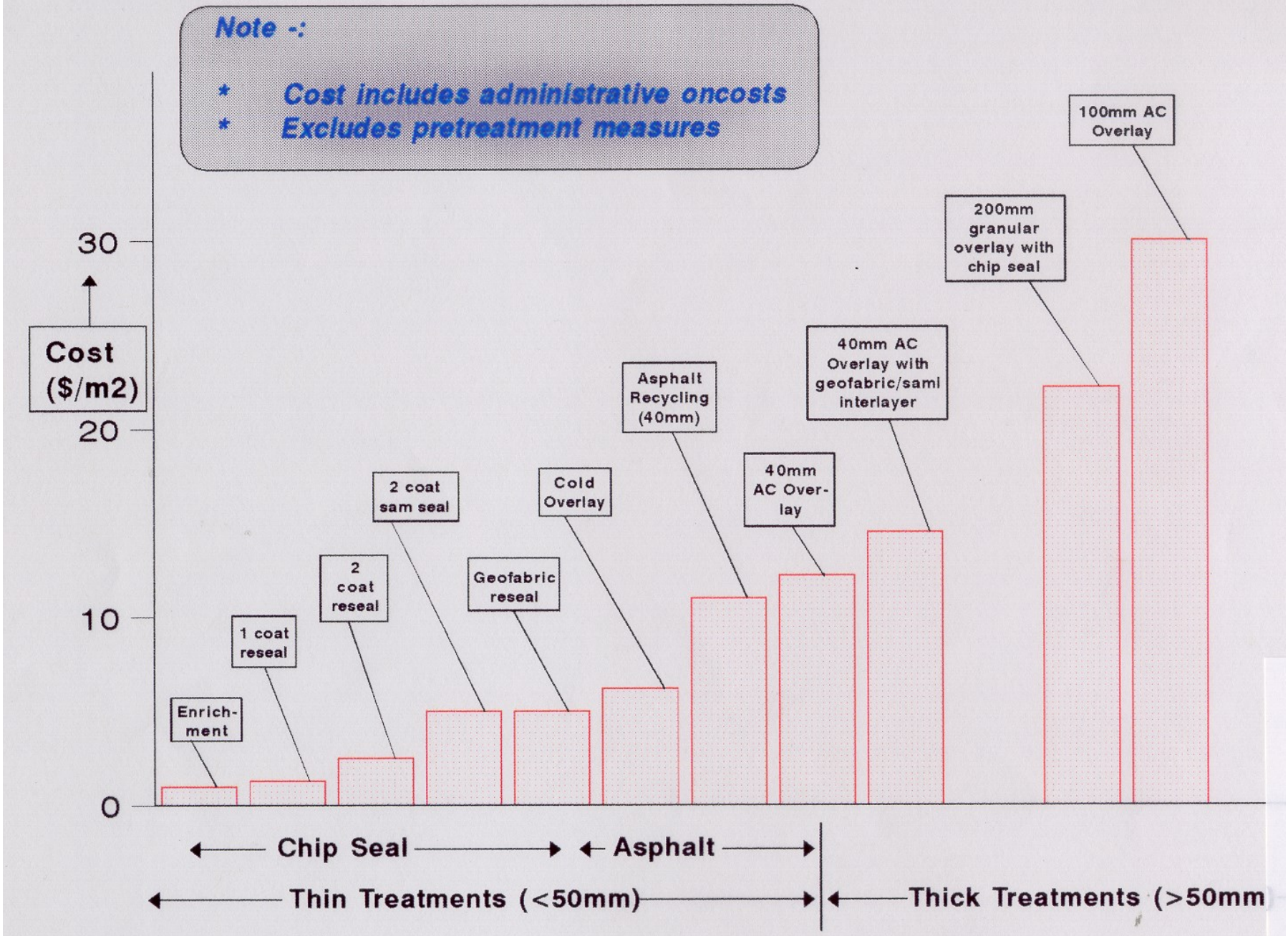
- Asphalt
- Slurry seals
- Hot or Cold recycling

Solutions -
Crack Repairs & Water Proofing

- Patching
- Crack infilling
- Hot/cold recycling
- SAM's or SAMI's
- Geotextiles

Solutions - Skid Resistance Improvements

- Open graded asphalts
- Grooving of asphalts
- Rejuvenators
- Reseal



Types of Rehabilitation