

# Modification to ASTM C157 to Measure Early Age Deformation of Concrete Specimens

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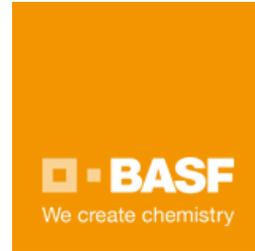
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# Outline

- Introduction
  - Concrete Shrinkage and Cracking
  - Existing Methods for Early-Age Deformation Measurement
- Modified ASTM C157
- Case Study: Behavior of Mixtures Containing a Shrinkage Compensating Admixture
- Summary

# Concrete Shrinkage

- Plastic shrinkage
  - Rapid loss of moisture in plastic concrete
- Drying shrinkage
  - Long-term loss of moisture in hardened concrete

# Shrinkage and Cracking



# Shrinkage and Cracking



# Shrinkage and Cracking

When Stress Exceeds Strength



# Concrete Cracking

- Accelerates Deterioration
- Unaesthetic
- Expensive to repair

# Corrugated Tube (ASTM C1698)

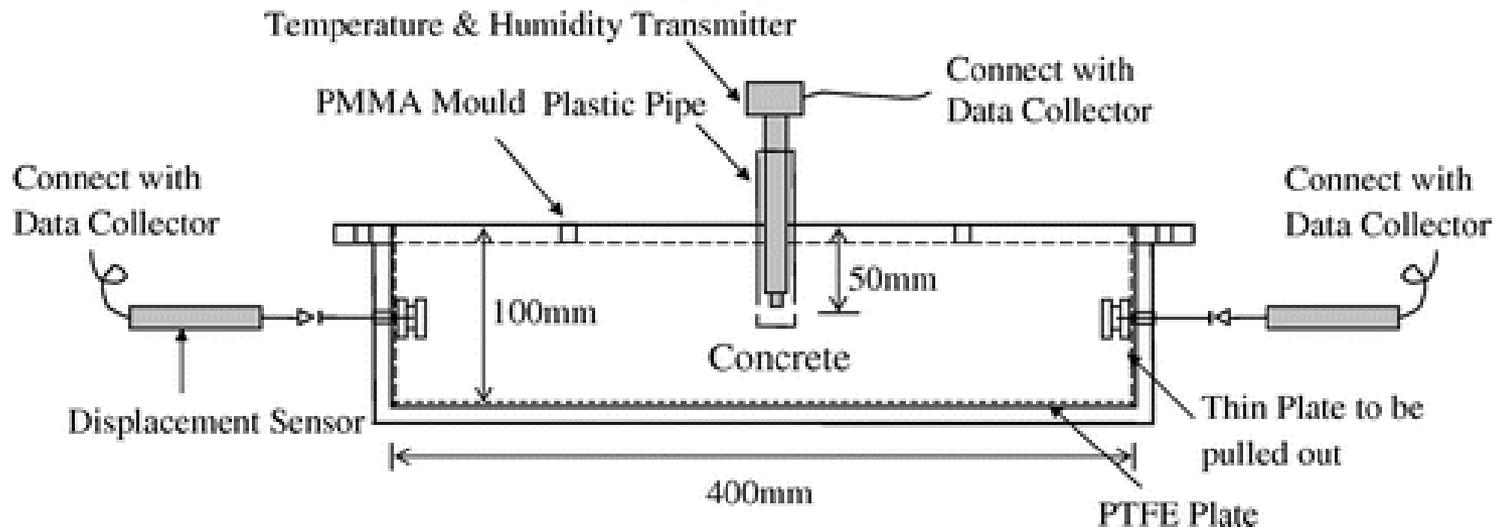
- Mortar/Cement paste only
- Cannot measure drying shrinkage
- Can be expensive



Reference: Germann Instruments, Inc., 2017, "Auto-Shrinkage Test Page", retrieved from <http://germann.org/auto-shrink-test-page>

# Specially Made Prismatic Molds

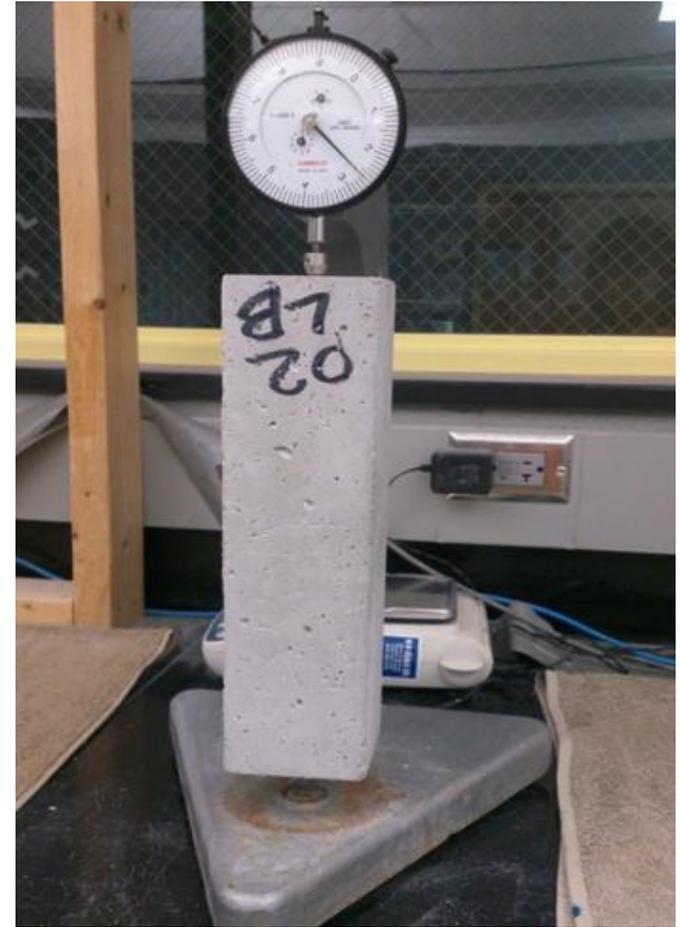
- Friction between concrete and mold bottom
- Not efficient for drying shrinkage



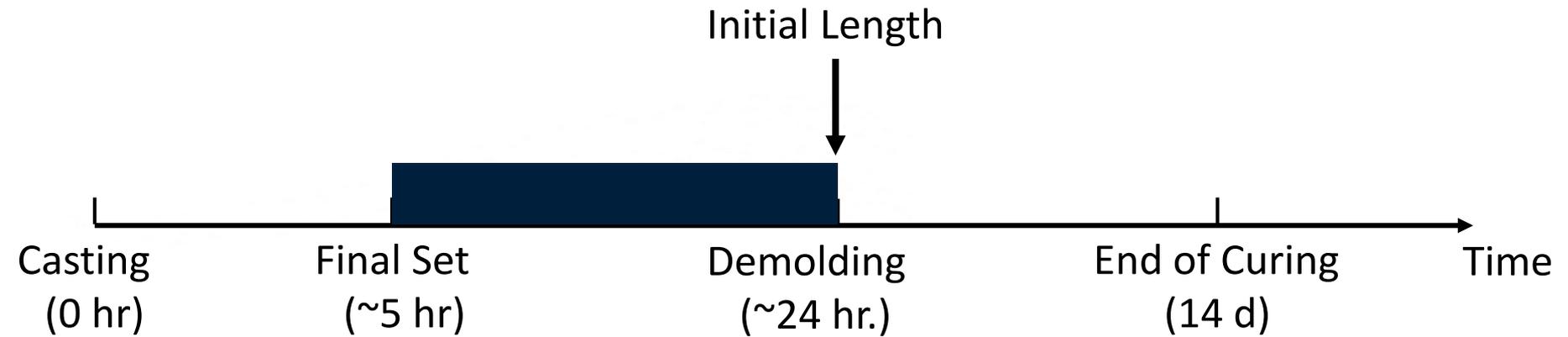
Reference: Zhang, J., Hou, D., & Gao, Y. (2012). Calculation of shrinkage stress in early-age concrete pavements. I: Calculation of shrinkage strain. *Journal of Transportation Engineering*, 139(10), 961-970.

# ASTM C157

- Measures free shrinkage of concrete specimens
- Demold 1 day after casting
- Shrinkage measured in microstrain with a comparator



# ASTM C157



# Modified ASTM C157

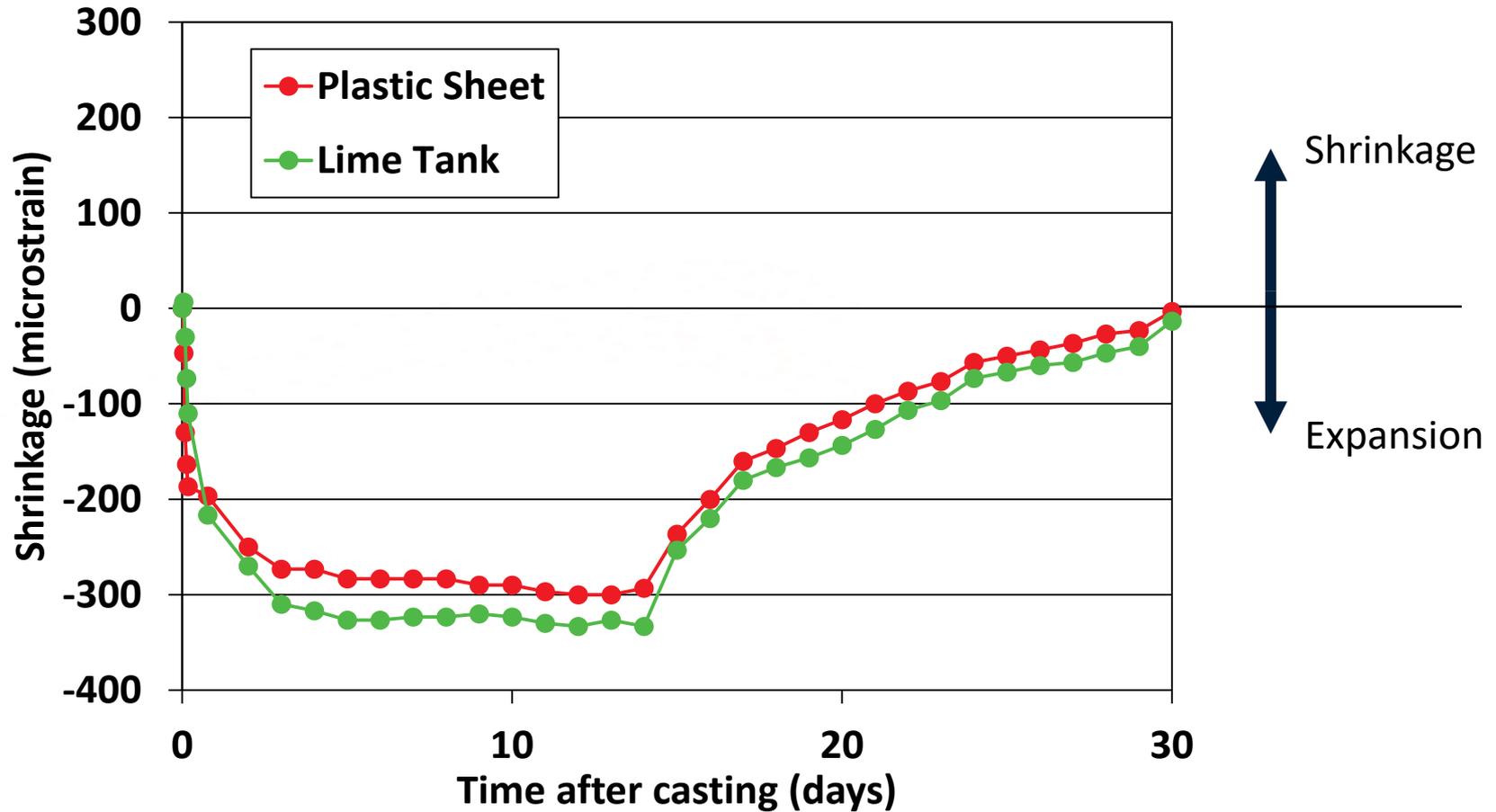
- Demold  $5\frac{1}{2} \pm \frac{1}{2}$  hr after casting
- 3 to 4 shrinkage measurements in first day of casting, daily reading during curing period
- Easy to operate, economic, allows for continuous measurements

# Storage Methods

- Plastic sheets
- Saturated lime tank



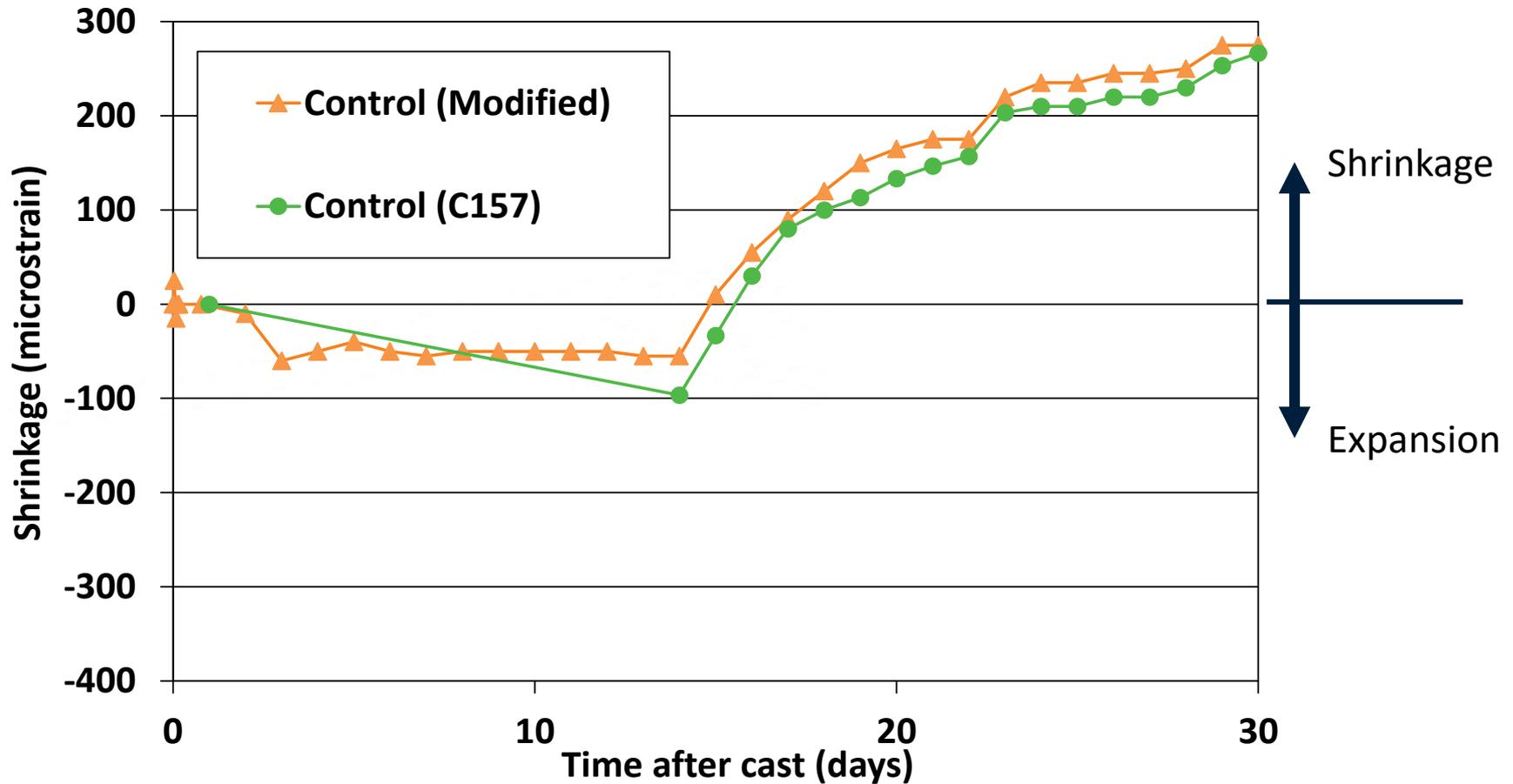
# Storage Methods



# Compatibility with ASTM C157

- Significant amount of existing results
- How do results obtained from modified test compare with standard test?

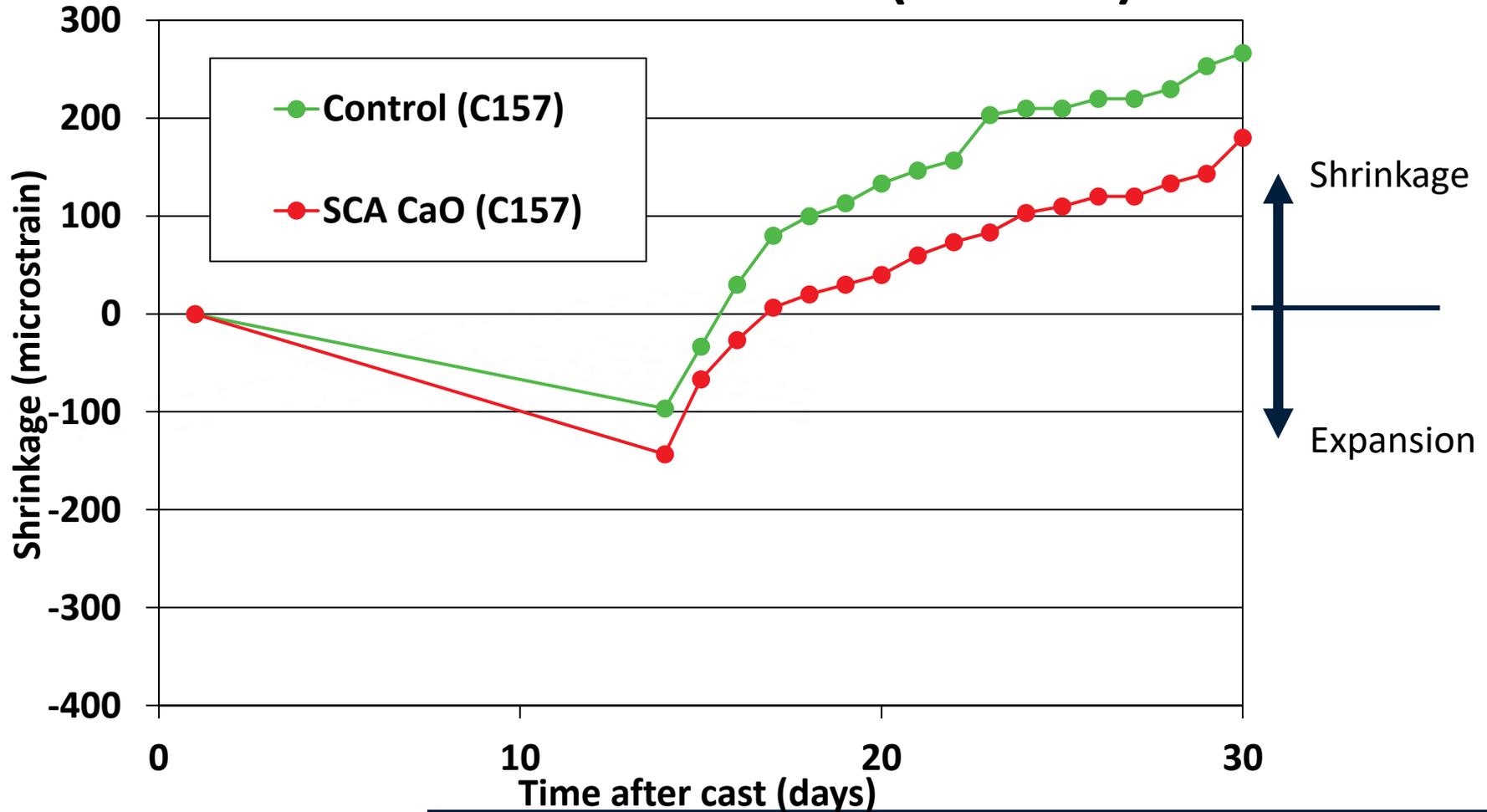
# Compatibility with ASTM C157



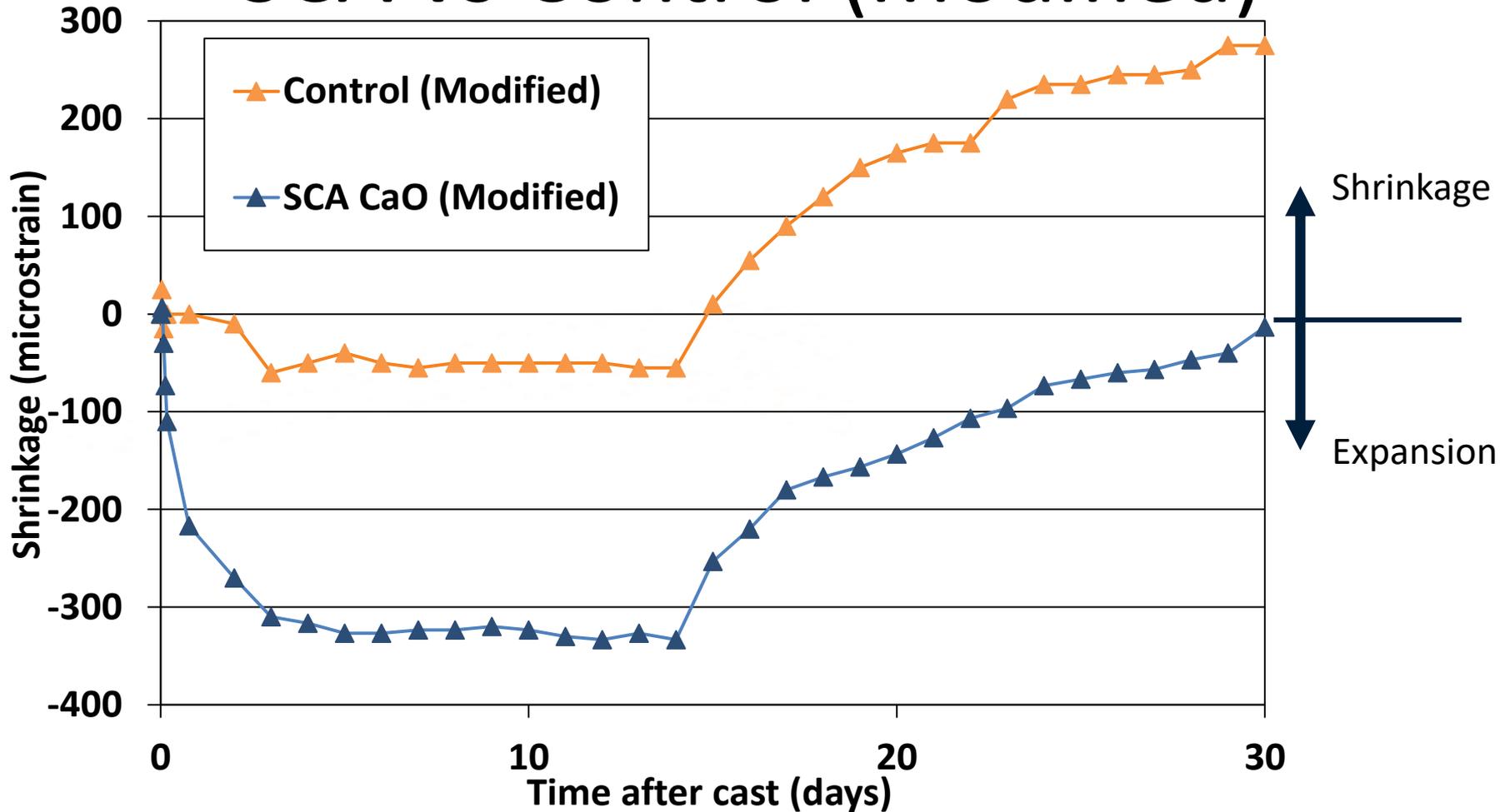
# Shrinkage Compensating Admixtures (SCA)

- Effective component: CaO/MgO
- React with mixing water and form  $\text{Ca(OH)}_2/\text{Mg(OH)}_2$
- Counteracts later shrinkage by inducing expansion
- Not to be confused with shrinkage reducing admixtures (SRA)

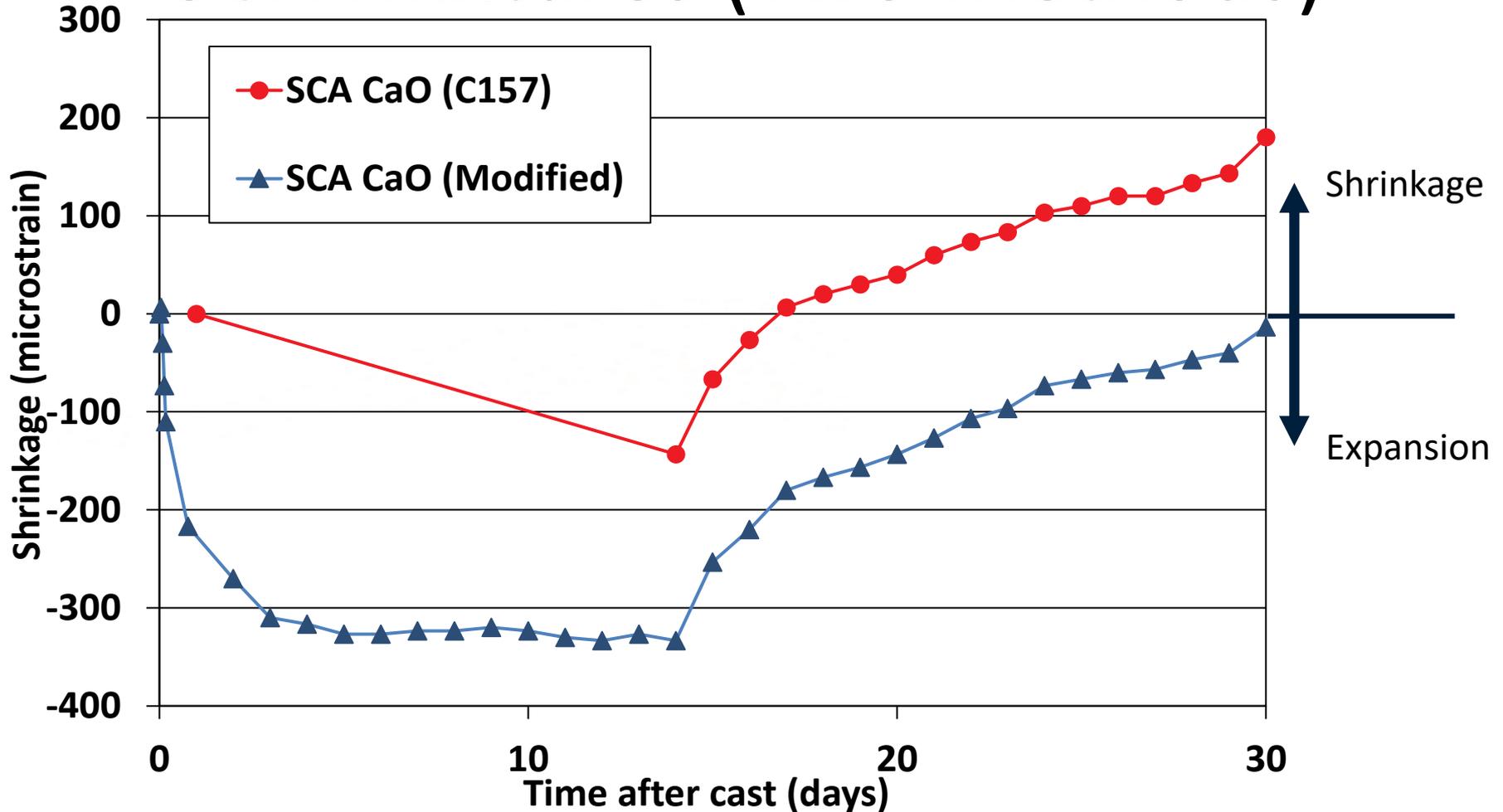
# SCA vs Control (C156)



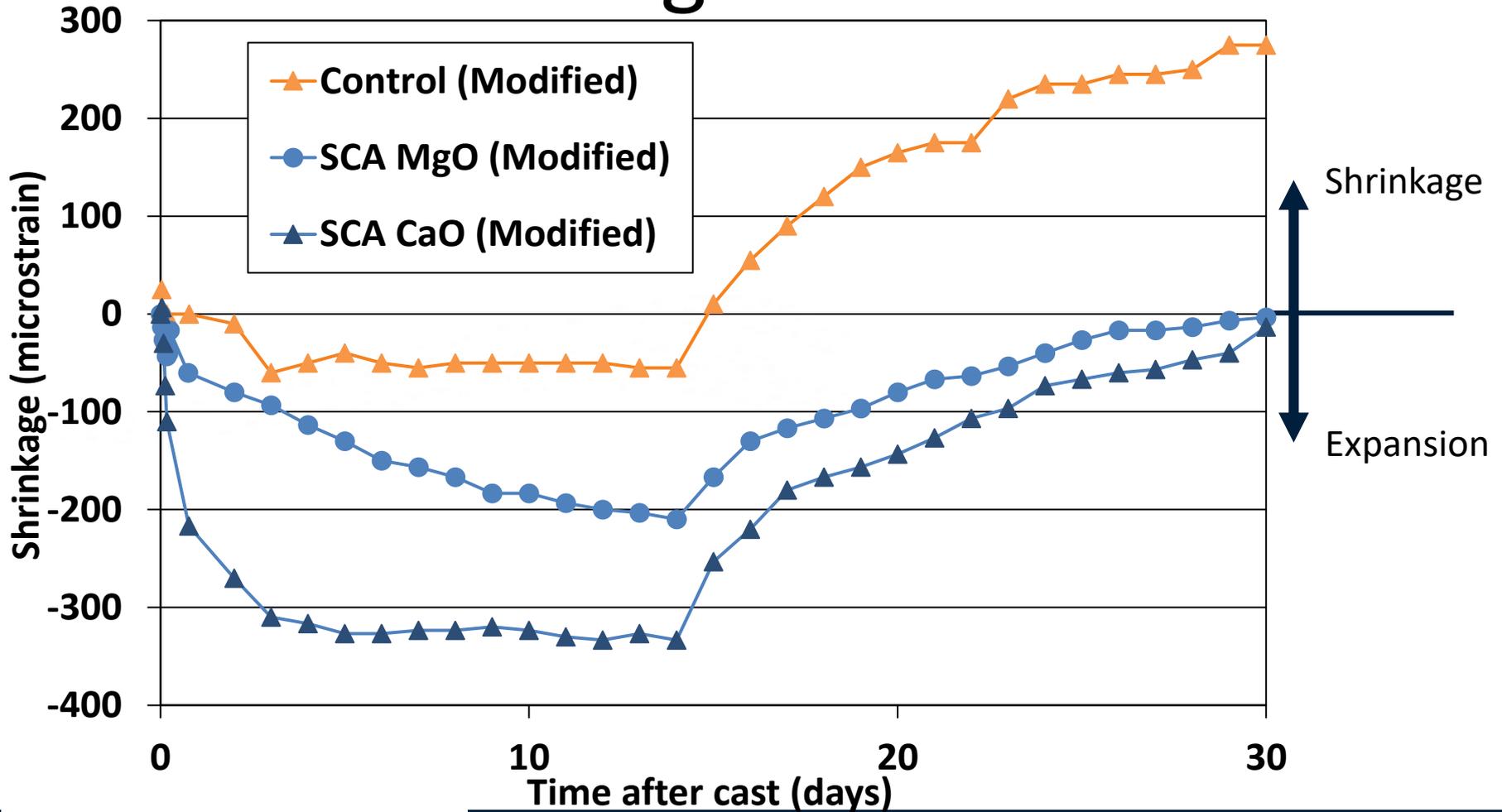
# SCA vs Control (Modified)



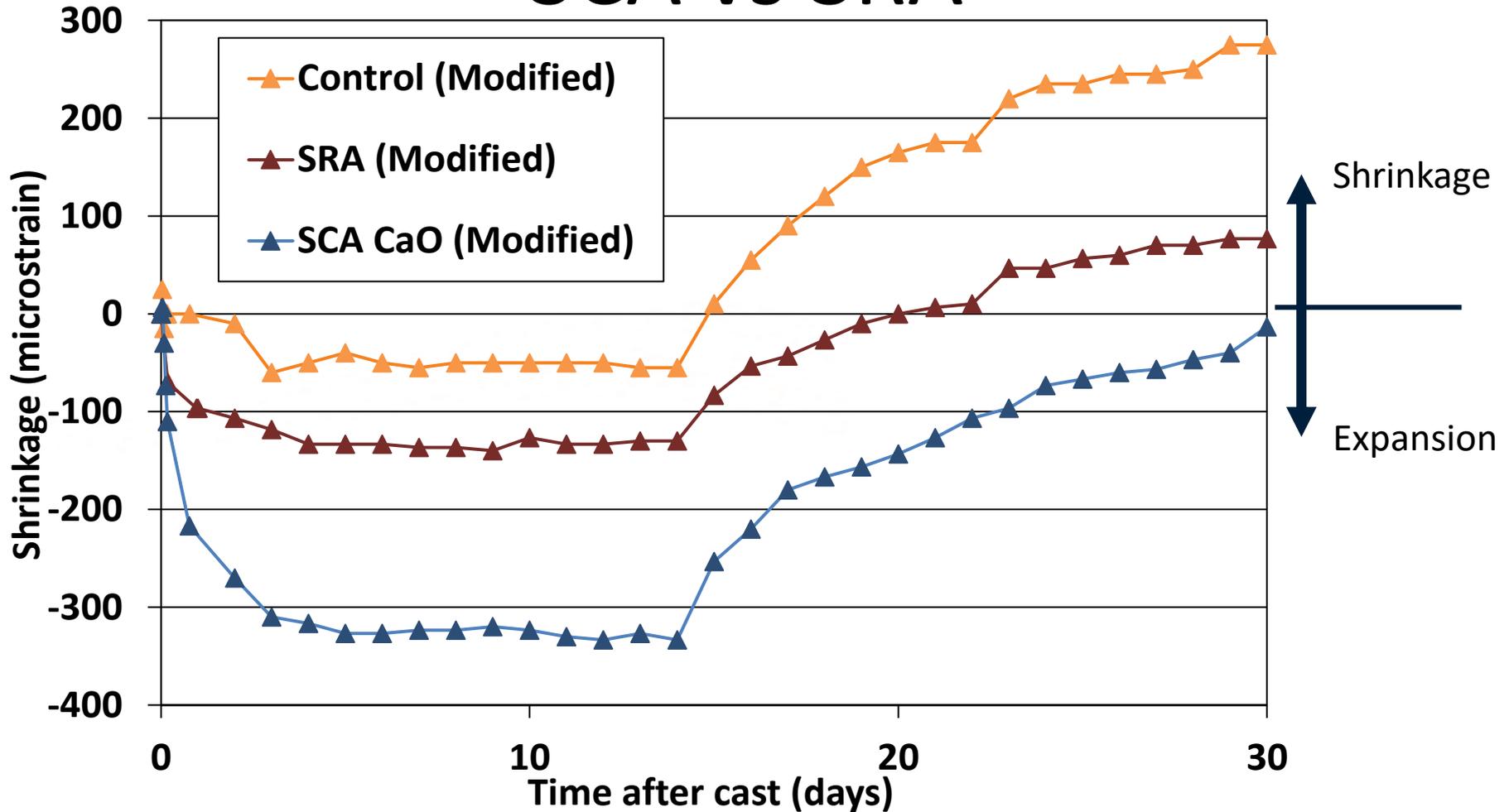
# SCA Mixtures (Two Methods)



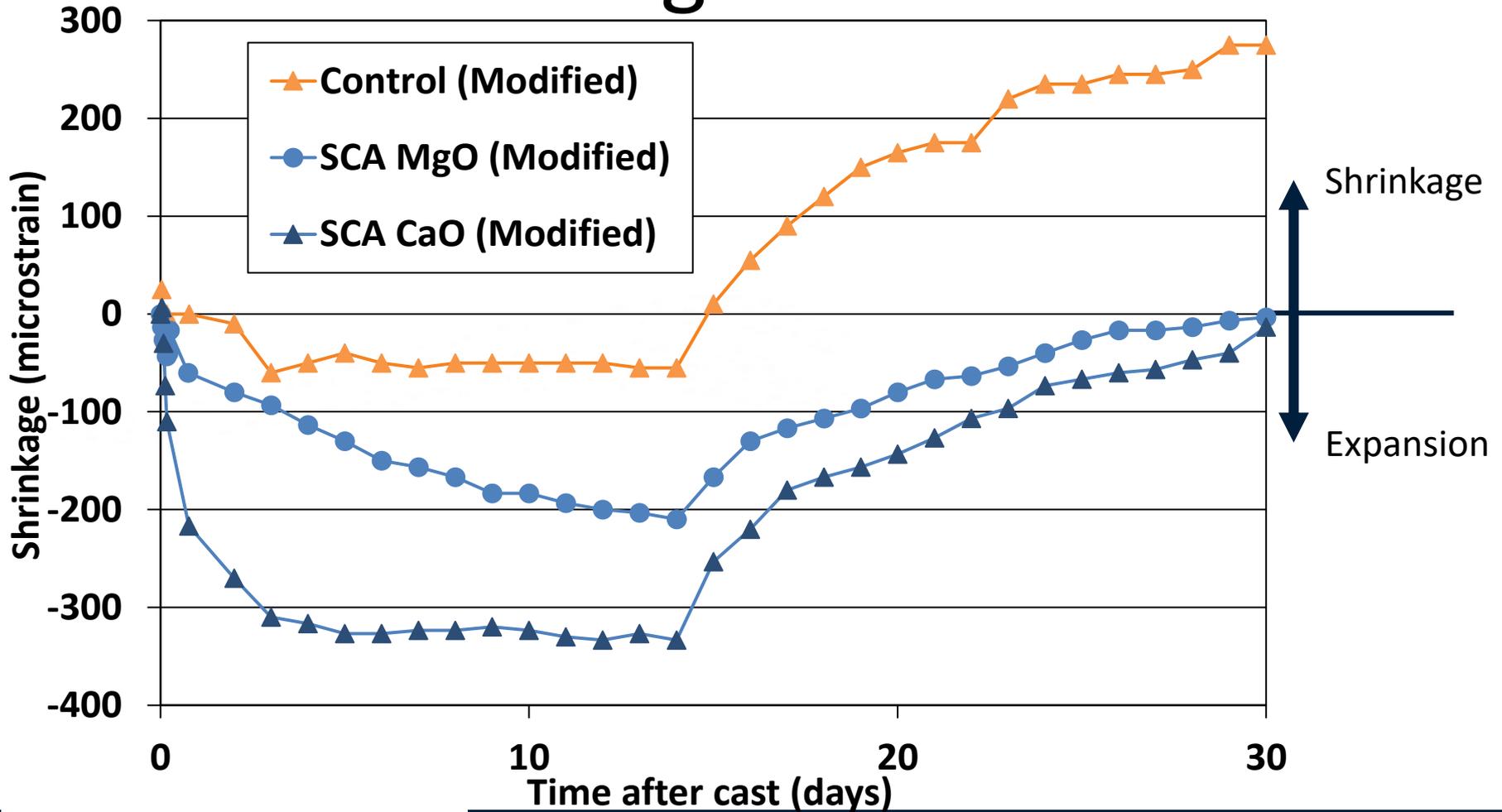
# CaO vs MgO Based SCA



# SCA vs SRA



# CaO vs MgO Based SCA



# Summary

- Modified ASTM C157
  - Captures early-age deformation
  - Easy to operate, economic
  - Captures both early-age and drying deformation
  - Results compatible with standard test results
- Concrete with SCA
  - Different expansion behavior
  - Different behavior than SRA mixes

# Thank You!





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