INTELLIGENT COMPACTION
The New & Improved PennDOT Way

37th Annual APC/PennDOT Fall Seminar, November 19, 2015

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OUTLINE

- APC Mission Statement
- IC summary
- Results
- Lessons Learned
- Project Statistics
- Conclusions & Future Directions
Establish a roller pattern on a test strip to determine how many passes are required to get the desired density.
Guess how hot the asphalt is.

Guess how many passes were made at this spot.

Assume that the density spot checks are representative of the mat.

Assume that random sampling is an appropriate method of ascertaining the quality of the mat.
Establish a roller pattern on a test strip just like normal. HOWEVER, also record the temperature, stiffness and pass count information for reference along with the density gauge readings.

**MONITOR** the IC data during construction. **COMPARE** the results to the target values established during the test strip. **TAKE APPROPRIATE ACTION** as warranted.
KNOW how hot the asphalt is.

KNOW how many passes were made at this spot.

KNOW the variation in the density (stiffness) across the mat.

KNOW whether the prerequisite for random sampling (relatively uniform conditions) have been met.
Appropriate contractor personnel need to be trained to use the IC tools at their disposal, to recognize deficiencies, and to implement changes to remedy the deficiencies. Deficiencies include not only low densities, but duplication of effort, wasted time, and wasted fuel.
Good work produces consistent, reliable, predictable, results. Some variability is expected – but, how much is too much?

Variability can be due to irregularities in the underlying materials. A contractor placing an overlay on an existing roadway is not likely responsible for variations in the existing conditions.
Variations that the contractor may be responsible for include:

- Changes in the asphalt mixture – a change at the plant (different material sources, processes, or admixtures, etc.), a different plant, delivery of the wrong material.

- Changes in the paving/rolling equipment, settings, or personnel.
If the data are reasonably consistent, and a step up or down occurs, and the data are reasonably consistent again, then there may be a satisfactory explanation for the change.

However, if the data generally indicate a lot of scatter in the values, then the quality of the work may be suspect.
This detail shows some minor variations in roller speed – but overall, the consistency is excellent.
While there are occasional exceptions, the temperature data indicates consistently good temperatures.
Lessons learned include:

- Set-up is not fool-proof
- Trees overhanging roadways
- Electrical lines and transformers
- Shallow bedrock
- Scale effects
- Other states
LESSTIONS LEARNED – STRAY CURRENTS

Signbridge with flashing warning lights and electrical transformer
LESSONS LEARNED – SCALE EFFECTS

THIS IS THE EXACT SAME SPOT AND THE EXACT SAME DATA! THE ONLY DIFFERENCE IS THE SCALE INTERVAL AND THE COLORS SELECTED.
Some states are requiring that all rollers be equipped with IC devices. Presently, the Department only requires the breakdown roller be IC equipped because it is the one that does most of the compaction work.

BUT, if the contractor is running tandem breakdown rollers like they did on ECMS 99054 on I-90 in District 1-0, then the IC only records half the passes because the second breakdown roller is not recording.
Also, if the intermediate roller “helps out” the breakdown roller such as happened on ECMS 101489 SR 222 in District 5-0, then again, the number of passes recorded by the IC will seem to be deficient because the second roller was not recorded.

By instrumenting all the rollers, there will be no blind spots. The Department may consider going this route to help clarify what is going on at all construction sites.
• We have had IC projects in 10 of the 11 Engineering Districts.

• We have had multiple IC projects in Districts 9(2), 10(2), 11(4), 12(6)

• 13 IC projects have been completed

• 5 IC projects are under construction

• 2 IC projects are in design
• We now have bid prices on 17 projects for a total of $256 M of construction costs including just over $1 M in IC costs.

• The cost for an IC project has ranged from $20,000 to $164,000.

• The unit cost for IC has ranged from $0.09 to $1.13 per SY.
• Contractors are generally not renting the equipment on a per SY basis. They are renting by the week, by the month, etc. Therefore, we are recommending that IC be used for every suitable material as long as the machine is on-site.
The key to achieving optimum compaction, that is, the required density with a minimum number of passes, is uniformity. Uniformity in pass counts means a consistent application of the roller effort – not too much, not too little. Uniformity in temperature means consistent workability – not too hot, not too cold. Uniformity in stiffness means consistency in compaction results – soft spots can be identified and mitigated during construction.
IC can eliminate unnecessary duplication of effort with its waste of time and fuel all while maintaining or even improving the quality of the finished product. As contractors gain experience using IC, it is hoped that their increased efficiency will lead to improved quality at no additional cost to the Department.
Future Issues

How much time / money does the Department want to “invest” in education before we remove the incentives?

Who will eventually be taking ownership of collecting and analyzing the IC data?

Is the Department / Industry willing to change the acceptance criteria for soils/asphalt materials to include criteria based on the IC data?
To Be Continued …
INTELLIGENT COMPACTION
A Contractor’s Perspective

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Lehigh Hanson
HEIDELBERGCEMENT Group
ECMS 8212
KEYSER AVENUE, SCRANTON
HIGHWAY FOR LIFE PROJECT
INTELLIGENT COMPACTION
PROJECT BID DATE: 8/23/12 with 4 addendums

PRIME CONTRACTOR: KRIGER CONSTRUCTION, INC., DICKSON CITY, PA

PENNDOT ACE: MR. JOHN ARCANGELO

PADOT IIC: MR. ROBERT SANTOSKI

PROJECT WAS REVISED: SEPTEMBER, 2013
- NEW BASE COURSE DESIGN, FALL 2013

- FULL WIDTH #3 AASHTO STONE BASE VARIABLE DEPTH. OUT TO OUT, CARTWAY AND SHOULDERS

- 7” 37.5MM BITUMINOUS BASE COURSE, OUT TO OUT

- 2 ½” 19MM BITUMINOUS BINDER COURSE

- 1 ½” 9.5 MM WEARING COURSE, FOUR DIFFERENT MIX DESIGNS, THREE WMA, INTELLIGENT COMPACTION
Course Laid Out for Keyser Valley Road

Base course is being laid for new road leading from Keyser Ave. to site of the old Lackawanna Railroad Shops in Keyser Valley which is being prepared as a food warehousing industrial site under plans of the Scranton Redevelopment Authority. New building of Affiliated Foods, Inc.—first new building on the site—is nearing completion. It is hoped that the new area will replace lower Lackawanna Ave. as the area's food distribution center.
INTELLIGENT COMPACTION SPECIFICATION

FOR THE KEYSER AVENUE PROJECT
ECMS 8212

SPECIAL PROVISION 9409-0001

SPECIAL INTELLIGENT COMPACTION ATTACHMENT
1. General Description:
This work shall consist of furnishing Intelligent Compaction (IC) rollers for the construction of the bituminous pavement within the limits of the work as described in the plans. The work consists of the compaction of the bituminous pavement with a roller equipped to measure and document compaction parameters provided by the roller and positioning, and documenting the locations by use of a Real Time Kinematic Global Positioning System (GPS).

This work also consists of providing project specific evaluations based on roller compaction parameters, density (stiffness), material temperature, number of roller passes and other roller parameters that will provide ongoing quality control data to the Department.
1.01 Definitions

IC is defined as a process that uses vibratory rollers equipped with a measurement/documentation system that automatically displays and records various critical compaction parameters in real time during the compaction process.

Parameters of the IC process include:

1. Intelligent Compaction Measurement Value (IC-MV) that is related to stiffness of in-place material

2. Asphalt temperature

3. Location and number of roller passes
1. Process and procedure for downloading and analysis of the IC data from the roller(s). The frequency of obtaining the data from the roller shall be at a minimum of twice per day of asphalt placement and compaction operations. The data shall be date/time stamped to allow for external evaluation at a later time.

2. Process and procedure for Pre-construction training for the field personnel including the roller operator(s) regarding the proper operation of the IC technology, including but not limited to: setup of IC rollers, set up of a GPS base station, verification IC GPS measurement with a hand-held rover, download data from IC rollers, in-situ point test measurements, handling/conversion of GPS data, export data from vendors’ IC software to required data format, import IC data to Veda, and data analysis/reporting with Veda. Contact www.IntelligentCompaction.com for IC training needs.
HANSON AGGREGATES PA LLC

QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR INTELLIGENT COMPACTION PAVING

KEYSER AVENUE PROJECT, ECMS 8212
March 15, 2015

Kriger Construction, Inc.
859 Enterprise Street
Dickson City, PA

RE: ECMS 8212, SR 3011 Keyser Avenue Scranton

Intelligent Compaction Quality Control Plan

Dear Jim:

IC QUALITY CONTROL PLAN (QCP) North Bound bituminous wearing course on travel lanes per plans and specifications. Plan presented is Per contract item 9409-0001-Intelligent Compaction for Asphalt Paving.

1. Detailed Procedure for correlating and verifying GPS for the IC rollers and rover.

Correlating and verifying GPS and IC rollers will be per the HAMM roller information attached HAMM HD+ 110i and the Omni Star System with GPS system. GPS to be provided by Reilly Engineering Associates, OmniStar Rover. (www.keynetgps.com) All verification of IC rollers and GPS will be conducted prior to paving operations.

Correlating and verifying per contract item 9409-0001 IC, Section 3.02 B

2. Detailed Plan and Procedure for the construction of the Test Sections.

Test Sections for each IC bituminous mixture will target the compaction pass counts and as applicable the strength per the nuclear testing process with corresponding pavement cores.

Pre-Construction Test per contract item 9409-0001 IC, Section 3.03 A

Construction Test Sections per contract item 9409-0001 IC, Section 3.03 B

3. Procedure for monitoring of the construction operations and IC rollers, production and evaluation
PREPARATION FOR I.C. TRAINING AND FIELD OPERATIONS

• TWO YEARS OF INVESTIGATION AND ATTENDING SEMINARS AND PRESENTATIONS

• CATERPILLAR PRESENTATION AT HANSON OFFICE, HAMM SEMINAR AT CHAMBERSBURG AND VOLVO INNOVATION PRESENTATION AT HANSON OFFICE

• EXCELLENT FHWA PRESENTATION IN HARRISBURG WITH HANDS ON AT THE NEW PENNDOT TESTING LABORATORY, ISS.
• SELECTION OF GPS SYSTEM AND ROLLERS, MATT WILSON FROM GROFF TRACTOR, OMNISTAR WITH HCQ HAMM PACKAGE

• HELP FROM HAMM, EVAN PERRY, AND FRANK FOLINO, INC

• ASSISTANCE FROM REILLY ASSOCIATES FOR GPS OMNISTAR SYSTEM ROVER

• ON THE JOB TRAINING FROM EVAN PERRY AND TIM KOWALSKI, HAMM, TRAINING SESSION ON JOB PROVIDED BY KRIGER CONSTRUCTION, INC
Anthony D. Folino
President

Anthony D. Folino is President of A. Folino Construction, Inc. He started his career in 1967 working for his father as a general contractor. In 1971 he took over the family business moving into his father's position of President. The original company, A. Folino Construction Co., was formed in 1938 by his grandfather. Folino Construction Inc. was formed in 1966 by his father. The company has grown to become one of the largest construction firms in the Northeast United States.
ACTUAL PLACEMENT, BITUMINOUS PAVEMENT OPERATIONS:

- The bituminous wearing was placed using Volvo paver and intelligent compaction Hamm rollers with HCQ packages.

- Omnistar verification of GPS location of rollers and test core locations was completed by Reilly Associates.

- All wearing course WMA and HMA paving was at night.

- At end of each shift, the I.C. roller data was saved to a jump drive and transported to PennDOT field office for analysis with "VEDA" software.
INTELLIGENT COMPACTION ADVANTAGES FOR QUALITY ASSURANCE AND QUALITY CONTROL

1. ROLLER PASS VERIFICATION FROM GPS LOCATION TRACKING, EACH PASS IS INDICATED IN DIFFERENT COLOR FOR ROLLER OPERATOR TO INSURE COVERAGE. ROLLER SPEED IS INDICATED.

2. MAT TEMPERATURE MEASURED AND INDICATED ON THE SCREEN FOR THE OPERATOR.

3. COMPACTION EFFORT IS MONITORED FROM SENSORS TO INDICATE THE STIFFNESS OF THE MAT AREA. BOTH FREQUENCY AND AMPLITUDE ARE MEASURED.

4. ALL DATA IS RECORDED AND TRANSMITTED TO VEDA SOFTWARE TO REVIEW THE ROLLING OPERATIONS AND MAT CONTROL.
✓ DID THE PROCESS PROVIDE USEFUL INFORMATION?

✓ DATA PRESENTS USEFUL GAUGE OF CONSISTENCY

➢ SHOULD I.C. BE USED ON MORE BITUMINOUS PAVING PROJECTS?

❖ CAN THIS FIELD CONSTRUCTION PROCESS OF INTELLIGENT BITUMINOUS PAVING EXTEND TO THE CLOUD AND THE PROCESS INTEGRATED TO ALLOW FIELD SUPERINTENDENTS TO SEAMLESSLY USE GPS POSITIONING CAPABILITY TO DRIVE FIELD PROGRESS REPORTING TO ENABLE MORE ACCURATE DAILY RECORDS? INTELLIGENT CONSTRUCTION