Michigan can lead

Presentation to the 2019 MI House Appropriations Transportation Subcommittee

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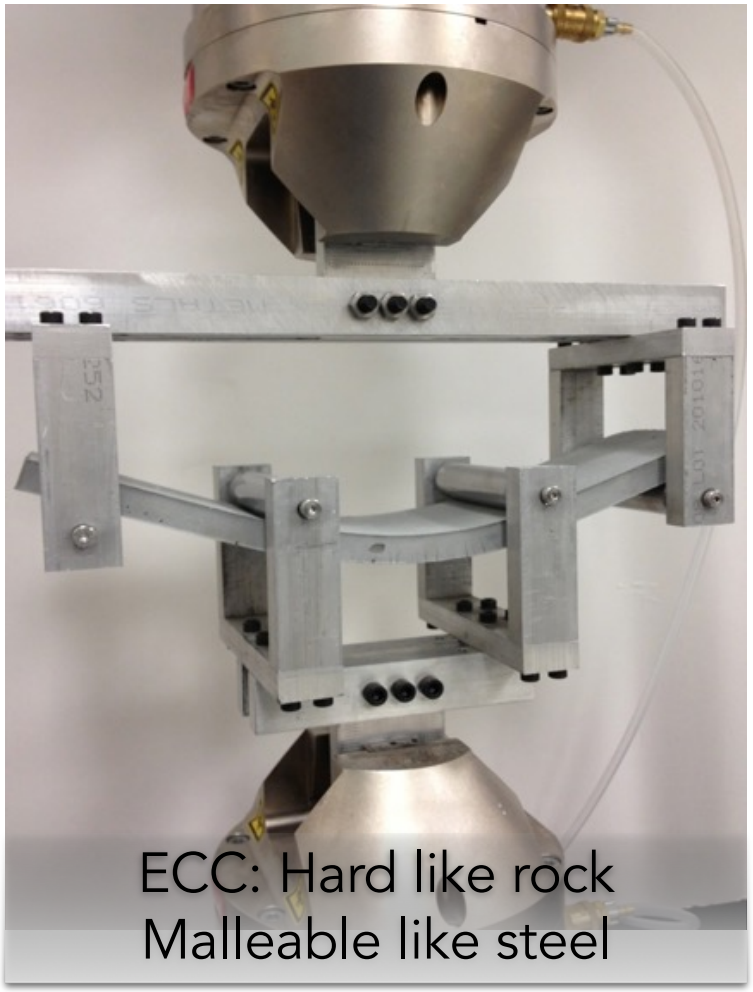
Bad road hurts


Cracks, cracks, cracks

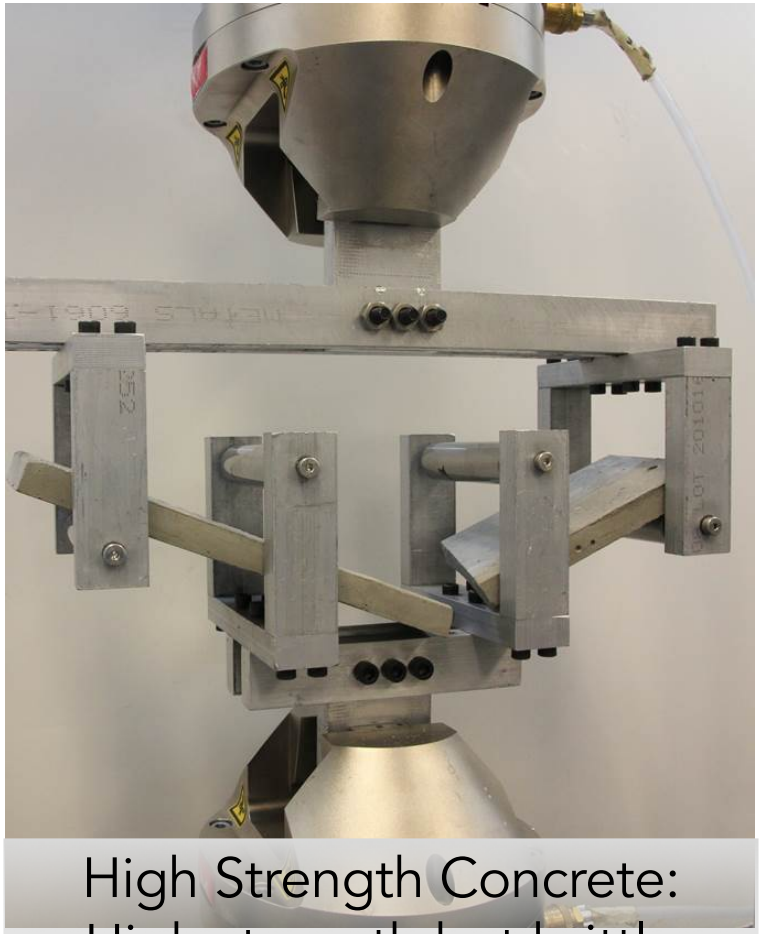
Tai Chi and abalone defense not by hard blocking, but by the ability to “give”

Bendable concrete (ECC) has the “give”

Invented in Michigan

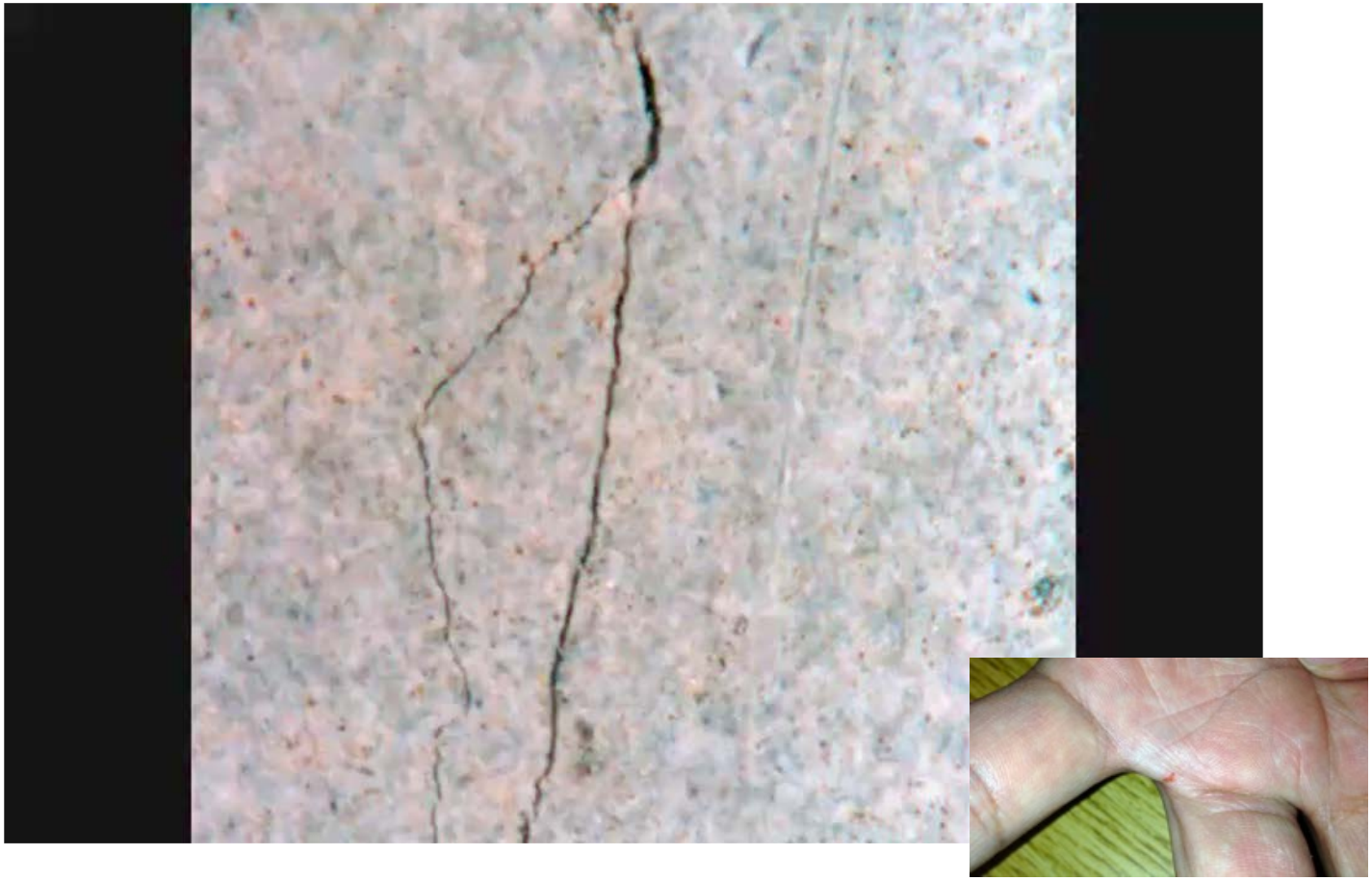


ECC: Hard like rock
Malleable like steel



High Strength Concrete:
High strength but brittle

ECC self-heals when damaged …



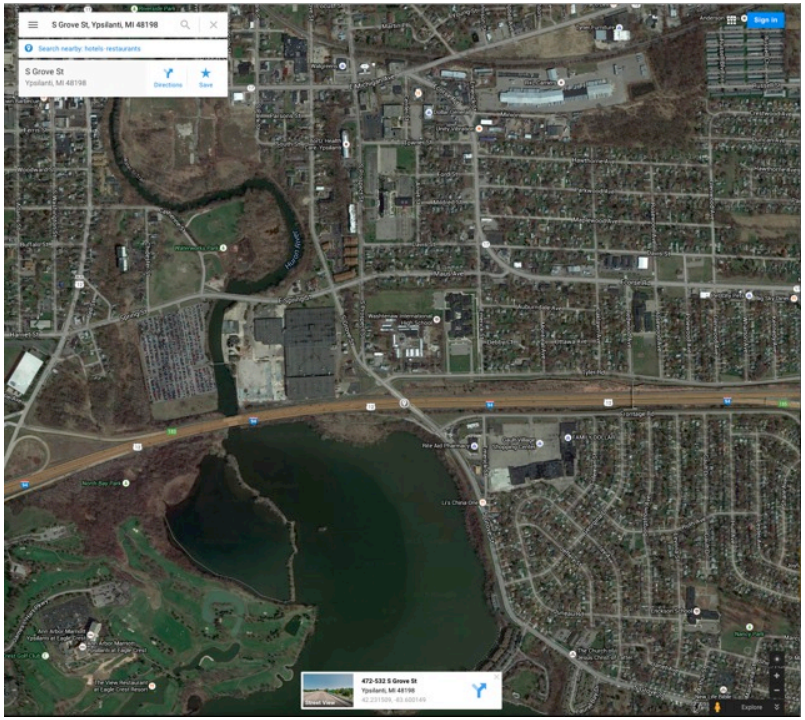
ECC has been used in full scale demanding applications

ECC reduces bridge deck maintenance

MDOT-UM Collaboration

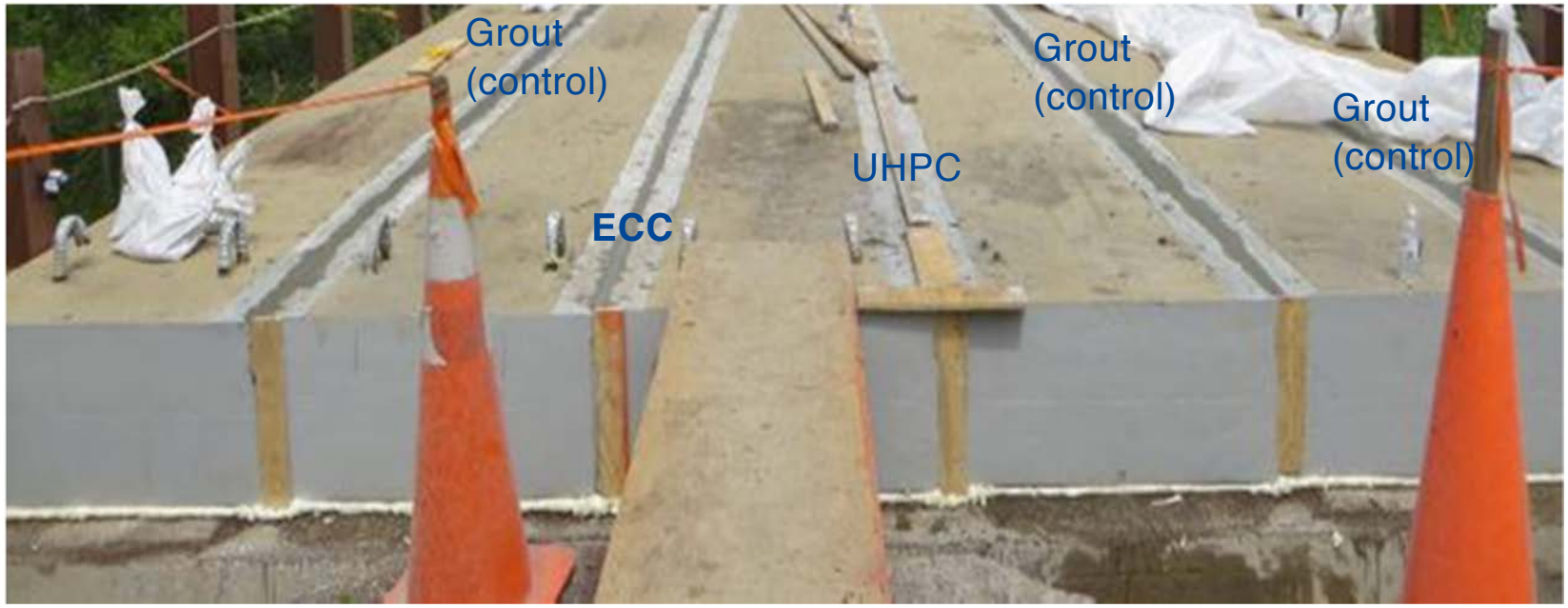
ECC link slab replaces high maintenance expansion joint (2005) on Grove Street Bridge, Ypsilanti, MI

Proven durability



(Google Map, July 2015)

VDOT experience: Shear keys to transfer loads between adjacent box beams

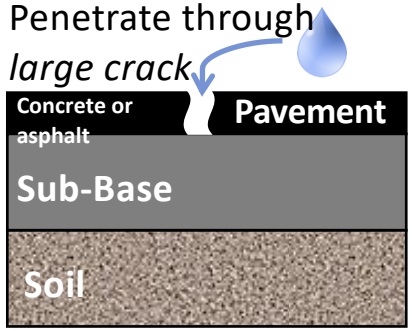


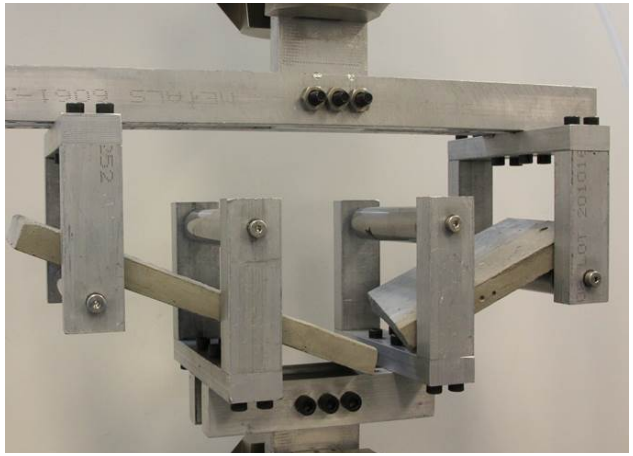
Typical problems: Issue is cracking, deicing salt leak, corrosion in prestressing strands, grout deterioration, limit shear transfer. Contractor: ECC cost = Non-shrink grout cost
Also use in closure pours and culvert repairs.
VDOT SP217-000110-00

VDOT finding: ECC is only material that did not leak

Fracture of pavement leads to potholes

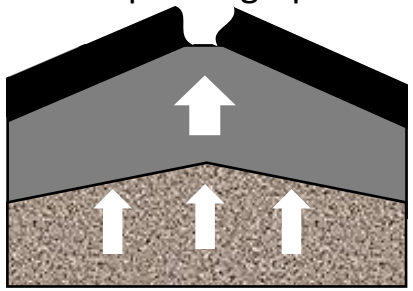
1. Water
Penetrate through *large crack*



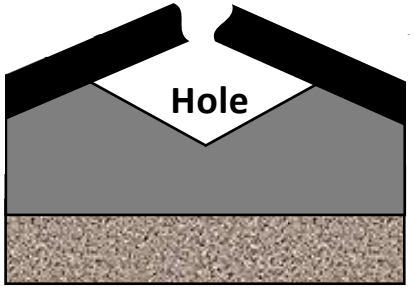


Concrete and asphalt (in winter) is brittle

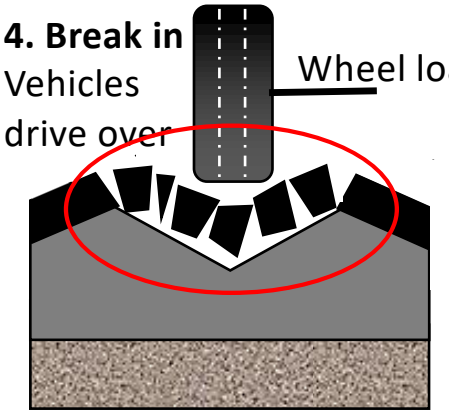
2. Freezing
Ground pushing up



3. Thawing
Ground returns, pavement partially suspended

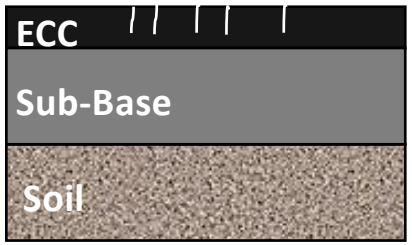


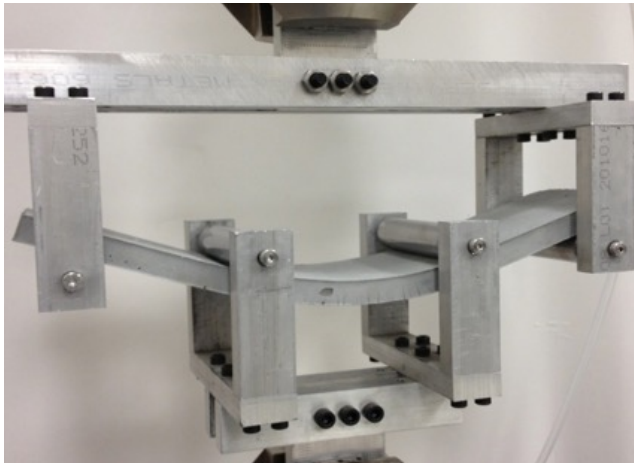
4. Break in
Vehicles drive over



Bendable ECC resists pothole formation

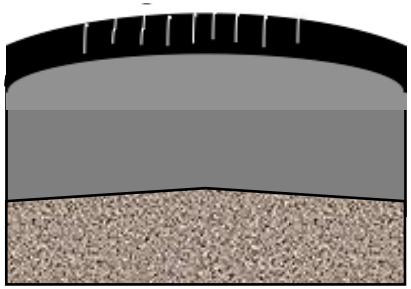
1. Water
Hardly penetrate through
fine cracks



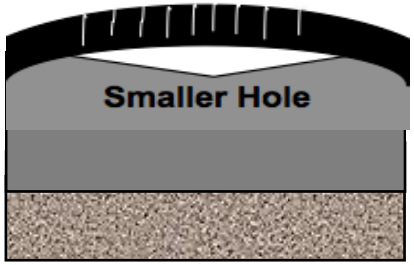


ECC is Ductile

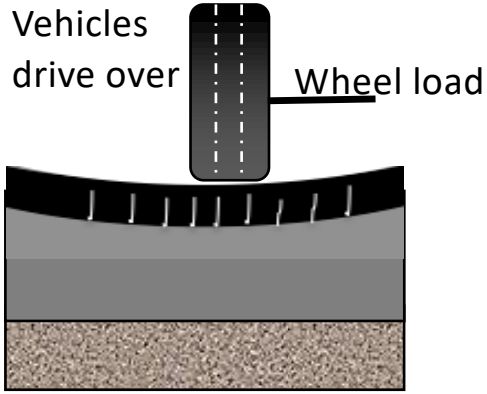
2. Freezing
Ground pushing up, multiple fine cracking on surface



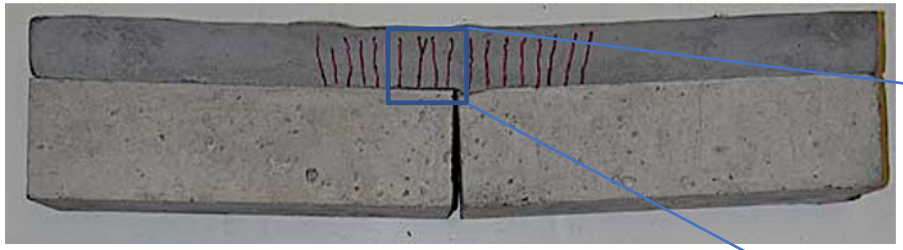
3. Thawing
Less water trapped, causes smaller hole



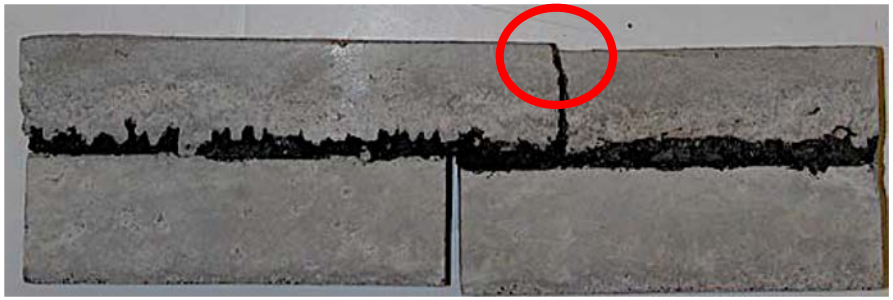
4. Bend back
Vehicles drive over



ECC overlay doubles service life with less than half the concrete overlay thickness



Thin ECC overlay



Thick concrete overlay with asphalt interlayer

Qian et al, 2008

Major life-cycle-cost reduction with ECC overlay

Table 2 Comparison of life cycle cost for different overlay systems

	Concrete overlay	ECC overlay	HMA overlay	ECC OL cost advantage over Concrete OL	ECC OL cost advantage over HMA OL
Agency cost	$10.1	$6.22	$14.8	38.4%	58.0%
User cost	$61.9	$37.4	$84.2	39.6%	55.6%
Environment cost	$0.9	$0.7	$1.11	22.2%	36.9%
Total cost	$72.9	$44.3	$100	39.2%	55.7%

(Note all units of cost are in millions)

Qian et al, 2008

Challenges ahead

- Risk perception inherent in innovations
  - Tests in lab and in field
- Cost
  - Higher cost compare to standard concrete (on per cyd basis)
  - Smart engineering reduces cost / mile of road
  - Long-term savings on O&M
- Training
  - Most current engineers not properly trained in ductile concrete
  - Universities and community college can help
- Collaboration
  - Government, universities, and private section
  - Supply chain lacking
  - Include in MDOT approved materials list
  - Demonstration projects to further reduce risk

Michigan talents

- University of Michigan
  - Advanced pavement materials
- Michigan State University
  - Great pavement testbed
- Wayne State University
  - Pavement durability assessment

Good roads, and green too!

- ECC as pothole killer
- Greening MI roads
  - Pavement that locks up CO_2
  - Mitigate climate change
- Turn a major challenge into an opportunity to lead other states
- Recommendation: Convene stakeholders to look at the technical, financial, risk, social aspects of road innovations
- Michigan **will** lead