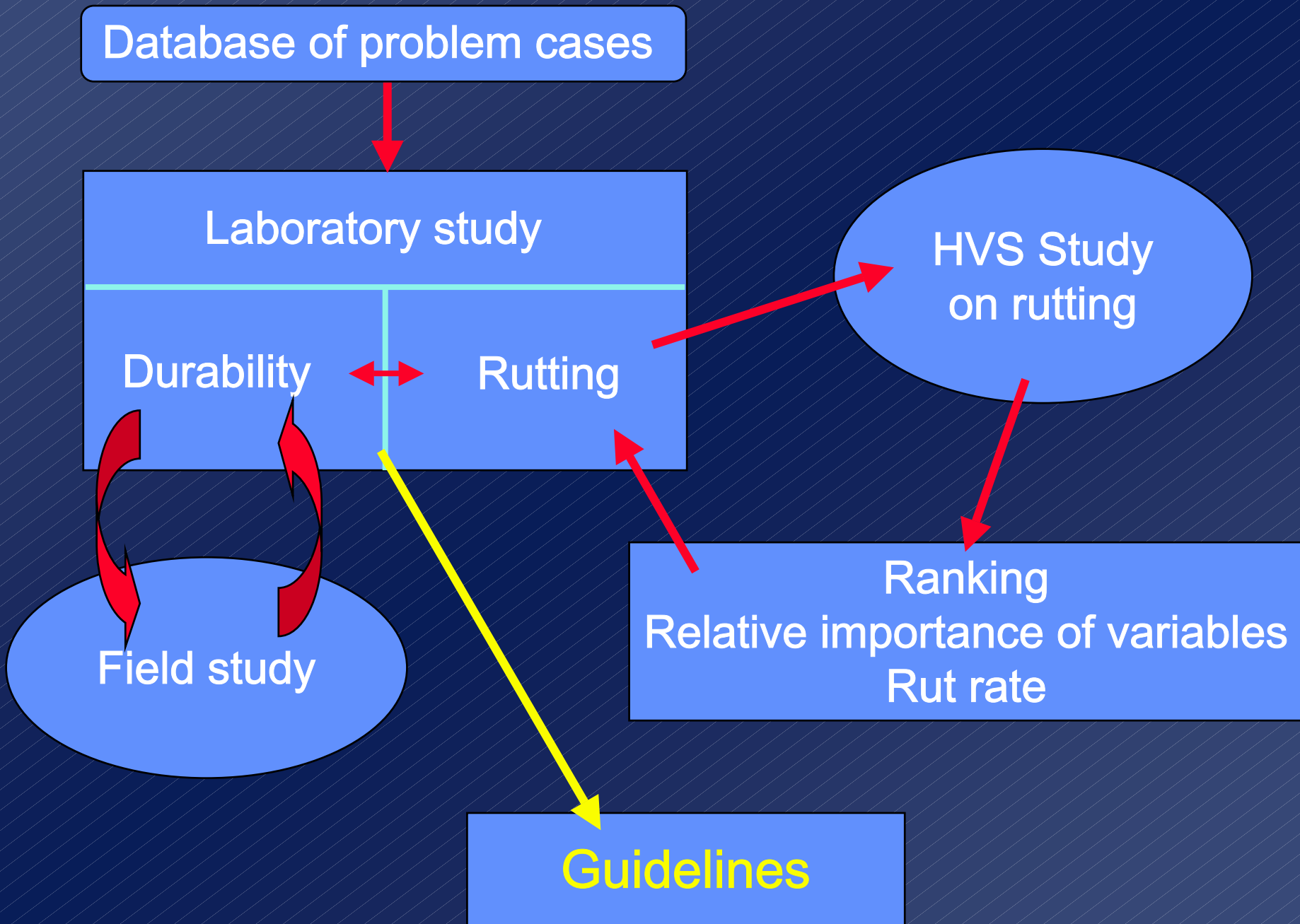


Needs

- **Rutting**
- **Durability (& permeability)**
- **Fatigue**
- **Others (related):**
 - **Density specifications**
 - **Lab simulation of field ageing**
 - **Reheating/re-constitution issues**
 - **Ultra-thin layers, micro-surfacings**

Preliminary studies

- Database of problem cases
 - Quality chain:
design → production → field performance
 - Problems → causes → learning → actions
- Durability
 - Permeability & moisture damage
 - Rolled-in chips
 - High voids (SMA, rut-resistant mixes)





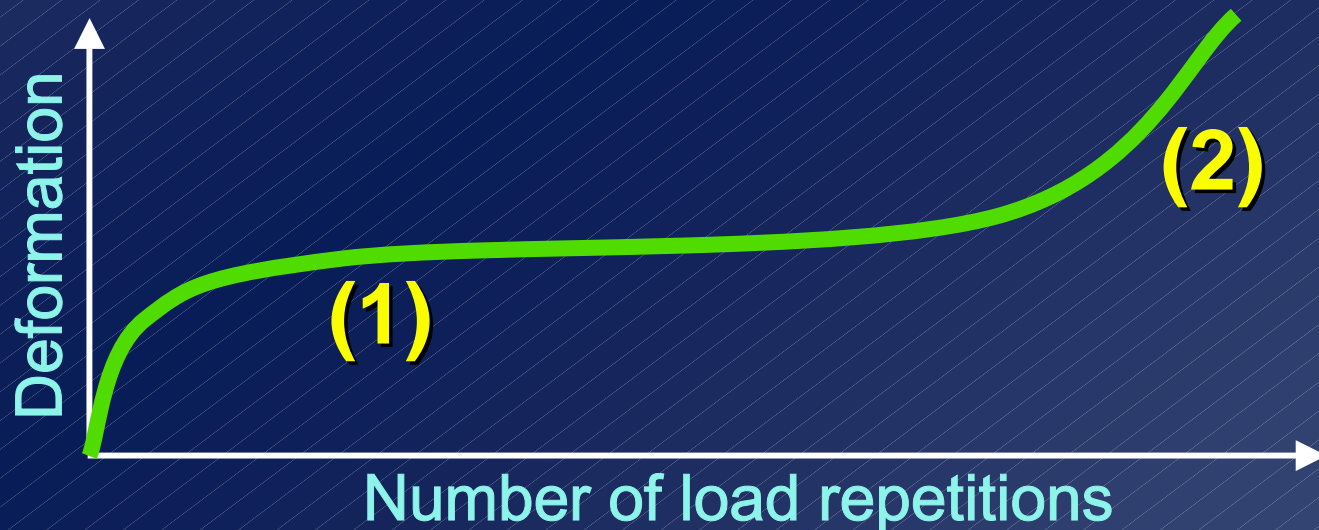
Rutting

Rutting

- **Most frequently observed and serious type of distress on HMA layers**
- **Leads to:**
 - **Ponding of water in wheel tracks leading to road hazard in wet weather**
 - **Poor riding quality resulting in increased vehicle operating costs**
- **RSA has seen an increase in frequency in rutting on account of:**
 - **Increased traffic volumes**
 - **Increased axle loads and tyre pressures**

Rutting mechanism

- Two-phase process:
 - Densification accompanied by a decrease in volume (1)
 - Shear deformation at constant volume (2)



Densification & volume decrease

- Initial densification: volume decrease under action of traffic
- Aggregate pushed into preferred orientation position leading to decrease in voids (7% to 4%)
- As densification increases → mix stability improves
- Further densification may reduce voids to refusal density (< 3%), although increased stability & binder ageing may counter this
- Mixes with voids decreasing to <3% more prone to rutting than mixes with voids of 4%
- Voids after primary densification are a measure of rut susceptibility of mix

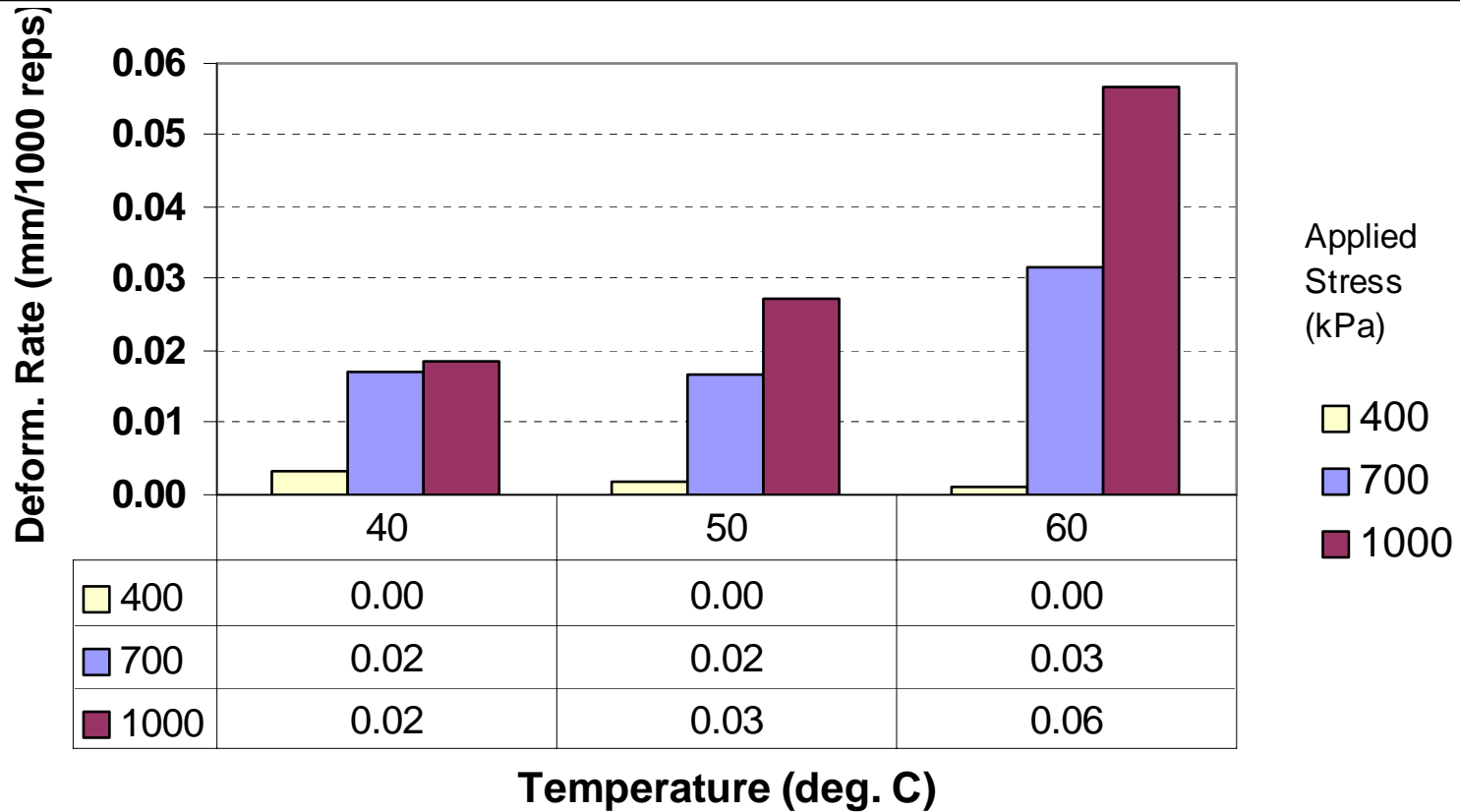
Shear deformation

- Occurs when combined rut resistance afforded by friction & cohesion is overcome by imposed stress state
- Shear deformation: small flow movements associated with repetitive traffic loads – gradual movements until depression or rut is formed
- Associated with movement or breakdown at particle-to-particle interface, resisted by:
 - Cohesion afforded by the mastic (binder & filler)
 - Macro-interlock by skeleton
 - Durability & frictional aspects of aggregate

Environmental factors

- **Temperature**
 - Most influencing variable
 - Affects viscosity and shear resistance of binder (>45C)
 - Cohesion function of binder type
- **Loading rate & vehicle speed**
 - Low rates of loading (slow moving) = high temperatures
- **Stress state**
 - *Shear stress*: distorts the material (causes plastic deformation)
 - *Bulk stress*: degree of confinement (resists plastic deformation)

Axial load slab test



Variables

- Temperature: 40 – 50 – 60°C
- Tyre pressure: 700 – 850 – 1000 kPa
- Load: 50 kN \pm 20%
- Wandering vs channelised (50°C/850 kPa)
- One mix type:
 - 40mm Continuous, 60/70 pen
- Number of tests: 6

Test matrix

	40°C	50°C	60°C
700 kPa		√	
850 kPa	√	√	√
1000 kPa		√	

Material factors

- **Viscosity of mastic**
 - Viscosity of mastic
 - Temperature susceptibility of mastic
 - Impacts depends on skeleton structure
- **Packing characteristics**
 - Influences frictional shear resistance
 - Stone vs sand skeletons
- **Volumetric aspects**
 - VFB = strong relationship to rutting performance
 - Layer thickness (max stone size vs layer thickness)
- **Aggregate characteristics**
 - Shape, surface texture, hardness, durability

Permutations

- **Mix types**
 - Continuous grading, 60/70 Pen
 - Continuous grading, 60/70 Pen, gilsonite
 - Continuous grading, SBS
 - SMA, 60/70, CF
 - Semi-open, bitumen-rubber
 - Ultra-thin layer (flushing)
- **Thickness (cont, 60/70)**
 - 40 mm
 - 60 mm
- **Number of tests: 7**