Pavement types and behaviour

Design Objectives

SUBGRADES AND SUBBASES

Content

- The role of the subgrade
- Subgrade stiffness for thickness design
- Purpose of sub-bases
- Sub-base types & influence on pavement design
- Shoulders and drainage

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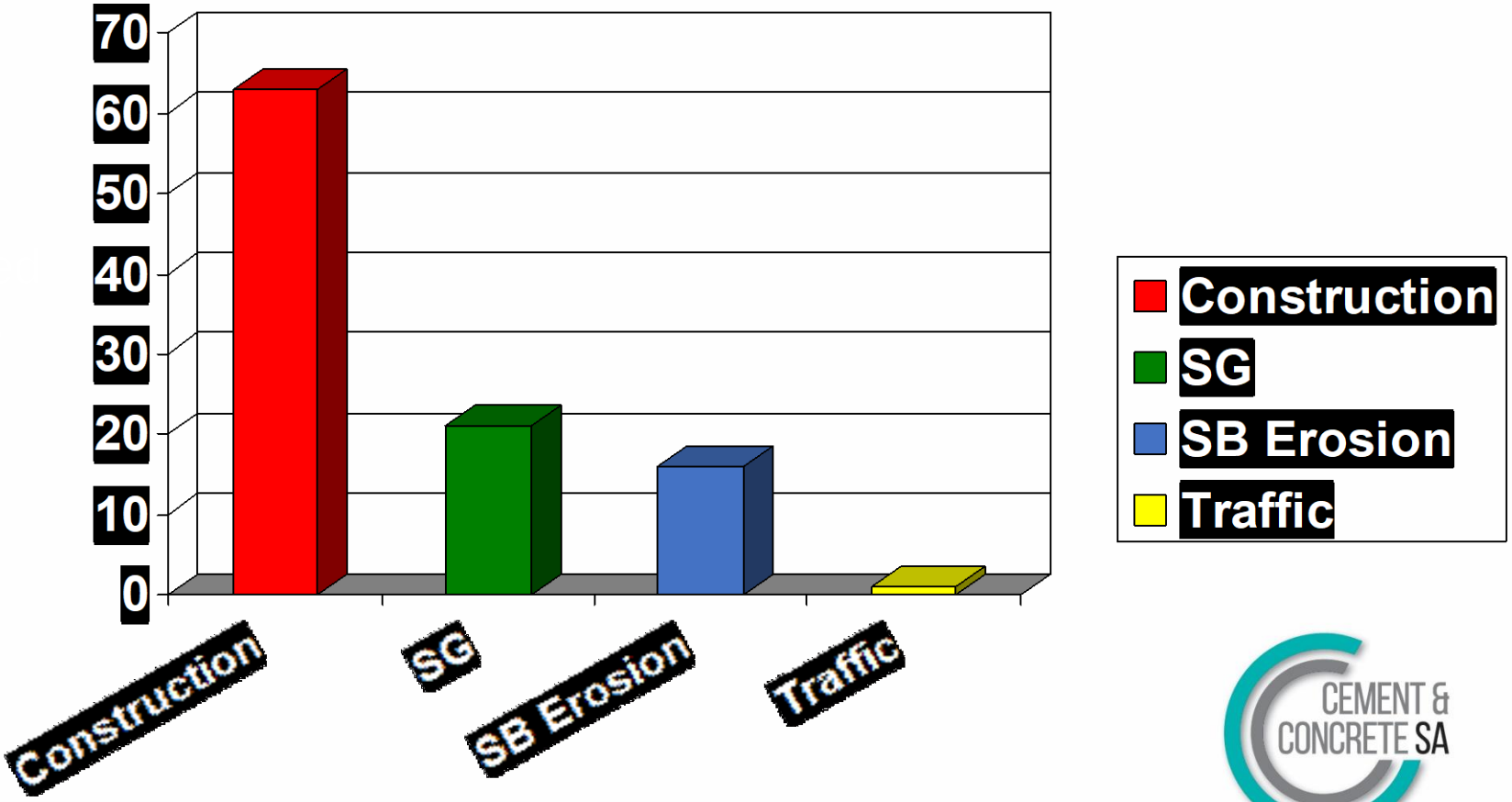
Concrete Pavement Failures 10 Years after Construction



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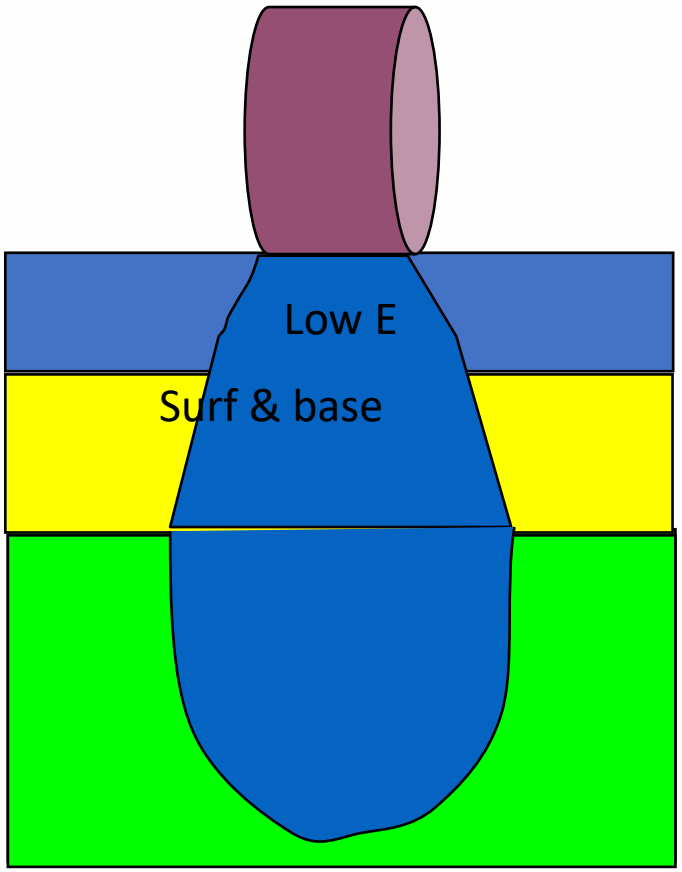
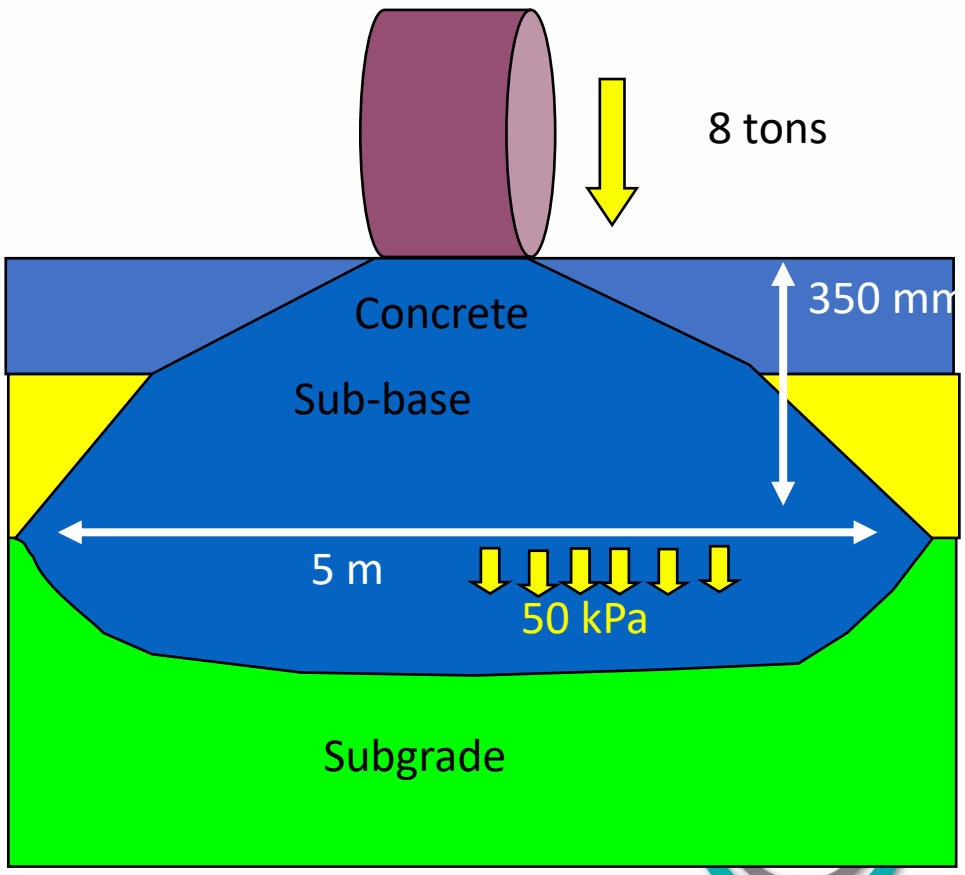
Important to Protect Subgrade

Less stiff upper layers

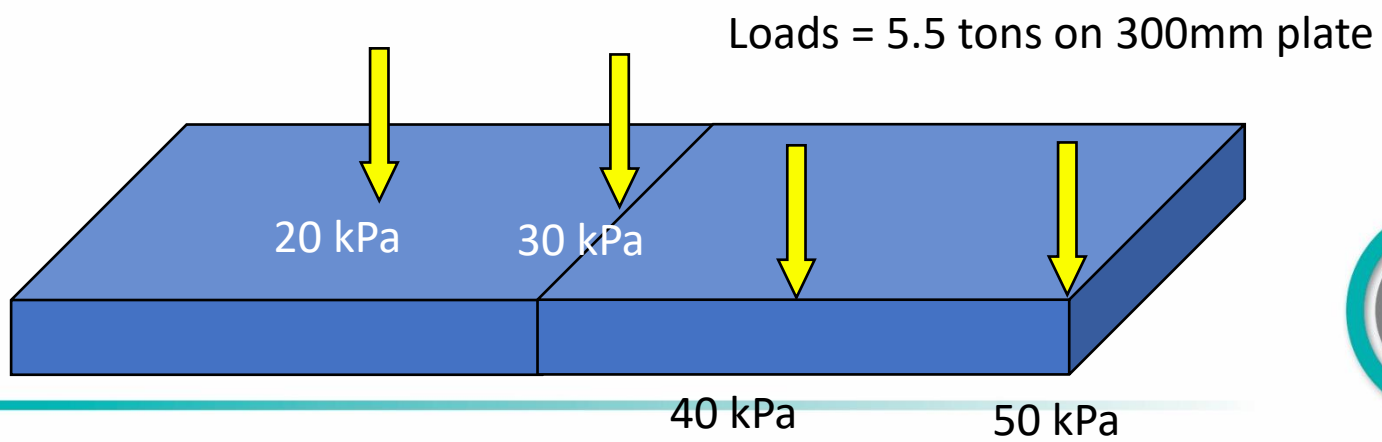


Concrete pavement



Issues Related to Support

- Road tests showed reduced support during wet periods
- Uniform support rather than high stiffness plus high variation
- Influence of load positions on $\sigma_{subgrade}$



Expansive Soils in the Subgrade

- CBR Swell 2 to 4% Moderate expansive
  . > 4% Highly expansive
- Be careful of surcharge removal in cuttings and delayed expansion
- Some solutions
  - Cover layer (surcharge & moisture control)
  - Stabilize moisture
  - Compact at 1 to 3% above OMC

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Collapsing Sands in the Subgrade

- Soil skeleton stiffened by suction, but collapses when loaded & wet
- Some solutions
  - Excavate and replace (compact at OMC+)
  - Impact roller
  - Pre-wetting (before & during construction)
  - Change vertical alignment
- GET GEOTECHNICAL ASSISTANCE

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Slab Support

- The role of the subgrade
- Subgrade strength for thickness design
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- Shoulders and drainage

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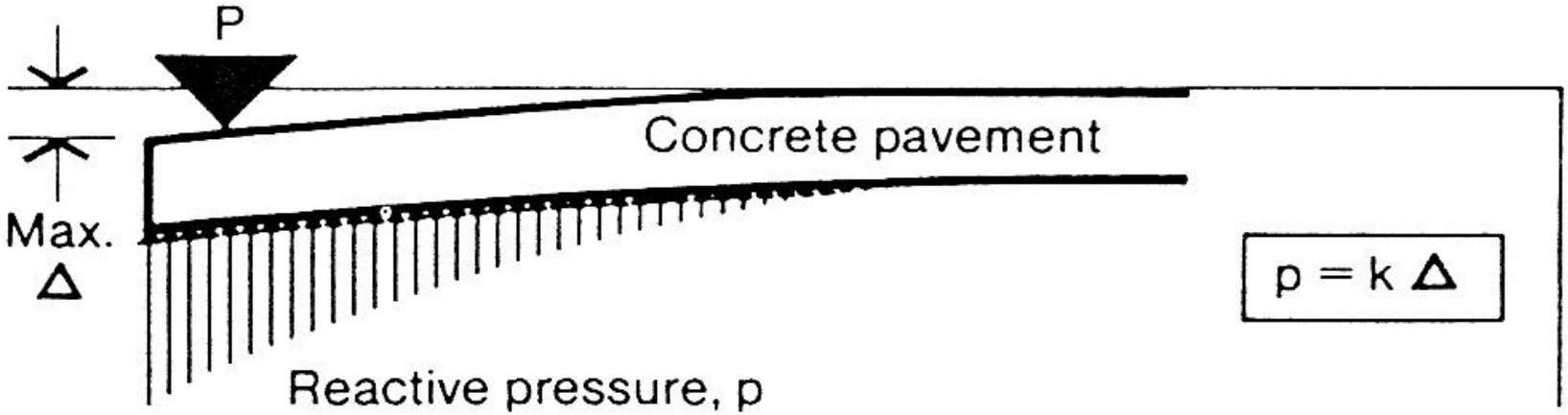
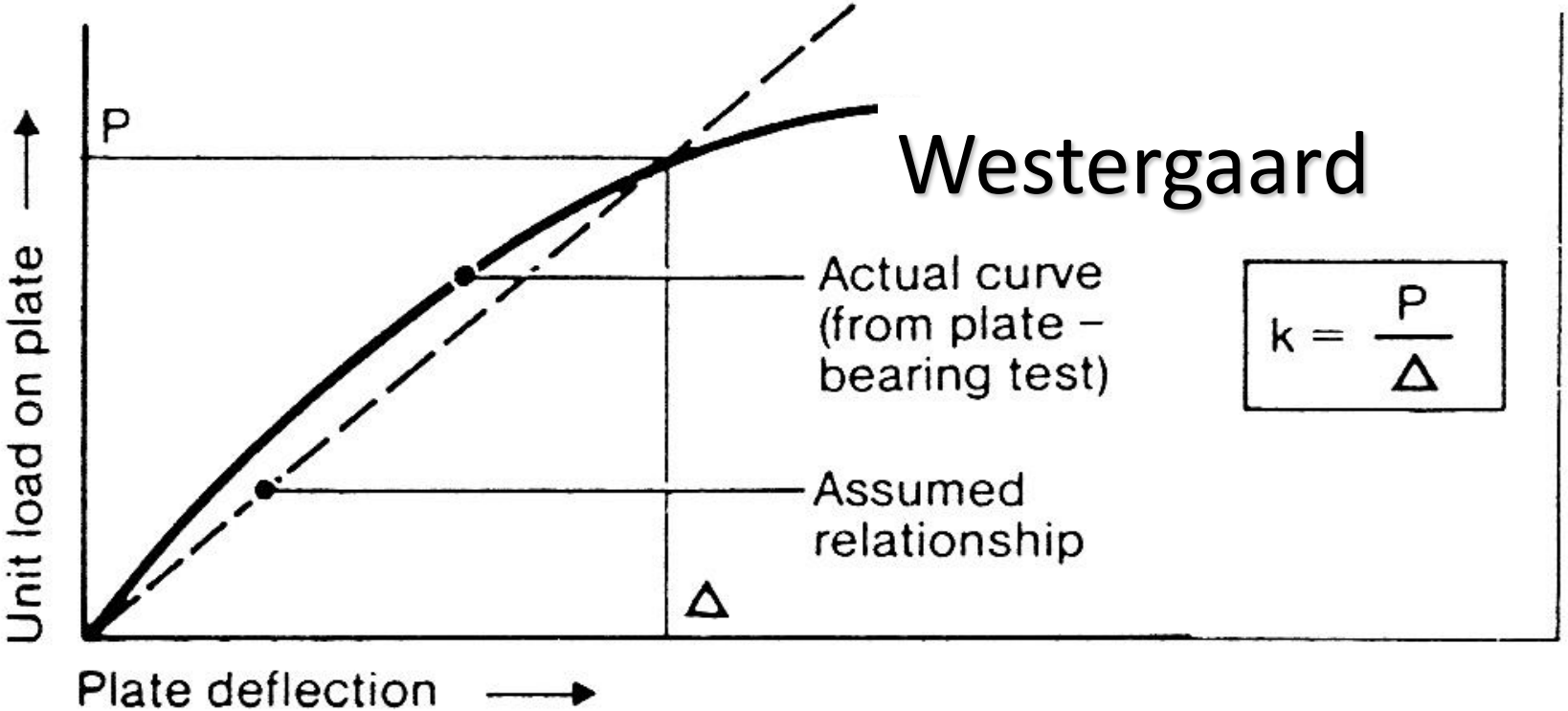
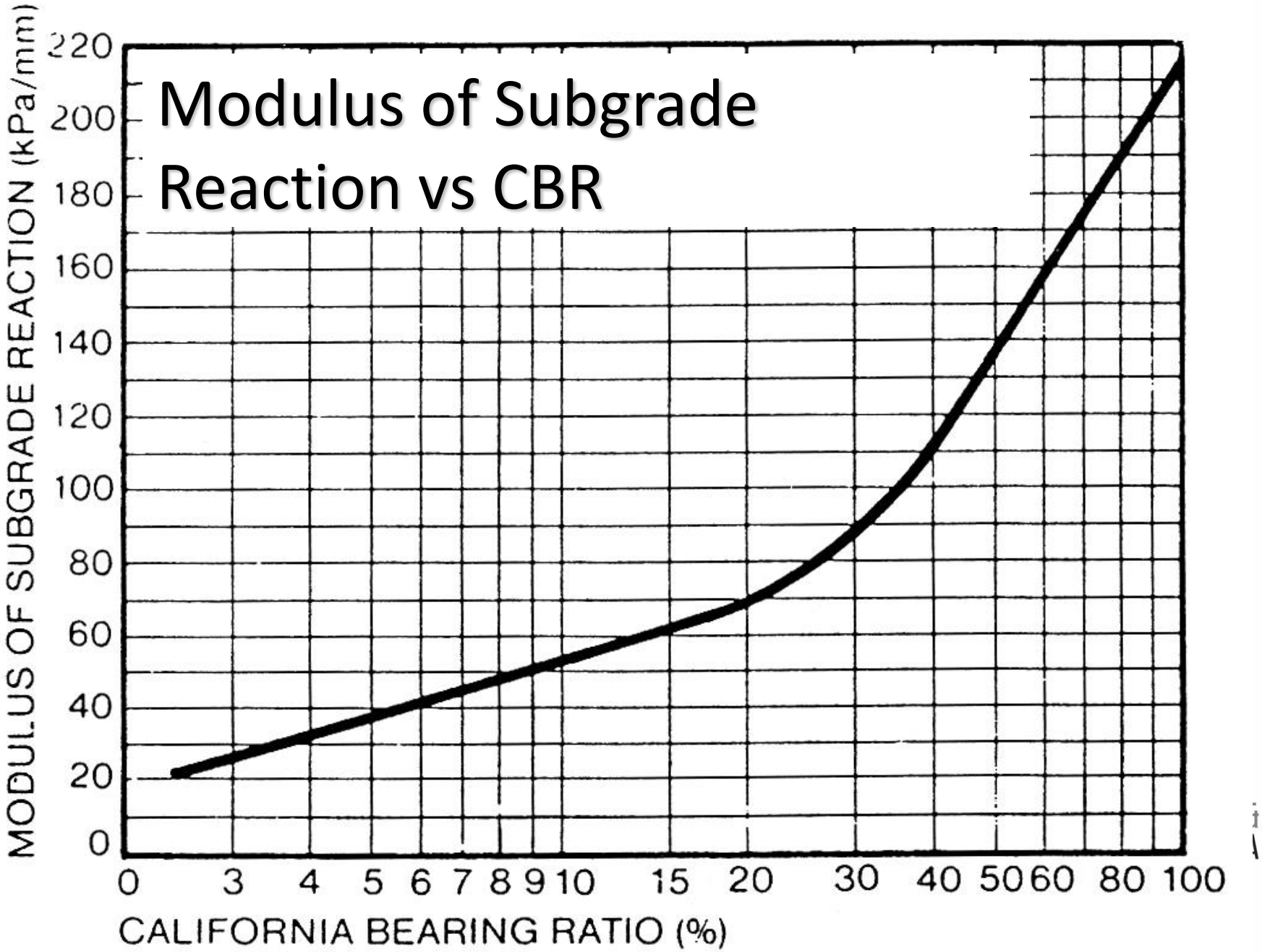


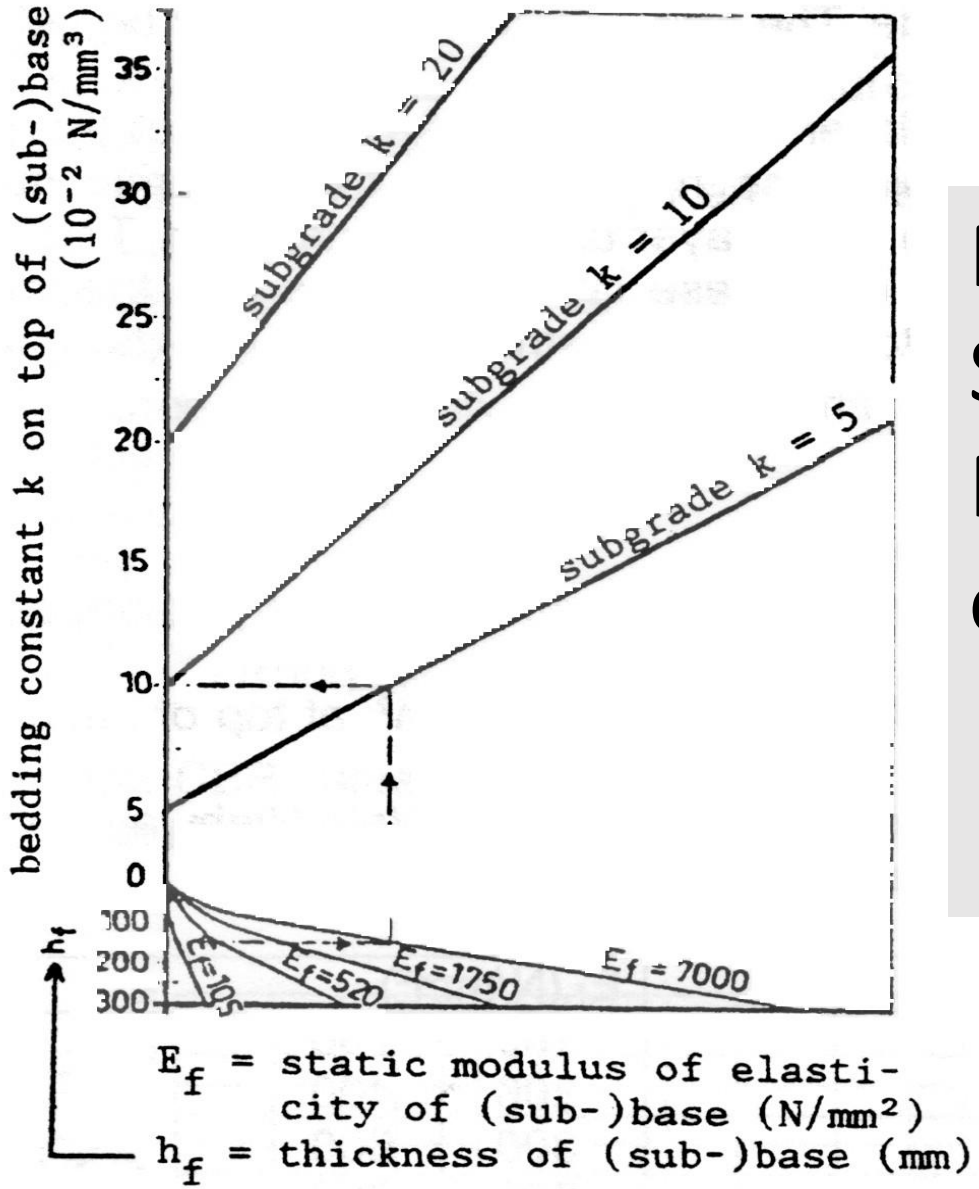
ASSUMED DEFLECTION/REACTIVE PRESSURE RELATIONSHIP



ASSUMED UNIT LOAD/DEFLECTION RELATIONSHIP

Modulus of Subgrade Reaction vs CBR





Modulus of Subgrade Reaction on top of Sub-base

Figure 6. Nomograph for the determination of the k-value on top of a (sub-)base layer (1).

SA Approach (M10)

Material Classification	Range of Mr (MPa)	Suggested Mr (MPa)
G4	140-300	150
G5	100-250	130
G6	70-200	110
G7	50-160	90
G8	40-120	70
G9	30-80	50
G10	15-50	30

Weinert > 5 use upper limit Weinert < 5 use lower limit

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Modulus from UCS

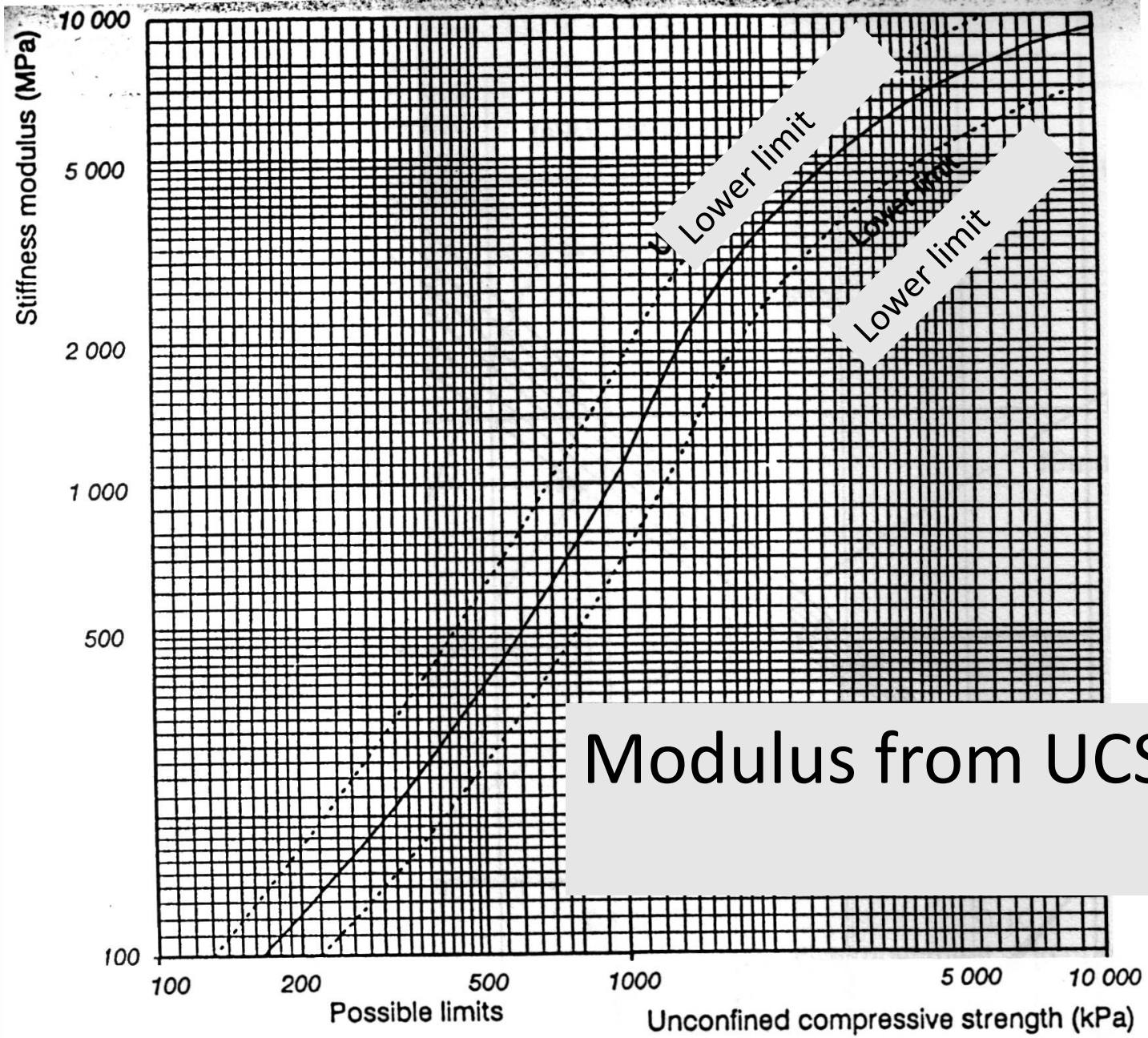

FIGURE 2.2

Determination of stiffness modulus of stabilised materials

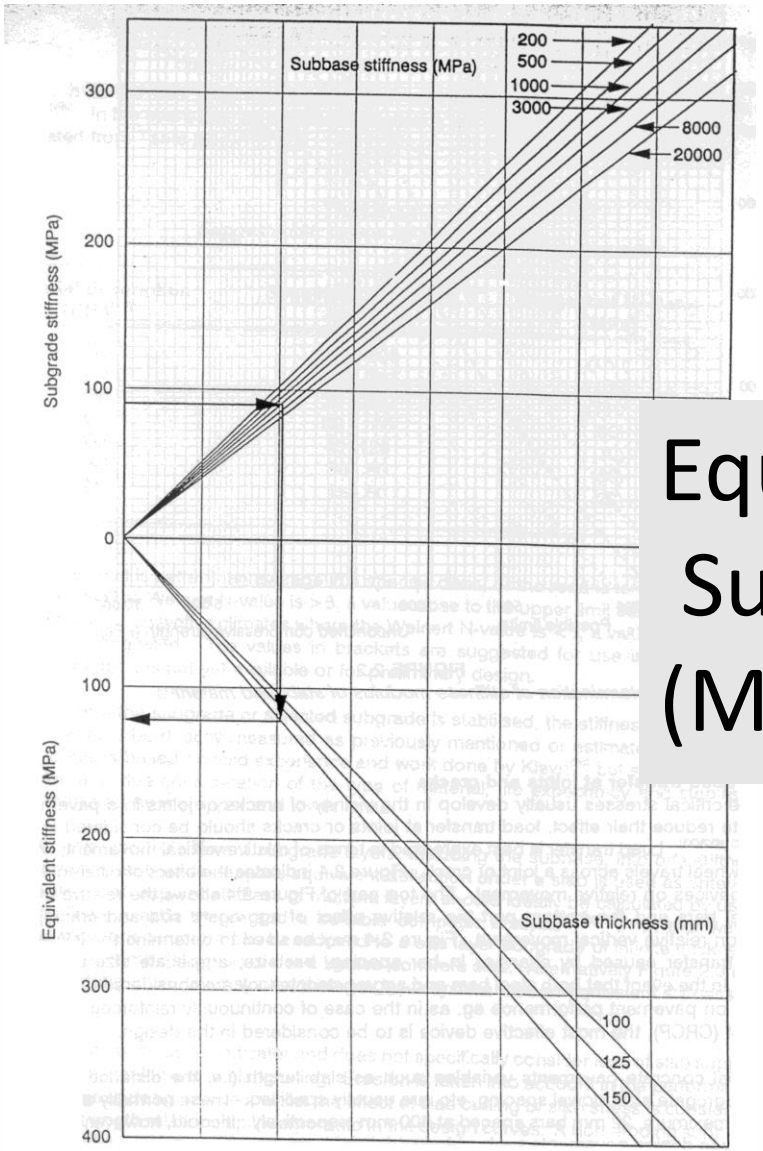

FIGURE 2.3
Determination of equivalent slab support stiffness

Equivalent Slab Support Stiffness (M10)

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Slab Support

- The role of the subgrade
- Subgrade strength for thickness design
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Subgrade Problems

- Concrete Pavements Built directly on underlying soil: no subbase
- Three conditions cause pumping
  - Subgrade soil with fines that go into suspension
  - Free water between pavement & subgrade or subgrade saturation
  - Frequent passage of heavy trucks
- Subbase layer designed to solve this

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Function of Subbase (base)

- Prevent erosion and pumping
- Stable working platform for construction
- Uniform, strong support
- Assists in controlling expansive soils
- Does not contribute significantly to overall pavement strength

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Types of subbase

- Granular subbase (lighter traffic)
  - Avoid material with high fines content
  - Resistance to permanent deformation
- Cemented subbase
  - Erosion resistant
  - Voids develop when slab curls
- Bituminous subbase (thin interlayer)
  - Erosion resistant
  - No voids develop when slab curls

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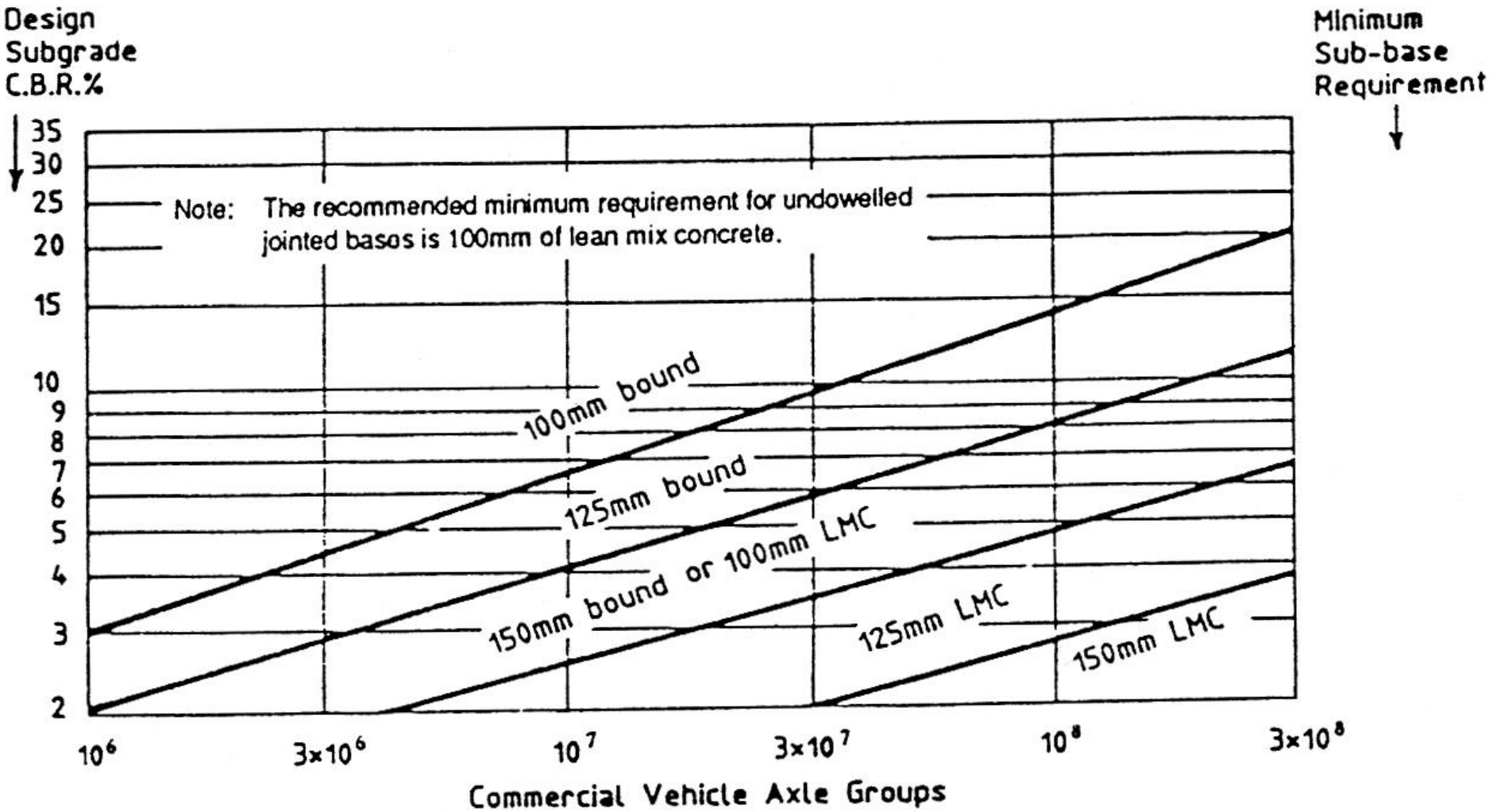
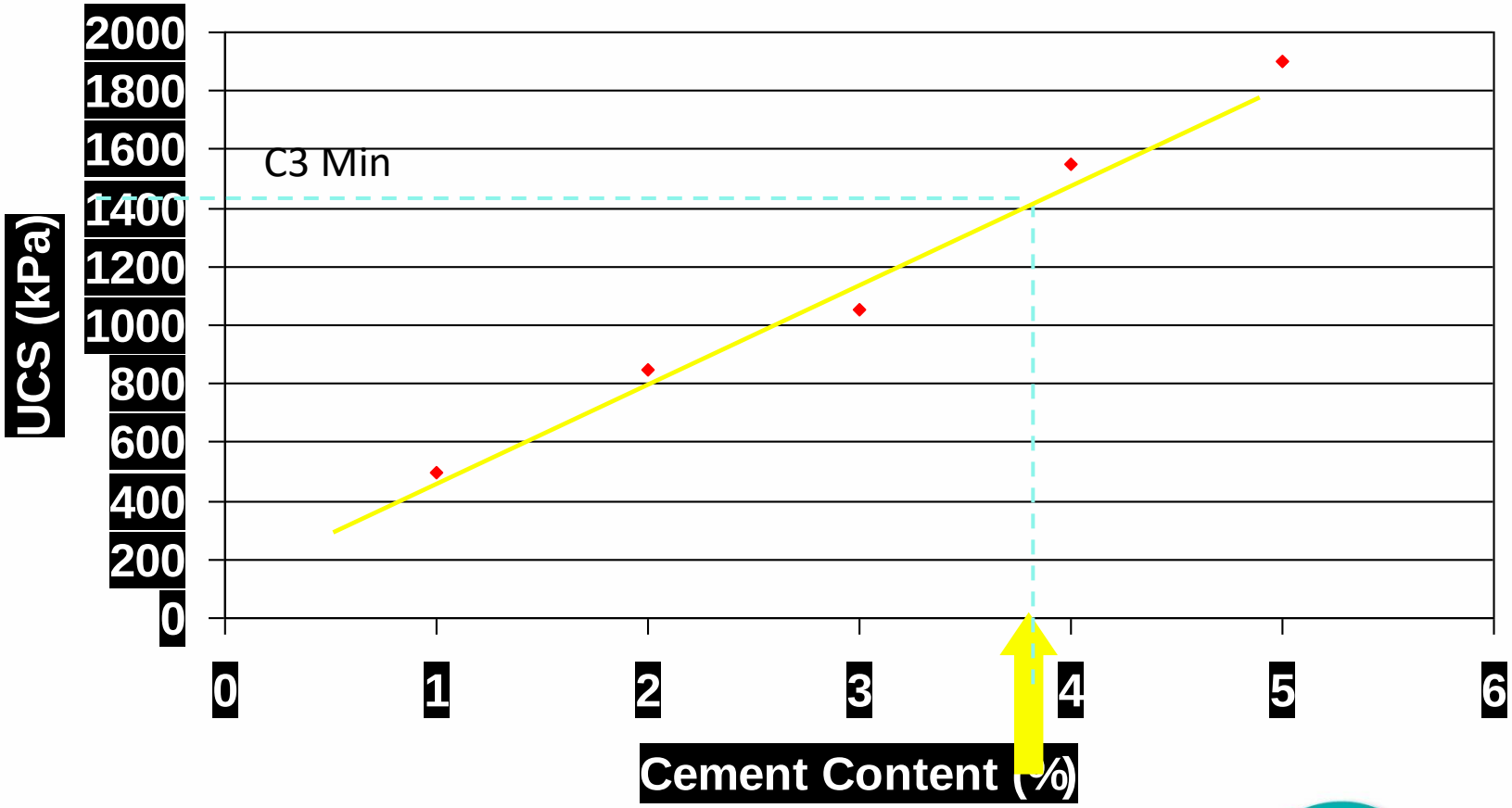
Granular subbase specs

Max aggregate size	< 0.5 x $t_{subbase}$
Passing 75 mm (%)	< 15%
PI	< 6%
LL	< 25%

Guidelines for minimum subbase requirement



Cement content



Design cement content = 4% x up to 1,6 (M5 Manual)

Slab Support

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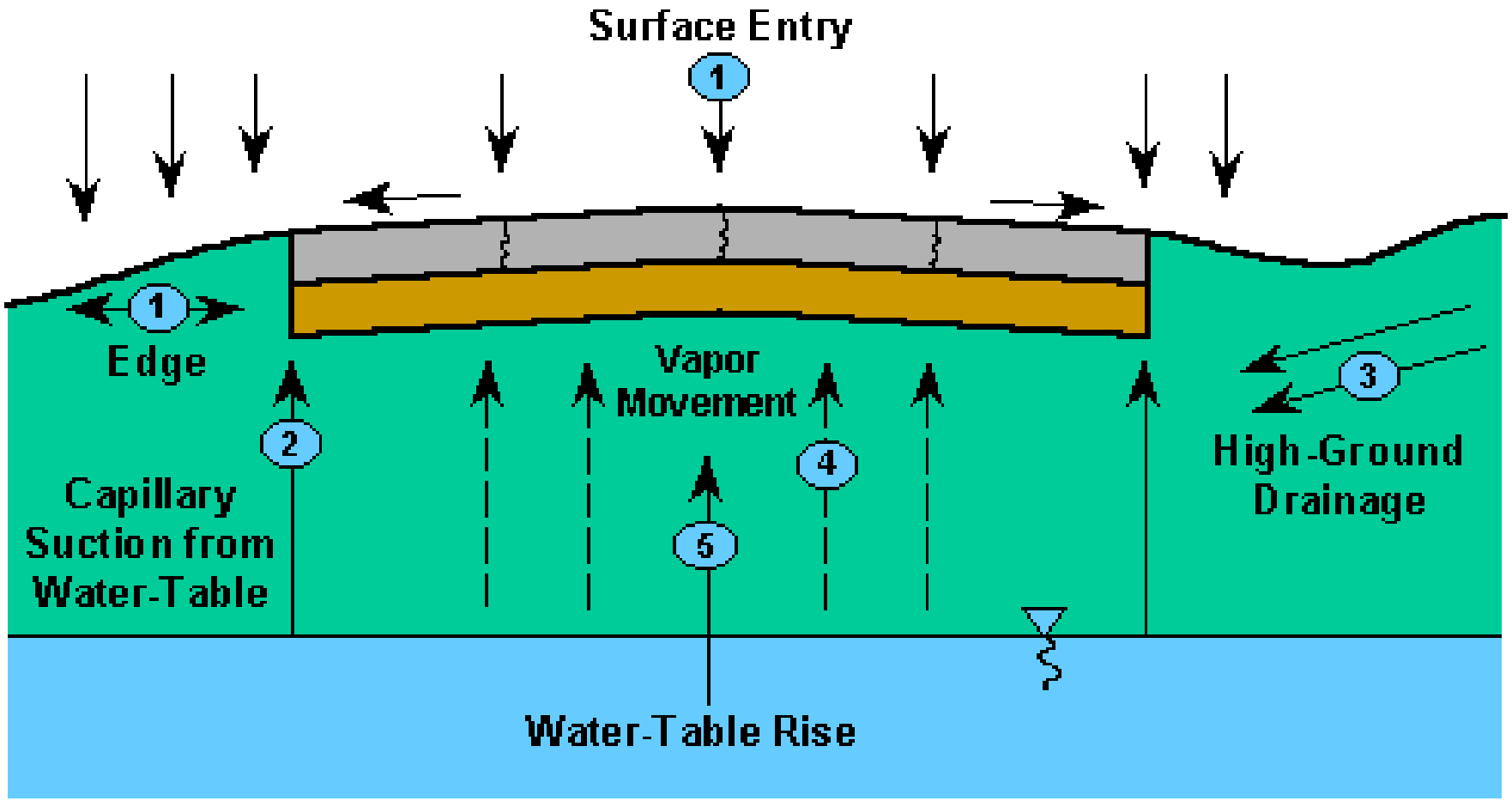
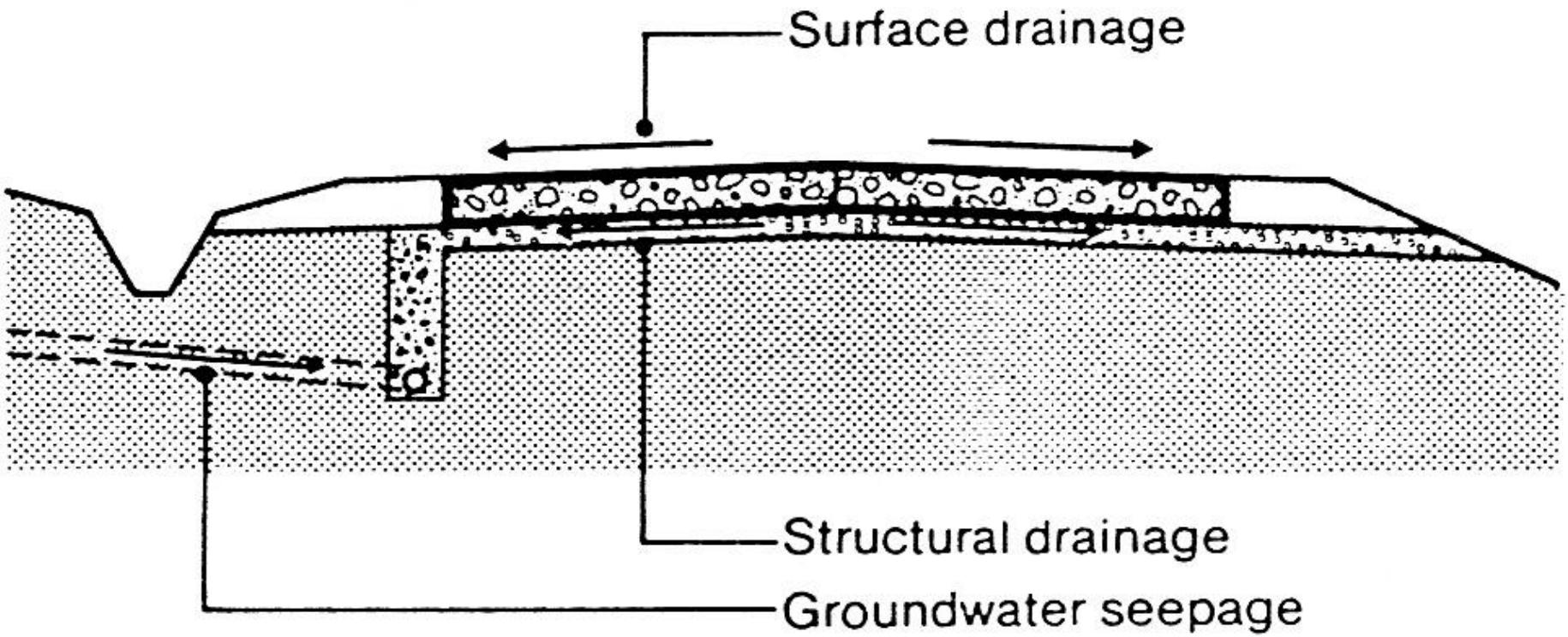
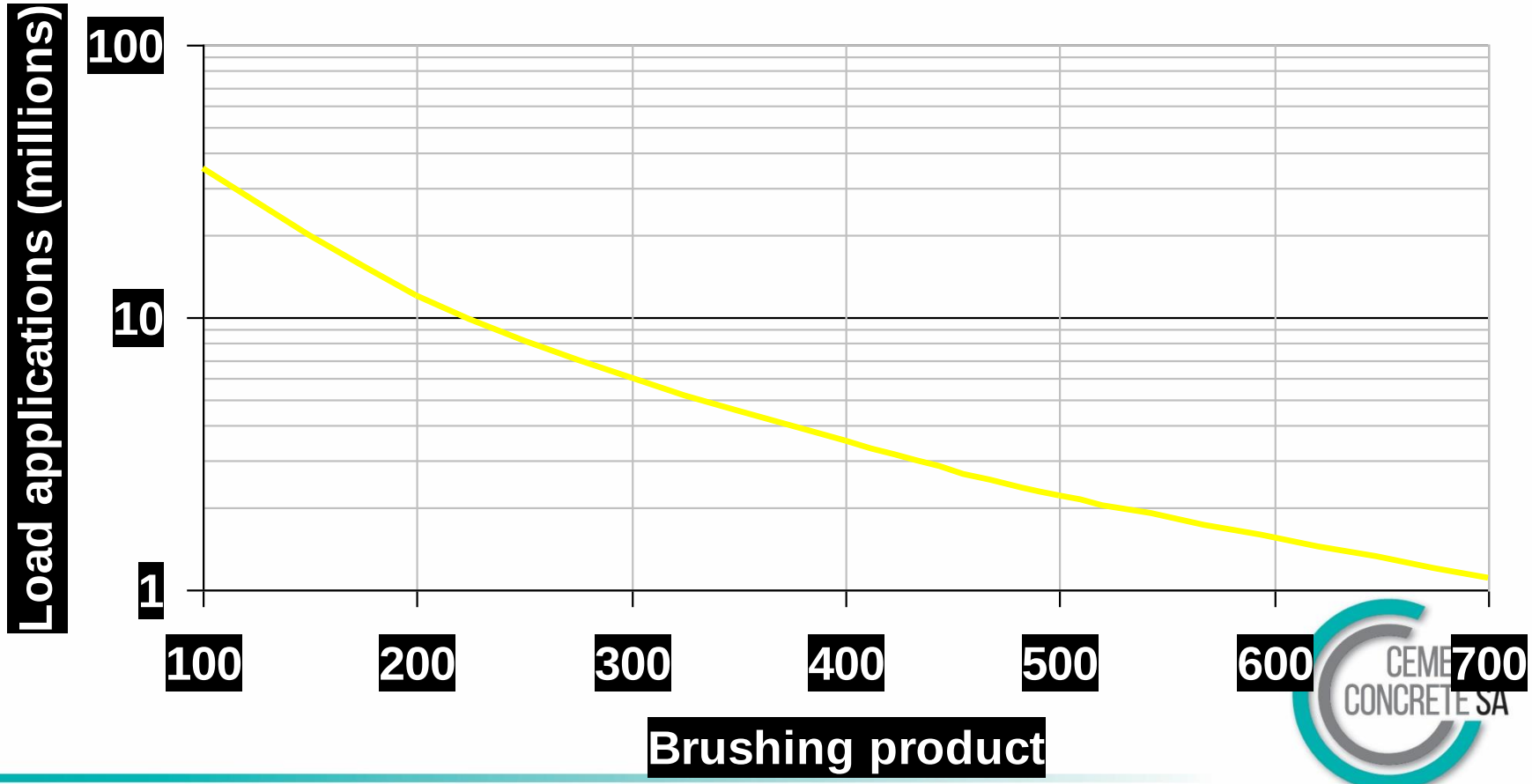
Sources of Moisture



Drainage Overview



Erosion Resistance

Brushing product = % wet/dry loss x %<0.425mm