PAVEMENT RECONSTRUCTION CHALLENGES AND INNOVATIONS ON I-40 WEST OF FLAGSTAFF

ADOT Geotechnical Services Section

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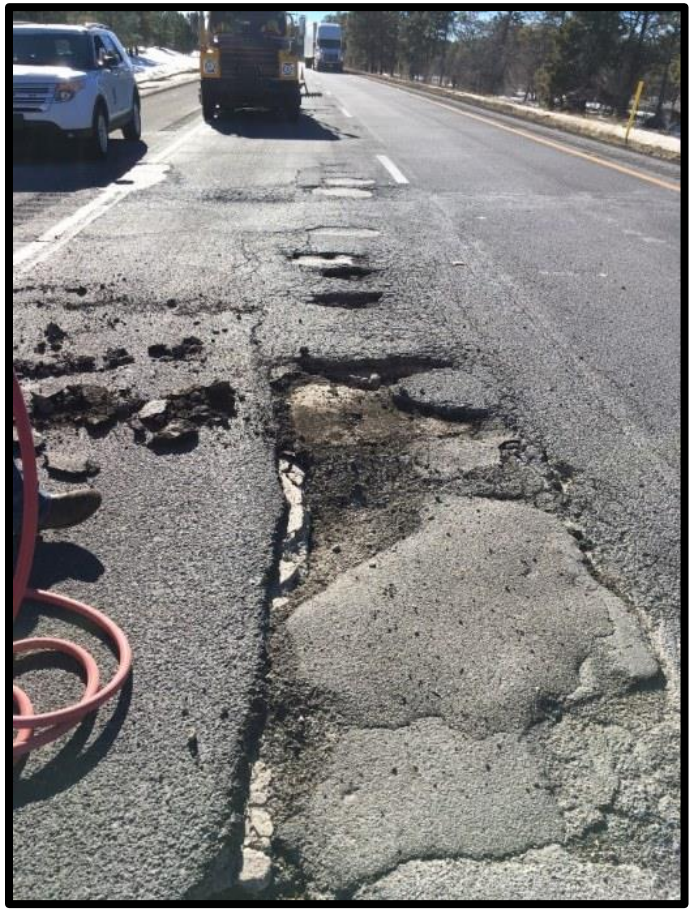
WINTER OF 2016/2017

Asphaltic Concrete Overlay on 8 to 9 inch PCCP



Spalling PCCP beneath AC Overlay

Maintenance worked diligently to attempt to keep road operational.

$$$ High Maintenance Expense

Media outlets in Williams and Flagstaff reported more than 150 blown tires in 60 day span. Many vehicles bent rims and damaged suspension and undercarriages.

ADOT's Response

- Devil Dog project was initiated in April 2017
- Cataract Lake project, previously scheduled for December 2017 bid advertisement, increased scope to include 6 miles of complete reconstruction

- Devil Dog to Williams I-40 MP 156.5 to MP 161
- Cataract Lake Road to Parks TI I-40 MP 162 to MP 179 (Presentation by Tad Niemyjski)

Devil Dog Project

- Initiated in Late March 2017
- Design Complete by June 2017
- Design Team – Gannett Fleming (Roadway), EcoPlan (Environmental), ADOT Pavement Design Section, ADOT Geotechnical Services, ADOT Contracts and Specs
- Project Manager – Suzanne Deitering
- Project Sponsors – SEO (Todd Emery and Barry Crockett)

Why Reconstruct Devil Dog?

- Cost to maintain existing roadway prohibitive
- 2014 project from MP 152 to MP 161 cost $16 million
- Yearly maintenance cost rising rapidly
- PCCP section spalling due to thin section (8 to 9 inches)
- Subgrade drainage ineffective
- Future truck traffic

Devil Dog Project

- Geotechnical investigation and recommendations completed April 20, 2017
- Large sections of subgrade were deeply saturated
- Some moisture contents near 30%

Devil Dog Pavement Design

- 14 inch doweled PCCP
- EB lanes – New construction from subgrade up (long season summer 2018)
- WB lanes – Place new PCCP on top of existing roadway. Adjust existing grade with AC to correct super-elevation. (short season July 15, 2017 to November 1, 2017)

Sustainability Design

- Specification for Class 6 aggregate layer written to encourage recycling of existing PCCP
- Specification for paving products allows Recycling of Asphaltic Concrete (RAP)

Devil Dog Construction

- Prime Contractor – Fann Contracting
- Contractor requested to change sequencing to perform complete reconstruction of EB lanes in short season
- Extensive recycling program developed by contractor


CAT


EPS
13-480


GOMACO
WITH Pride


ERIE

PCCP Dowel Placement

Devil Dog Material Haul

- Cement – Drake Plant 35 miles
- Fly Ash – Cholla Power Plant Joseph City 115 miles
- PCCP Fine Agg – Hanson in Prescott 60 miles
- PCCP Coarse Agg – Fann's Red Lake Source 17 miles
- AC Paving – Produced at Fann's Red Lake Source 17 miles
- Recycling PCCP reduced approximately 3,000 aggregate truckload hauls to project

Project Costs

- Bid Award - $33,980,986
- Design - $641k or 1.8% of construction
- Closeout - $36,591,790
- 7.7% overrun - $2.6 million
- Pumping subgrade $520k
- Bid item overruns $2.1 million

How to Improve?

- Adjusting super-elevation grades on WB over-topping design with AC proved difficult. Up to 30 inch wedge in some places. Major source of cost over run.
- Pumping subgrade. Focus on mainline PCCP. What about shoulders?
- Gradation for PCCP recycling produced waste product from bottom end. Could have designed to utilize this product.

Project Successes

- Completed EB reconstruction in short season before winter – 105 days
- On-site concrete batch plant
- On-site crusher
- Partnering – Listened to contractor to allow EB full reconstruction vs WB over-topping in short season
- Traffic crossovers to keep work separated from traffic

I-40 Pavement Reconstruction
Cataract Lake to Parks TI

Cement Treated Cinder Base

Cataract Lake to Parks Traffic Interchange

- Section of I-40 was constructed in about 1967
- Scoped as a pavement rehabilitation project
- 17 miles of milling and replacing surface asphalt
- East of Williams and extended to Parks, Arizona
- Several areas of pavement showed signs of full depth failure during the winter of 2016/2017

Pavement Failures

Pavement Failures

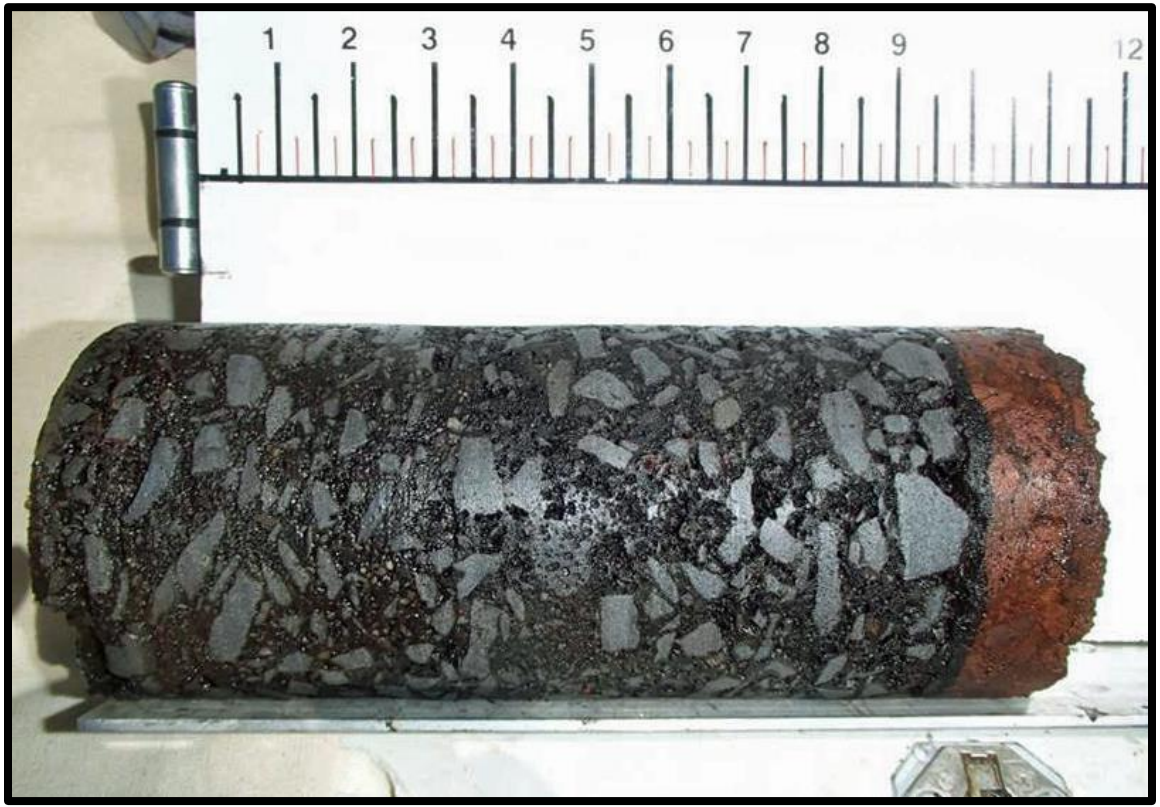
Reconstruction Areas

- Scope increased to include investigating failing pavement late in the design process
- Several areas of repeated patching of pavement
- Five mile section and a one mile section
- Both lanes in each direction

Subsurface Investigation

- Subsurface Investigation began with 21 borings in April of 2017
- Supplemental Investigation included 37 additional borings in August of 2017

Subsurface Investigation



Subsurface Investigation

Subsurface Investigation

Subsurface Investigation

- Processed cinder pavement foundation material
- Primarily silty to clayey sands
- Averaged:

  98% passing the 3/4” sieve

  71% passing the #4 sieve

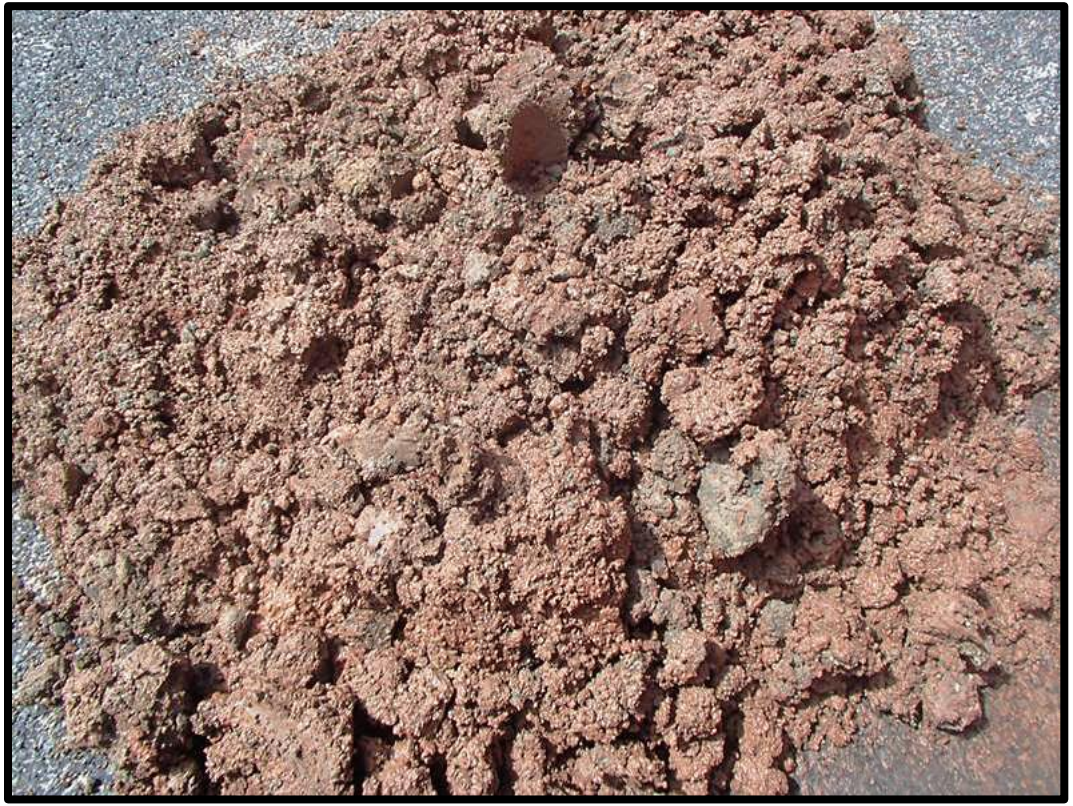
  15% passing the #200 sieve

Subsurface Investigation

Subsurface Investigation

- Encountered wet cinder conditions
  - Particularly in early part of the construction season
- Moisture contents ranged from 8 to 27% moisture
- Averaged 17% moisture by weight

Subsurface Investigation



Evaluation of Reconstruction Options

- Mill and overlay as planned
- Full depth reconstruction
- Use of geogrid and geotextile below the pavement
- Overexcavation of cinders and replace with aggregate base
- Choice based on construction cost and schedule:

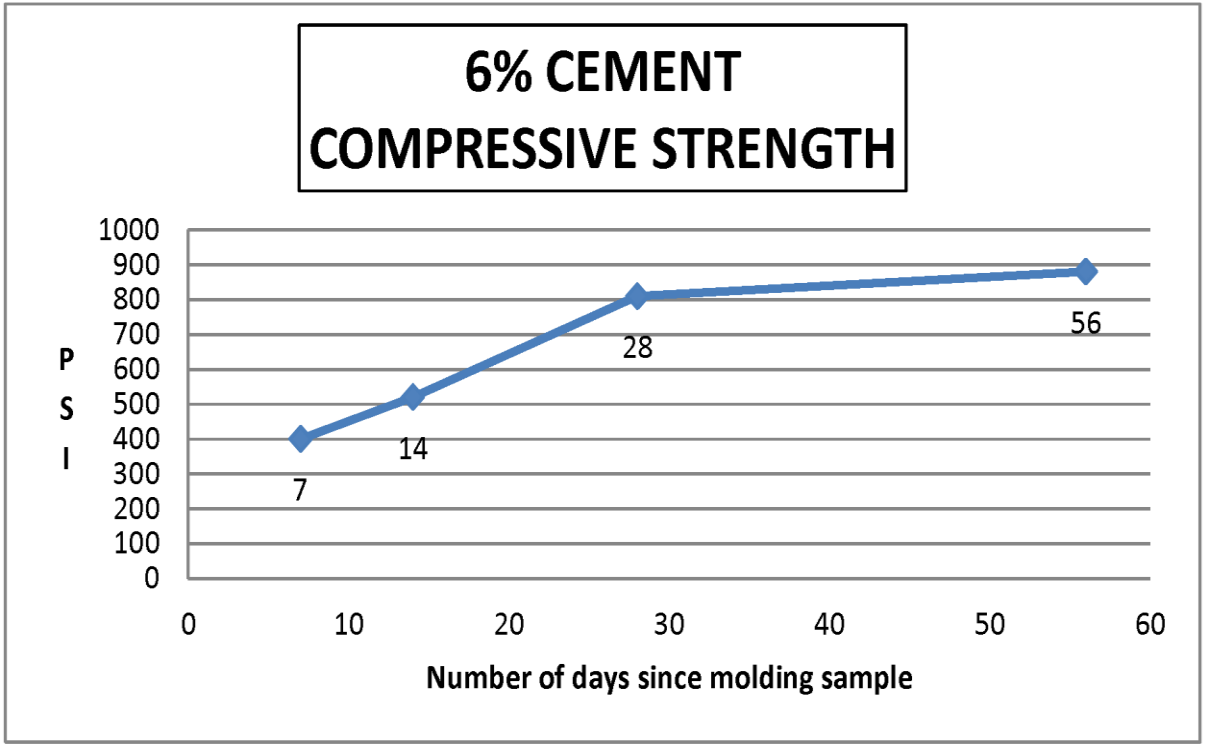
  Treatment of existing cinder foundation materials

Cement Treatment of Cinders

- Required no overexcavation and replacement which reduced haul costs and construction time
- No costly aggregate base required
- Minimal waste material generated
- In place mixing and curing

Cement Treated Cinder Mix Design

- Varied cement content
- 28 day strength design
- 6% portland cement by weight



Base Shrinkage Cracking Concern

- Pavement base stiffer than AC pavement section
- Concerns of shrinkage cracks reflecting to the surface
- Pavement cracks introduce water into the subgrade
- Texas Transportation Institute study on the use of microcracking of cement treated bases

Microcracking

- "Effectiveness of Minimizing Reflective Cracking in Cement-treated Bases by Microcracking" (FHWA Report No. FHWA/TX-05/0-4502-1, Oct. 2004)
- Frequent cracking mitigates large shrinkage crack widths
- Reduction of risk for surficial reflective cracking
- Stiffness reduction

Construction

- In-situ mixing and curing bid price was $7 per sq. yd.
- Intelligent compaction used to monitor microcracking strength reduction
- Microcracking was performed about 3 days after mixing and compaction

Construction

Construction

Construction

Notice rutting of untreated cinders on right side

Construction

Finished cement treated cinders in the middle of image

Construction

Lessons Learned and Project Successes

- Cement stabilized cinders was effective
- Microcracking was important
- Intelligent compaction was effective for monitoring strength reduction
- Accelerated reconstruction efforts
- Saved between 8,000 and 9,000 haul truck trips
- No construction change orders
- About $5 million saved

Questions