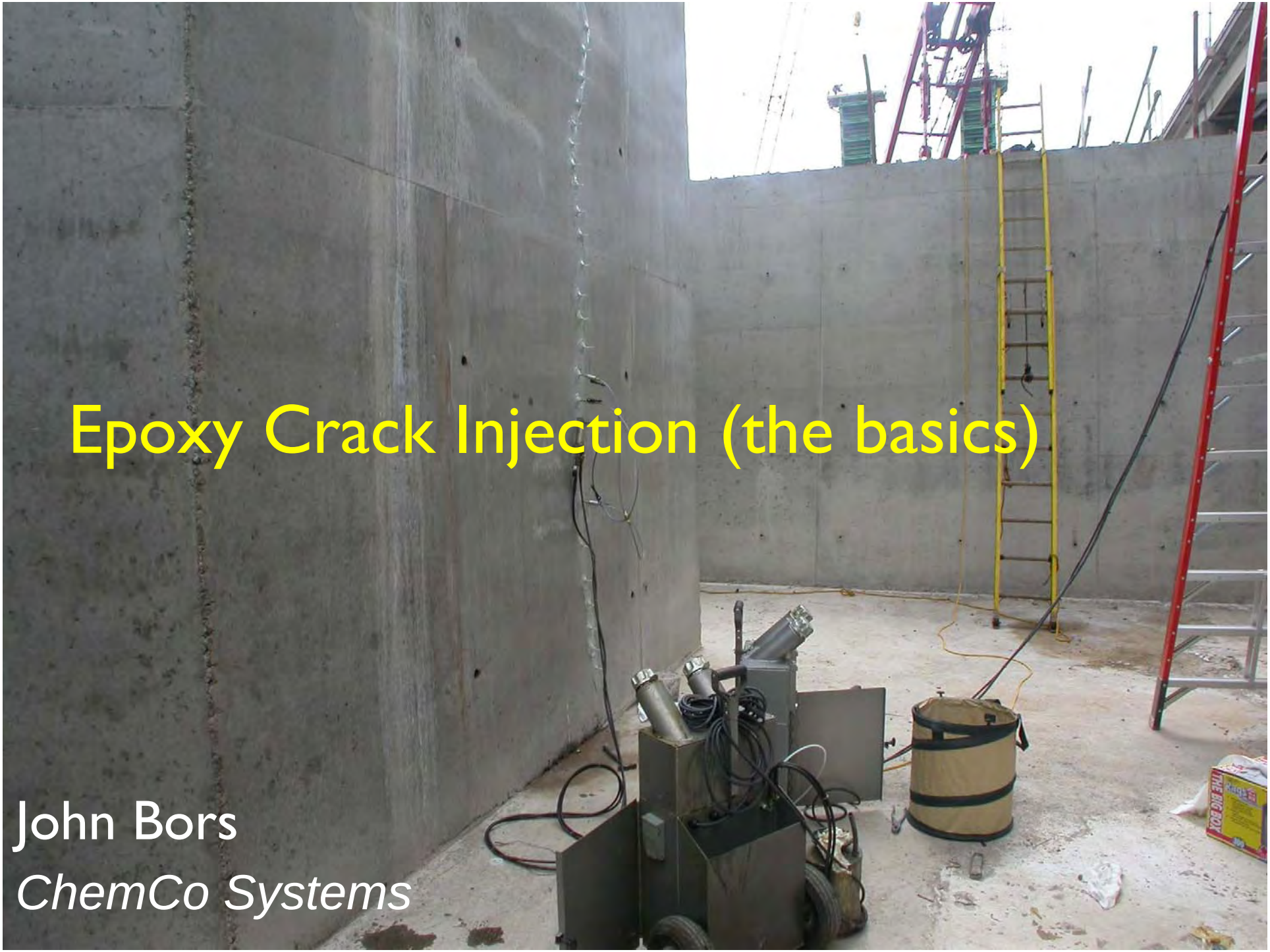


Epoxy Crack Injection (the basics)

John Bors
ChemCo Systems

Introduction

- Overview of pressure crack injection
- Practical and technical issues
  - Choose a primary repair technique
- Epoxy properties
- ChemCo Systems
  - epoxies and structural concrete repair
  - metering pumps and equipment
  - 50 years of experience
  - Kemko® applicator program

Injection Process

1. Identify cracks for repair
2. Optimum port spacing and location
3. Surface preparation

4. Seal crack at surfaces
5. Inject
6. Remove seal
7. Restore surface

Crack Preparation

- Wire brushing or grinding
  - remove laitance
- Seal selection
  - conditions dependent
- Port or portless (taped)?
- Crack chasing or routing?
- Useful tools
  - scalpel, razor, tape, wax
- Cleaning up
  - solvent, stripper, propane torch

Taped ports are considered to be more time efficient

Special surface seals




StripSEAL—a unique removal surface seal

- Epoxy pastes
  - high mod. *vs.* flexible
  - short *vs.* long potlife
- Wax, hot melt seals
- Silicone seals
- Cementitious
- StripSEAL™
- Considerations
  - wet conditions
  - post-repair surface appearance
  - ease of removal
  - seal cracking (thermal cycling)

Crack evaluation

- What is a crack?
  - width and depth limitations
  - pocket microscope
  - Structural vs. non structural
  - Identify cause and need for repair

ACI 224 guidelines for crack width		
Exposure condition	**Tolerable crack width (in.)**	**Tolerable crack width (mm)**
Dry air or protective membrane	0.016	0.41
Humidity, moist air, soil	0.012	0.30
De-icing chemicals	0.007	0.18
Seawater and seawater spray: Wetting and drying	0.006	0.15
Water retaining structures (excluding pressure pipes)	0.004	0.10

Epoxy Injection

- Port locations
  - access to both sides?
- Sequence
- Is water present?
- Pressure and duration
- Finished appearance

Pacoima Dam in Southern CA

J Bors ChemCo Systems

Injection QC

ChemCo's Ratio and Pressure Check Device

- Pump ratio check
  - volumetric samples at pressure
- Static mixer condition
- Temperature vs. crack width
- Cure time and temp relationship
- Core examinations

Strength of Injected Repair

Table 1: Summary of Test Results

	Beam 1		Beam 2		Beam 3	
	Original	Repaired	Original	Repaired	Original	Repaired
Cracking load(lb)	1,400	1,500	1,300	1,300	1,300	1,600
Ultimate load(lb)	10,000	10,600	9,600	10,000	9,700	9,900
Max. deflection(in)	1.27	1.26	1.27	1.48	1.10	1.03
No. of cracks repaired	—	10	—	13	—	6

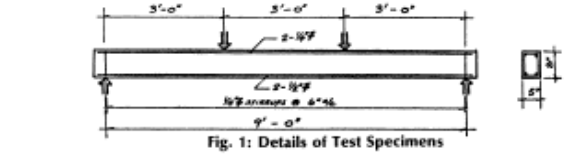


Fig. 1: Details of Test Specimens

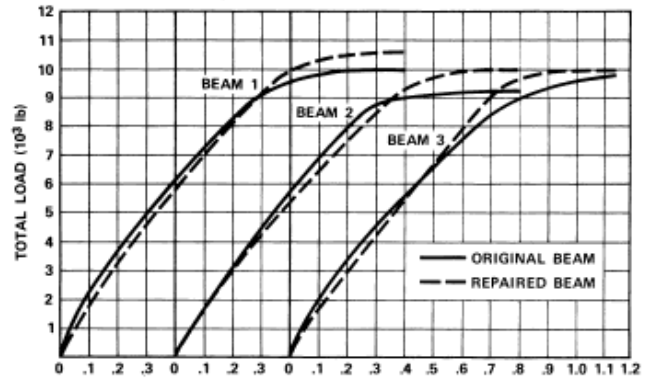
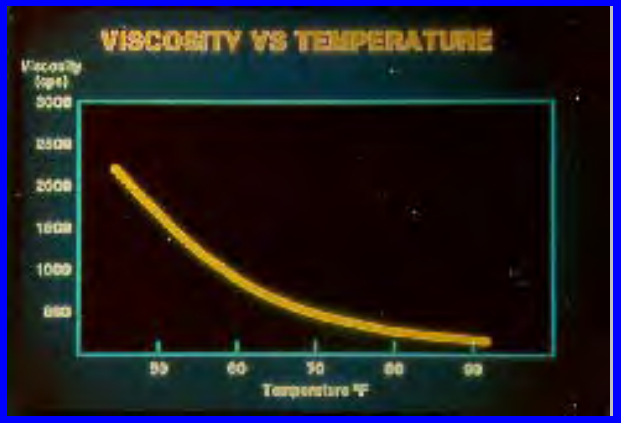


Fig. 2: Load-Deflection Curves — Mid-Span Deflection (in.)

- Standardized reinforced concrete beams were tested to failure
- Cracked beams were injected then retested
- **Repaired beams had <u>same failure strengths</u> as original beams**
- Study by Dr. H.W. Chung, University of Hong Kong

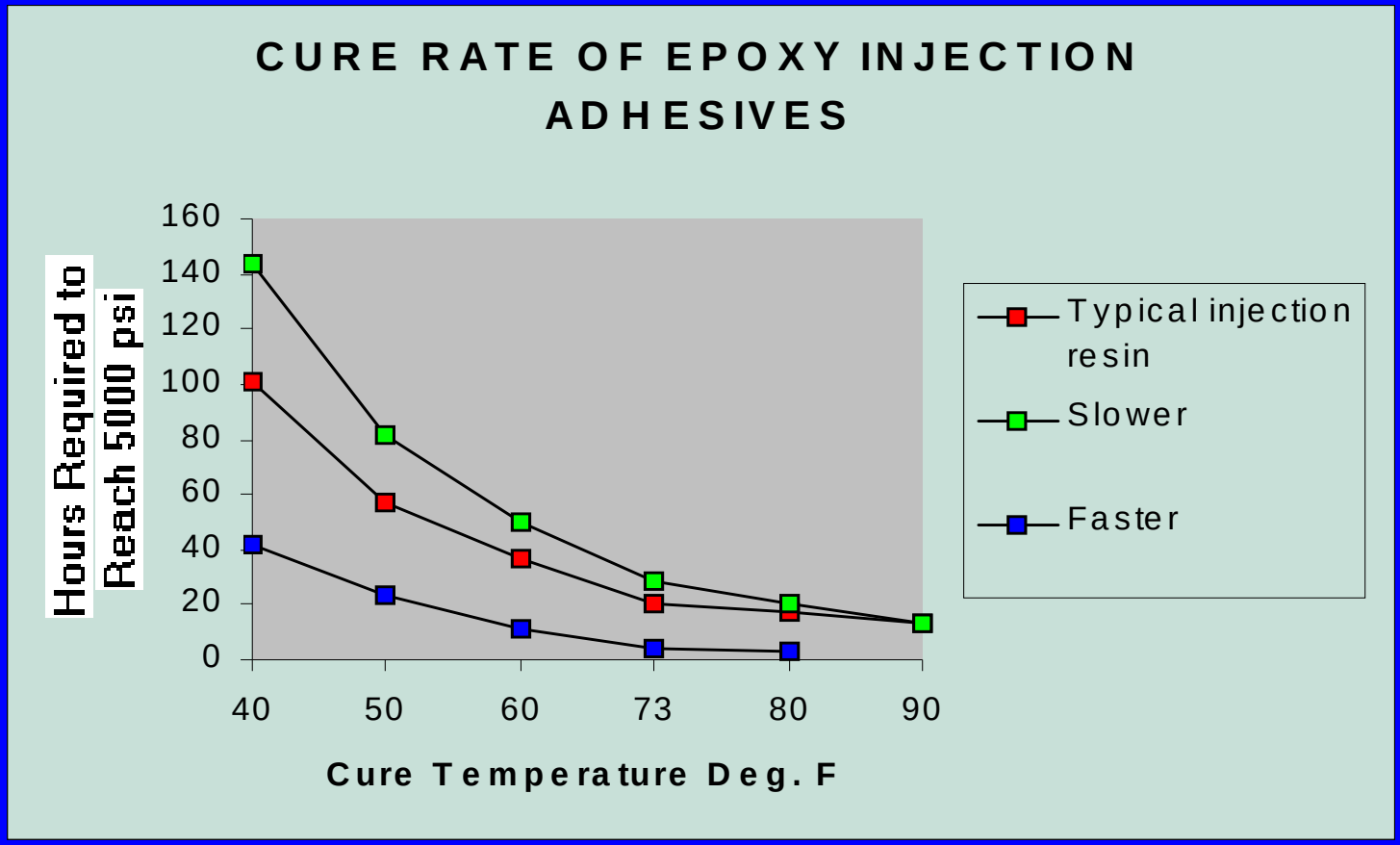
Epoxy behavior



- Temperature behavior
  - viscosity change
  - reaction/cure rate change
- Crack size and viscosity
- Exothermal in bulk (large quantities and voids)
- Excellent shelf life (3 years typical)

Epoxy cure time

When can you move a panel or vibrate the concrete?



Injection resin typical properties (ASTM tests)

Tensile Strength	6-9,000 psi
Elongation	2%
Compressive	14-16,000 psi
Flexural	10-12,000 psi
Viscosity	200-500 cps
HDT	120-165°F
Gel time	14-210 min.

Special applications

- Large voids, honeycombs
- old-to-new concrete
- Leaks or underwater
- No backside seal
  - slump pumping
  - paste injection
- Internal splices
- External plates
- Cold joints
- Water tanks

Equipment

ChemCo Systems Model B

- Positive displacement mix pumps
  - gear *vs.* piston
  - portability
  - reliability
- Static mixers
- Ports
- Pressure test kit
- Functional gauges
- Flush kit

Safety & Environmental

- Eye protection
  - glasses or shield
  - eyewash (5 minutes)
- Solvents & strippers
  - in confined spaces
  - grounded containers
- Skin protection
  - use gloves
  - long sleeves and pants
  - dermatitis
- MSDS ***on site access***
- Cleanliness
  - wash-up every time
- Disposal

Where to find more information

- Company training sessions
  - Kemko applicator training
- ICRI booklet and specification
- *Epoxy Injection in Construction*, Trout Aberdeen Grp.
- ACI repair committees