Teknologi Bahan Konstruksi

Elasticity
Shrinkage
Durability

Ferdinand Fassa

Outline

- Elasticity
- Shrinkage
- Durability

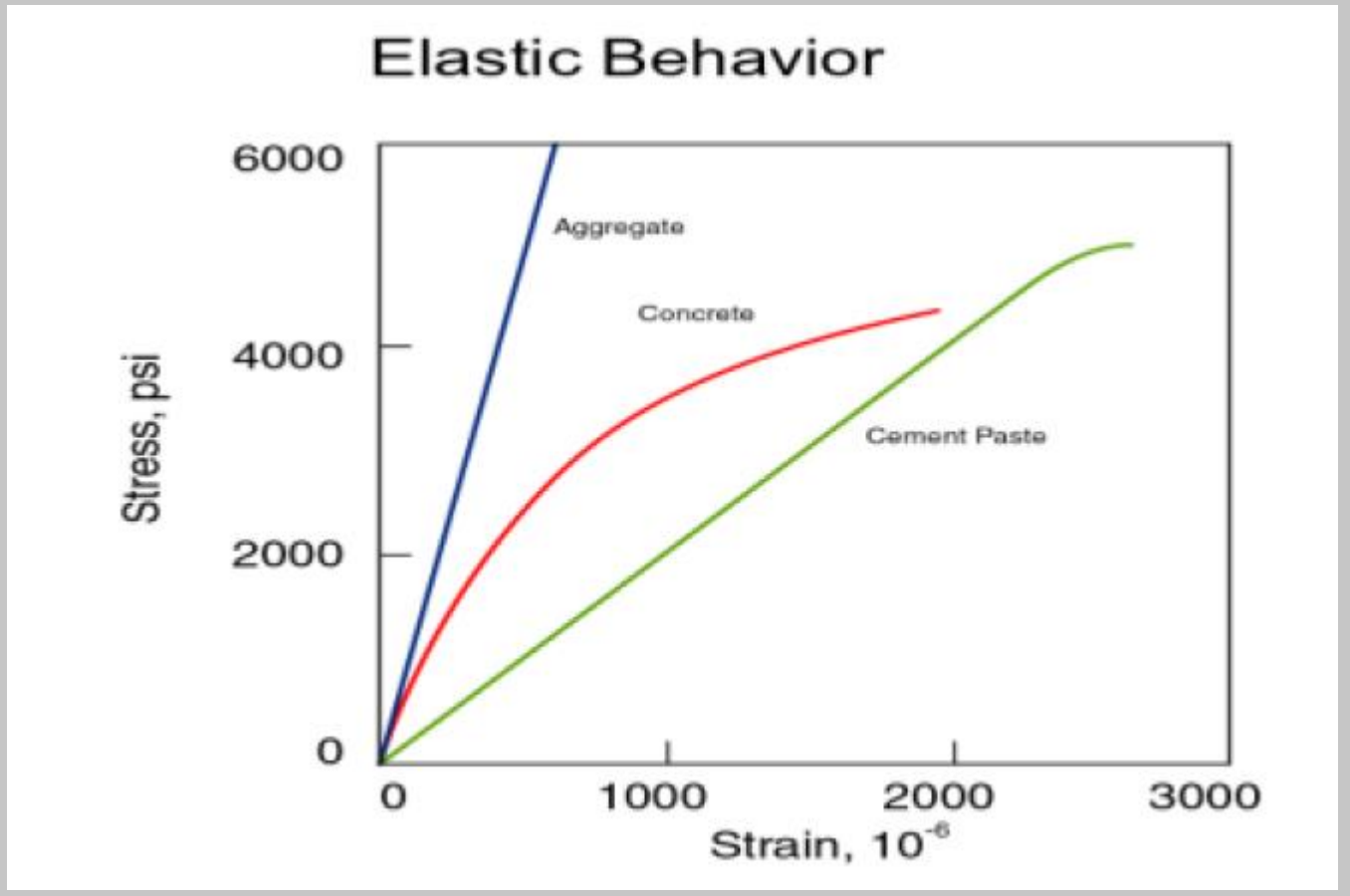
Elasticity

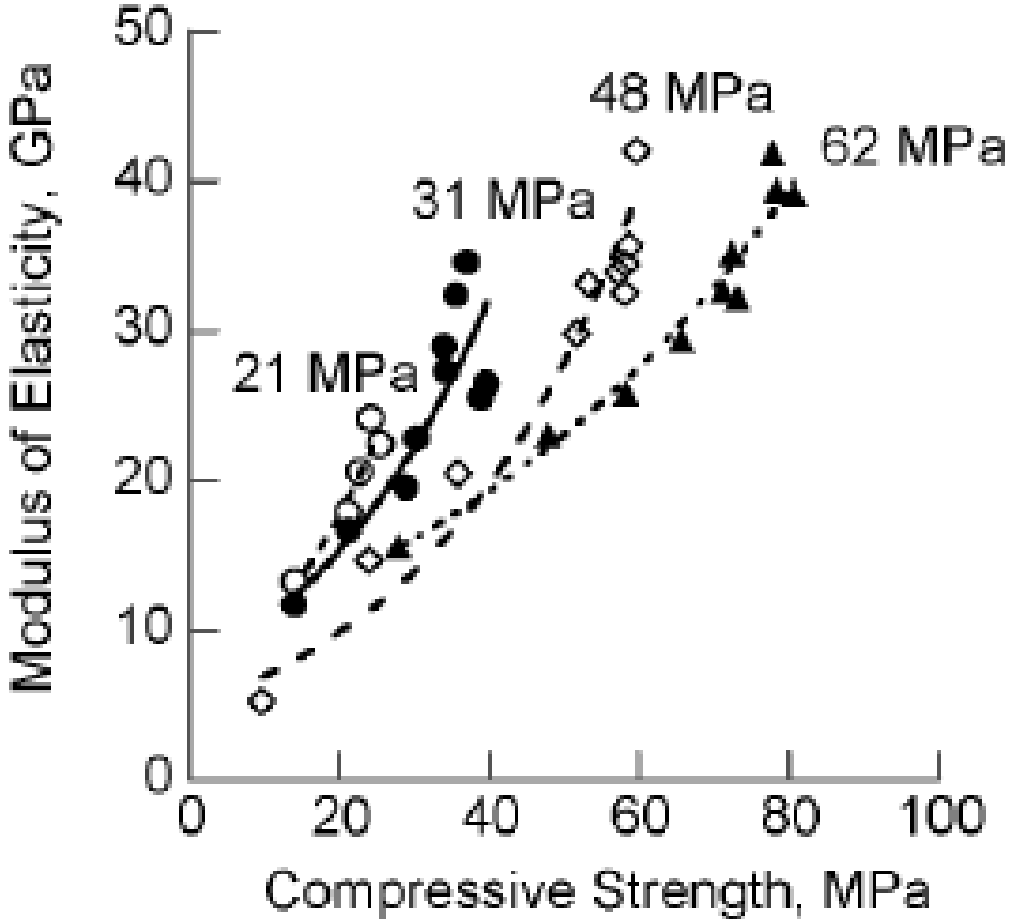
- Factor influence elasticity on concrete →*strength of concrete*.

strength of concrete ↑ Elasticity ↑

$$E_c = 3320\sqrt{f_c} + 6900 \text{ MPa}$$

where Ec is the elastic modulus of concrete, fc the compressive strength.





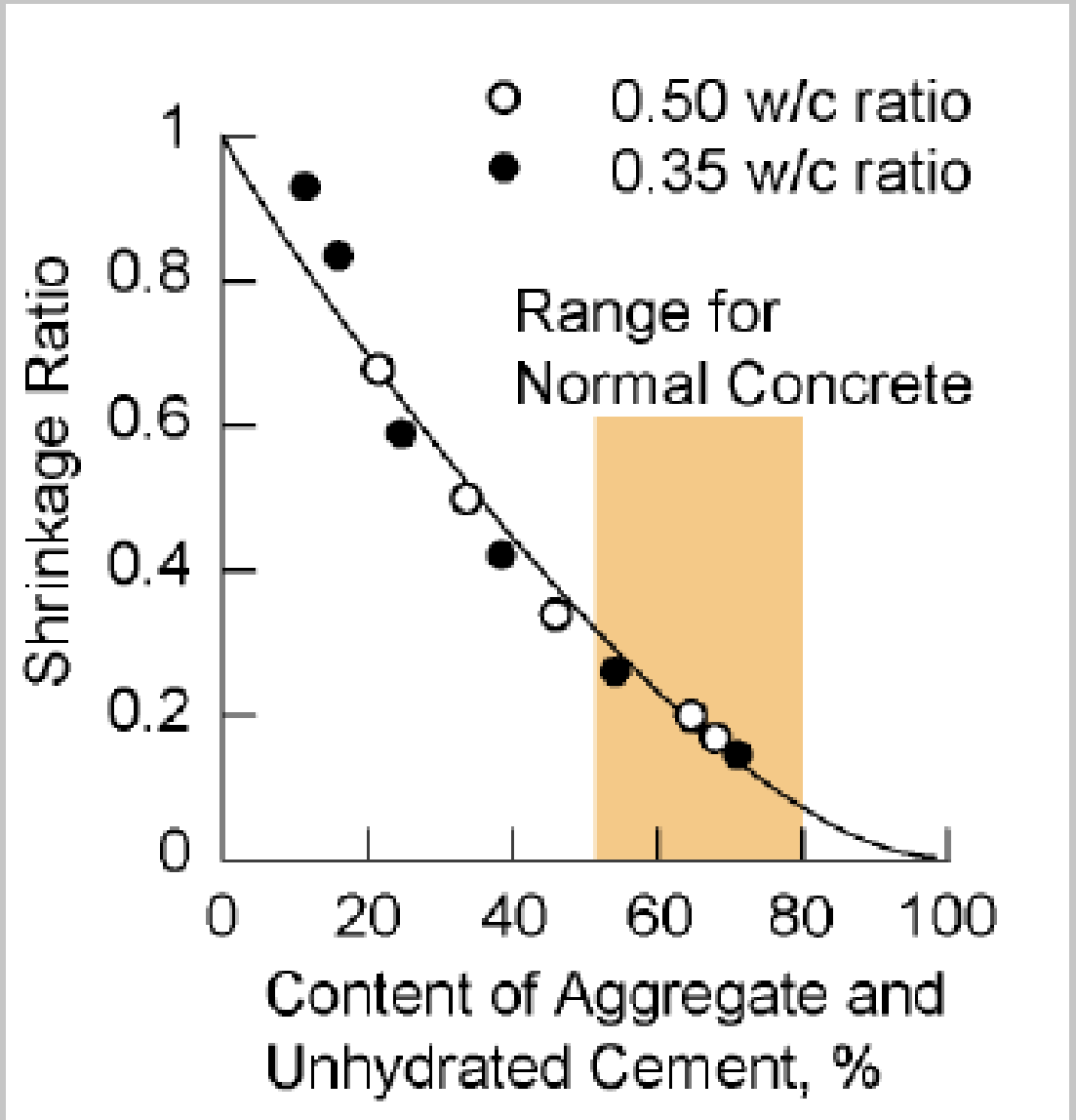
- Quality and Quantity of agregat → significant effect on elasticity

ACI-318

Shrinkage

Definition of shrinkage according to the Japanese Concrete Institute

“macroscopic volume reduction of cementitious materials when cement hydrates after initial setting”



Shrinkage

Plastic Shrinkage

Shrinkage

The fibers are used to reduce shrinkage cracking.

fibers are used in slabs and pavements that have large exposed surface leading to high shrinkage crack.

Durability of concrete

Kemampuan untuk melawan *weathering action, chemical attack,* serangan sulfat, or proses kerusakan *(Deterioration)* lainnya.

Contoh: ketahanan (durabititas) beton yang rusak akibat serangan kimia, api

When well compacted and cured, concretes containing steel fibers seem to possess excellent durability as long as fibers remain protected by the cement paste.

In most environments, especially those containing chloride, surface rusting is inevitable but the fibers in the interior usually remain uncorroded.

Recommendations for Improved Durability

- Better quality assurance during construction
- (including curing)
- Better concrete quality (low w/c ratio)
- Epoxy coated bar (controversial)
- Sealing and painting
- Maintenance

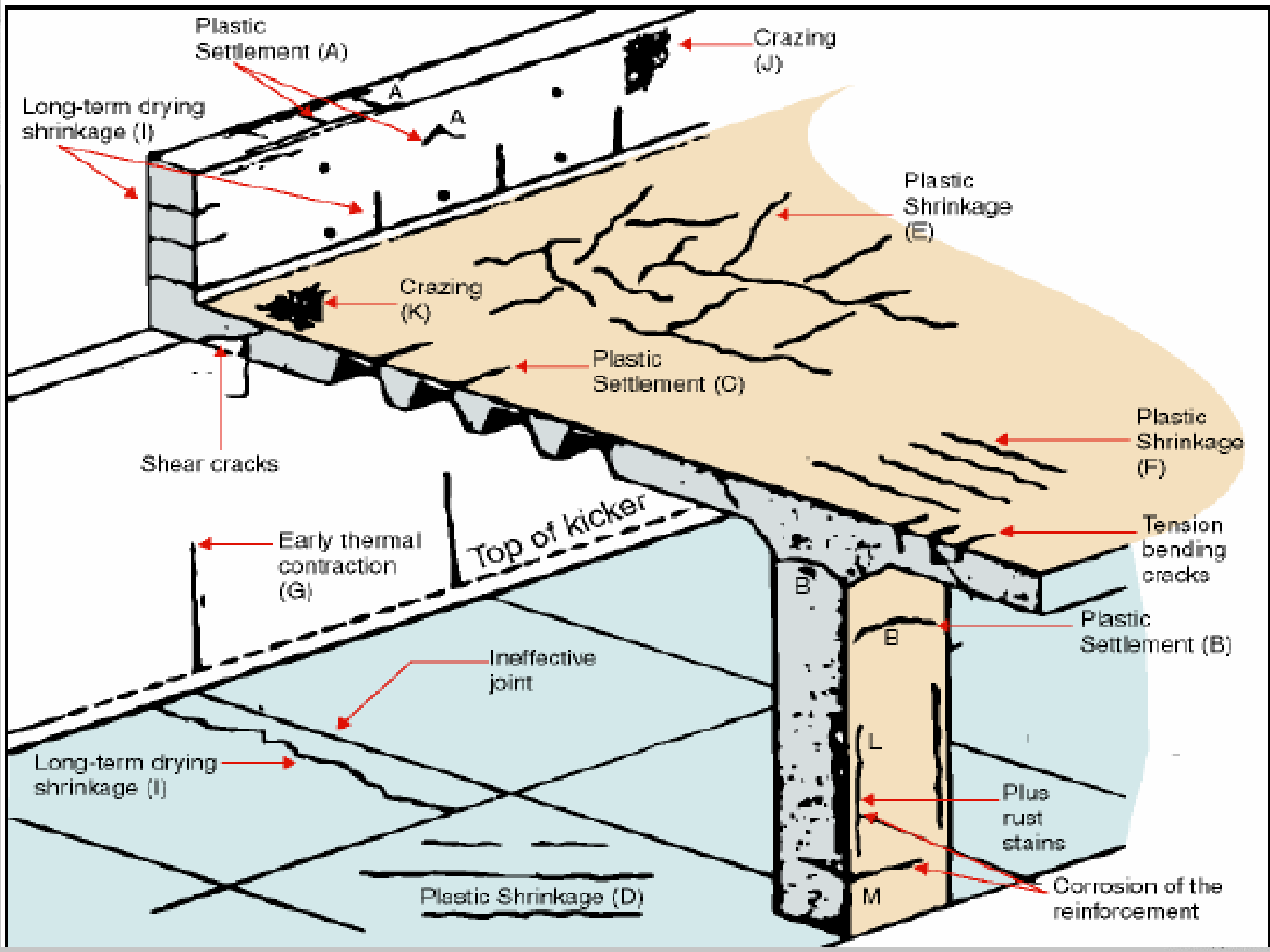
Effect on Concrete
Poor Durability

Alkali-Silica Reaction

Built in 1965, this deteriorated bridge is located 9.7 miles west of Lee Vining at 9400 feet elevation on the eastern slope of the Sierra Nevada.

Alkali-Aggregate Reaction

- High pH of cement causes reaction with aggregates, particularly those with certain siliceous minerals
- Continued reaction (requires water) creates gel which expands
- When expansion strain greater than failure strain, concrete cracks
- Can completely crack, destroy concrete
- First identified in California in 1920s


Plastic Settlement (A)
Crazing (J)
Long-term drying shrinkage (I)
A
A
Plastic Shrinkage (E)
Crazing (K)
Plastic Settlement (C)
Shear cracks
Plastic Shrinkage (F)
Top of kicker
Early thermal contraction (G)
Tension bending cracks
B
B
Plastic Settlement (B)
Ineffective joint
Long-term drying shrinkage (I)
L
Plus rust stains
M
Corrosion of the reinforcement
Plastic Shrinkage (D)

Kerusakan yang di akibatkan oleh api

Corrosion

Sulfate Attack

ACI Building Code 318

- **Negligible attack**: When the sulfate content is under 0.1 percent in soil, or under 150 ppm (mg/liter) in water, there shall be no restriction on the cement type and water/cement ratio.
- **Moderate attack**: When the sulfate content is 0.1 to 0.2 percent in soil, or 150 to 1500 ppm in water, ASTM Type II portland cement or
- portland pozzolan or portland slag cement shall be used, with less than an 0.5 water/cement ratio for normal-weight concrete
- **Severe attack**: When the sulfate content is 0.2 to 2.00 percent in soil, or 1500 to 10,000 ppm in water, ASTM Type V portland cement, with less than an 0.45 water/cement ratio, shall be used

Effect and Factors that influence Sulfate Attack

Effect of Sulfate Attack

Loss of Strength and Mass

Factors that influence Sulfate Attack:

- Flow of ground water and soil porosity
- the amount of sulfate
- *Seasonal variation*
- *Quality of concrete*

Solution

- Cement with low C3A (less than >4 dan <8%)
- Low w/c (less than 0.45)
- Pozzolan

Thank You