




American Concrete Institute®
Advancing concrete knowledge

Shrinkage-Compensating Concrete—Past, Present, and Future, Part 1

ACI Fall 2012 Convention
October 21 – 24, Toronto, ON

ACI
WEB SESSIONS



Edwin (Ed) A. McLean Civil Engineer Bradley University Peoria, IL 1979
“Certified Concrete Technologist” 1982. Southern Illinois Native Raised in family owned limestone quarry business having learned production, quality control and customer service, sold company in 1982. Started concrete pump company in 1984. In 1985 purchased control interest in 5 ready mix concrete plants with 55 truck mixers, sold these business ventures in 1989. Western Sales Engineer for Lone Star Cement developing/promoting blended cement technology and assisting the sales staff. January 2004 General Manager for three profit centers including concrete production, concrete block production and building material resale in central Illinois. 1999 SI Concrete (Fibermesh): Western Regional Support Engineer - Mississippi River West and Western Canada. Provided SFRC design suggestions for SOG construction and championed the two steel/polypropylene blended fiber systems that have ICBO (ICC) and Steel Deck Institute certifications. 2004 CTS Cement Manufacturing – Central US - Director of Engineer Sales promoting solutions using pure hydraulic CSA cement and Type K expansive cement. Championed Rapid Set LowP Cement for structural wearing surface overlays and structural repairs. Assisting in various research projects and University of Oklahoma efforts in developing current stress/strain information in mass shrinkage compensating concrete. McLean Consulting – various concrete construction projects over 30 years.

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Shrinkage-Compensating Concrete - Bridges


“Crack Free Decks” –
Concrete International Ed Rubin

ASTM C-845 Type K Cement

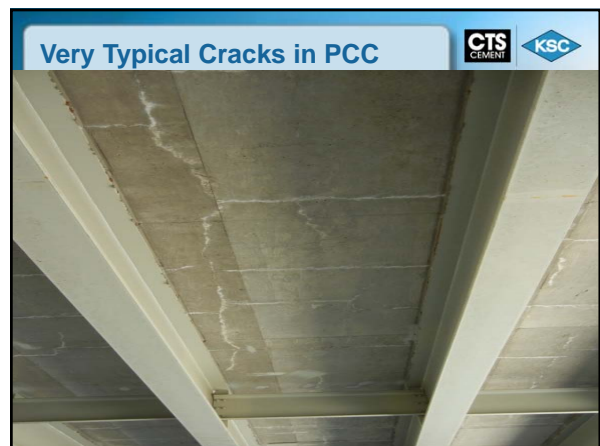
Ed McLean
Director Engineer Sales Central USA
CTS Cement Manufacturing



2010 Kansas Study Confirms



- ◆ Cracks Provide Avenues for Moisture to Get to Reinforcing Steel
- ◆ Great Idea to Use Low Porosity Low Permeability Concrete - between the Cracks! Don't We Want to Stop Cracks?
- ◆ Cement Technology To Compensate Drying Shrinkage Cracks in Concrete Available Mid1960s ASTM C845 Type K





Shrinkage-Compensating Concrete - Not New Technology

CTS CEMENT KSC

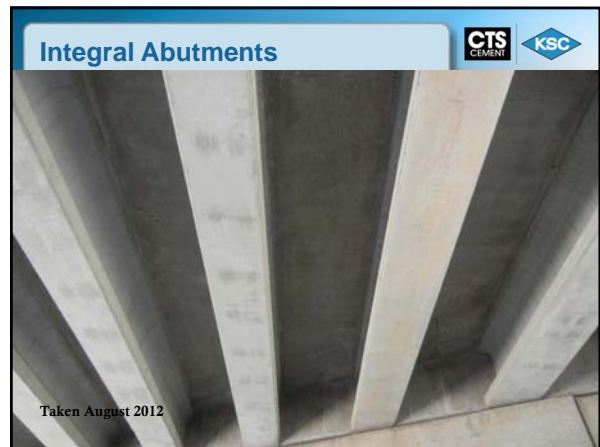
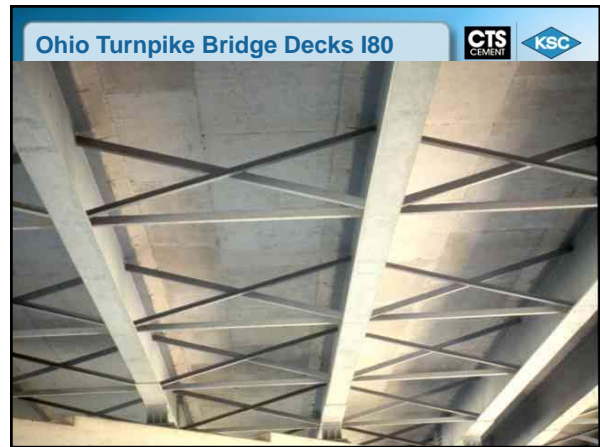
- ◆ Since 1960's used in Elevated Decks
 - ◆ Conventional Reinforced Structural Concrete
 - ◆ Post-Tension Structural Decks
- ◆ ASTM C-845 Defines the Cements K, L & M
- ◆ Type K, L & M Not Proprietary
- ◆ SRAs Delay Shrinkage - Not Compensate
- ◆ "G" is an additive but does not fall into ASTM C-845 or C-494 Classifications





Shrinkage Compensating Concrete

CTS CEMENT KSC

- ◆ ASTM C-845
 - ◆ Type K, L and M
 - ◆ Concentrates of these are allowed
- ◆ Over 600 Bridges Have Been Constructed Using The Type K Cement Technology
- ◆ Performance is Exceptional!
 - ◆ No Cracking – Survey 2012 - 1994 Bridges MI/OH – Confirmed Ed Rubin's Claims
 - ◆ Surface Condition – Maintaining Tine Depths and Little Noticeable Wearing Surface
 - ◆ Not Showing Deicing Chemical Attack





Abrasion Resistance  

- ◆ ACI 223-98 Para 2.5.7
 - ◆ “Shrinkage-compensating concrete...has an abrasion resistance 30 to 40 percent higher than portland cement concrete...”
- ◆ 2012 MI and OH Bridge Survey Surfaces in Remarkable Condition – Most have 70% Tine left in Wheel Tracks – No Scaling – 35 Year Decks



M-6/US-131 Grand Rapids, MI  



- 20 miles of new freeway
- 57 bridge decks constructed with Type K and Komponent
- 40 bridge decks completed in 2005

Michigan M6 Bridges 2006  






Typical Bridge Deck Mix Design  

- ◆ 550 - 600 lbs Portland
- ◆ 90 - 100 lbs ASTM C-845 Type K – Komponent (low alkali content)
- ◆ DOT Approved Bridge Quality Coarse and Fine Aggregates (Natural and Manufacture Sand -Limestone)
- ◆ Fly Ash at 15% Can Be Considered
- ◆ Air and Mid Range WR
- ◆ High Range When Needed



Grand Blac Road 2005  




Lodge Project MDOT Gateway Bridge Complex 2009  





04/29/2009 07:105

Lodge Project MDOT Gateway Bridge Complex 2009  



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Myths That Can Be Dismissed  

Equipment, mixes, design, conditions

- ◆ SCC - Use Same Production, Pumping, Placing Equipment
- ◆ Water Cement Ratio Required .44 to .55 (5 to 6" Slump) No Bleed - No Water of Convenience
- ◆ Can Use Traditional Design and Reinforcing
- ◆ Can Place Outside and During Daylight
- ◆ Same Hot or Cold Weather Practices as PCC

Lodge Project MDOT Gateway Bridge Complex 2009  




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Lodge Project MDOT Gateway Bridge Complex 2009  



05/08/2009 09:09

Myths Than Can Be Dismissed  

- ◆ **ASTM C-845 Type K Cement Concrete is Not New in Bridge Design**
 - ◆ In Ohio Since 1968
 - ◆ Type K Cement Listed in FHWA
 - ◆ Many Articles – Proven Performance
 - ◆ Established - Lowers Permeability and Limits Shrinkage Cracks
 - ◆ Over 600 Bridges

Ohio Bridges  

- ◆ 1968 U.S. Route 33 in Marysville
- ◆ 1974 I 675 Dayton – Black Bar few repairs
- ◆ “High Performance Bridge Deck – Use of ASTM C 845 Type K Shrinkage Compensating Cement with Lightweight Aggregate for Optimized Internal Curing, Excellent Durability and Performance Benefits” 2008 - PCA – FHA - National Concrete Bridge Council – MoDOT – ACI – Gulyas, McCabe, Katlin 15,000 cy 120 lb per cf – 715 lb mix - Cleveland lakefront “HPC”

I 80 Ohio Turnpike Meander Creek 2006  





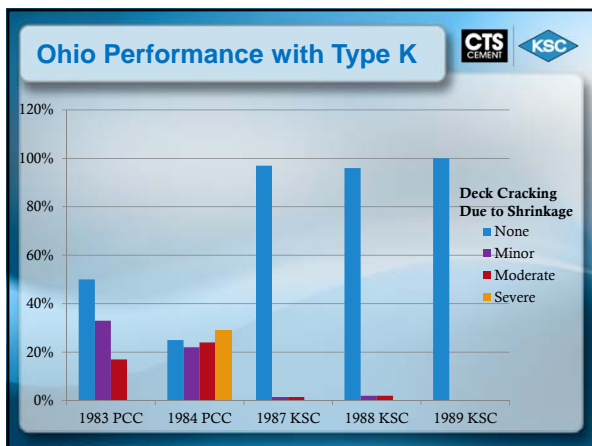
Ohio Turnpike Authority Director

Type K Shrinkage Compensating Concrete Addresses Many Concerns from Safety to Ride Characteristics.

“We don’t even think about cracks, crack maintenance or spalls on our Shrinkage Compensating Concrete Decks – Expecting 35 Year Life on The Decks Wearing Surface” Doug Hedrick Chief Engineer Ohio Turnpike

Ohio Turnpike Bridge Replacement Program 1983 – 1989

Year	Degree of Cracking				Total Bridges with crack	% of decks with crack
	None	Minor	Moderate	Severe		
1983	50%	33%	17%	0%	50%	PCC
	3	2	1	0	6	
1984	25%	22%	24%	29%	75%	PCC
	17	15	16	19	67	
1985	87%	10%	3%	0%	13%	KSC
	33	4	1	0	38	
1986	96%	4%			4%	KSC
	43	2			45	
1987	97%	1.5%	1.50%		3%	KSC
	72	1	1		74	
1988	96%	2%	2%		4%	KSC
	57	1	1		59	
1989	100%				0%	KSC
	53				53%	
1984 thru 1989 95% Crack Free						
1985 thru 1989 97.8% Crack Free						
Less than 3% Minor and no Moderate or Severe						
1984 2 Bridges Used Type K Concrete no drying shrinkage						
1885 to Date All bridge decks are specified with Type K Concrete						



Ohio Turnpike Authority

When asked the question;

“How does this effect maintenance costs?”

The Answer Is Quite Simple, Very Low Cost to Maintain the Actual Shrinkage Compensating Concrete Decks – No Deck Delaminations, Spalls or Steel Corrosion



Green

- ◆ A Total of 13 LEED Point Are Available With ASTM C-845 Type K Komponent Cement
- ◆ Lower Heat Island Effect
- ◆ Use of Re-Cycled Materials
- ◆ Low Emitting Materials
- ◆ Low CO2 Output in Production

Shrinkage Compensating Cements

CTS CEMENT **KSC**

- ◆ Several International Cement Manufactures Marketing in USA
- ◆ “K” is Available Throughout USA, Canada, Mexico and South America
- ◆ Sell Primarily to Ready Mix Producers
- ◆ Some Flatwork Contractors Have Silos
- ◆ Incorporates Traditional Concrete Materials and Mix Design Protocols
- ◆ Very Workable Concrete

