

# First Winter Joint Damage in Airfield Pavement – Offutt AFB, NE

Toy Poole

September 23, 2008



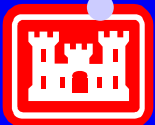
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# Background

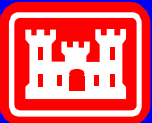
- Concrete placed summer and fall 2006
- Opened for traffic – early Dec 2006
- First winter - major damage to spalls and corners
- Second Winter – little new damage – some expansion of old damage

• USAF – What Happened!



# Responsible Parties

- USAF – owner, managed design
  - Alleged improper construction by USACE, probably air entraining problems
- USACE – managed construction
  - Alleged snowplow damage by USAF



# Concrete Mixture Proportions

Cement	Ash Grove, Type IP – 564 lb/yd <sup>3</sup>
w/c	0.42
Fine aggregate	Natural ~1200 lb/yd <sup>3</sup>
Coarse aggregate	Limestone #67, #4 ~1800 lb/yd <sup>3</sup>
WRA	MB Master Pave N, 9 oz/cwt
AEA	MB Pave-Air 90, 12 oz/cwt
Air content	6.2%
56-day flex	750 psi
56-day compressive	6200 psi



# Major Form of Damage

## First Winter



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# Shape of Sliver Spalls



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# Damage – cont'd

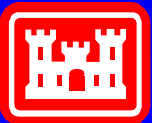


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# Objective

- Figure out what happened
- Recommend Revisions to Practice






# Construction Testing

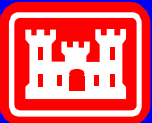
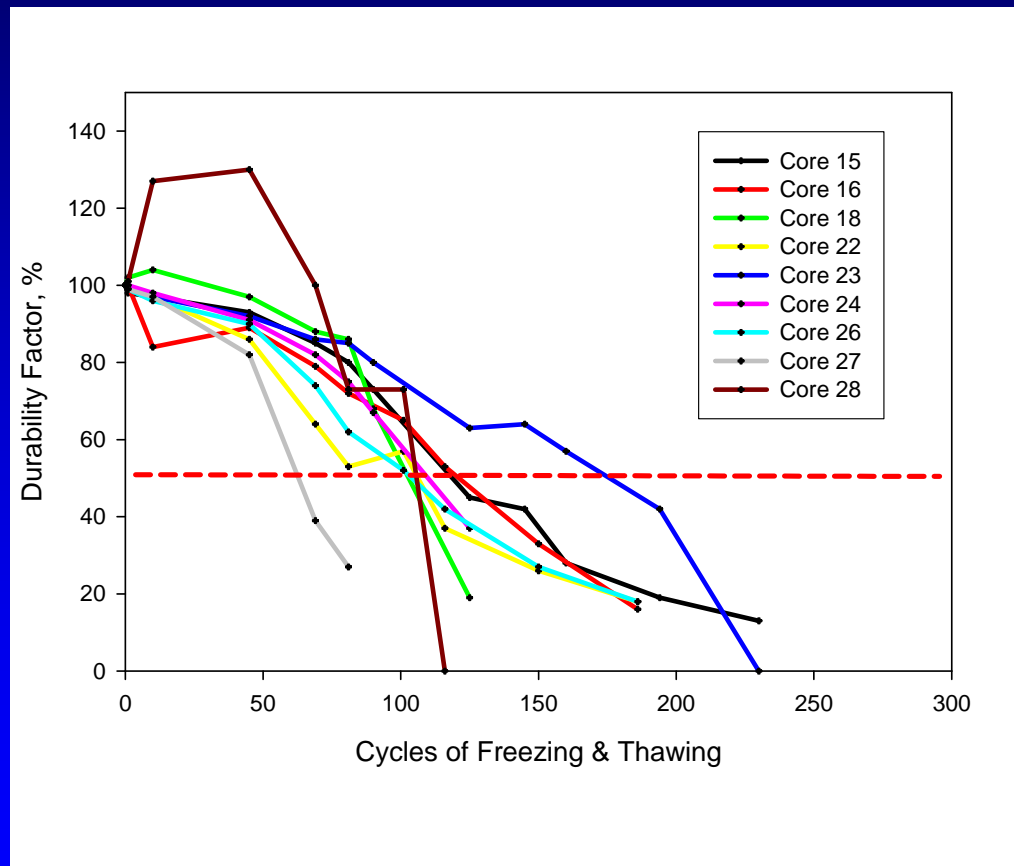
- Aggregate
  - ASTM C 295 – April, 2006
  - ASTM C 1646 - 2004
- Cement – mill certificate, Type IP
- Air Content – QA data:
  - Mean (range) = 5.2% (4.5 – 6.2%)
  - Std (CV) = 0.4% (8%)



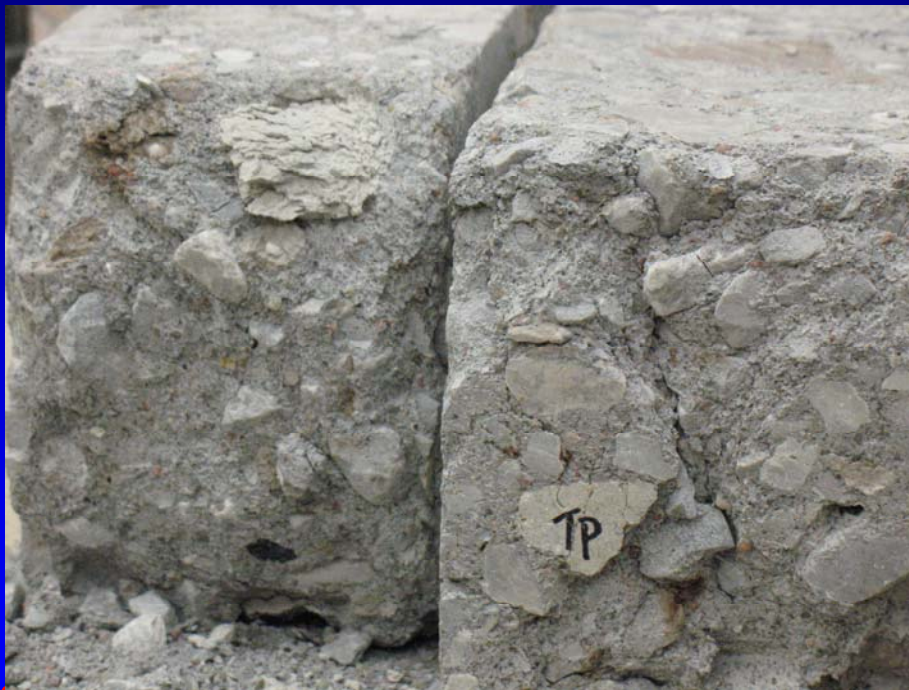
# Analysis of Field Concrete

- C 457 – air void parameters
- C 1646 – cycles of freezing and thawing
- D 5312 – freezing and thawing w/ deicer
- C 295 – aggregate mineralogy
- Monitoring – 2<sup>nd</sup> winter
- C 1074 – maturity at first freezing and  
 pavement opening

# ASTM C 1646 – Cycles of Freezing and Thawing



# Petrography – Gross Reaction

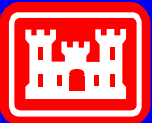
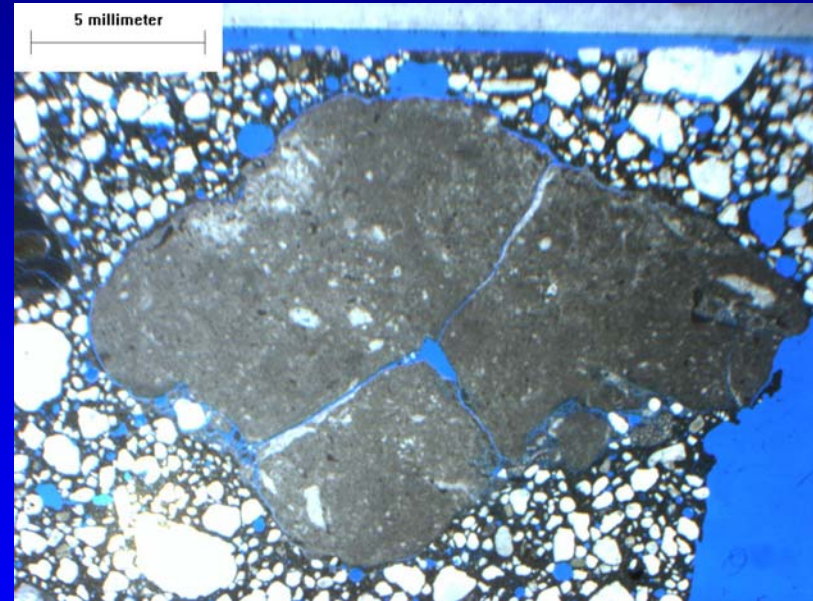
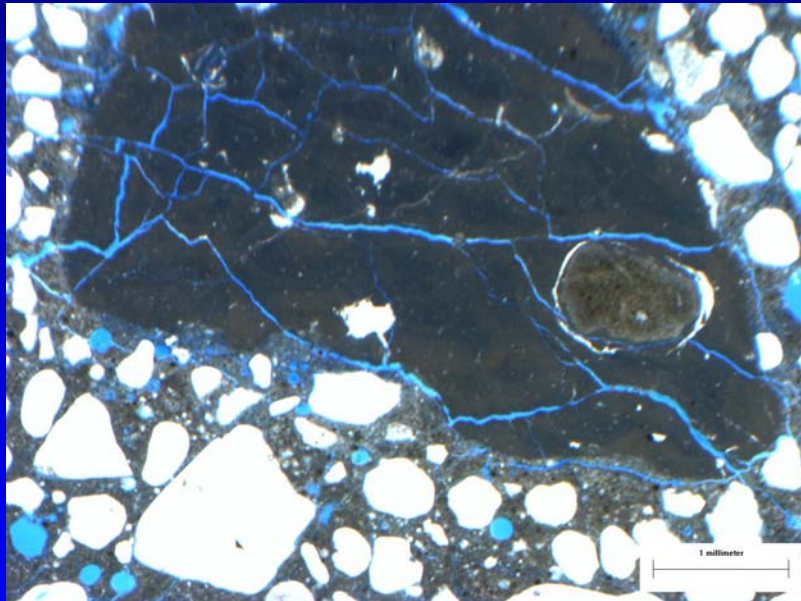


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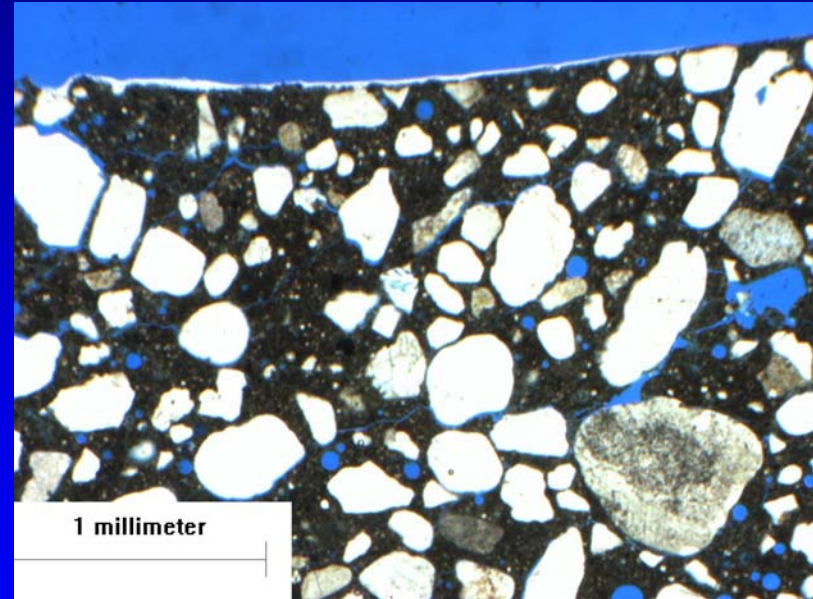
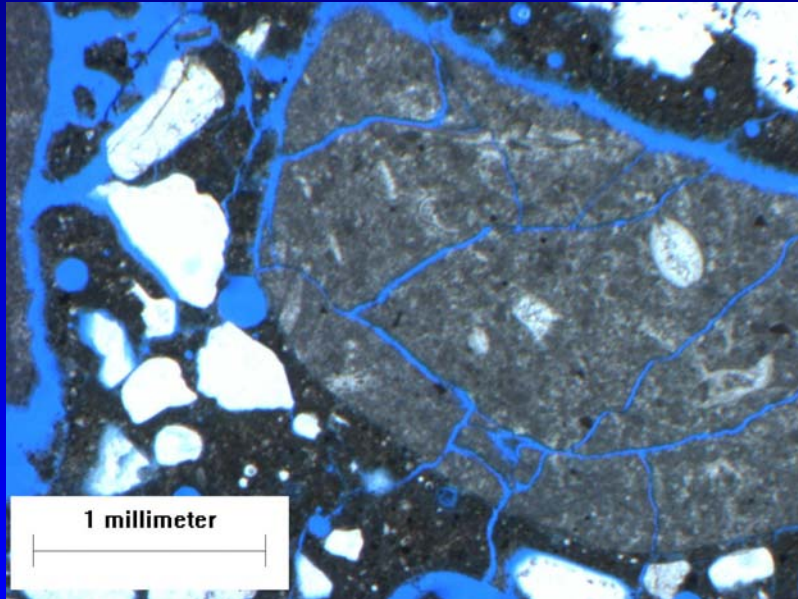
# Petrography – Thin Sections



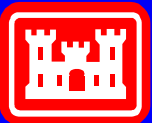
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# Petrography – Thin Sections



Paste damage

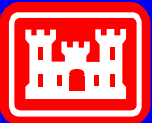
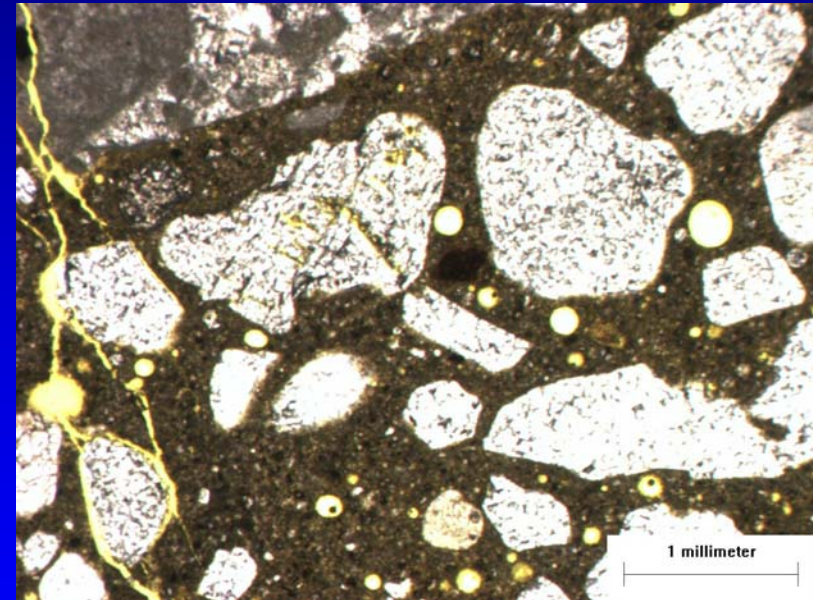
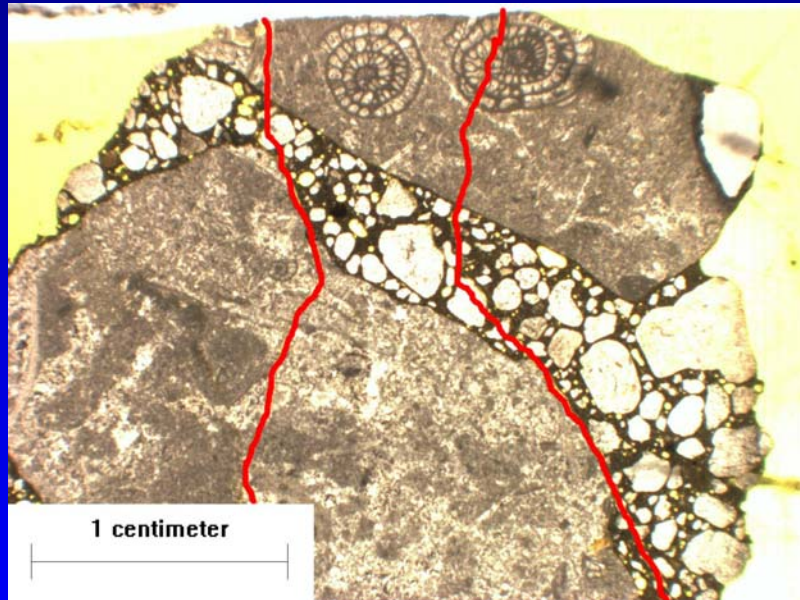


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# Field Damage



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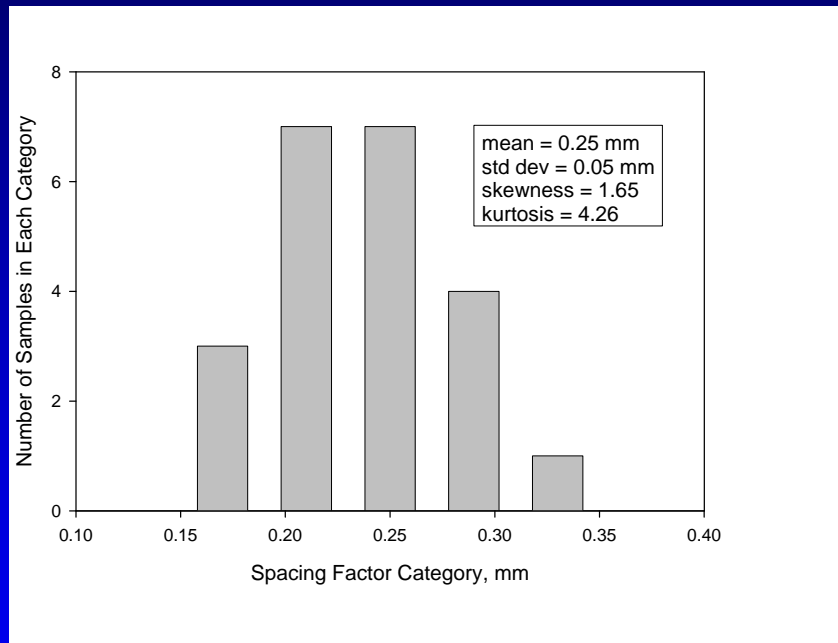
# ASTM C 457 – Air Void Parameters

Property	Mean	Std	CV
Air Content	3.9%	1.6%	40%
Spacing Factor	0.25 mm	0.05 mm*	22%
Specific Surface	21 mm <sup>-1</sup>	6.3 mm <sup>-1</sup>	30%

\*expect 0.02 mm from variation in test method



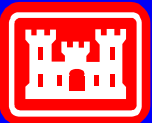
# Distribution of Spacing Factor



Spacing Factor of small areas near C 1646 damage ranged from ~0.4 to 0.6 mm

Guidance: ACI 0.20 mm  
CSA 0.23 (max 0.26 mm)

Spacing Factor – std C 457 samples



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# Air Void Parameters, Small Zones

Specimen ID, cm <sup>2</sup>	Total Air, %	Spacing Factor, mm	Specific Surface, mm <sup>-1</sup>	notes
7	1.8	0.25	32	Minor damage
7	2.5	0.28	26	Close to damage
7	6.3	0.25	19	Unexposed to F/T
7	3.8	0.47	12	Modest damage
7	12.1	0.51	6	Major damage
7	4.5	0.49	10	Unexposed to F/T
7	5.2	0.29	16	Unexposed to F/T
7	5.4	0.39	11	Minor damage
7	5.6	0.52	9	Minor damage
15	4.7	0.58	9	Major damage
15	4.3	0.38	13	Major damage
25	3.8	0.16	33	Modest exterior damage
25	8.9	0.17	17	Modest exterior damage



# D 5312 – Deicer Effects



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19 cycles of freezing & thawing

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# Potassium Acetate Exposure >19 F/T Cycles

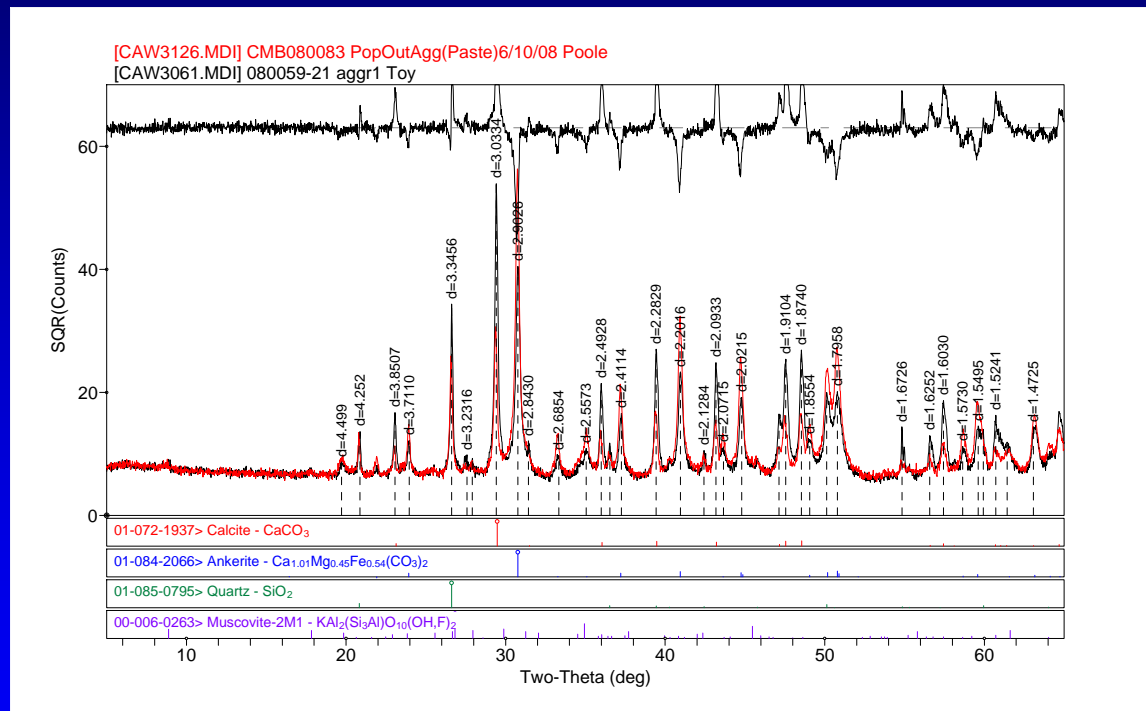


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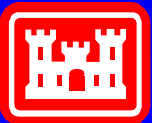
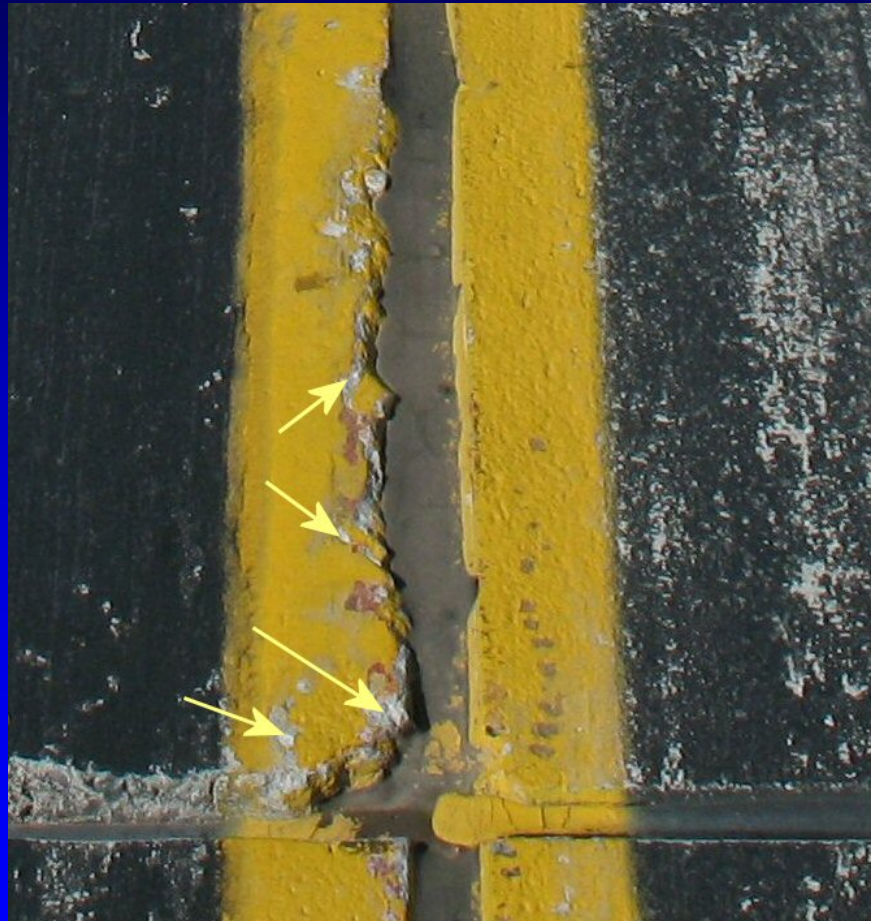
# Offending Aggregate



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# Monitoring 2<sup>nd</sup> Winter



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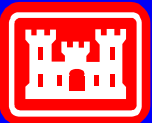
# Possible Deicer Effect



Dec 07



Jun 08



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# Non-Random Aggregate Dist?



Dec 07



Jun 08

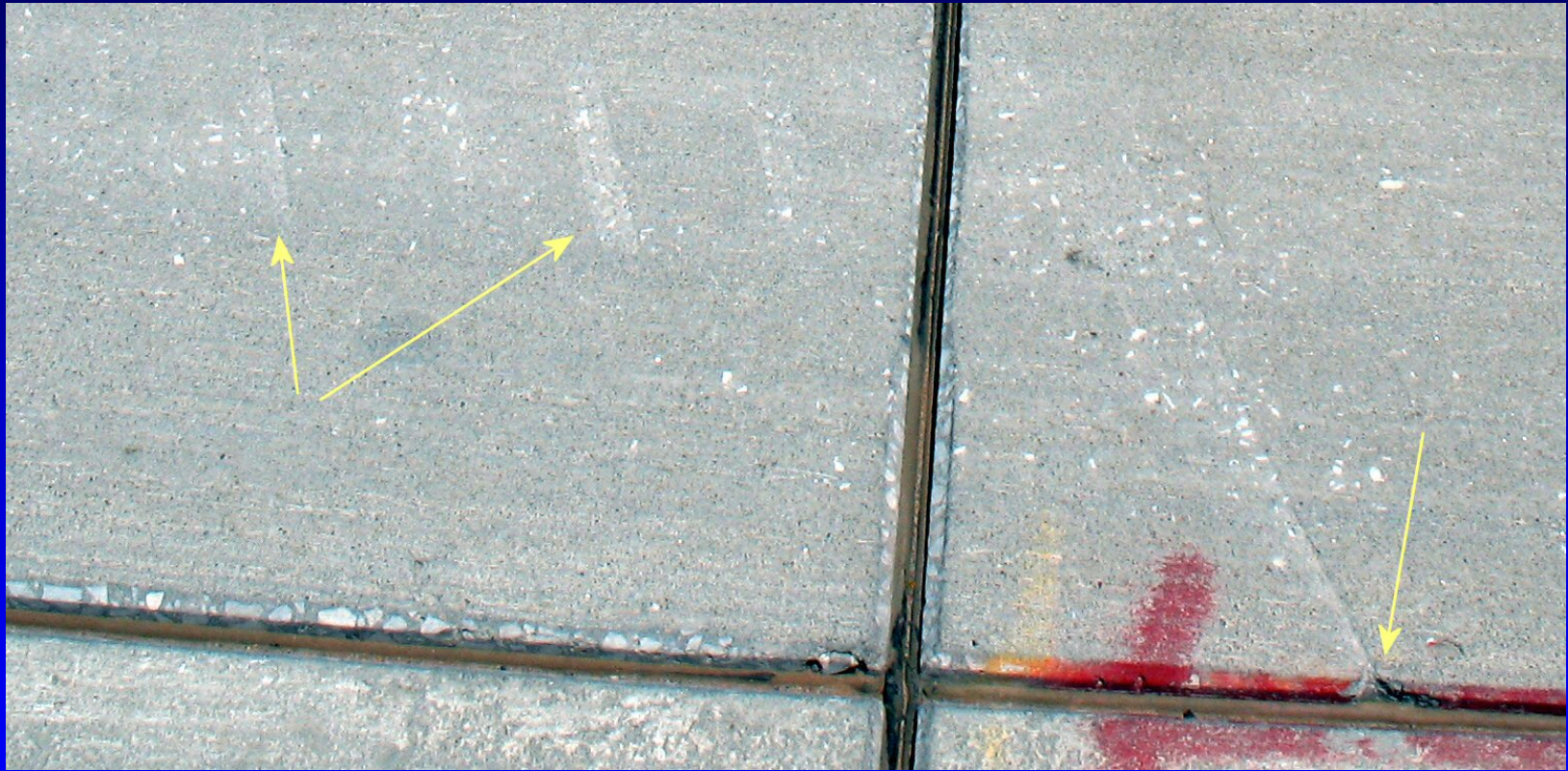


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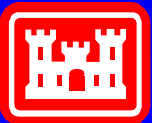
# Snow Plow?



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# Typical Snowplow?

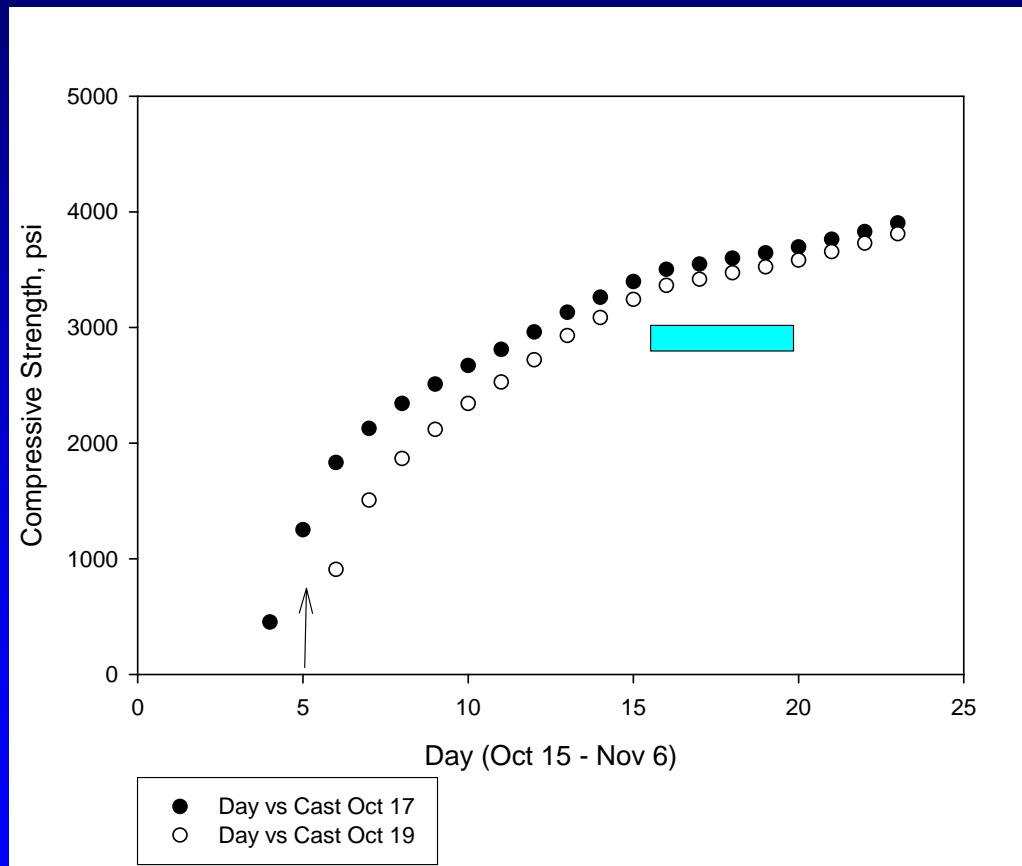


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# Maturity



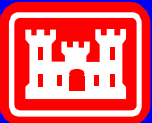
# Conclusions

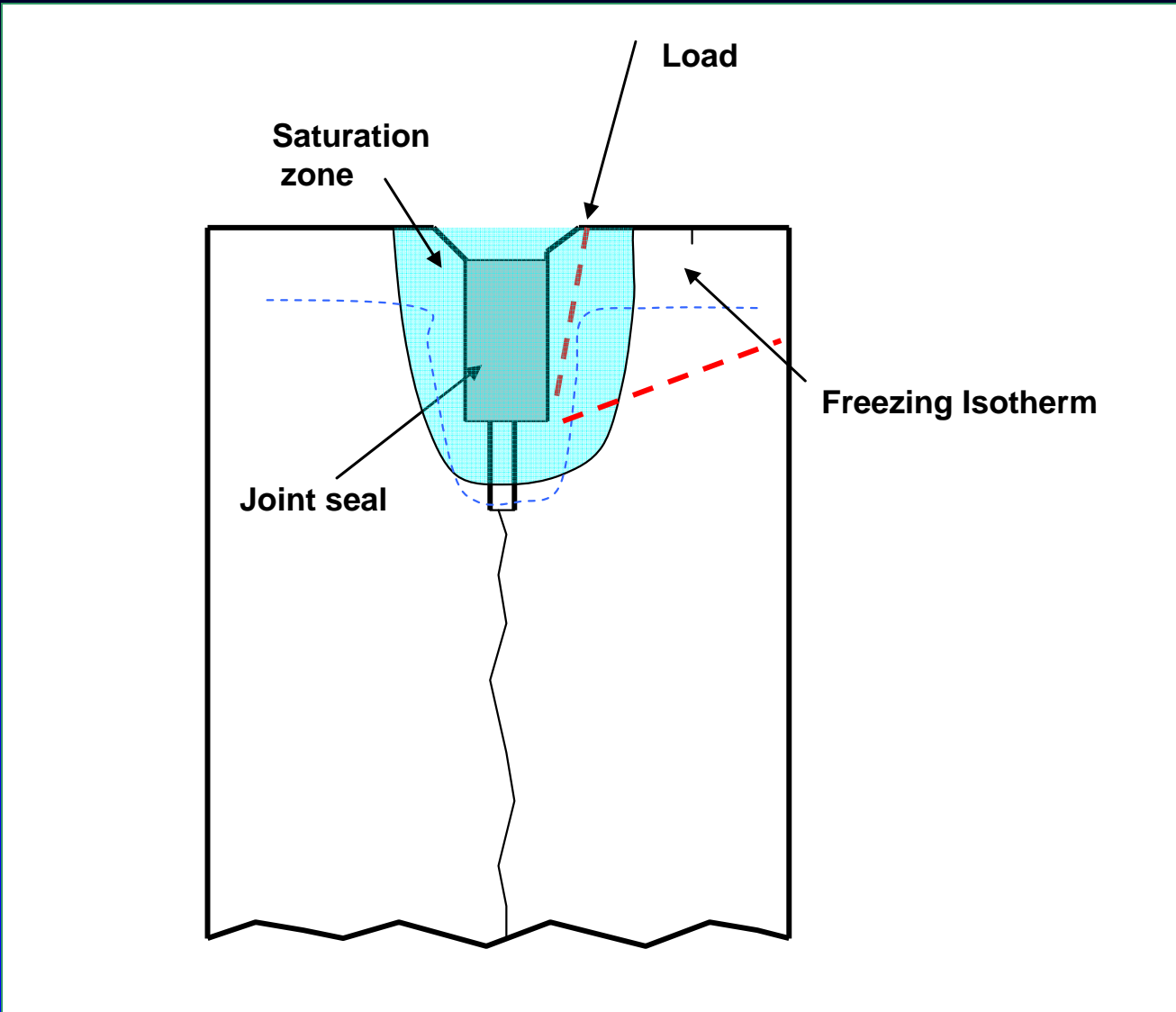
- Air void spacing factor
  - Slightly deficient on average
  - Maybe more than slightly in specific locations
- Non-durable coarse aggregate
- Deicing salt damage to paste & aggregate



# Conclusions, Cont'd

- Interactions among all three individual damage mechanisms?
- Damage revealed by service loads





# Recommendations

- Increase target air content
- Use of the air void analyzer to verify distribution of air voids
- Revise aggregate acceptance protocols
- Look into effects of deicing salts in more detail

