HIGHWAY ENGINEERING
SAB2832

Highway Drainage
&
Maintenance

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Highway Drainage & Maintenance

by

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Highway Drainage & Maintenance

- Highway Drainage System
- Highway Maintenance
- Pavement Rehabilitation
- Visual Assessment of Flexible Pavement Surface Conditions

Highway Drainage System

- Adequate & proper road drainage is VERY, VERY, VERY IMPORTANT! Both for the safety of road users and pavement construction and maintenance

1. *User safety – accumulated water caused hydroplaning, splash and spray*
2. *Pavement - reduce sub-grade strength, hydraulic pressure from passing traffic, binder stripping, slope stability*

- Two types of drainage:

1. *Sub-surface drainage – cut/fill area, high water table*
2. *Surface drainage – rain, snow, run-off water*

Sub-surface Drainage System

- Provided within the pavement to lower the water table, intercept seepage from cut or sidehill, and drain out seepage water from pavement structure, drainage during and after construction
- If inadequate – premature destruction of pavement (high pore pressure, frost action), slope failure (increase stress, reduce shear strength)
- Usually installed on expressway and trunk road
- Three major sources of underground water:

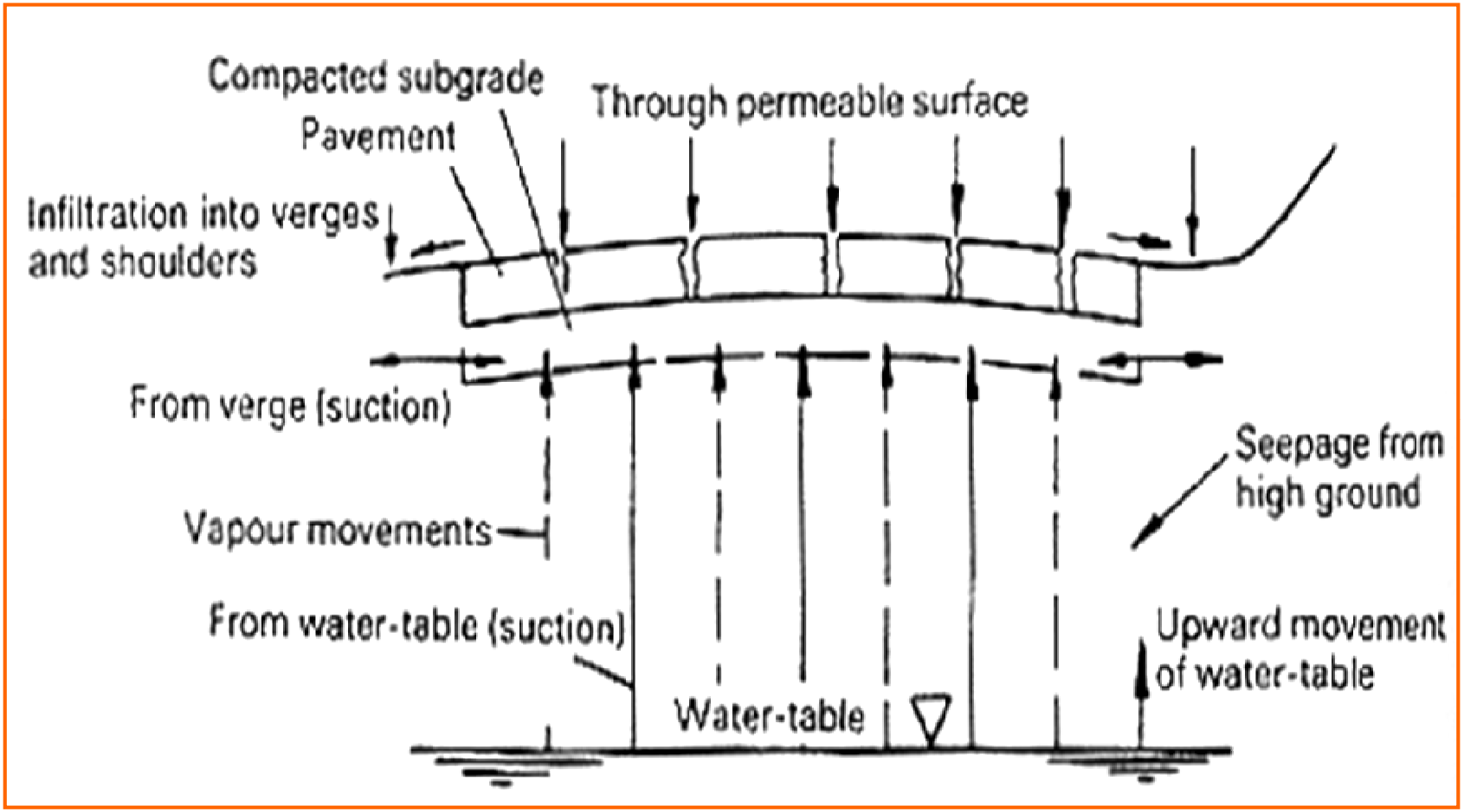
1. *Natural ground water (WT) – seasonal*
2. *Capillary action – move upward tru underlying soil strata, particle size dependent*
3. *Seepage – permeated tru slope, pavement, road shoulder*

Sub-surface Drainage System

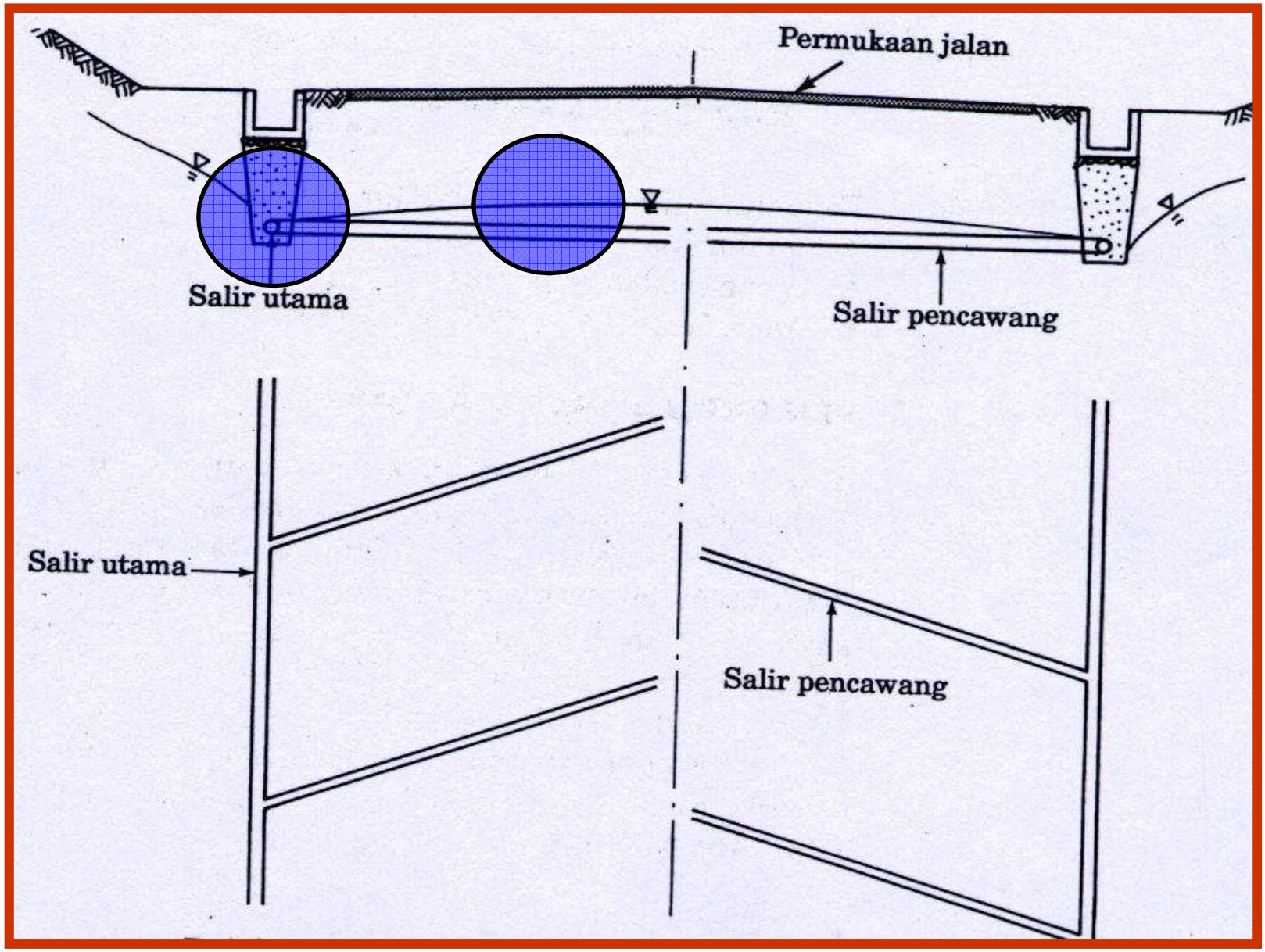
- Types of sub-surface drainage system:

1. *Longitudinal – filtered perforated pipe along road shoulder*
2. *Transverse – if longitudinal not adequate*
3. *Interceptor pipe – cut area, pipe at toe*
4. *Horizontal – inserted into cut/fill slope*
5. *Drainage blanket – high coefficient layer*
6. *Porous sub-base – percolated water carried out to side drain, cover entire road formation*

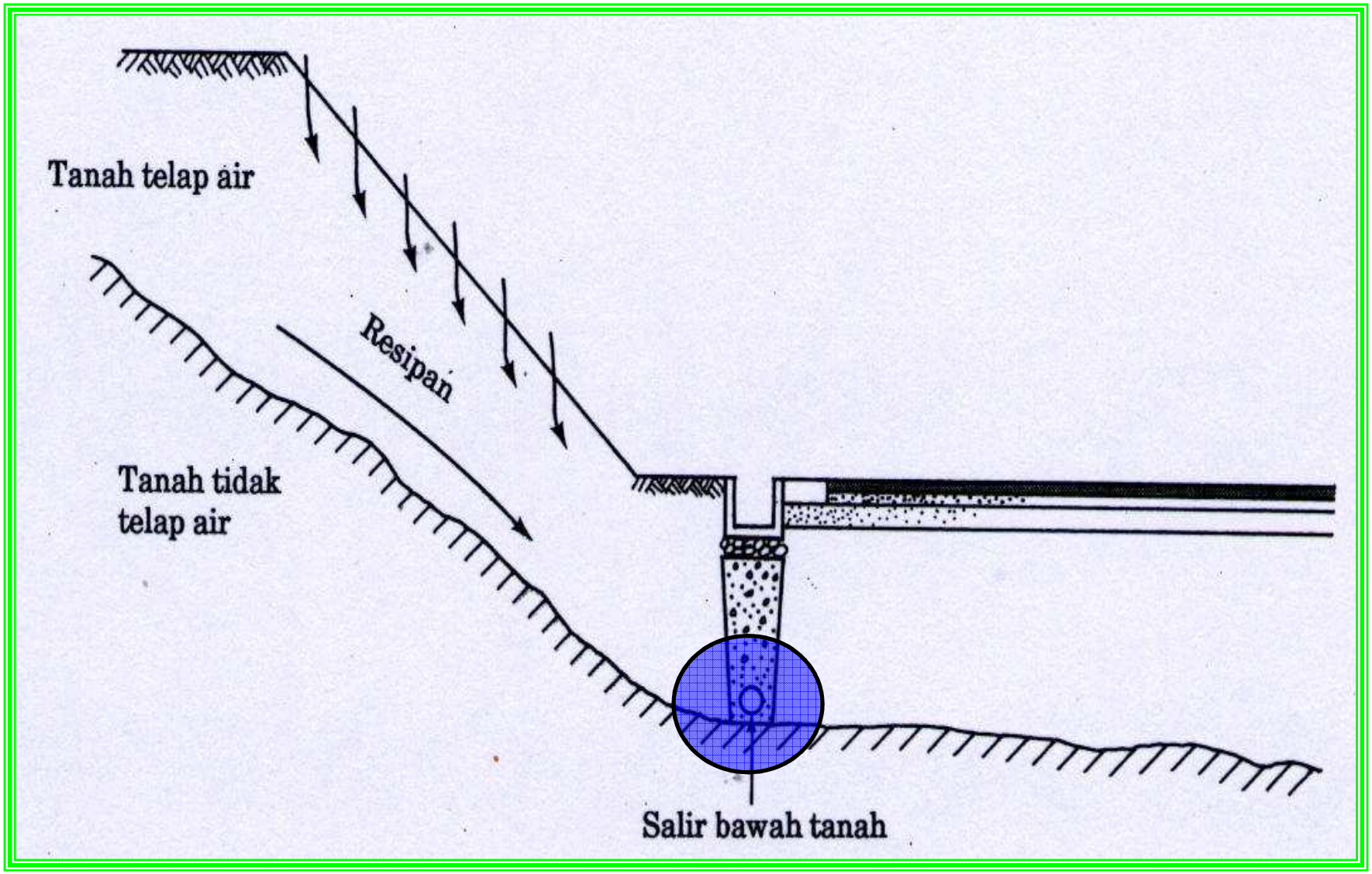
Source of ground water



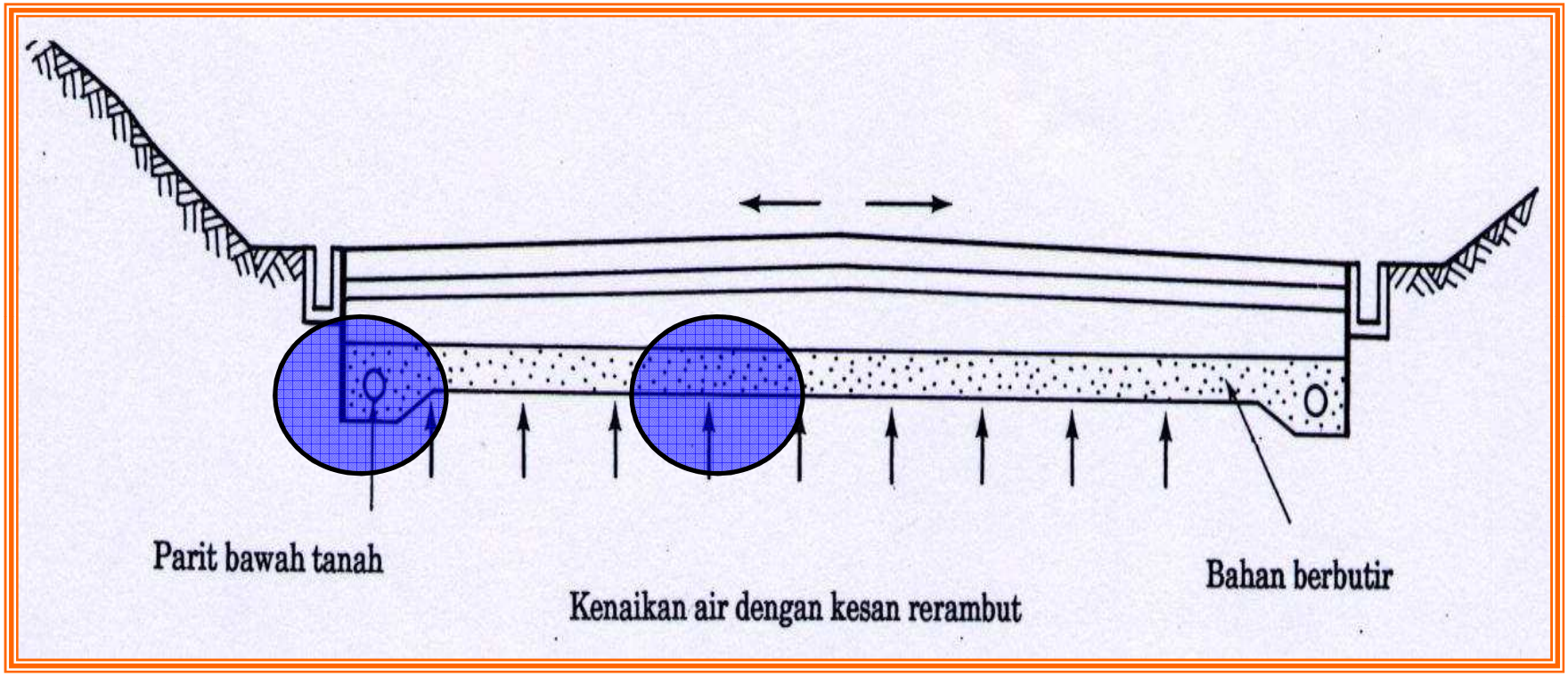
Longitudinal & transverse drain2



Interceptor pipe



Drainage blanket

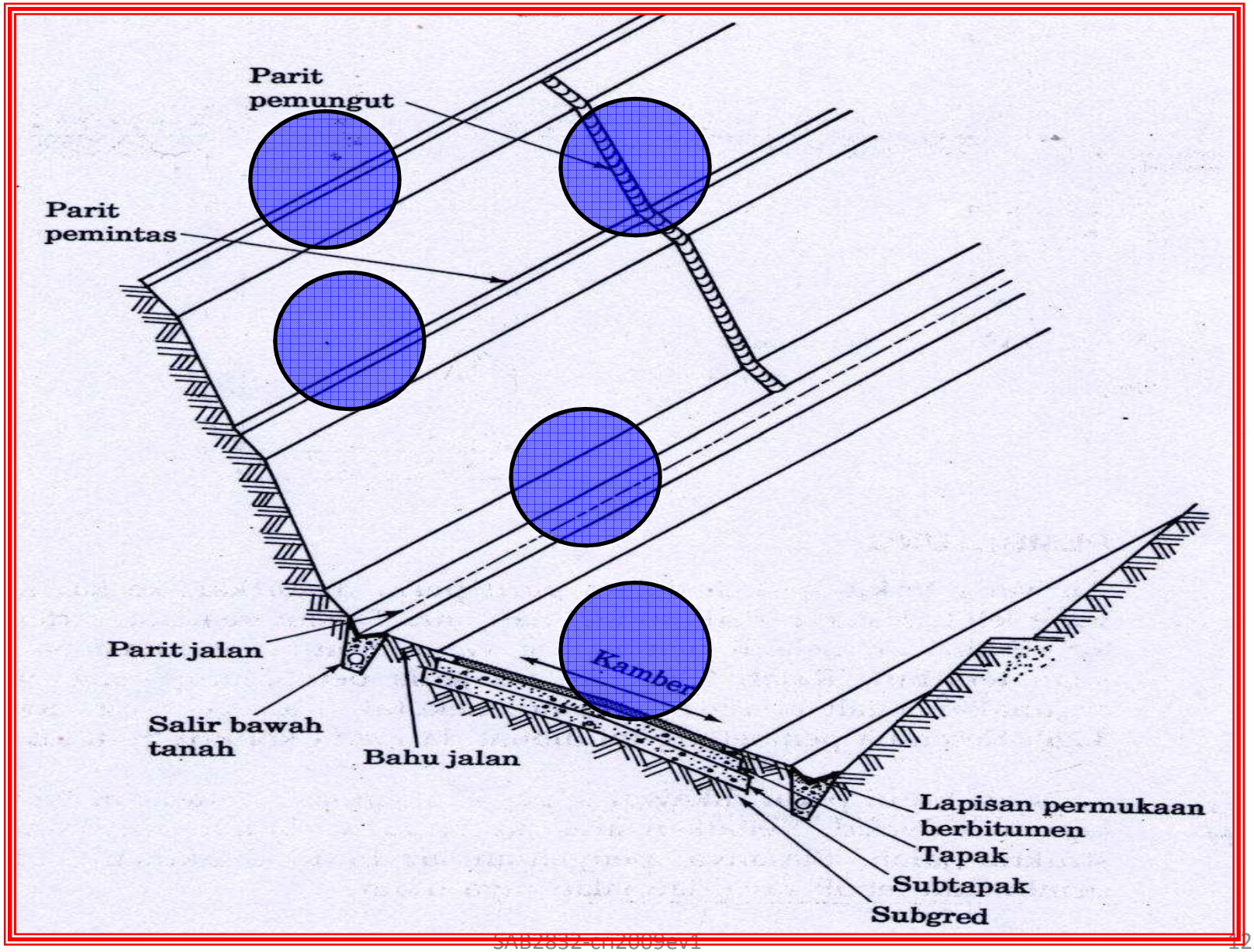


Surface Drainage System

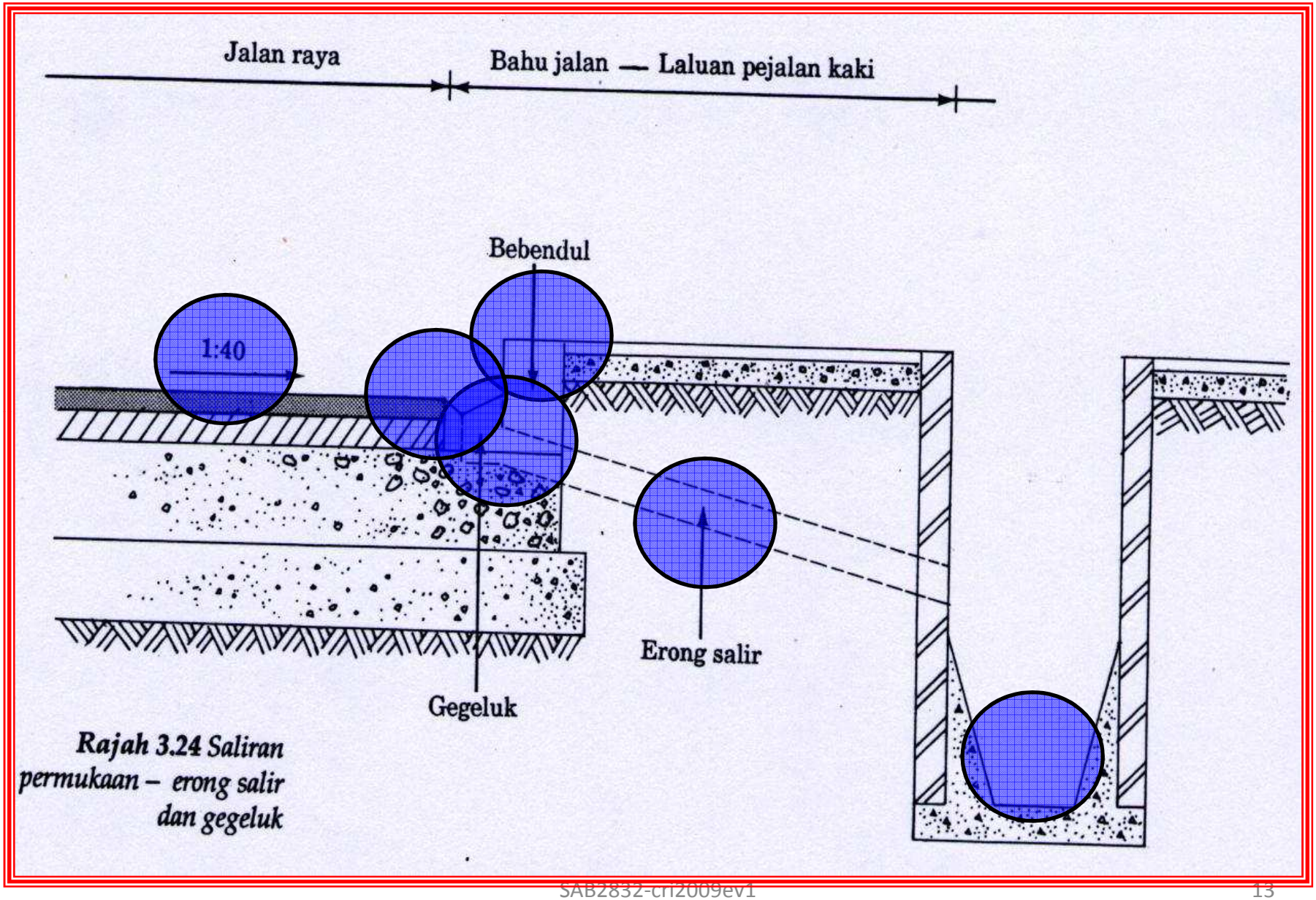
- Road surface need to be free of standing water to ensure safety
- To intercept surface and watershed run-off into designed channel for discharge into river or natural waterways
- Types of surface drainage system:

1. *Transverse slope/crown – facilitate removal of surface water*
2. *Side drain – alongside of highway to collect water from pavement surface, subsurface and ROW*
3. *Longitudinal slope – optional, help expedite water flow*
4. *Interceptor drain – at top of cut area to prevent water from flowing onto pavement, erosion, discharge into paved spillway/outfall*
5. *Curb,Gutter and Scupper drain – drainage, embankment erosion, and encroachment (urban)*
6. *Culvert – under pavement, carry water across road*
7. *Bridge – across river or waterway, part of a road*

Camber, interceptor, collector, side

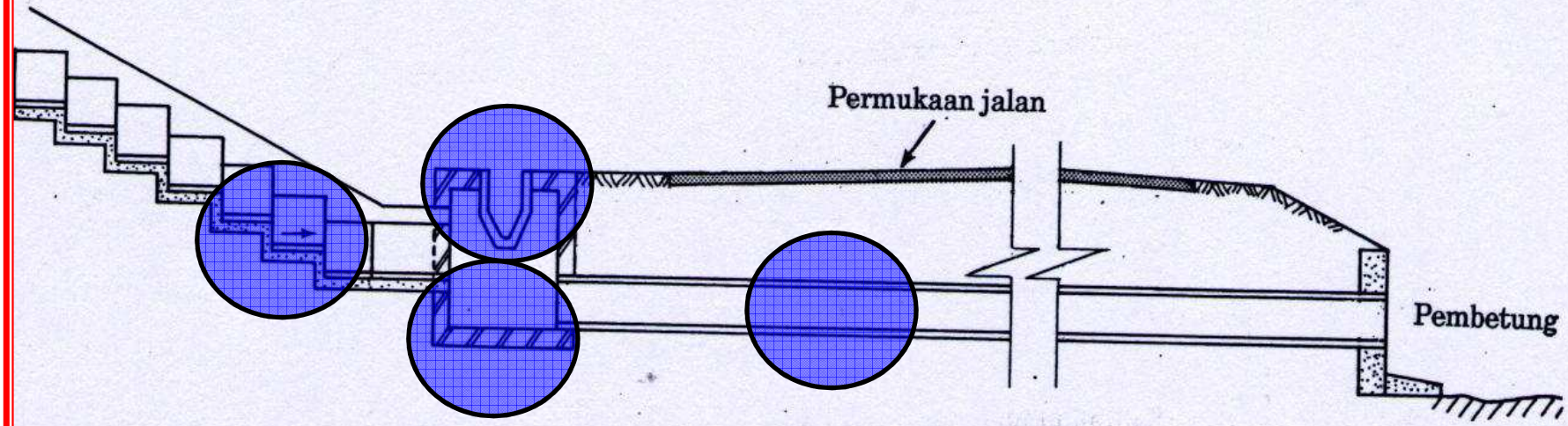


Curb, Gutter & Scupper

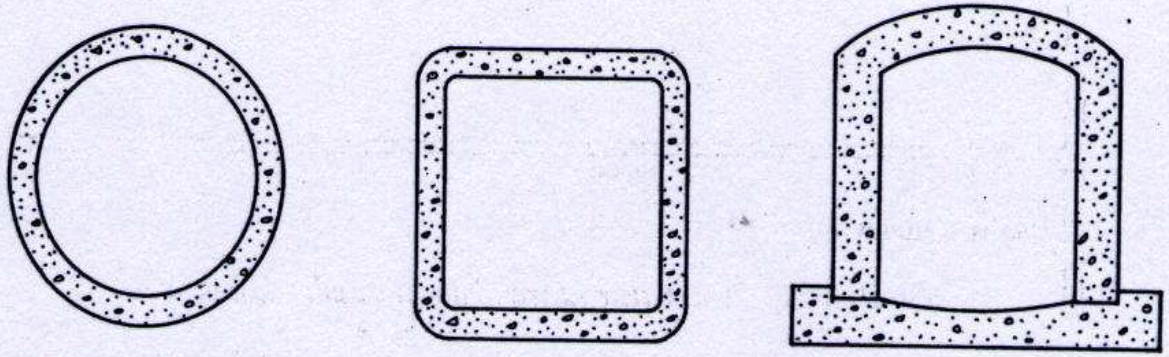


Rajah 3.24 Saliran permukaan – erong salir dan gegeluk

CULVERT



Rajah 3.25 Keratan rentas jalan – kedudukan pembetung



Pembetung paip

Pembetung kekotak

Pembetung gerbang

Maintenance

- Pavement maintenance is required to keep road network in satisfactory conditions to ensure safety and low road user costs
- Federal roads maintenance – privatization?
- Consist of (component based):

1. *Resurface and patching*
2. *Shoulder maintenance and grass cutting*
3. *Repair and stabilized slope*
4. *Clean, repair, reconstruct culvert, bridge, and drains*
5. *Maintenance of road furniture and markings*

- Does not includes widening and structural strengthening

Maintenance

- Maintenance activities (frequency based):

1. *Routine – not subject to detailed planning, performed throughout the year, usually small scale/simple, can be carried out on a regular basis (grass cutting, patching, shoulder, drainage, signage, landscaping, routine inspection)*
2. *Periodic – carried after once in a few years, normally large scale, require specialized equipment and skilled manpower, costly and need proper identification and planning (preventive maintenance, resurface, road marking)*
3. *Emergency works – need to be dealt without delay, non-planned, have immediate effect on serviceability of the road*

- Routine and periodic maintenance needed to maintain acceptable safety level and to avoid costly repair

Maintenance - Patch

Maintenance - Shoulder

Maintenance - Slope

Maintenance - Bridge

Maintenance - Drain

Maintenance – Furniture, Landscape

Pavement Rehabilitation

- Various techniques, selection depends heavily on engineering judgment but other factors such as cost, construction feasibility and effect on road users should be considered as well.
- Rehabilitation methods:

1. *Restoration*
2. *Resurfacing*
3. *Recycling*
4. *Reconstruction*

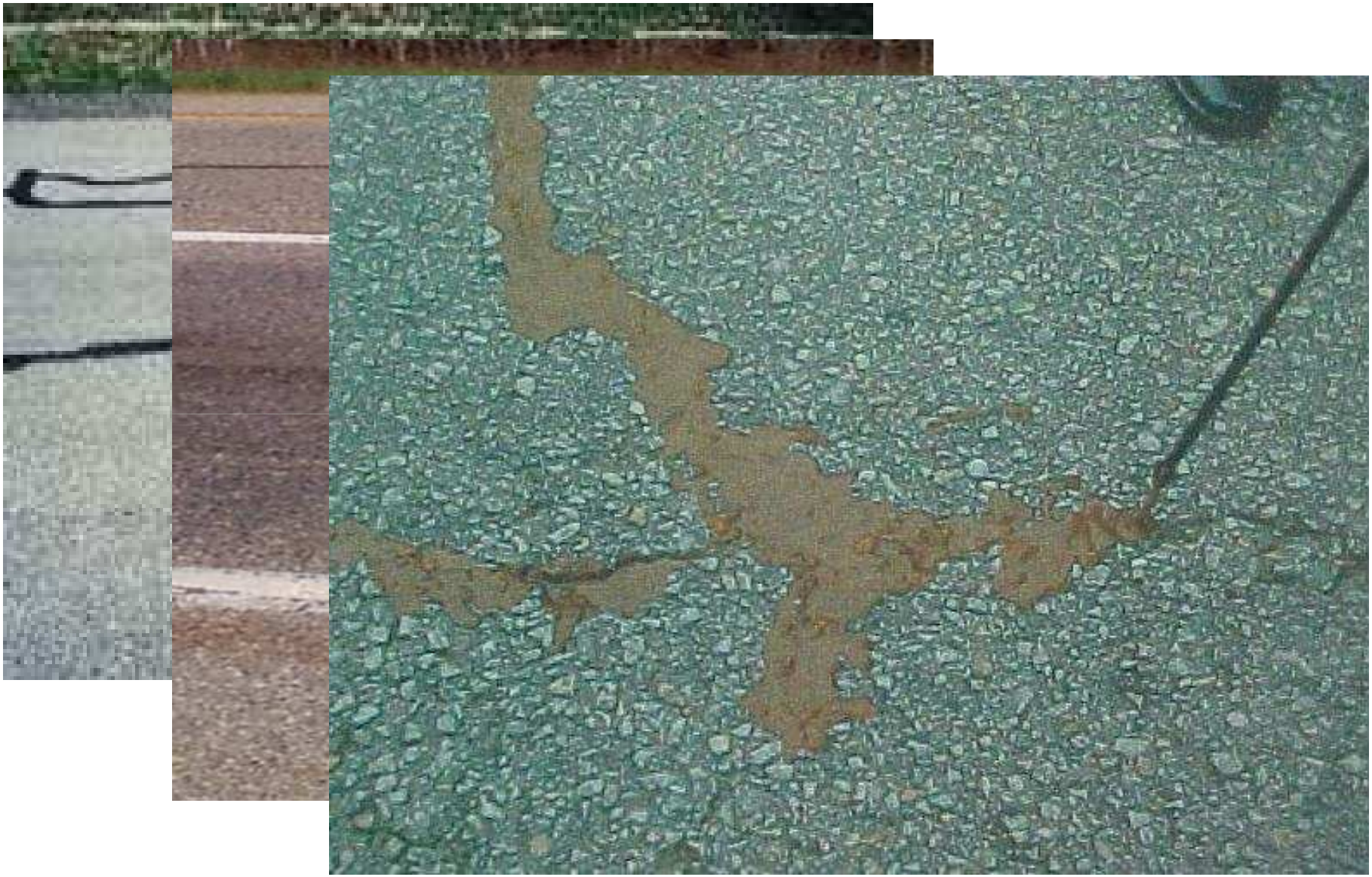
Restoration

- When distress such as cracking and polishing.
- Restoration will – repair existing distress, reduces roughness rate and slow down pavement deterioration.
- Restoration techniques:

1. *Rejuvenating –spray on aged surface*
2. *Crack sealing – fill crack with slurry, or bitumen + sand blotting*
3. *Cut and patch – hot or cold patch mix*
4. *Thin bituminous overlay – slurry seal,surface dressing, thin hot mix*

Rehab - Rejuvenating

Rehab - Cracksealing



Resurfacing

- When pavement have severe and extensive structural damage - structural improvement required
- Most popular in Malaysia
- Involved placement of fresh material – improves riding quality, enhance structural strength
- Need to properly design the overlay thickness to achieve design life
- Using thick asphalt overlay – with or w/o prior granular overlay (pre-treatment required)

Rehab – Resurfacing

Recycling

- Use of old pavement material to correct raveling, bleeding and improve skid resistance
- Types of recycling:

1. *Hot recycling – repair surface crack, road base still sound, use heat to soften surface*
2. *Cold recycling – milling defected surface and reuse with addition of stabilizer, rejuvenator or bitumen*
3. *Base recycling – road base fail, use stabilized old surface material as base, lay new surfacing*

Rehab – Hot Recycling

Rehab – Cold Recycling

Reconstruction

- Removal and rebuilding of all or part of pavement using fresh material (current practice recycle) and new construction specification
- Pavement failed severely where deterioration has been allowed to occur w/o maintenance, or inadequate sub-surface drainage
- Types of reconstruction:

1. *Hot recycling with overlay*
2. *Cold recycling with overlay*
3. *Construction/improvement of sub-surface drainage*

Rehab - Reconstruction

Visual Assessment of Pavement Surface Conditions

- Assessment of pavement surface conditions used by highway agencies to:

1. *Measure the ability of pavement to continue to provide service to public*
2. *Determine deficiencies and inadequacies of pavement*
3. *Determine remedial measures to be taken and its fiscal needs*
4. *Planning and programming of pavement maintenance and/or rehabilitation*

Visual Assessment of Pavement Surface Conditions

- Types of distress in flexible pavement:

1. *Cracks*
2. *Surface deformation*
3. *Surface defects*
4. *Patches*
5. *Potholes*
6. *Edge defects*

Pavement Cracks

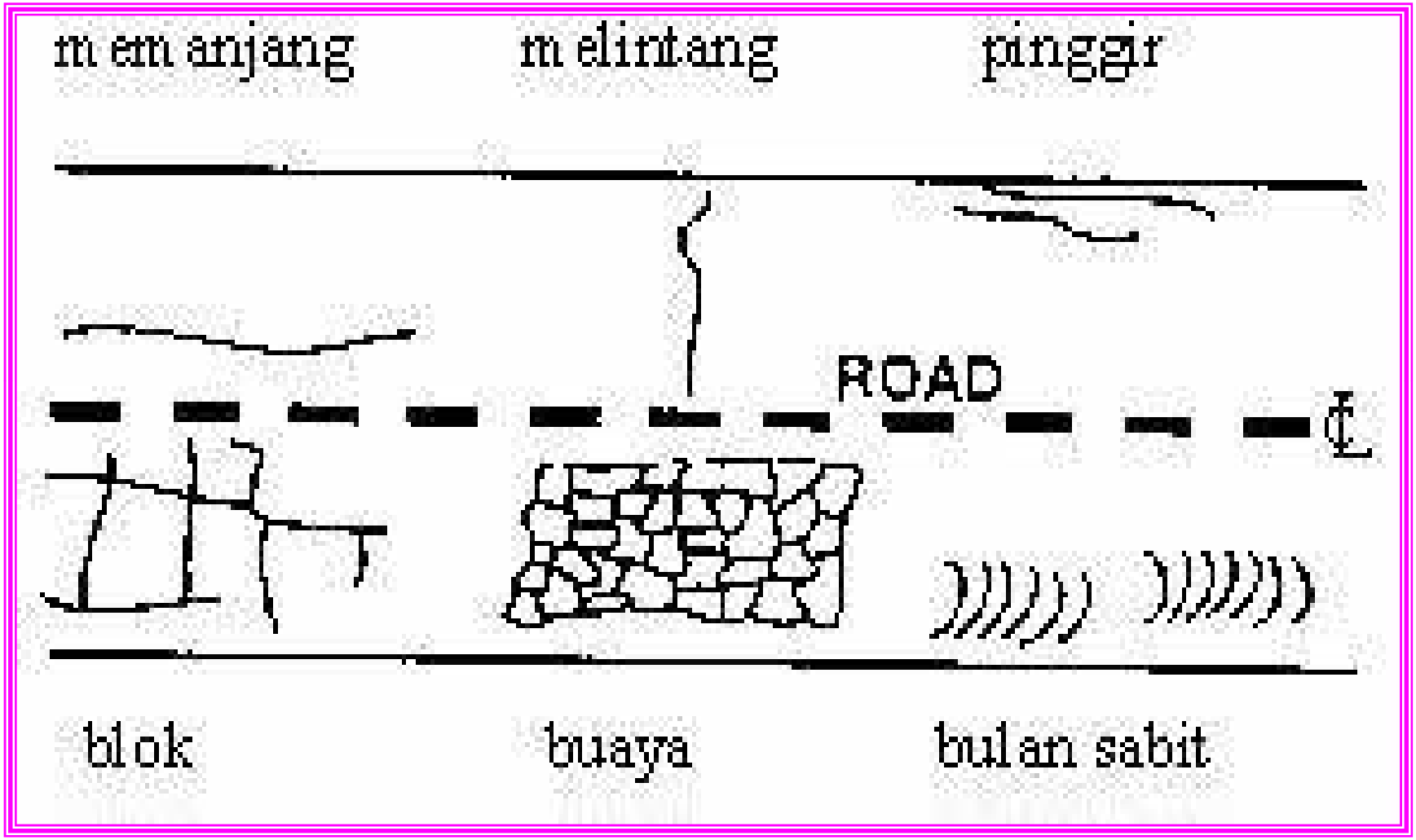
- Cracks – fissures resulting from partial or complete fractures of the pavement surface
- Variety of patterns from isolated to interconnected over entire surface
- Detrimental effects of cracks:

1. *Loss of water proofing*
2. *Loss of load spreading ability*
3. *Pumping and loss of fines from road base*
4. *Loss of riding quality*
5. *Loss of appearance*

Pavement Cracks

- Possible causes of cracks –Depression, Fatigue life of surfacing exceeded, Age embrittlement of surfacing, Reflection cracks from underlying layers, Shrinkage, Poor construction joint
- Probable treatments – cut and patch, reconstruction, replace surfacing, crushed aggregate overlay, crack sealing, improve drainage and shoulder, widen pavement, strengthen shoulder, overlay with stiffer mix
- Types of cracks – longitudinal, transverse, block, crocodile, edge, crescent shape

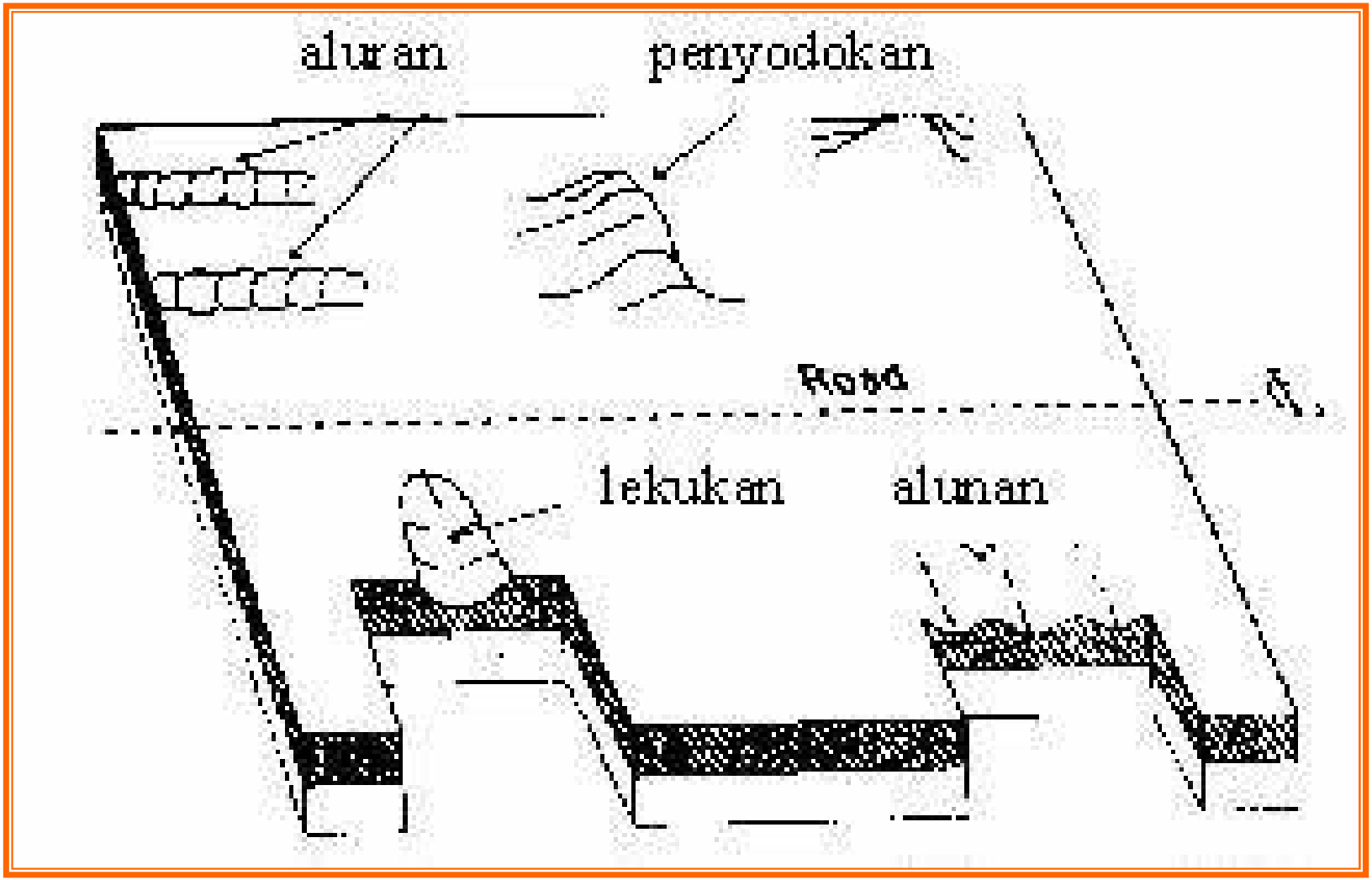
VA - CRACKS



Surface Deformations

- Deformation takes place when surface undergo changes from its original profile (due to traffic, environment, inadequate control during construction)
- Influences riding quality and may reflect structural inadequacies, may lead to cracks
- Possible causes – inadequate thickness, poor compaction, unstable premix, base or sub-base, volume change, settlement, lack of bond between bituminous layers, start-stop
- Probable treatments – overlay or reconstruction, replace/recycle with stiffer mix, base/sub-base strengthening, improve subsoil drainage, shoulder improvement
- Major types – rutting, corrugation, shoving, depression

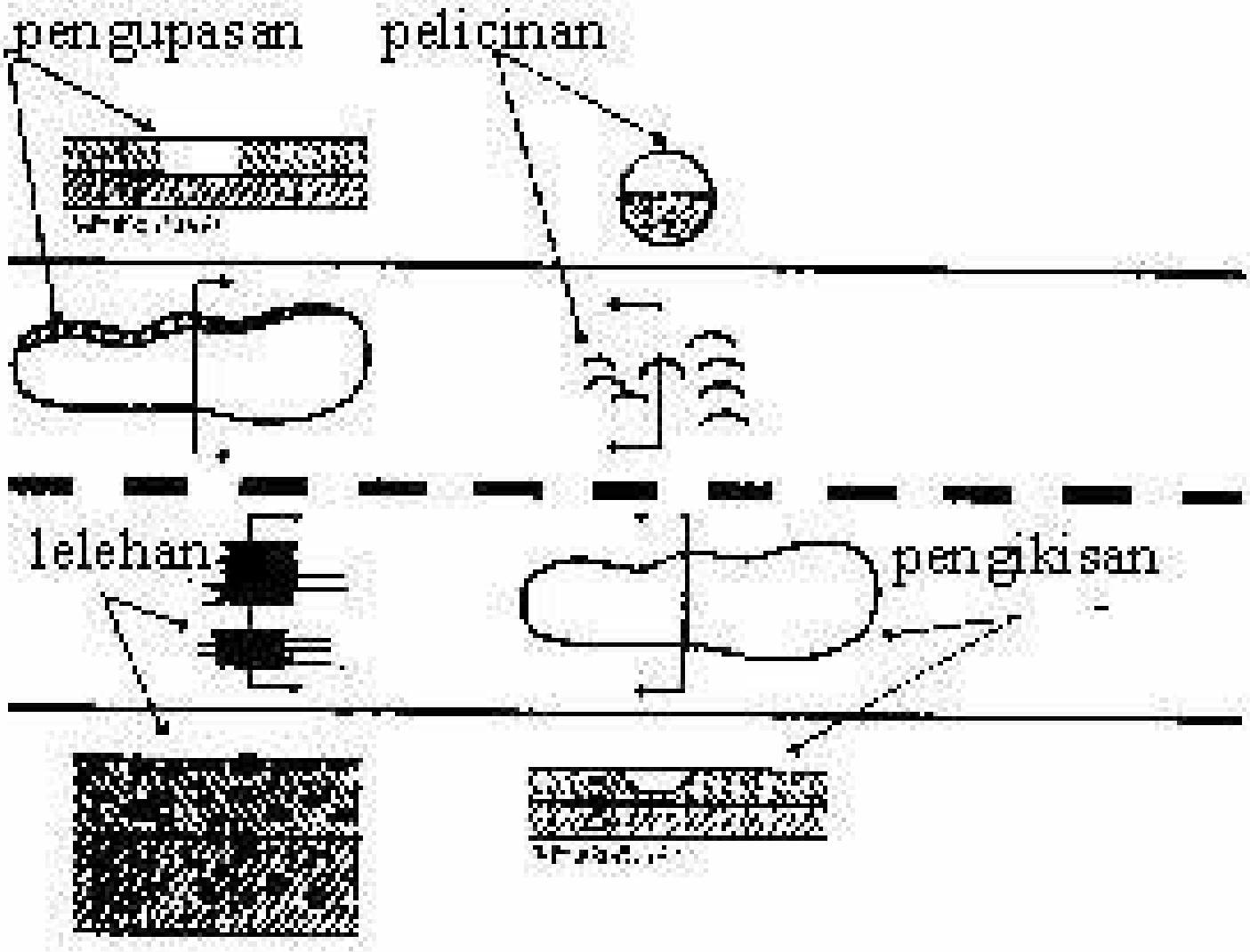
VA - SURFACE DEFORMATION



Surface Defects

- Surface defects cover loss of surfacing materials and surface micro/macro texture
- Have significant influence on serviceability, safety (skid resistance and maneuverability), and riding quality. If not corrected may lead to loss of pavement structural integrity
- Possible causes – excessive/lack of binder content, excessive/lack of coating, paving over flushed surface, poor adhesion between aggregate and binder, inadequate compaction, low PSV, seepage of water tru surface, adhesion of binder to vehicle tyres
- Probable treatments – apply hot sand, thin bituminous overlay, use stiffer mix, mill and re-lay upper layer, replace WC, reconstruction of weak layers
- Major types – bleeding, polishing, raveling, delamination

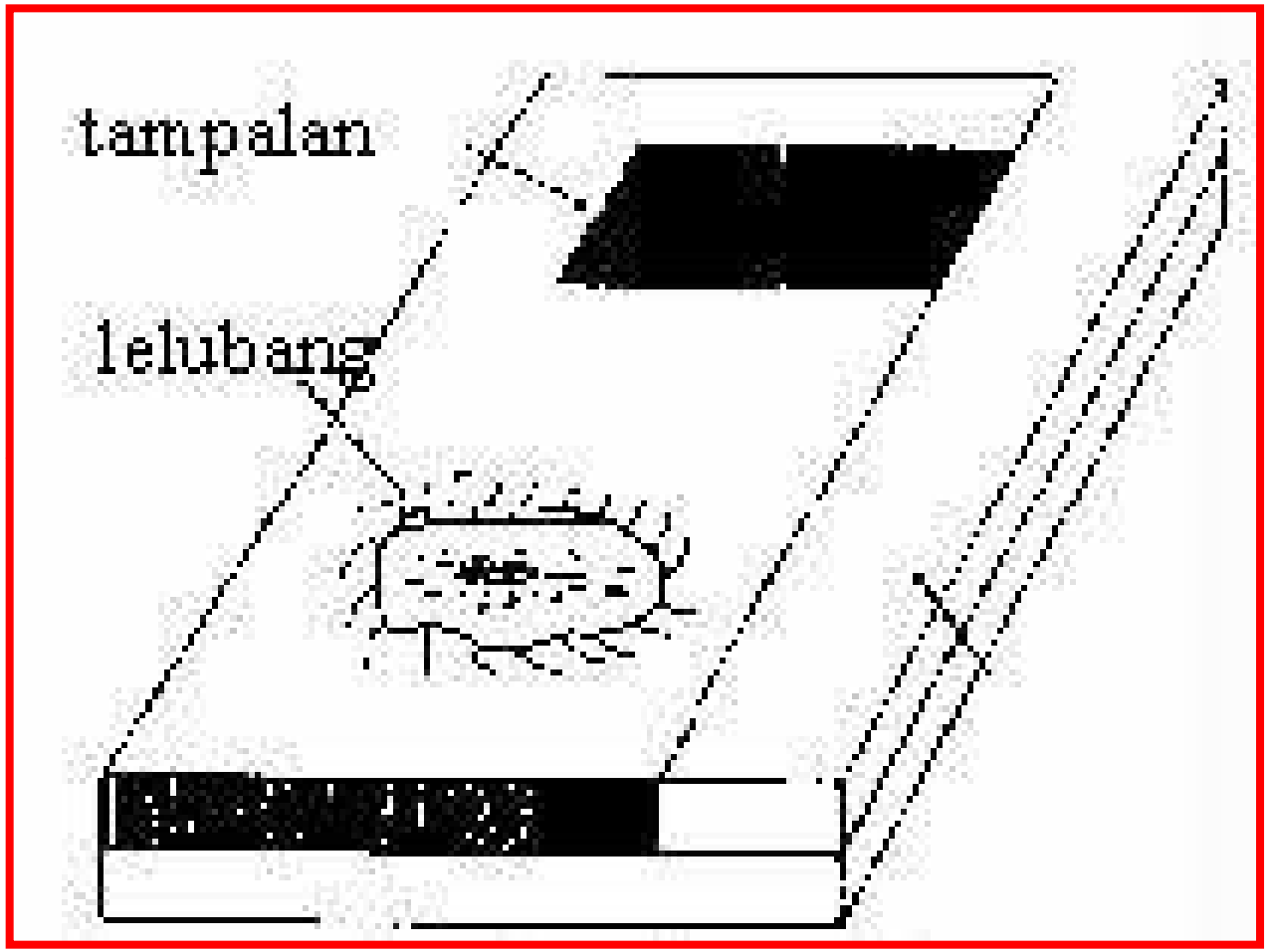
VA - SURFACE DEFECTS



Patch & Pothole

- Patch – repaired section where a portion of pavement has been removed and replaced
- Extend and frequency as indicator of structural adequacy
- Defects can occur within a patch or patch higher/lower than pavement surface
- Pothole – bowl shape cavity in the pavement from loss of WC and BC
- Produced when traffic breaches small pieces of pavement allowing water to enter > disintegrate, collected water accelerates disintegration
- Possible causes – loss of surface, moisture entry tru cracks, load associated base disintegration
- Probable treatments – cut and patch, base reconstruction

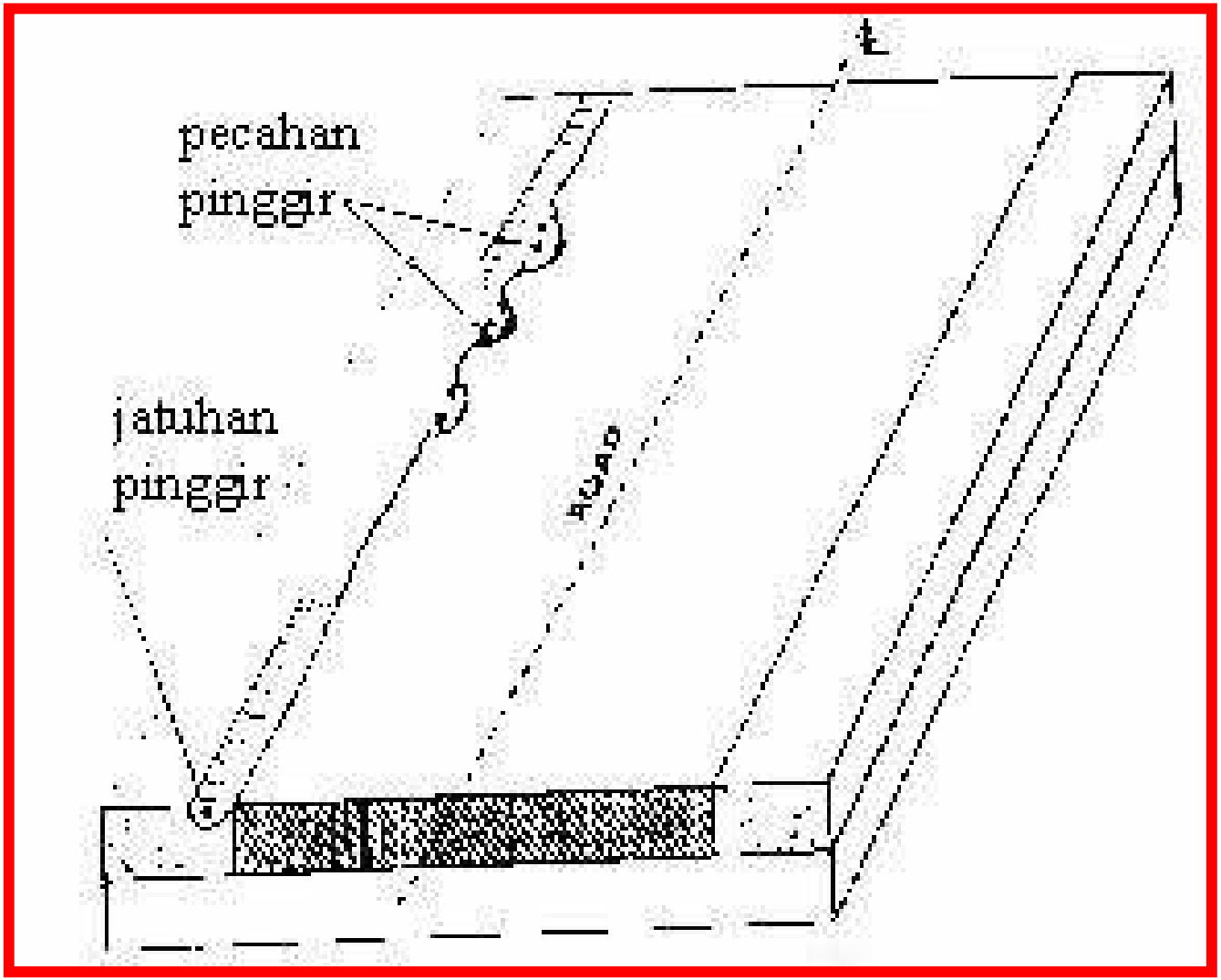
VA - PATCH & POTHOLE



Edge defects

- Occur along interface of pavement and shoulder, most significant if shoulder unsealed
- Detrimental effects – reduction of pavement width, loss of riding quality and maybe loss of control, channeling water erodes shoulder, entry of water into base
- Possible causes – inadequate width/edge support, poor alignment, edge drop-off,loss of adhesion to base, shoulder material of low resistance to abrasion and erosion, resurface pavement w/o resurface shoulder
- Probable treatments – widening, re-alignment, strengthen and leveled shoulder, cut and patch, replace shoulder material
- Types of edge defects – edge drop-offs, edge breaks

Va - Edge defects



VAF6 — ???