Hello everyone and thank you for participating in this webinar. The title of this 90 minute webinar is "Intelligent Compaction, A Quality Control Tool for Constructing Asphalt Pavements". This webinar is offered through the Asphalt Institute in cooperation with FHWA. Asphalt Institute has been working with FHWA since 2007 on research and implementation activities related to Intelligent Compaction. Starting in 2012, AI started offering a four-hour "IC Overview Workshop" that was very popular with state DOTs. This workshop is still available for free through FHWA upon request.

This webinar will provide participants with an overview of Intelligent Compaction (IC) technology including a description of the many benefits of using IC on asphalt paving projects. The presentation will provide a simple and easy-to-understand description of what IC is and how it can be used as a Quality Control tool during asphalt pavement construction. Although IC can be used for compaction of all pavement materials (including soils, subbase, aggregate base materials), again this webinar will focus on the application of IC technology on tandem drum rollers used for compaction of asphalt pavement materials.

Please feel free to ask questions using the chat function during the webinar.

Wrapping up the webinar, let me just say that....Oops, this website should be www.intelligentcompaction.com. [READ]

Topics for Today

- What is Intelligent Compaction (IC)?
- What are the Benefits of IC?
- What were the Findings of FHWA IC Research?
- How can IC be used as Quality Control (QC) tool… not an acceptance tool?
- Where can you find IC Resources?

Here is a list of the topics we will cover. First we will briefly discuss compaction in general with an emphasis on how important it is to obtain optimum density. Then, we will move on to a discussion to help you understand what IC is and what the benefits of IC are. Then, I will summarize what was learned in several major research projects that have been conducted in the United States in the past decade or so. Finally, I will discuss how IC can be used as a QC tool to improve the compaction process and will finish up by showing you where you can access various resources (such as the current status of IC technology equipment in the United States, specifications, data management and analysis software, etc).

Please feel free to ask questions using the chat function during the webinar.

Let's get started.

What is Intelligent Compaction (IC)?

What is IC? It is likely that many of the folks on this webinar may have heard the term but may not be sure what IC really is and how it works. Others may be very knowledgeable. Well, I am going to try to explain that in a simple, easy to understand manner.

What is Intelligent Compaction?

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An Innovation in Compaction Control and Quality Control

When we are trying to describe IC, it is important to tell you that IC is an innovation in both the area of compaction control (in other words, how to continuously monitor the compaction process) and it is an innovation in the way that the results of compaction can be tested and used. My reference to IC as an innovation comes from the folks that manufacture compaction equipment. IC vendors tell us that they look at IC as a major innovation in compaction technology that offers a way to improve the compaction process and to make it more effective and efficient. In fact, Intelligent Compaction technology has been nominated for the NOVA award through the Construction Innovation Forum in 2014. CIF created the NOVA Award in 1989 to recognize and advance significant innovation in all areas of the construction industry around the world. So, it is quite an honor to be nominated for the NOVA award.

What is Intelligent Compaction?

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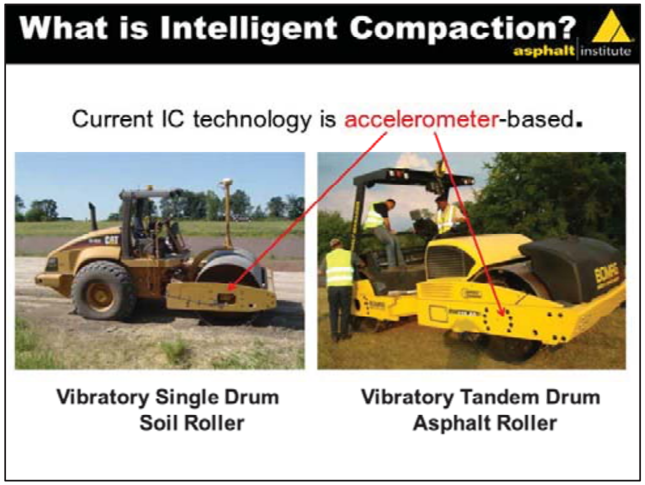
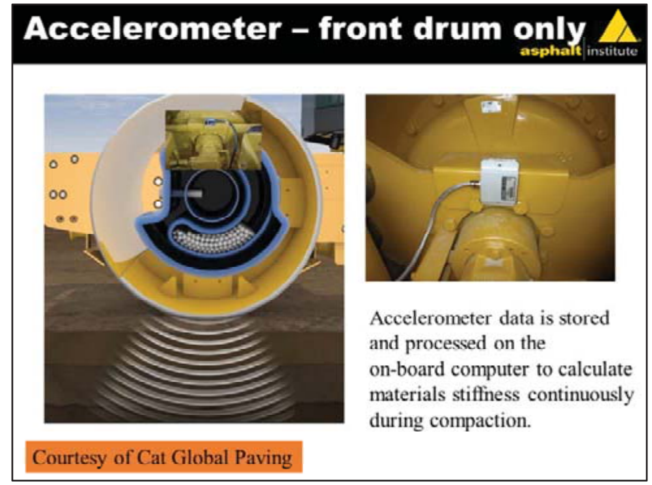
- IC consists of a vibratory roller that is equipped with various hardware/software tools and Global Positioning Systems (GPS) that work together to:
  - improve the pavement material compaction process through consistency and uniformity
  - provide data that can be processed, viewed and analyzed by contractors/owners for enhanced evaluation of compaction related parameters

Here is a simple and concise definition of Intelligent Compaction. [READ] We will get into a more detailed definition later.



Intelligent compaction technology is available in the United States in both single drum vibratory rollers for soils / aggregate base compaction and double drum vibratory rollers for asphalt pavement compaction. Many of the roller manufacturers that are marketing in the US are currently developing and marketing IC technology at this time (we will be listing the roller manufacturers that currently offer IC technology in a minute). One of the key component of an IC roller is a measurement system that continuously measures the "stiffness" of the material during compaction. The most common IC rollers used in the United States at this time (and that we studied in the major research projects) are all accelerometer-based, which means they have an accelerometer installed on the front drum of the vibratory roller. The accelerometer monitors the behavior of the vibratory drum and the material being compacted and sends that data to an on-board computer. The accelerometer data is then used to calculate a vendor specific measurement (or "stiffness") value.



This slide shows what the accelerometer looks like mounted on the roller drum. As the vibratory roller passes over the material being compacted, the drum is impacting the material at a given frequency and amplitude as the eccentric weights inside the drum rotates. The behavior (motion or acceleration) of the drum will change depending on the density of the material being compacted. As the material stiffens, more of the energy starts to be reflected up and measured by the accelerometer. This results in the calculated measurement value increasing as the material is compacted.

Vibratory energy is focused on the ground and is absorbed as the soil becomes more compact (or stiffness/load bearing strength increases). As the stiffness increases, more of the energy starts to be reflected back up and measured by the accelerometer.

IC Measurement Value (ICMV)

- IC suppliers have various "stiffness" (or measurement) values
  - Bomag – E_{vib} (MN/m²)
  - Caterpillar/Trimble – CMV
  - Hamm/Wirtgen – HMV
  - Sakai - CCV
- ICMV is a generic term used to describe all suppliers' measurement value

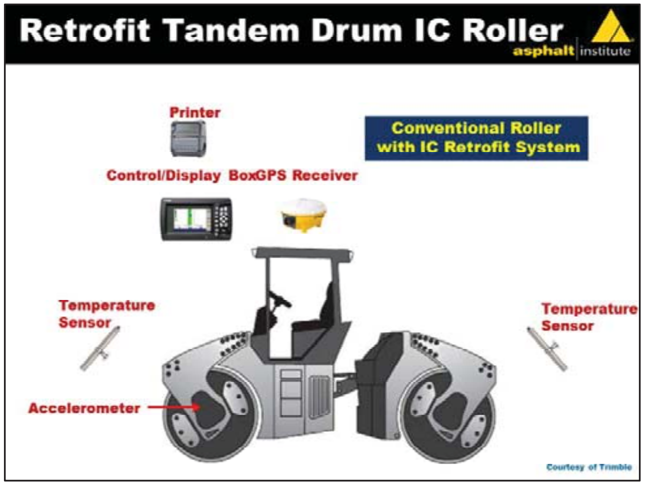
OK, let's talk about a basic term (or actually an acronym) that we will be using a lot for the rest of the webinar. It is ICMV, which short for Intelligent Compaction Measurement Value. All of the major IC vendors use a different stiffness value that is calculated from the accelerometer data received during the compaction process. Note that we list some of the vendors and their respective stiffness values. For instance, Bomag call theirs Evib, Caterpillar/Trimble - CMV (Compaction Meter Value), Hamm/Wirtgen calls their value Hamm Measurement Value (HMV) and Sakai calls their value – CCV (Compaction Control Value). As you can guess, it can be confusing to have a different value for each manufacturer. ICMV is simply a generic term that describes any of the various vendors stiffness measurements.

FHWA Definition of IC

- Tandem drum vibratory rollers that are equipped with:
  - Accelerometer-based IC Measurement Value (ICMV)
  - GPS-Based documentation system
  - On-Board, Color-Coded display
  - Surface temperature measurement system
  - Data produced is compatible with Veda software

I gave you a general definition before but here is a more detailed one. FHWA specifications actually has fivef major requirements or capabilities that must be present to meet the FHWA definition of intelligent compaction for asphalt pavement compaction. They are listed here. The first requirement is for an accelerometer-based IC Measurement Value (ICMV). The second thing required is a Global Positioning System (GPS)-based documentation system. We will discuss later that GPS plays a major role in IC technology. An onboard, color-coded display in the roller cab is another requirement. An asphalt roller is required to have a temperature measurement system and finally, that data produced by the IC roller must be compatible with the FHWA-produced software called Veda. We will discuss that software later. Shown in red: the surface temperature gauge is used on asphalt applications only.

Well, these are photos of three "approved" tandem drum rollers that are equipped with IC technology. Tandem (or double) drum rollers are used for compaction of asphalt materials only. Also shown as an option to "full" IC rollers that are put together in the factory or in the field using that supplier's IC technology and equipment (sometimes referred to as Original Manufacturers Equipment or OEM). For instance, a Sakai IC roller will have Sakai IC equipment installed on it. There are also "retrofit" system supplied by Trimble or TopCon (these are sometimes referred to as "after market" equipment/technology). As the name implies, a retrofit system consists of various "generic" components that can be installed on any brand of conventional vibratory roller on a project-by-project basis. Some specifications allow the use of retrofit IC systems and some do not. So, check your specifications closely to see if the retrofit is an option on a project.



As I just discussed, there are some vendors that offer "retrofit" IC components that can be installed on virtually any vibratory roller. Here I show the IC components In addition to the "full" IC rollers shown earlier, retro fit IC systems are available that can be installed on any conventional vibratory roller. This slide shows the various components that are included in the retrofit kit and installed on the roller

Components of IC Roller

Courtesy of Sakai America

This slide walks through the various equipment/components of a tandem drum IC roller. This is an IC roller manufactured by Sakai America which is just one of the suppliers in the United States. There are other suppliers of IC that have similar features and capabilities. Just using Sakai as an example to illustrate the typical equipment and capabilities of IC rollers.

1. an accelerometer is mounted on the front drum of the vibratory roller.

2. an infrared device that measures the mat temperature is mounted on the front of the roller

3. an IC roller must have GPS capabilities. You can see the radio and receiver mounted on top of the roller cab.

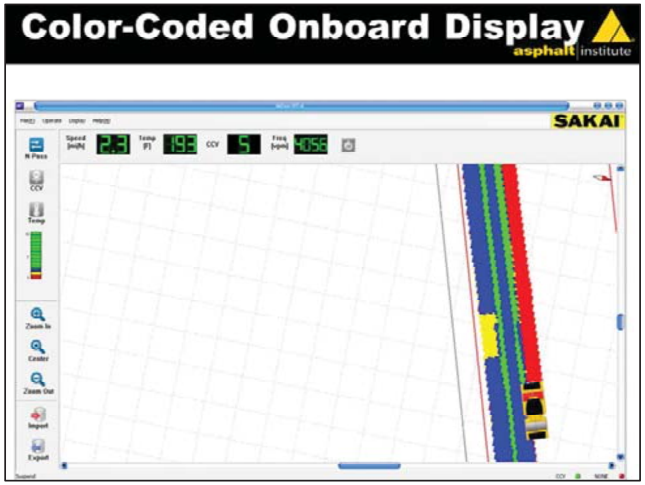
4. a Documentation System (that includes an on-board computer) is mounted on the roller

5. An On-Board, Color-Coded Display is mounted in the roller cab where the operator can easily view it while compacting the mat.

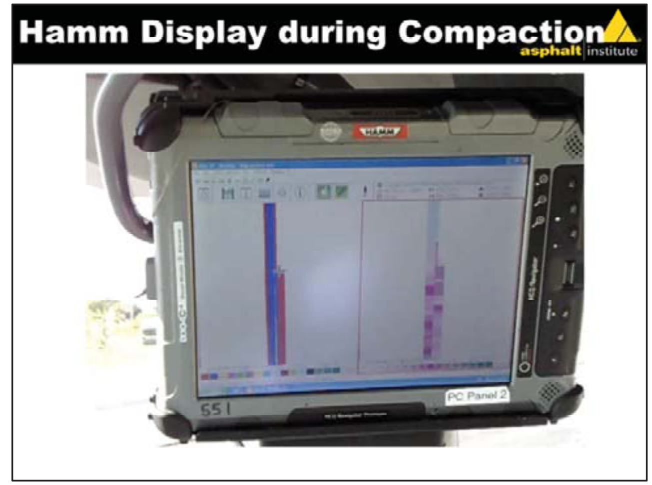
Hamm IC Onboard Display

Courtesy of Hamm Wirtgen

Now, let’s take a closer look at the color-coded displays. The first thing to emphasize is that the displays are mounted in the roller cab in a location that is easily viewed by the roller operator during the compaction operation. This is the Hamm display. The purpose of the display is to provide a user-friendly tool that will allow the operator to see (in real time) important factors that they can use to do a better job with compacting the asphalt mat. The operator can toggle the display to show ICMV, roller passes and mat surface temperature. We have found that the operators generally like and use these displays.



This is a screen shot of a Sakai display in “roller passes” mode, where the roller operator can clearly see the number of passes that have been applied to the pavement. Note the roller icon that show the “real time” position of the roller. In this case, one pass is red, yellow is two passes and three passes is blue. Experience has shown that the display provides the roller operator with a great tool to improve the consistency of the number passes placed on the pavement.



How can IC Improve QC?

- During compaction, operator can use the onboard display to track work in "real time":
  - Make sure that the optimum number of passes is applied consistently
  - Monitor the mat temperature
  - Use a target ICMV value which can relate to density
- Data can be collected and post processed to:
  - view, edit and statistically analyze the data
  - evaluate the critical components of the compaction process to learn how to improve future work

IC can be used in two ways…during the compaction process itself and the data collected can be processed with IC software later. [READ ALL THE WAY THROUGH THEN COME BACK TO BULLET #3] On bullet number three, this may seem to contradict what was just said that ICMV does not have a good enough correlation to replace density testing as an acceptance tool. This is true but on many of our research projects, there was definitely a statistical "relationship" between ICMV and density. For instance, as ICMV increased, density also increased. Therefore, it is possible to establish a target ICMV that corresponds to the desired density on a test section conducted on the project. Then, the roller operator can use the target ICMV as a QC indicator that density is being achieved. OK, let's move on with our discussion of "how can IC improve QC".

Veda Software

The Veda software that was developed through the ICPF has been improved over the years to be work with IC data produced by nine different single drum and tandem drum IC rollers available today. It also can be used to analyze data from IR thermal temperature testing equipment. The best thing about Veda is that it is free and can be downloaded from the IC website.

Positioning Systems for IC

- Global Positioning System (GPS)
- Laser-based positioning systems
- Other Wireless positioning technology

Positioning systems (most often GPS) plays a major role in IC technology work. Using positioning technology allows the roller location to be continuously monitored in real time. There are several kinds of positioning systems that could be used including Global Positioning System (GPS) that we are all familiar with as well as other laser-based and wireless positioning technology. In the vast majority of the cases, GPS is used for typical pavement construction situations. Lets briefly discuss what GPS and how it works. Having at least a fundamental understanding of GPS and specifically how it is used in IC technology will allow you better understand practical IC challenges.

Non-GPS Wireless positioning systems include cellular-based, UWB (ultra Wide Band), RFID (Radio frequency ID), WLAN (wireless area network).

Algorithms included: triangulation, scene analysis, proximity.

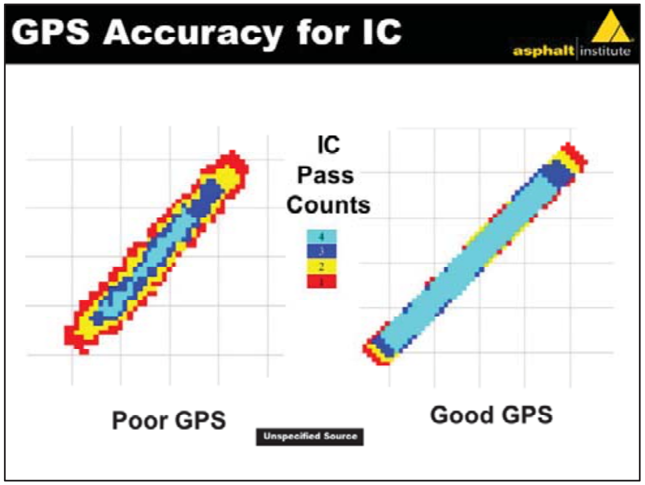
- Triangulation uses the geometric properties of triangles to estimate the target location.
- RF-based scene analysis refers to the type of algorithms that first collect features (fingerprints) of a scene and then estimate the location of an object by matching online measurements with the closest a priori location fingerprints.
- Proximity algorithms provide symbolic relative location information.

OK, now let's talk about how the use of GPS looks on an IC project. On a typical project, we are going to be using "Real Time Kinematic" (or RTK) GPS, which provides us with the high precision needed. This slide shows the GPS receiver and radio being installed on the roller (center photo), the base station set up on the project at a fixed location (left photo) and the GPS rover (right photo) that is tied into the base station and is used to identify density or non-destructive device testing locations.

It is common for contractors to ask for a GPS solution that does not use a base station. The OmniStar system is a non-land based technology now being evaluated as an alternative to land based GPS technology on research projects being conducted by FHWA at this time. It is said to be capable of obtaining 2-4 inch (10 cm) precision for the best applications. Omnistar is a proprietary Differential GPS (DGPS) technology that is used in many other applications (such as agriculture) and requires a subscription. There are other DGPS technologies available besides Omnistar. At this time, the jury is still out on whether there is non-land based systems that can provide high precision GPS for IC applications.

The OmniSTAR HP service requires OmniSTAR-capable dual-frequency GPS receivers. By using L1/L2 atmospheric corrections and carrier phase techniques this service achieves even higher levels of accuracy.

Wiki: Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that provides improved location accuracy, from the 15-meter nominal GPS accuracy to about 10 cm in case of the best implementations. DGPS uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudoranges and actual (internally computed) pseudoranges, and receiver stations may correct their pseudoranges by the same amount. The digital correction signal is typically broadcast locally over ground-based transmitters of shorter range.



This slide illustrates the reason that high precision GPS is needed for effective IC operations. Note in this view of the pass counts, poor GPS precision does not provide an accurate view of the precise location of roller passes and overlap. Bottom line is better precision GPS provides a much clearer and realistic view of the roadway being compacted and the compaction operation.

What are the Benefits of IC?

OK, let’s discuss the benefits of using IC.

What are the benefits of IC?

- Increased operator awareness
  - Real-time compaction, temperature, pass count data providing the operator the ability to make changes in real-time while asphalt is hot
- Improved, more uniform density/air voids
  - This results from more consistent roller coverage
- Night-time paving operation
  - Ability to “see” roller passes in the dark
- Lower operating costs
  - Optimized pass coverage, better efficiency
- Documentation
  - Quality control and post-process data analysis
  - View opportunities for improvement
- 100% coverage of the entire area being constructed
  - Provides a comprehensive view with color-coded mapping of roller passes, mat temperature and ICMV
  - Opportunity to identify potential problem areas

Here is a list of the specific benefits of IC. [READ]

IC Provides 100% Coverage

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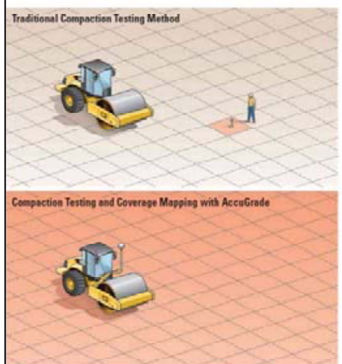

- Traditional methods only obtain data on a single spot that represents a large area
  - is test result representative?
- IC provides data for the entire area being compacted
  - ICMV, temperature, pass count
- Color coded mapping of 100% of area provides permanent records

We haven't discussed the concept of 100% coverage yet. But it is important because many people say this is one of the most important benefits of using IC. In traditional compaction testing, typically data from only one spot that represents a large area is evaluated. 100% coverage simply means that the continuous data collection and mapping during IC allows the user to have data and valuable input for the entire roadway being compacted. This includes ICMV, temperature and pass count data for the entire area being compacted. This is obviously a huge advantage. In addition, the collected data can be evaluated in IC software to produce color-coded maps of the compacted roadway for permanent records.

Overall Benefits of IC

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- Improve density....better performance
- Improve efficiency....cost savings
- Increase information...better QC/QA

- Overall Benefit:

  Improved Pavement Performance!

We just listed some specific benefits and here are some more general benefits. It is no exaggeration to say that the use of IC technology can result in better pavement performance, significant cost savings and better process control and acceptance procedures. Most importantly, IC used properly will result in improved pavement performance.

What Were the Major Research Findings?

Lets quickly look at the major findings of major research efforts in the United States in recent years.

IC Research Projects - US

- There have been three major research efforts in the United States
  - Two have been completed / final report avail.
    - NCHRP 21-09 "Intelligent Soils Compaction Systems" (2007-2008)
    - TPF 5 (128) "Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base, and Asphalt Pavement Materials" (2008 – 2010); IC Pooled Fund (ICPF)
  - One is ongoing
    - FHWA "HMA IC and Density Projects" (2012-2014)

There have been a large number of research projects on IC both at the state and federal level over the last ten years in the United States. This slide shows the three major IC research projects. Notice that the first two have already been completed and one is on-going. We will be focusing on the findings of the second one listed here...TPF 5 (128) which we will refer to as the IC Pooled Fund research project (or ICPF for short). At the end of this section we will be also touching on the findings of the "HMA IC and Density Project".

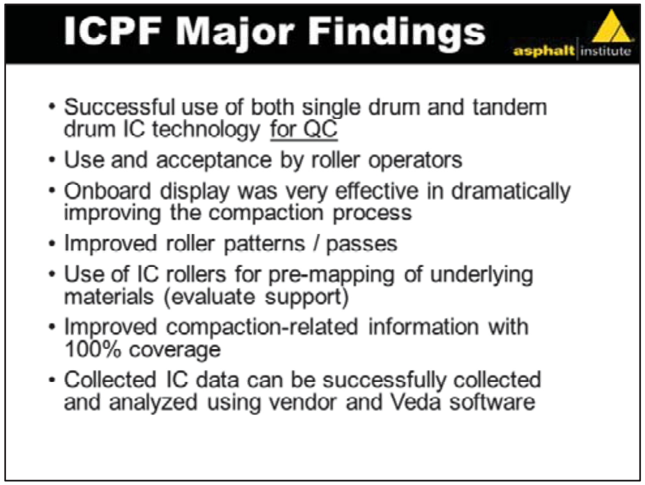
IC Pooled Fund Project

OK, lets look at the TPF 5 (128) project that we call the IC Pooled Fund research project or ICPF for short. Shown in green are the states that participated in the ICPF during the study period of 2007 to 2011. Each of these states sponsored at least one project where IC technology was substituted for the conventional rollers on the project.

IC Pooled Fund Project

- ICPF was a three year research project to study IC technology from various suppliers on actual pavement projects
- 12 states participated in the ICPF
- Research included various types of pavement materials, including
  - Asphalt materials
  - Soils
  - Sub base (including aggregate base)

Here is some details about the ICPF research project. The research did not just look at IC applications on asphalt pavements alone but also included extensive testing on IC applications for soils and subbase including aggregate based materials. You can find the final report on this research effort at www.intelligentcompaction.com.



Next, let's quickly go through some of the general findings of the ICPF in each of the area listed on this slide. [READ]

One question that was asked a lot at the beginning of the research was: How will roller operators react to having IC technology and equipment on the roller? Considering that IC technology is fairly technical, will they accept it and be able to use it? How quickly will they learn to use the equipment effectively? There was a concern that roller operators would be intimidated by the complexity of the equipment and would either not want to or would not be able to use it. Answering this question was a major goal of the ICPG research projects.

Roller Operator Training

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On each of the ICPF research projects, two IC manufacturers would provide an IC roller to be used on the project. The contractor would supply two of his roller operators to go through some training on how to use the IC rollers on the project. Generally, the roller operators were able to learn to operate the IC technology quickly and were able to use the technology effectively and consistently during the three day research period. The manufacturers should get a lot of credit for doing a great job of designing their onboard displays to make them user friendly and easy to use. Most of the operators liked the new IC technology and appreciated the way that it gave them a tool to improve the compaction process.

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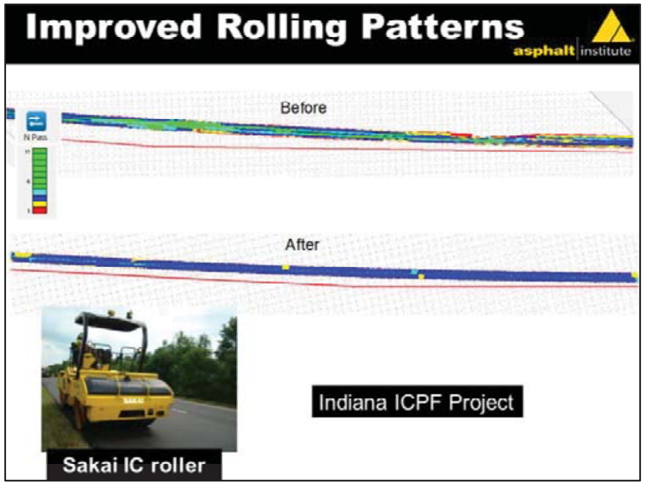
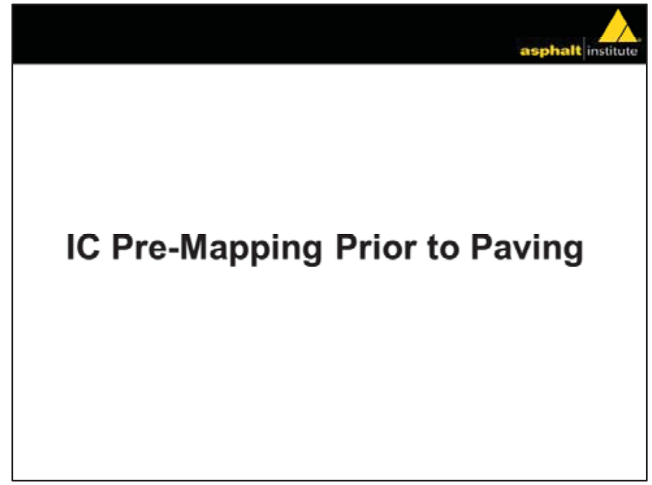
Improved Roller Passes

A critical question to be answered in the research was: Will IC help the operator to apply improved roller passes. This is defined as the ability to consistent apply the optimum number of target roller passes on the entire width and length of the project. The answer on all virtually all projects was yes.

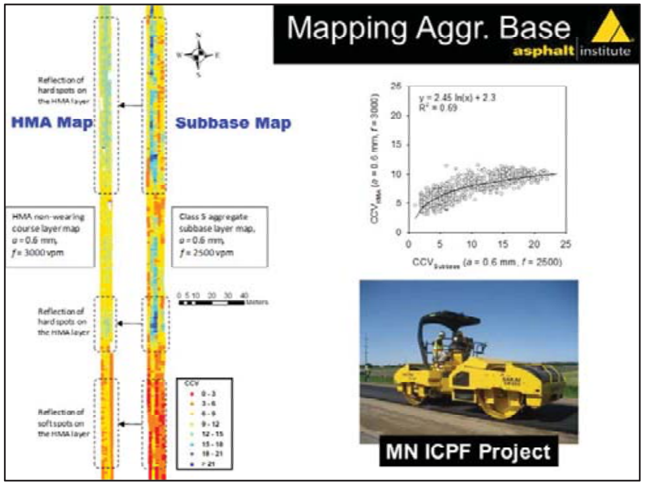


Although researchers have extensive data on all of the ICPF projects, we will just show one example of improved roller passes. This is from a project in Indiana. Look at the color legend right here [POINT] that shows that the first pass of the roller is red, the second is yellow and the third pass is blue. The optimum (or target) number of passes of the breakdown roller was 3 on this project. On each of the projects, researchers would set up the IC equipment on the roller (including the color-coded display) but initially the display would be covered. The roller operator was then asked to just roll the material being compacted as they normally would (which is the before illustration). Note the “before” (operator was not using display) color-coded plot of a section of pavement being compacted that show that the number of passes being applied was very inconsistent as indicated by the “rainbow” appearance of the plot. Contrast that with the “after” (operator was using the display) plot that shows a much more consistent number of passes indicated by the predominately blue plot. This improvement was noted in all of the research projects. The benefit of dramatically improving the consistency of roller passes is obvious. This will result in much more consistent compactive effort throughout the pavement. That will translate to much more consistent density resulting in improved pavement performance.

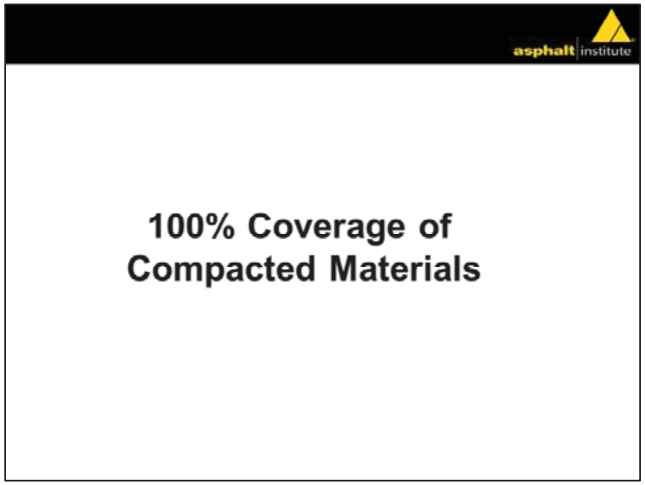


The ICPF research projects looked at the practicality and benefits of using IC technology to “pre-map” the in-place materials prior to paving. The pre-mapping consisted of simply taking a single pass with the IC roller on the underlying materials to measure the ICMV of the in-place materials. If successful, mapping would be a useful tool to evaluate the underlying support (or stiffness) that is available to provide a stable platform for subsequent compaction of the next pavement layer.

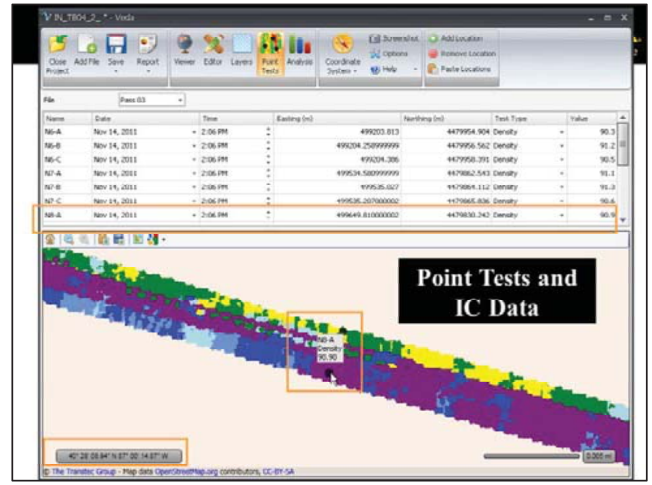
Here is an example of IC pre-mapping. This was on an ICPF project in Minnesota. On this new construction project, the embankment and aggregate were already in place and asphalt paving was scheduled. The day before asphalt paving was to start, the Sakai tandem drum IC roller was used to "map" the in-place materials. The roller took a single pass over the entire roadway in the vibratory mode to measure the support of the underlying material. The roller settings were low amplitude and reduced frequency of about 2500 vpm. The mapping data was then processed to produce a color-coded map of the entire length of the roadway. On this particular project, a significant amount of variability in measured ICMV was found, along with a number of "soft" areas were identified in the in-place materials.



This slide shows the color coded map of both the ICMV measurements of the aggregate/subgrade prior to paving and the first lift of asphalt base. It is difficult to see the legend here but let me describe it for you. Red and orange means low ICMV values while blue means higher ICMV values. Note that there some large areas of soft spots (red/orange) found in the subbase map on the right. There were also areas of good support that you can see here (blue). When you look at the map on the left (which is the asphalt base course map) you can see that the soft and hard spots in the subbase "reflected" up through the HMA layer as can be seen with yellow/orange areas that corresponded to the soft spots in the underlying material. Finally, the regression analysis shows that there is a good correlation between the measured ICMV of subbase and HMA at the same locations. Bottom line is that the ICPF found (on many projects) that using the IC roller to "pre-map" the underlying material prior to paving is an viable way to identify areas of uneven support.



We discussed the benefit that IC can provide “100% coverage” of the area being compacted. One of the goals of the ICPF research was to determine if IC technology could be used on a real pavement construction project to reliably get 100% coverage.



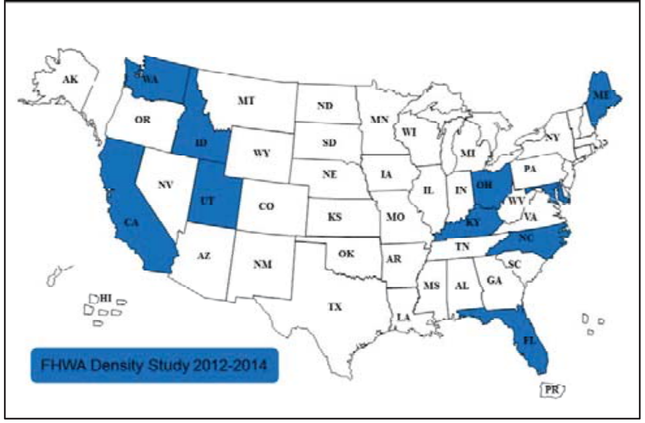
Here is a screen shot from the analysis of data collected on one of the ICPF projects that shows ICMV data for the entire roadway being compacted with an IC roller. This is output from the generic Veda software that was developed under the ICPF. Although there were occasionally some issues with GPS or the IC equipment that prevented data collection, it was found that IC technology (when used properly) can reliably obtain the goal of getting IC data on 100% of the area being compacted.

ICPF – Unresolved Issues?

- Improve correlation of ICMV and density
  - Research projects now underway
- Data Management and Analysis
  - Improve data collection and management
  - Improve Veda software and offer training
- IC Specifications
  - Best ways to use IC on pavement construction projects?
- Continue to work toward development and implementation of IC technology
  - Best ways to encourage and support implementation by agencies?

There were a number of unresolved issues identified in the ICPF report (remember that report was published in 2011 so it is several years old; many of these issues have been addressed since then). These are all important issues that needed to be resolved but FHWA was especially interested in focusing on the first item I have listed here...to do some more work to look at the correlation of ICMV and density. That was important because if a good correlation between measured in-place density and measured ICMV would mean that IC could be a more reliable QC tool or maybe even an acceptance tool.

IC Asphalt Density Study



So, moving on the latest FHWA research study was conducted from 2012 to 2014. The primary purpose of this research project was to address some un-answered questions from previous research, especially to evaluate the correlation of ICMV versus in-place density. Like the ICPF project, it consisted of field projects in various states around the country. This slide shows the states in blue where research projects were conducted. A total of nine field studies were conducted, the research is now wrapping up and the final report will be published by the end of 2014.

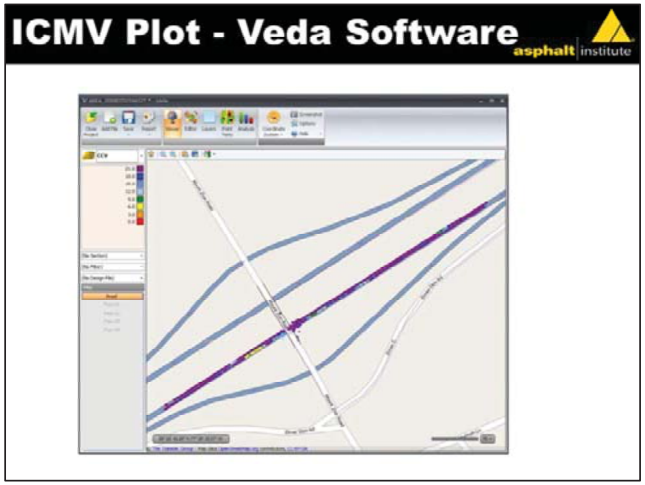
Research Findings – ICMV

- Overall findings
  - At this time, IC is **not** ready for use as a Quality Assurance (acceptance) tool
    - Consistently reliable correlation between ICMV and in-place density readings have not been established
    - On many projects, there has been a "relationship" between ICMV and density
  - IC can be used as a Quality Control tool
    - Contractors can use IC capabilities to improve their compaction process

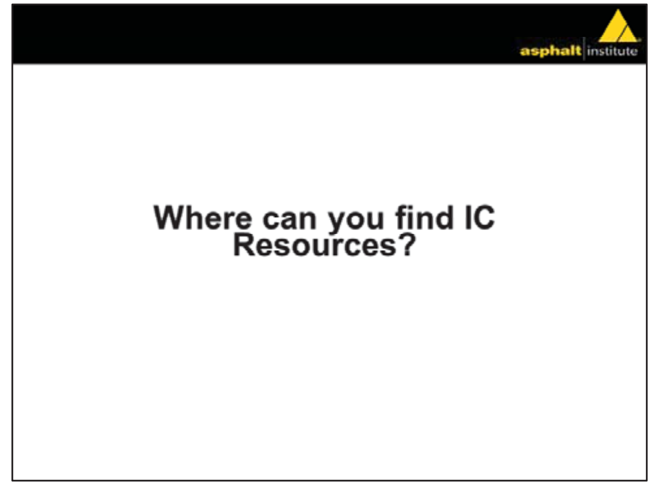
Due to the relatively mediocre correlation between measured density and ICMV found on most of the asphalt projects where this data has been collected and analyzed, one of the major findings of the research is that IC IS NOT ready to be used for acceptance test to replace in-place density measurements with either nuclear or non-nuclear density gauges or with coring. This is because the density of the asphalt materials can not be reliably predicted by measured ICMV consistently enough to be used as an acceptance tool. Therefore, the overall findings of the research is that IC be used strictly as a Contractor's Quality Control (or process control) tool only. Research has shown that IC can still be used a valuable tool in many ways to improve the compaction process.

Caterpillar IC Onboard Display

As we discussed previously, the color-coded onboard display has proven to be a valuable tool for roller operators. The display allows the operator to improve the roller passes, monitor the mat temperature and view ICMV continuously curing the compaction process. Again, IC technology has been well accepted by the operators.



OK, we talked about the IC data being collected, stored and analyzed at a later time. This slide shows a screen shot of the Veda software where you can see a view of the ICMV data plotted on top of a map of the roadway where an asphalt overlay is being placed. This is an example of the collected data can be imported into the Veda software where it can be viewed, edited and analyzed.



OK, let's finish up by telling you about the IC resources that are easily accessible for someone that just wants to learn more about IC or for someone that is thinking of using IC technology on a project.

What Resources are Available?

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- IC Website
  - www.intelligentcompaction.com
    - Guide specifications
    - Available Training
    - Veda Software and Support
    - Library of IC related documents
    - Research project reports
- IC Technical Support Service Center
  - http://www.fhwa.dot.gov/construction/ictssc/
- Asphalt Institute Webinars
  - Free recorded webinar "IC, a Quality Control Tool for Asphalt Compaction"; 90 minutes; 1.5 PDHs

The primary source of resources such as guide specifications, available training, Veda software download and support, research project reports as well as an extensive library of IC-related articles, papers and reports is at the IC website (www.intelligentcompaction.com). FHWA has also set up a website called the "IC Technical Support Service Center" that can be found at this link. The ITSSC includes a forum that allows folks to request support either via e-mail or by calling a phone number.

Let's Wrap it up…

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- IC is an exciting innovation that offers many benefits to both contractors and agencies in the construction of asphalt pavements
- IC and GPS technologies are readily available through multiple vendors
- IC is ready to implement now as a Quality Control tool.
- "Real world" use of IC and GPS technology can present challenges for contractors and agencies
- IC resources such as specifications, training/support and software are available through FHWA and at www.asphaltinstitute.org.

Wrapping up the webinar, let me just say that....Oops, this website should be www.intelligentcompaction.com. [READ]

My last slide is of an IC project in a beautiful location on the reconstruction of the Sitka Alaska airport in 2013. The contractor successfully used three IC vibratory rollers to complete this project. Any questions?