

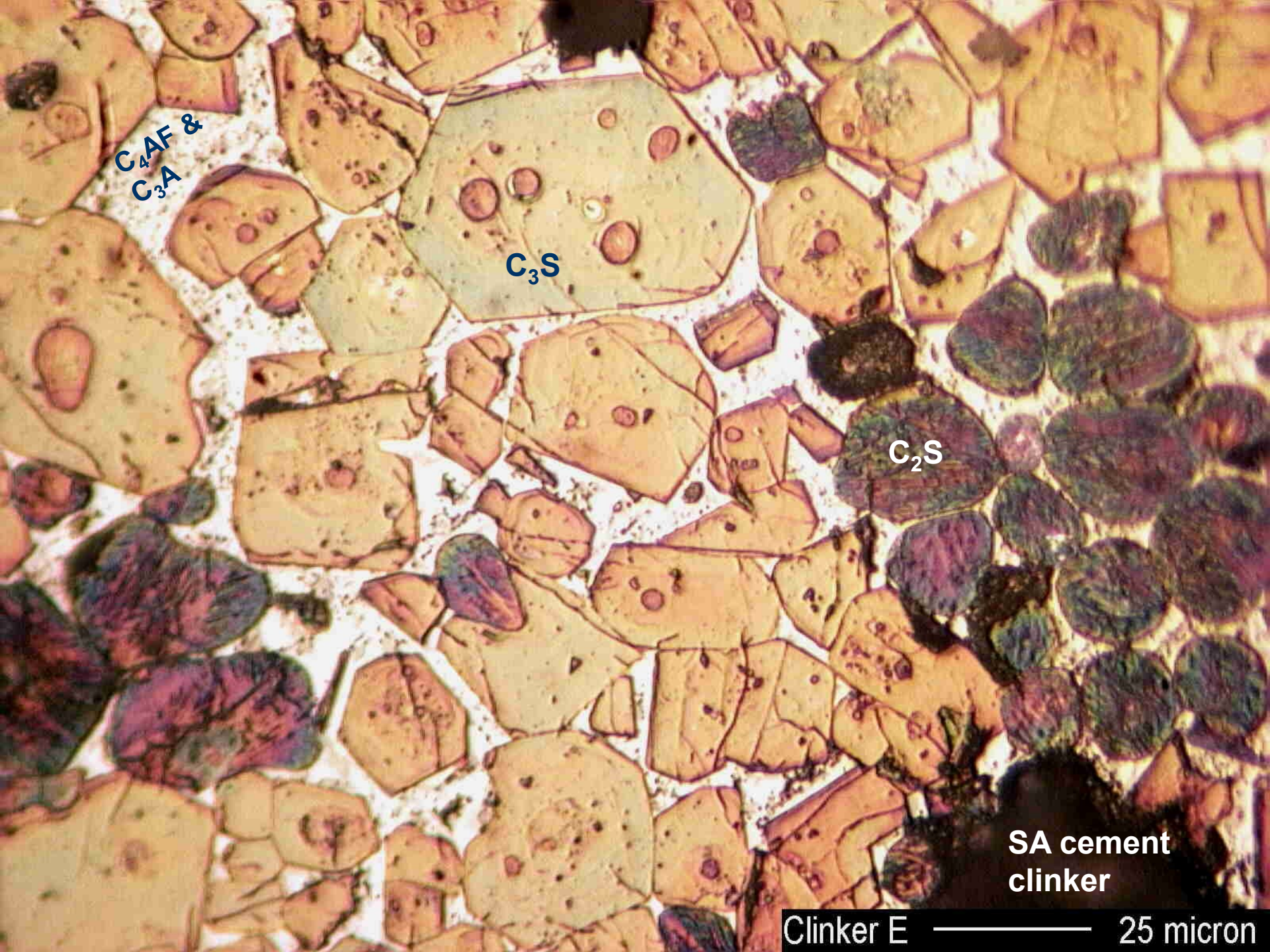
# ISSUES IN CONCRETE DURABILITY

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# Outline

- Durability and the Chemistry of Cement Hydration
- Forms of Deterioration
- Physical Properties of Concrete Affecting Durability
- Carbonation and Reinforcement Corrosion
- Chloride Ion Diffusion and Reinforcement Corrosion
- Rate of Corrosion of Reinforcing Steel



$C_4AF \text{ \& } C_3A$

$C_3S$

$C_2S$

SA cement  
clinker

Clinker E ————— 25 micron

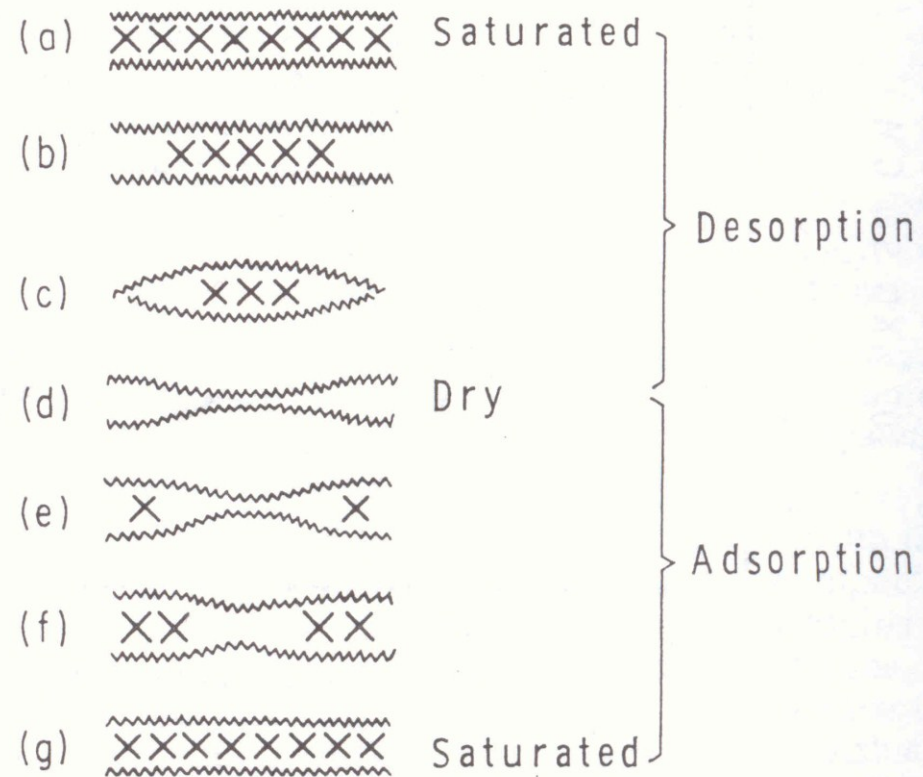
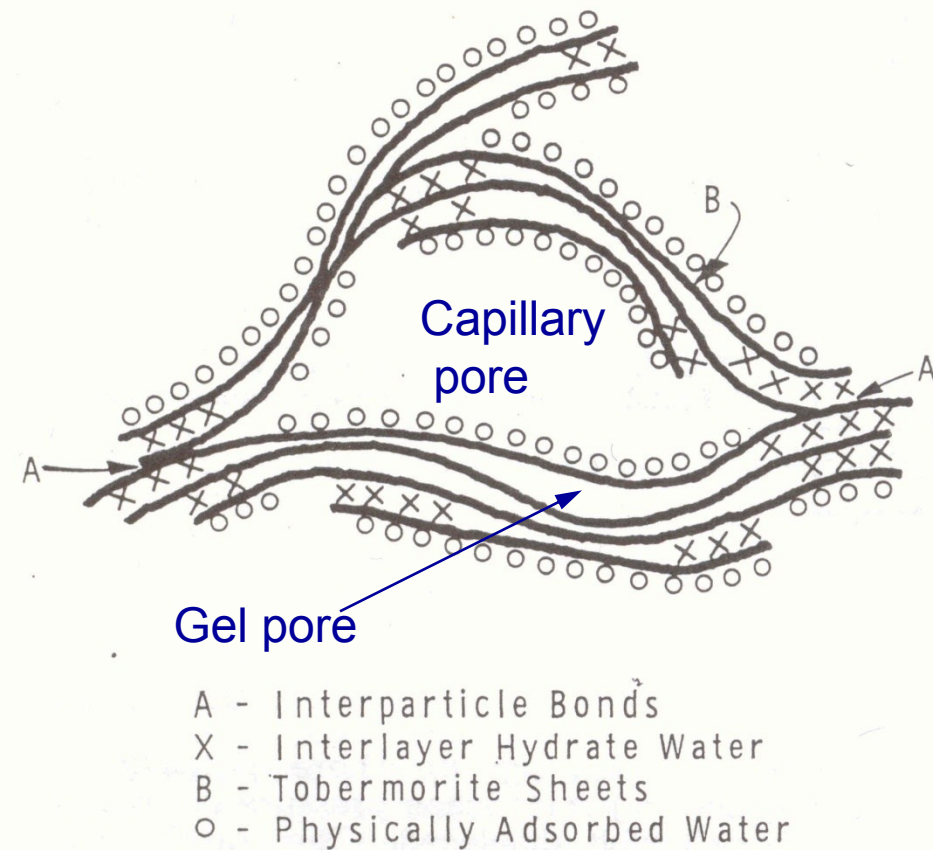
# Cement Hydration

**Cement + Water  $\rightarrow$  CSH + Calcium Hydroxide**

**Calcium Hydroxide +  
Alkali Metals (Sodium and Potassium Oxides)  
gives concrete its characteristic high pH (~13,2)**

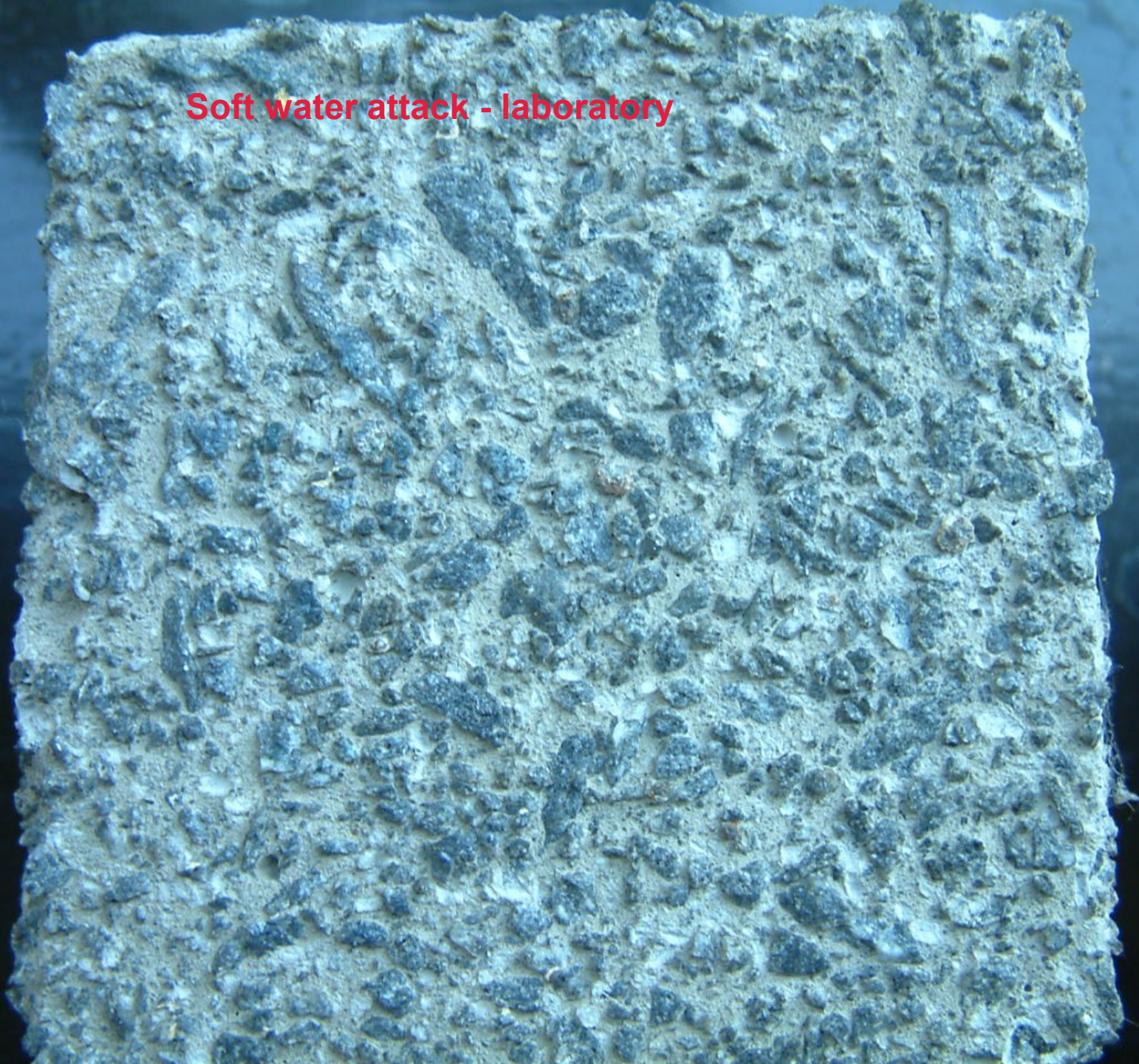


# Feldman & Sereeda Model





Soft water attack - laboratory





**Soft water attack – in situ**





**Sulphate attack**







A microscopic image showing a large, dark brown to black, irregularly shaped aggregate of iron pyrite. The aggregate has a rough, crystalline texture. It is surrounded by a light-colored, granular rock matrix. A yellow arrow points from the text label to the aggregate.

Iron pyrite  
in aggregate



Effect of pyrite oxidation





Acidity of rain water





## Alkali Silica Reaction



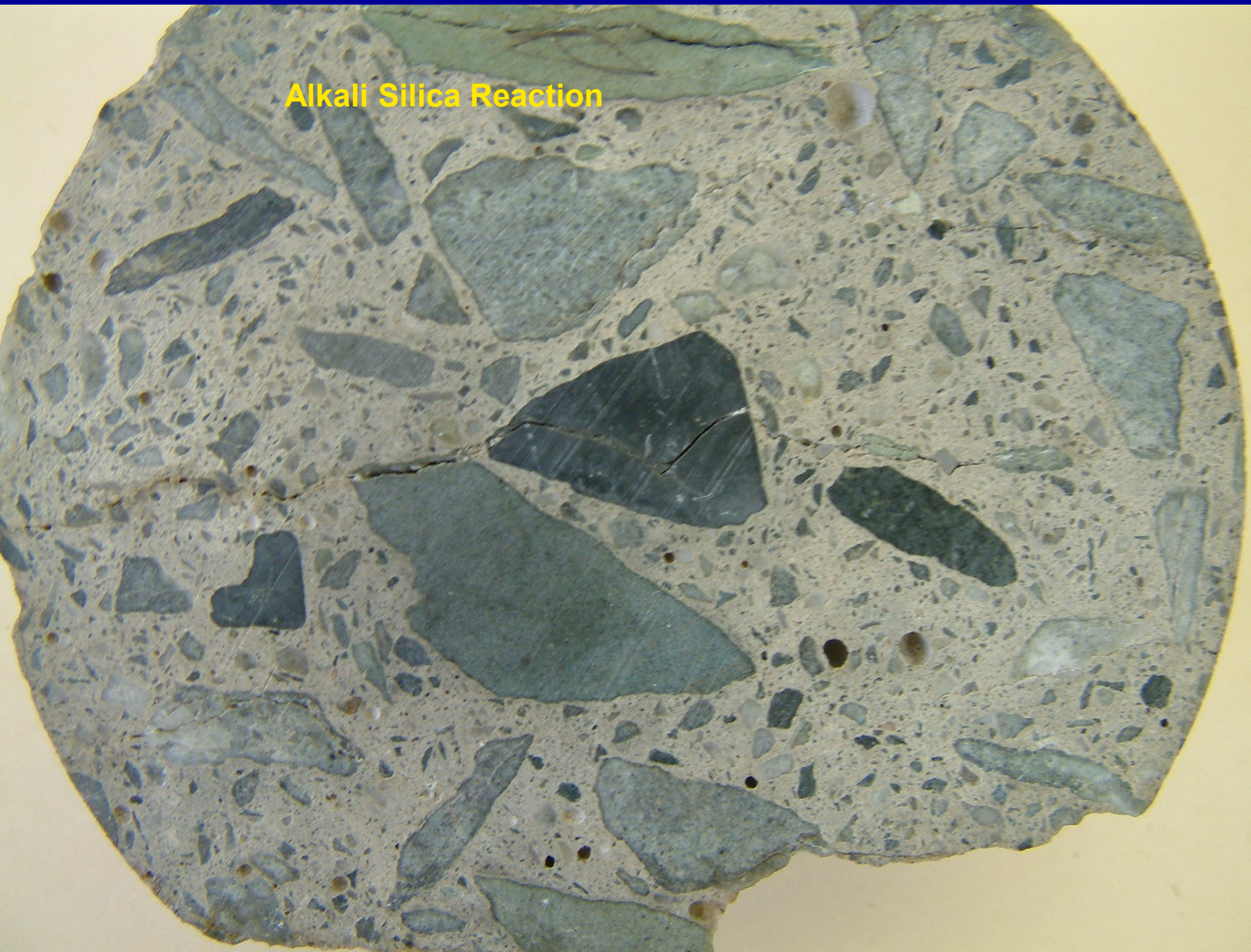




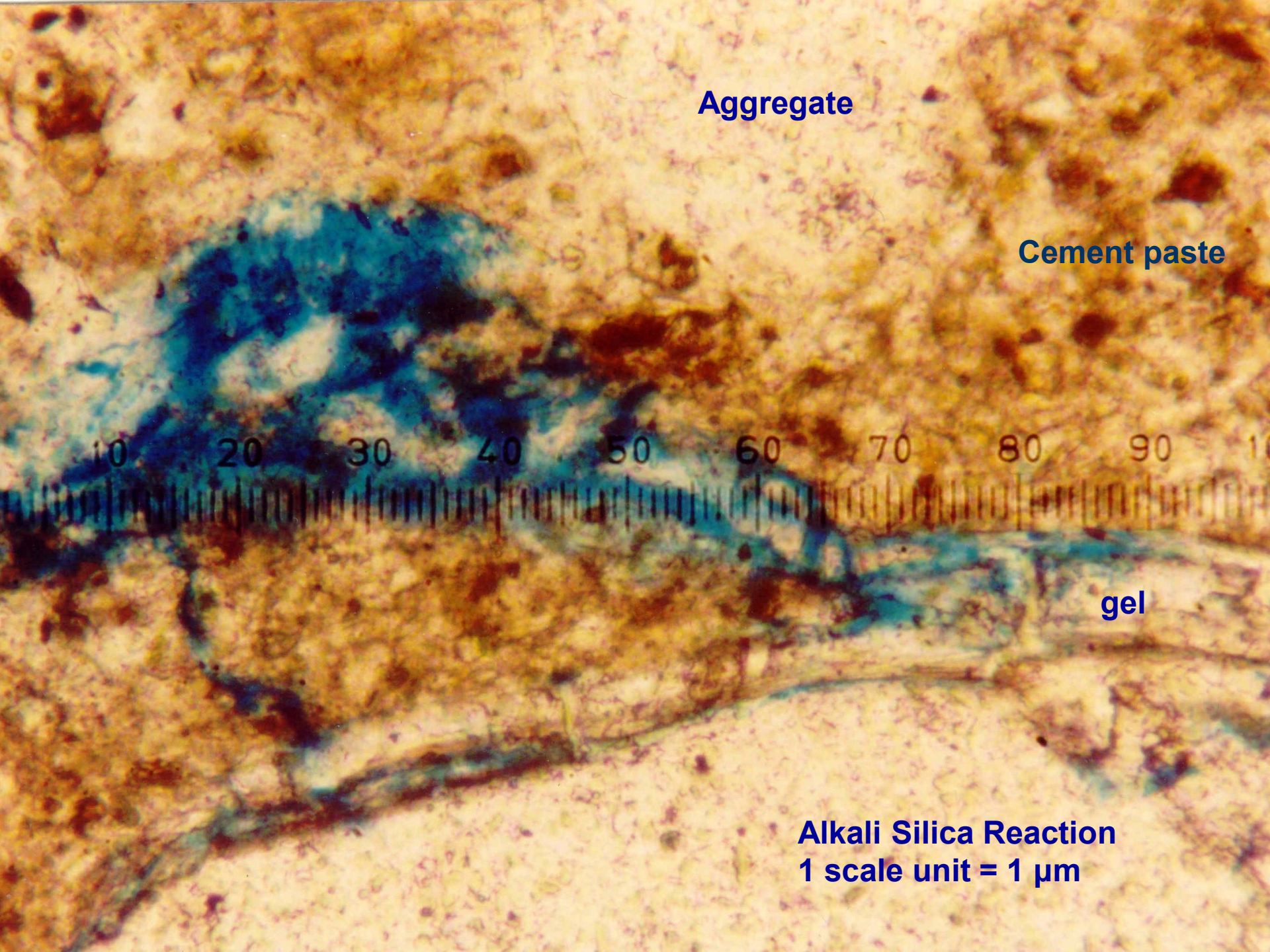
**Alkali Silica Reaction  
with soft water attack**



## Alkali Silica Reaction







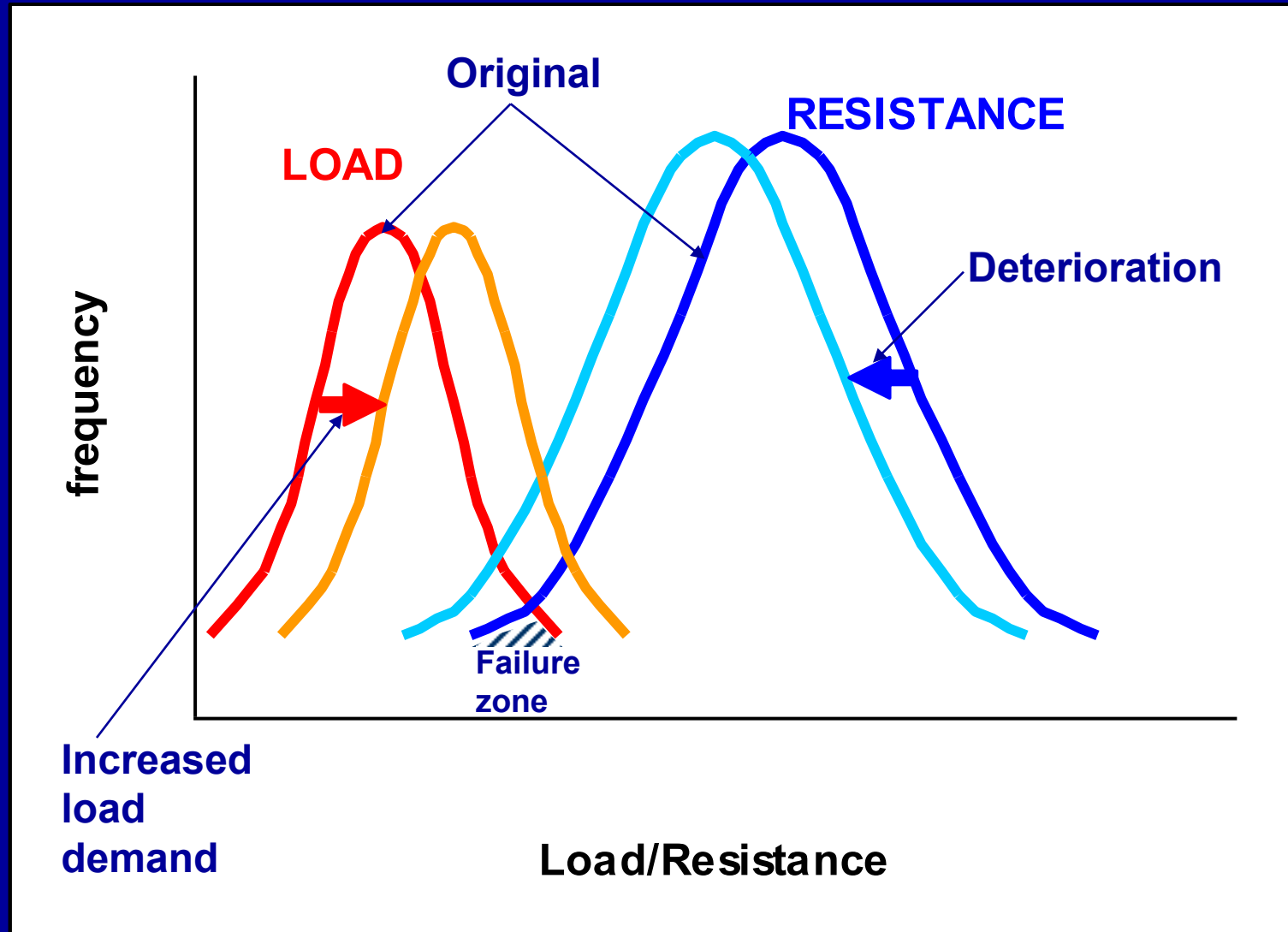
**Aggregate**

**Cement paste**

**gel**

**Alkali Silica Reaction**  
**1 scale unit = 1 μm**

# Probabilistic Approach

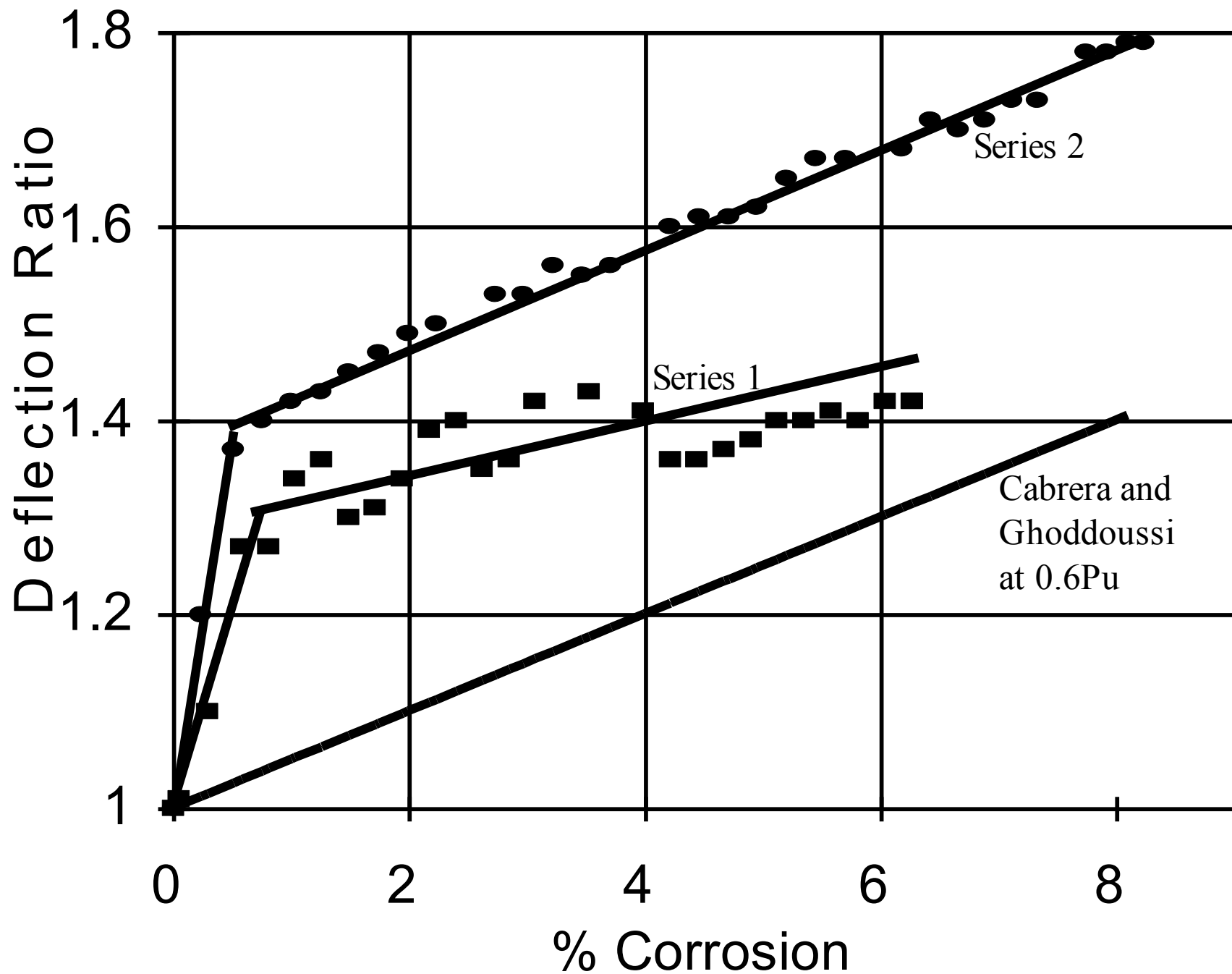




# Physical properties affecting durability

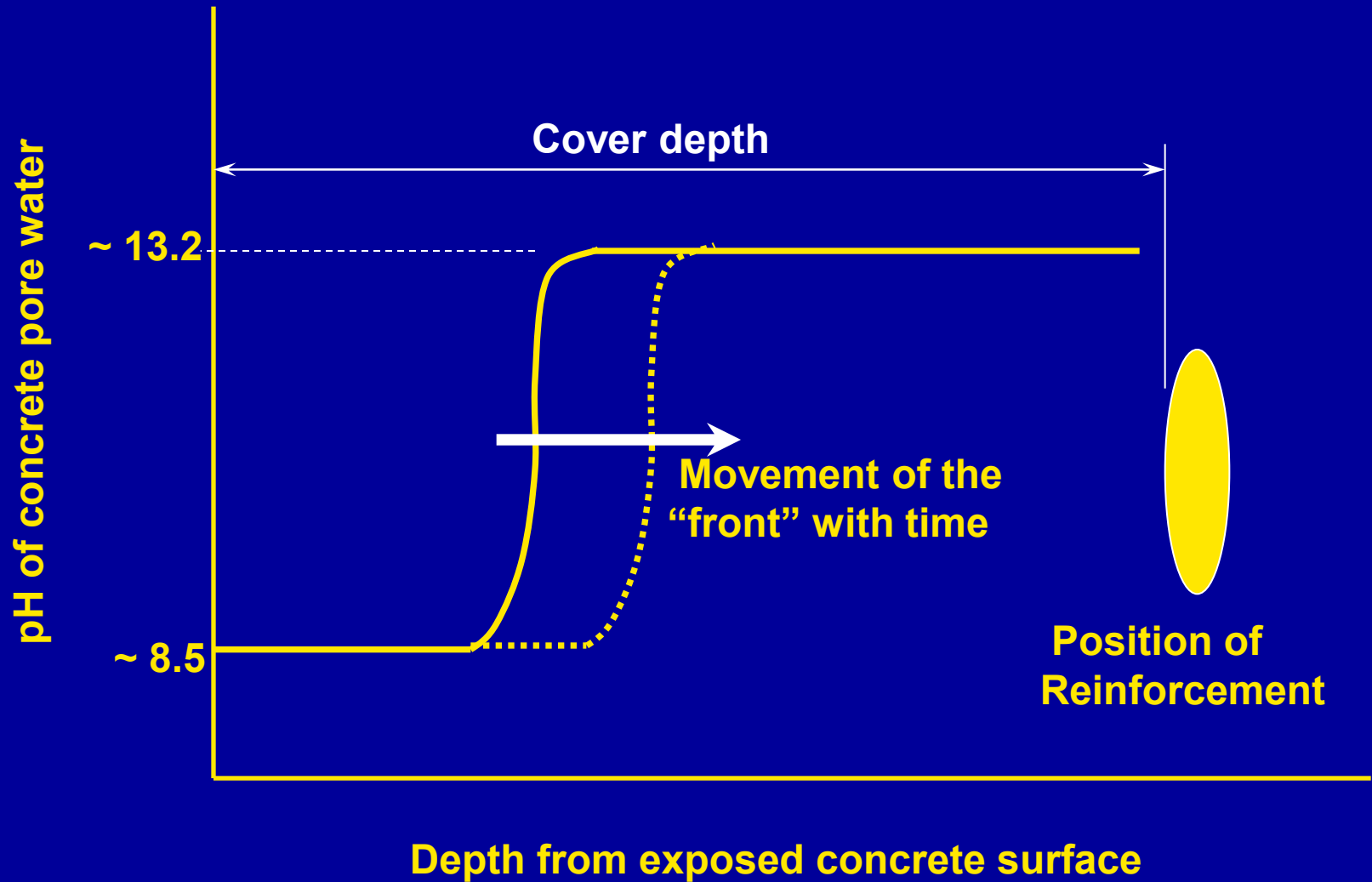
- Fluid transport (“permeability”)
- w/c ratio
- Binder type
- Mixture design
- Compaction
- Curing







## THE CARBONATION "FRONT"





## THE CORROSION PROCESS

