

# Frequently Asked Questions on Intelligent Compaction (IC)

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## TOP Questions

1. Q: What properties of the compacted materials do the IC rollers measure?  
A: IC rollers measure relative compaction values in stiffness/moduli or unitless indexes based on the vibration of the roller drums and the resulting response from the underlying materials. Current IC technologies measure stiffness. Stiffness is a mechanical property; density is a material proportional property. Intelligent compaction measurement values (ICMVs) can be related to other conventional point measurements such as Lightweight Deflectometer (LWD), Dynamic Cone Penetrometer (DCP), and Plate Loading Tests (PLT), etc. Different IC rollers provide different roller measurement values that are mostly patented, but they are generically referred to as ICMVs.
2. Q: What are the factors that influence intelligent compaction measurement values (ICMVs)?  
A: Several factors affecting ICMVs include machine weights, sizes and compacting energy, operation speeds, vibration amplitudes and frequencies, properties of compacted materials (including moisture, soil type, and particle shape for soils/bases and temperature for asphalt), and underlying support condition and water table.
3. Q: Can intelligent compaction measurement values (ICMV) indicate how deep weak spots are?  
A: No. Coring, trench digging, or Dynamic Cone Penetrometer (DCP) can be used to verify these weak spots. The GPS system can locate the depths of these locations.
4. Q: How can IC data be correlated to conventional testing?  
A: If conventional tests are conducted properly, IC data correlate well with Lightweight Deflectometer (LWD), but not nuclear density data. Regardless, IC can be invaluable as a mapping or "proof rolling" tool on existing surfaces to identify soft spots for corrective actions and to help ensure 100% coverage by the roller.
5. Q: IC technologies seem complicated-how steep is the learning curve for roller operators?  
A: The IC training for roller operators is very straightforward. The time for operational training is generally one to two hours. It would take additional practice to improve the operation of the entire IC system, data recording, and data file downloads. The daily setup for IC and GPS is challenging, but it is not the roller operator's responsibility.
6. Q: How can agencies implement IC in construction specifications?  
A: FHWA has issued generic specifications for IC implementation as guidelines. Agencies need to have a plan (including timelines and goals) and assemble a team for implementation. Assistance from FHWA for agencies' pilot projects is highly recommended. It is recommended to use IC for quality control initially, and then for acceptance later on.

7. Q: What are the barriers for implementing IC?  
A: The main barrier is the lack of "IC champions " in agencies who have a passion for innovative technologies and quality pavements. Other barriers include: contractors' resistance of initial capital investment in the equipment; and lack of training for contractors, QC technician and managers, agency field inspectors, etc. In addition, IC equipment availability and inability to handle large volumes of data generated are often seen as barriers by states.
8. Q: How can IC data be used in the acceptance process?  
A: We currently recommend using IC for QC only. Current IC-based QA methods have been high-risk, or difficult to implement on large-scale projects. Several studies with the objective of determining a low-risk means of using IC as a QA tool are underway. Harmonization of IC test data needs to be addressed before IC can be effectively used as a QA tool.
9. Q: How can IC data be used in quality control?  
A: Roller operators, inspectors, and the quality control manager can use readouts from IC displays or daily printed IC summary results to verify consistency and uniformity of the applied effort. Roller operators can use IC to do real time adjustment to ensure complete coverage.
10. Q: Has AASHTO or the industry (e.g., NAPA, AGC) released any comments on IC?  
A: No comments from the above entities have currently been released. However, FHWA is currently working with AASHTO, AGC, and ARTBA on nationwide implementation of IC.
11. Q: How available is IC equipment?  
A: IC equipment manufacturers have reassured users that IC rollers are available if contractors or agencies plan ahead.
12. Q: It appears that FHWA has decided to support this technology. Was the decision made based on higher quality of the finished product, a financial benefit, or both?  
A: The decision was made based on all of the above. IC technology has matured. The technology is accessible, and many studies have indicated that the IC technology works, saves life-cycle costs, and improves quality. For example, IC mapped embankment would be less likely to have settlement or slope failure, which would save in maintenance costs.
13. Q: Using this new technology will cost money. Does FHWA financially support buying or using this technology?  
A: Yes, the FHWA is financially supporting this technology via MAP-21 under section Sec. 1304: Innovative Project Delivery Methods. This section says "The Federal share payable may be increased by up to 5 percent of the total project cost, not to exceed 100 percent, for projects determined to meet the requirements specified in 23 U.S.C. 120(c)(3)."
14. Q: Has FHWA developed an Independent Assurance procedure with the QC/QA process for use during IC implementation?  
A: The FHWA has not developed it yet, but there are plans to develop one. There are a number of additional studies that must be completed before the FHWA can start to address this subject.

15. Q: What was the focus of the FHWA-sponsored IC pooled fund study?  
A: The FHWA/TPF IC study focused on the existing technologies and field demonstration. An ongoing FHWA study (2012-2014) is focused on correlation among ICMV, other IC records, and in-place asphalt densities.
16. Q: Is the contact information for IC vendors available somewhere?  
A: This information can be found on [www.IntelligentCompaction.com](http://www.IntelligentCompaction.com).
17. Q: What kind of horizontal GPS control is needed for the IC roller to be able to track roller passes?  
A: Real-time kinematic (RTK) GPS is required in the FHWA generic IC spec in order to reliably track roller passes. In some locations, repeaters for GPS base station signals are necessary. Vertical GPS precision is not required now, but it may be required by agencies that elect to track as-built production quantities.

## Features and Benefits

18. Q: Is it valuable for the roller operators to know the speed and frequencies shown on IC screens during operation?  
A: Yes, the on-board screen gives direct feedback to the operator with the opportunity to monitor the machine settings with respect to contract requirements, which will also affect the stiffness values measured during vibration.
19. Q: What type of temperature readings does an IC roller provide?  
A: IC uses infrared temperature sensors to measure HMA surface temperatures, though internal temperatures would be better.
20. Q: What are the shortcomings of conventional compaction?  
A: There are several. Conventional compaction is difficult at night: IC is especially useful for nighttime paving to achieve consistent roller passes. Conventional compaction also requires "after-the-fact" conventional point tests, which cover only 1/1,000,000 of the compacted areas.
21. Q: What are All Passes Data and Final Coverage (Proof) Data?  
A: All Passes Data are time series data that includes all IC passes over a compacted area. Final coverage (Proof) Data are the final or last pass data for a given area.
22. Q: Can IC be used to reduce conventional testing?  
A: Potentially, yes. IC maps can be used to improve test location selection. For example, testing can be focused on weak spots instead of random testing. Also, IC mapping can be performed at certain intervals, say, at every 2.5 feet along with DCP testing which can penetrate up to 2.5 feet (lift thickness can be limited based on soils types). Since a contractor would be without supervision up to 2.5 feet, this would permit the contractor to work at his own pace and QA would be performed with IC and DCP. If IC and DCP values do not agree, a contractor would be fixing at his own expense.

23. Q: Can IC be used for thin lift asphalt construction?

A: IC can be used for thin lift asphalt construction, but the roller often needs to be operated at static mode as required by some agencies. In this case, ICMV is not measured and IC is used mainly to track roller passes and asphalt surface temperatures.

## Availability of IC Systems

24. Q: Do IC vendors offer rental and/or retrofit options?

A: Most vendors do not provide rental options. In terms of retrofit, there are different options based upon the manufacturer.

25. Q: Are there short-term rental options for IC?

A: It depends and varies from vendor to vendor.

## Specifications and Standardization

26. Q: Are generic specs based on the experience of IC pooled fund and state projects?

A: Yes, experience from and challenges faced during those 16 field projects in 13 states under the IC pooled fund study are included.

27. Q: The FHWA generic specs mentions hot mix asphalt (HMA). Is that being emphasized over warm mix asphalt (WMA)?

A: No, the FHWA generic spec will be updated to mention simply asphalt pavements. IC worked fine on one WMA project that was tried. It would probably be the same but with lower temperatures.

28. Q: Is IC able to map on milled surface in static or low vibratory mode?

A: IC systems can be used to map the existing milled surface in low vibration amplitude and frequency, although this is not often done. The mapping cannot be done in static mode since the accelerometer-based measurement systems can only work in vibration mode. Caution needs to be taken according to the manufacturer's recommendation. Additionally, it is not recommended that this testing be included in a contract, as not all contractors will want to run their equipment in vibration mode due to potential equipment wear (i.e., this may be high risk to an agency requiring these measurements).

29. Q: How does MnDOT require IC in its specifications?

A: By supplemental agreement, IC has been applied to granular soils, non-granular soils, bases, full-depth reclamation and stabilized full-depth reclamation material, and asphalt materials.

30. Q: What corrective actions do states require for “weak spots” identified with IC?  
A: Currently, MnDOT does not require any corrective actions based on IC measurement values—they are only required through conventional methods. This is because MnDOT cannot satisfactorily determine target measurement values for IC in the field. INDOT performs DCP tests on weak areas. If the test fails, the contractor has options which include drying and recompacting or replacing with better material.
31. Q: Can IC data be standardized?  
A: The IC data format and elements can be standardized similar to the standardization process for GPS data. However, the standardization of IC measurements is much more difficult due to different systems from various vendors and machine types.
32. Q: What is Veda?  
A: Veda is a standardized software tool developed by MnDOT and FHWA for geospatial data management, viewing, analysis, and reporting. Veda allows users to import and analyze IC data from various manufacturers and serves as an important element in IC standardization. More information on Veda can be found at [www.IntelligentCompaction.com](http://www.IntelligentCompaction.com).
33. Q: Is including an IC specification intended to be required or permissive?  
A: Currently, it is permissive or optional.

## Field Calibration and Verification

34. Q: Is there a standard procedure for calibrating/verifying temperature measurements?  
A: No, the only requirement is to use an independent temperature gauge to verify the measurements.
35. Q: Are there any necessary procedures to ensure accurate GPS data?  
A: Yes, daily GPS verification is needed. Further information on GPS validation can be found in the FHWA generic IC specs on [www.IntelligentCompaction.com](http://www.IntelligentCompaction.com).

## IC Training

36. Q: Is Veda training available?  
A: Yes, FHWA is sponsoring intelligent construction data management (ICDM) workshops that include training for Veda. More information on ICDM and Veda workshops can be found on [www.IntelligentCompaction.com](http://www.IntelligentCompaction.com).