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16. Abstract The FHWA has been leading a national effort to advance the Intelligent Compaction (IC) technology through a transportation pooled funded project, TPF-5(128), with twelve (12) States (DTFH61-07-C-00032) since 2008. Under this project, the Transtec Group has conducted seventeen (17) field IC demonstrations successfully to address material types that include granular soils, cohesive soils, stabilized base, and Hot Mix Asphalt (HMA) pavements. The FHWA Intelligent Compaction National Workshops were the continuing effort to fulfill the IC Road Map developed under the TPF IC project in order to provide three (3) regional training workshops to States and industry around the country. The first workshop was conducted on December 13, 2011 in Atlanta, Georgia. The second workshop was conducted on February 28, 2012 in Salt Lake City, Utah. The third workshop was conducted on May 3, 2012 in Bloomington, Minnesota. Reports were produced for each workshop. This document is the report summarizing all three workshops and recommendations for future action.		
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FHWA Intelligent Compaction National Workshops
Final Report

Background

The FHWA has been leading a national effort to advance the Intelligent Compaction (IC) technology through a transportation pooled funded project, TPF-5(128), with twelve (12) States (DTFH61-07-C-00032) since 2008. Under this project, the Transtec Group has conducted seventeen (17) field IC demonstrations successfully to address material types that include granular soils, cohesive soils, stabilized base, and Hot Mix Asphalt (HMA) pavements.

The FHWA/TPF project, led by the Transtec Group, also developed an IC Road Map that addresses the gaps and barriers for implementation that includes four major tracks: (1) Equipment and Technologies, (2) Data Management and Integration, (3) Specifications, and (4) Technology Transfer and Training (see Figure 1). An extensive knowledge base was built from those field demonstrations and is readily available to the public via the IC website (www.intelligentcompaction.com), developed and maintained by the Transtec Group. The IC National Workshops under the FHWA TOPR No. 5 (DTFH61-10-D-00027) are intended to address key elements of the IC Road Map.

Figure 1. The Intelligent Compaction Road Map

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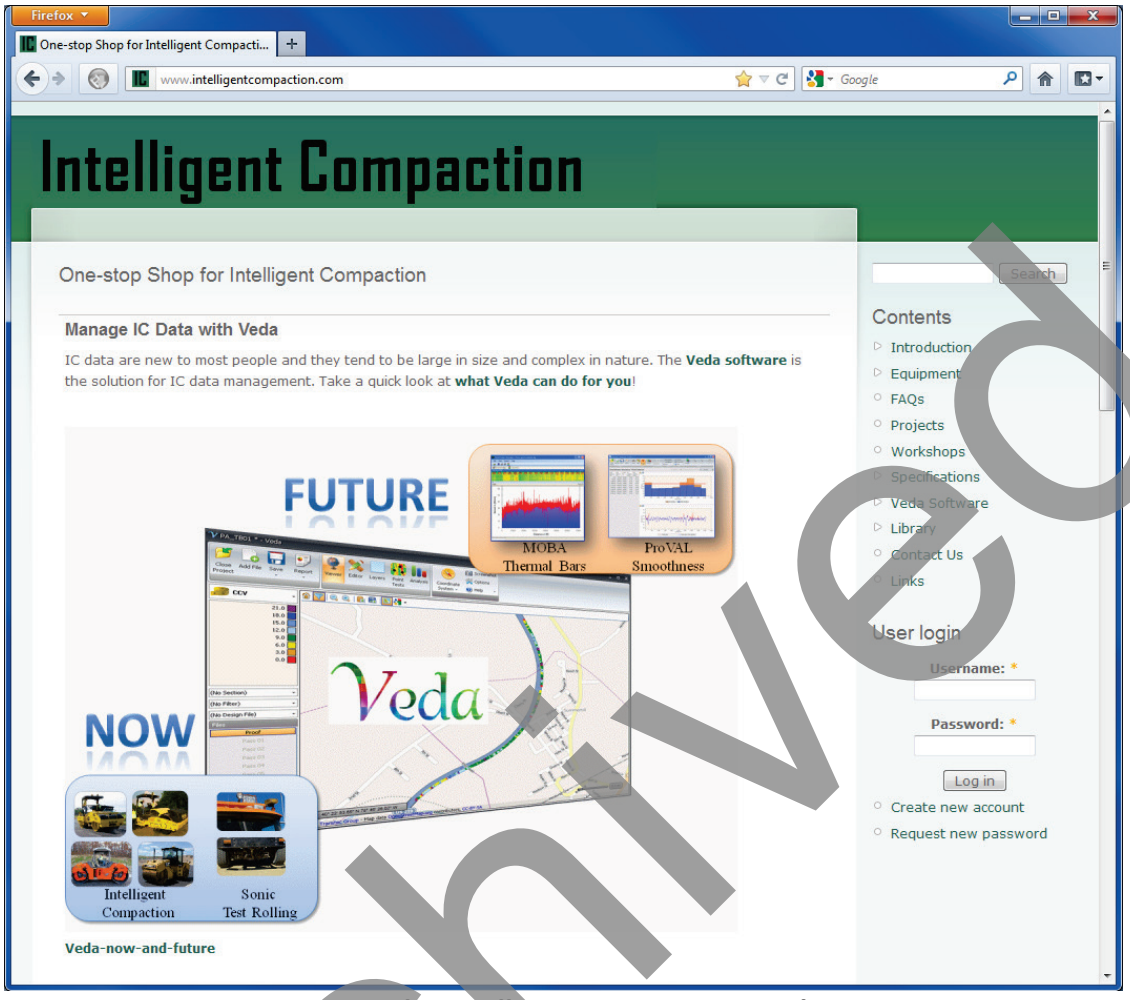

Figure 2. The Intelligent Compaction Website

Project Objectives

The objective of this task order was to provide non-personal support services to The Federal Highway Administration (FHWA) in facilitating, coordinating and documenting the Intelligent Compaction (IC) National Workshops in three (3) different regions of the country. Three such locations were selected by FHWA in Atlanta, GA, Salt Lake City, UT, and Minneapolis, MN. Specific activities under this task order included: scheduling, organizing, and documenting the meetings, and coordinating and providing travel support to State Department of Transportation (DOT) representatives and the non-Federal presenters who spoke at and/or participated in the workshops. Furthermore, the FHWA offered professional development hours (PDH) credit to the attendees as part of the workshops and needed support in documenting and processing the requests.

The following includes a summary of the three workshops.

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Workshop Events

The first IC National Workshop was held December 13, 2011 in Atlanta, Georgia at the Sheraton Gateway Hotel Atlanta Airport. The Salt Lake Plaza Hotel in Salt Lake City, Utah was the site of the second workshop on February 28, 2012. Finally, the third workshop took place in Minneapolis, Minnesota on May 3, 2012 at the Crowne Plaza Minneapolis International Airport Hotel & Suites. The flyer announcing the first workshop is in Appendix A.

Participants

Between the three workshops there were a total of 227 different participants. Five attended twice, and nine people were present for all three events. Appendix B contains the list of participants.

Attendees were associated with FHWA, State DOTs, cities, counties, contractors, vendors, consultants, and academia – 100 organizations in all. States, selected by FHWA, were invited to send one representative each, with travel sponsored by FHWA. Table 1 and Table 2 summarize participation.

Table 1. Geography of Attendees

State DOTs (32)		
Alaska	Arizona	Arkansas
California	Florida	Georgia
Idaho	Illinois	Indiana
Iowa	Kentucky	Louisiana
Michigan	Minnesota	Mississippi
Missouri	Nebraska	Nevada
New Jersey	North Carolina	North Dakota
Ohio	Pennsylvania	Rhode Island
South Carolina	Tennessee	Texas
Utah	Vermont	Virginia
Washington	Wisconsin	
Additional States Represented, without DOT Participation (4)		
Alabama	Colorado	Maryland
Washington, D.C.		
International Participants (2)		
Germany	Japan	

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Table 2. Organizations Represented

Manufacturers (9)		
BOMAG	Caterpillar	MOBA Corporation
Sakai	Tensar Co.	Topcon Positioning Systems
Trimble	Volvo Construction Equipment	Wirtgen/HAMM
Consultants, Contractors, Vendors, and Other Companies (37)		
AGEC	Allied Blacktop Company	AMEC
American Engineering Testing, Inc.	Ames Engineering, Inc	Anderson Brothers Construction Company
Asphalt Technology Consulting	Braun Intertec	CME Transportation Group
Construction Engineering Solutions	Geneva Rock	Granite Construction Company
Hayden-Murphy Equipment Company	Heavy Highway Engineering Group	Horrocks Engineers
Itasca Consulting Group, Inc.	Jim Schrecoman Consultant	King Asphalt
Mathy Construction	Pittman Construction	PnK Constructors
Project Engineering Consultants	Raba-Kistner Infrastructure	RDO Equipment Co.
Reeves Construction Co.	RMS	SRF Consulting Group, Inc.
Staker Parson Companies	Stanley Consultants Inc	STRATA, A Professional Services Corporation
The Transtec Group	URS Corporation	Western Technologies
Wire Grass Construction	WSB & Associates, Inc.	Yager Materials
Ziegler CAT		
Industry Associations (3)		
Asphalt Institute	GA Asphalt Pavement Assoc.	MN Asphalt Pavement Assoc.
Federal Agencies (9)		
FHWA	FHWA – EFLHD	FHWA – Florida Division
FHWA – Georgia Division	FHWA – Idaho Division	FHWA – Iowa Division
FHWA – Minnesota Division	FHWA – Utah Division	US Bureau of Reclamation
Cities and Counties (8)		
City of Bloomington	City of Chattanooga, TN	City of Cottonwood Heights
City of Hastings	Goodhue County Public Works	Olmsted County
Sandy City Public Works	St. Louis County Public Works	
Academia (4)		
Brigham Young University	Georgia Tech	University of Florida
UTEP		

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Several of the photos taken at the workshops are shown below.

Figure 3. Top left: Atlanta Workshop. Top right: Salt Lake City Workshop. Lower left: Minneapolis Workshop. Lower right: State DOT Panel at Minneapolis Workshop.

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Workshop Materials

At the first workshop, each attendee received hard copies of all workshop materials in three-ring binders. For subsequent workshops, a limited number of complete binders were distributed to conserve resources. Instead, all attendees were emailed a link to download a PDF of the workshop materials in advance. At the workshops, each attendee received printouts of the workshop agenda, IC Road Map, IC demo solicitation, and workshop evaluation. In addition, a printed roster of attendees was provided at the final workshop.

The workbook content included: agenda, contact information, presentation slides, and top-ten questions and answers. The material for the second and third workshops also included the workshop roster and the generic HMA IC specification.

Agenda and Speakers

The objectives of these workshops were to:

- Familiarize attendees with fundamentals of intelligent compaction;

- Demonstrate the route to successful IC implementation; and
- Develop attendees into technology champions of IC for their organizations or companies.

The agenda was similar at all three workshops. There were general sessions as well as breakout sessions, allowing participants to choose between IC for HMA and IC for soils/subbase. Formats for the sessions included presentations, discussion, panels, and a software demonstration. The third workshop's agenda is in Appendix C.

The speakers participating in all three workshops were:

- Victor (Lee) Gallivan, P.E., FHWA
- Dr. George Chang, P.E., The Transtec Group
- Bob Horan, P.E., Asphalt Institute
- Larry Michael, LLM Asphalt Consultant
- Rebecca Embacher, Minnesota Department of Transportation
- Jennifer Rutledge, The Transtec Group

Other speakers included:

- Antonio Nieves, FHWA
- Georgene Geary, State Materials and Research Engineer, Georgia DOT
- James Christian, Division Administrator, FHWA Utah Division
- Derrell Turner, Division Administrator, FHWA Minnesota Division

Workshop Notes

There were many discussions during the workshop – one of the key elements that drew positive feedback from the participants. A summary of common discussions and questions/answers during the workshop is below. More detailed notes are in Appendix D.

***Disclaimer**: The following workshop notes were recorded and edited as a part of the final report to the FHWA. Neither the FHWA nor the project staff makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government. The opinions expressed herein do not necessarily state or reflect those of the United States Government and shall not be used for advertising or product endorsement purposes.*

It was generally agreed that IC is a valuable tool for quality control. Although there are still improvements to be made, the technology is already beneficial now. IC addresses many of the shortcomings of conventional compaction, including consistency and uniformity. Knowing pass count, speed, and coverage helps improve quality. IC also reduces the steps and cost for grading work.

A common concern is cost. However, the cost increase may be outweighed by other benefits considering the life-cycle cost. A retrofit system could be a less expensive option. Availability of equipment is another concern. Manufacturers may not be willing to provide additional

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equipment until interest increases, but agencies are hesitant to require IC if equipment is not readily available. However, manufacturers reassured attendees that rollers are available if contractors plan ahead.

Key areas that need to be addressed are training and certification, calibration, and data management. IC users need training and initial on-site tech support from the suppliers. More IC training is needed for everyone involved including management, roller operators, and personnel handling IC operations and data management. In addition, a national calibration center for IC has been suggested.

Currently there is no standard unit for intelligent compaction measurement values (ICMVs) – each manufacturer has its own ICMV. This makes it difficult to compare measurements from different vendors' machines. However, the third-party intelligent compaction data management program Veda helps standardize viewing and analysis. Roller manufacturers should make sure their IC systems are compatible with the Veda software. Veda training may be offered in the future.

Contractors need to see the benefit of IC before they will be willing to try it. Clearly explaining the cost and savings to them will help move them towards adopting IC. Years ago air conditioning was optional in cars, and expensive, but now it is standard. IC will be the same way – eventually more of a standard. Benefits to contractors will be the driving force of IC technologies.

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Workshop Feedback

There were 112 evaluation forms completed and submitted. The summary for the workshop evaluation is presented in Table 3.

Table 3. Summary of Workshop Evaluation

	E	G	F	P	VP
Meeting facilities	27	59	21	5	1
Preparation of the instructors	61	48	2		
Friendliness of the instructors	79	32			
Overall quality of the instructors	62	45	4		
Ability of the instructors to respond to questions/comments	64	46	2		
Ability of the instructors to lead the discussion	54	53	4		
Instructors' knowledge of the topics covered	67	38	6		
Usefulness of the materials/information for your needs	25	70	16		
Timeliness of the materials/information presented	38	66	7		
Quality of the technical presentation	39	65	5	1	1
Workshop agenda	36	62	8	5	
Quality of folders, handouts, and other workshop materials	28	55	20	7	
Overall quality of the workshop	43	58	9		

E - Excellent, G - Good, F - Fair, P - Poor, VP - Very Poor

Over 90% of all responses were either Excellent or Good. Nearly 92% of attendees rated the overall quality of the workshop Excellent or Good; no one considered it Poor or Very Poor.

When asked what could be improved about the workshop, a common answer was to increase contractor involvement. This could include a presentation or panel focused on contractors who have used IC sharing their experiences, the benefits, and the challenges. As one responder said, "This technology truly needs to be driven by contractors." Another suggestion was the following: "Need to show practical ways how contractor can benefit because the benefits are there!"

Some suggested changes to the format of the workshops: a hands-on portion, small discussion groups, and non-concurrent sessions for asphalt and soils. Others had ideas for additional content: more case studies and States' experiences with IC, information about IC technology and specifications in Europe, a greater focus on manufacturers' data differences, a clearer idea of cost, and reference to research reports on the benefits of uniformity in construction to life of pavements.

In addition, there were comments regarding the future of the technology and the workshop in general:

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- Need a clearer explanation of what IC will mean to DOTs and contractors over the next 5-10 years.
- Need to emphasize that must there must be buy-in by both agency and industry at the executive level.
- Would like to see action items with planned dates for execution as opposed to talking about it. More direction on how to promote and get contractors on board.
- Another workshop for others at my company.
- Excellent overview on IC – good stepping stone on bringing this technology to our state agency.

All suggestions from participants were taken into consideration. Feedback from each event influenced subsequent workshops. Specific changes are detailed in the individual workshop reports.

Improvements resulting from attendees' input stretched beyond the workshops. A few of the additional outcomes included the following:

- Points of contact for IC equipment were added to the intelligent compaction website.
- The generic specification previously referred specifically to HMA. It was modified to more broadly cover asphalt materials, in order to also include WMA and SMA.
- In the Veda software, the y-axis of the histogram chart was changed from Frequency (%) to Occurrence (%).

Specifications

Prior to the national workshops, FHWA developed generic specifications for intelligent compaction. There are three separate documents with guidance for asphalt, soils, and subbases. The specifications provide information on equipment, including requirements for IC rollers and GPS. Furthermore, the specifications list guidelines for developing a Quality Control Plan. (The specifications do not yet recommend IC for quality assurance.) Other sections within the documents include IC construction and the basis of payment.

The generic IC specifications for HMA were included in the materials distributed to participants of the second and third workshops. They are also posted on IntelligentCompaction.com, along with the generic specifications for soils and for subbases.

The asphalt and soils IC specifications were updated as a result of the workshops. These and the 2011 subbase specification are in Appendix E.

Future Needs

Through dialog with and feedback from workshop participants, necessities for furthering IC technology were identified. Common discussions addressed cost and availability of equipment,

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certification, calibration, and the need for standardization. One unanswered question was how to get buy-in from decision makers.

Based on feedback from the workshop participants, the following needs for the future of IC were identified:

- It would be easier if everyone worked with one ICMV (intelligent compaction measurement value).
- A formal certification program could be beneficial.
- There should be a conversation with manufacturers about a way to calibrate for temperature.
- Involvement is needed from contractors, dealers, and management.
- Specifications may need to differentiate land-based system or satellite system (OmniSTAR). The GPS check is not applicable for satellite systems.
- Add caution to specifications about using low amplitude for pre-mapping.
- Future needs would include percent roller coverage based on plan file and actual roller coverage.
- Combining IC and thermal bar technologies has great potential to achieve better density.
- More IC training is needed for all personnel involved including roller operators and whoever handles IC operations and data management.
- Interest in training on the Veda IC data management software was expressed.
- Data decimation should be on the wish list for future Veda improvement. Therefore, users could choose different complexity levels of viewing data.
- Managing data from multiple IC machines should be on the Veda wish list.
- Vendors' systems should be improved to better filter/handle/record data prior to Veda viewing/analysis.

There are plans for future studies, ongoing collaboration with equipment manufacturers, and enhancements to the Veda IC data management software.

Conclusion

The three national intelligent compaction workshops successfully introduced participants to IC and showed the current state of the technology. Attendees learned the basics of intelligent compaction through presentations, panels, and conversations. Invited State representatives shared their success, obstacles, and plans for implementation. The workshops served their purpose of promoting intelligent compaction nationwide. Now, the interest and momentum gained must continue, and work must be done to bring about future progress. As individuals return home as IC champions and ongoing discussions among workshop participants occur, intelligent compaction will continue to advance, and greater consistency and uniformity will be the end result.

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