



State Transportation Innovation Council (STIC)

2015 Fact Sheet

Intelligent Compaction

Technology Translates into Smoother Ride, Longer Pavement Life

Compaction is the important final step in constructing high-quality, longer-life, asphalt pavements. Intelligent compaction (IC) facilitates real-time compaction monitoring and timely adjustments to the compaction process by integrating computerized measurement, documentation, and control systems.

IC uses a combination of relatively new, essentially off-the-shelf instrumentation technologies (GPS to track the roller passes and speed, infrared sensors to monitor the surface temperature, and accelerometers to measure the material stiffness) and applies them to the compaction of common roadway materials to provide better control and oversight. The result is improved and more uniform compaction, increased productivity, and a reduction in future highway repair costs.

When used properly, IC achieves cost savings for the contractor, without any reduction in safety, all with no additional expense for the Department of Transportation. IC is a win-win for both PennDOT and the contractor.

How does it work?

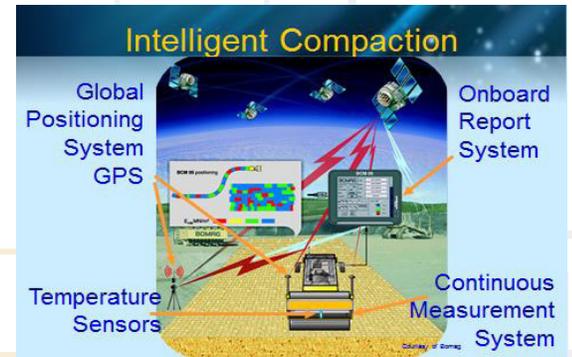
- IC basically consists of four integral components (*see illustration above*):
- 1) the position of the roller is determined by GPS;
 - 2) the temperature of the mat is monitored by infrared sensors, typically mounted on the front and rear of the roller, to measure the temperature in the direction of travel;
 - 3) the drum rebound vibration is monitored using an accelerometer strategically mounted on the axle of the front drum of the roller; and
 - 4) data from all these tools are continuously monitored and recorded by an on-board computer system mounted on the roller and displayed on a monitor positioned in the cab where the roller operator can easily see it.

The technology can be applied to the compaction of soil subgrades, subbase, hot-mix/warm-mix asphalt, and roller compacted concrete materials. It provides graphical information that can be used to better manage the operations, resulting in the target properties of the layer being achieved more uniformly and more efficiently. Although the system requires routine inspection and calibration checks, IC technology is relatively reliable and robust considering the construction conditions under which it must operate.

Where can it be used?

Intelligent compaction methods can be used on any project where materials require compaction as long as suitable GPS satellites are available. The initial focus of IC in Pennsylvania has been on bituminous paving. Consideration is currently being given to using IC on embankment and subbase materials.

Although the IC vibration may not be desired on some projects, such as thin lifts, and the temperature data may be of marginal value on other projects, such as earthwork, IC produces a map, depicting the number of passes made over the site together with the roller speed, that provides useful information regardless of what else the project may entail.



The State Transportation Innovation Council (STIC) has selected intelligent compaction as an innovative technique for providing more efficient compaction of materials, resulting in smoother, longer-lasting pavement. The Federal Highway Administration has also included intelligent compaction as part of its Every Day Counts program, which is an initiative designed to identify and deploy innovation that shortens project delivery, enhances safety, and protects the environment.

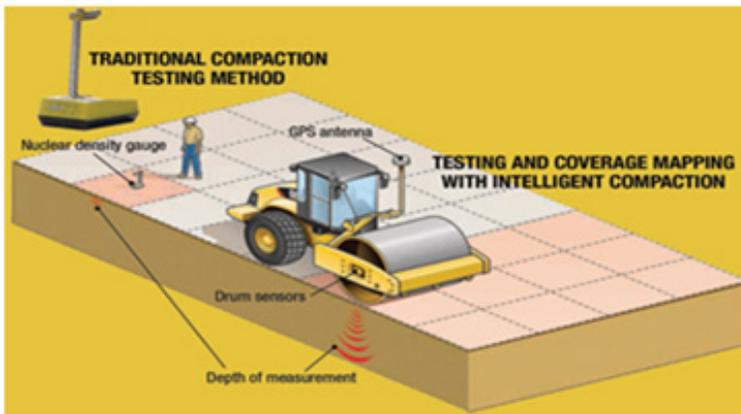
What does the future hold?

PennDOT is seeking suitable paving projects for employing intelligent compaction (IC), and the initial focus has been on bituminous paving. Consideration is also being given to using IC on embankment and subbase materials. In 2014, five IC projects were completed. In 2015, 11 projects are planned.

PennDOT has drafted a Special Provision and Publication 771, "Procedures for Implementing IC on PennDOT Projects," to offer guidance to PennDOT personnel, contractors, inspectors, and other interested persons. These documents are expected to be finalized in 2015.

What are the benefits?

- Minimizes the number of roller passes by running a more efficient rolling pattern.
- Provides uniformity with respect to pass coverage, temperature, stiffness, etc., and discloses irregularities during construction so that corrections can be made effectively.
- Reduces unnecessary passes to save fuel and time.
- Avoids over- or under-compaction.
- Helps to provide a durable, long-lasting pavement option.
- Allows the operator to adjust the speed and amplitude settings to complete the compaction before the asphalt cools.
- Generates valuable information that provides a better indication of the quality of the construction than just the traditional quality assurance testing.
- Provides collection of data that serves as a record of field conditions at the time. This information is useful for planning future maintenance activities.
- Helps to produce better quality roadways that keep motorists safe and allow PennDOT to operate more efficiently.

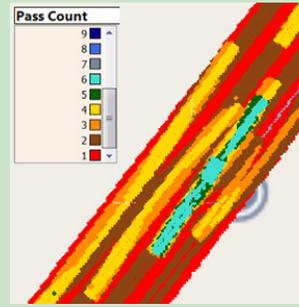


Uniformity is the Key for Optimum Compaction

The key to achieving optimum compaction is uniformity. When conventional compaction equipment and techniques are used for pavement construction, roller operators receive very little feedback as to what is happening to the materials being compacted, especially after the first roller pass. Typically, the operators rely heavily on the application of preestablished roller patterns and the use of portable gauges that measure density at spot locations. In contrast, the continuous graphical and numeric information produced by IC-equipped rollers creates a window into the layer compaction process.

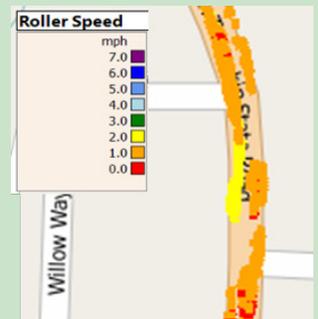
Intelligent Compaction & Technology

GPS INSTRUMENTATION



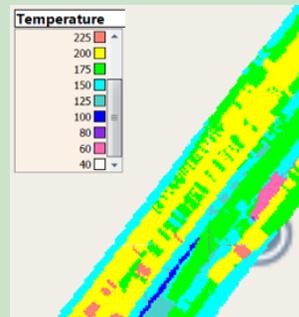
The roller-mounted GPS instrumentation is the kingpin of the IC system. This graph (left) depicts one of the color-coded screen options on the monitor and shows where the roller has been in real time. As the instrumentation tracks the position of the roller, it counts the number of times the roller has been over the same spot. The operator can tell how many passes have been made by observing the color on the screen.

Not only does the GPS track location, it also tracks time, which translates into roller speed. This graph (right) shows how the operator can monitor the roller speed by observing the color on the screen.



The Handheld GPS Rover provides a vital connection between the real world and the project plans. This tool is used to calibrate the roller GPS and to collect the coordinates for such locations of points-of-interest as:

- Where anomalies in the IC data suggest that deficiencies may exist.
- Where changes occur in the tack coat, asphalt mixture, plant source, etc.
- Where changes occur in the underlying pavement section.
- Where the paving equipment stopped for a long time or broke down.



INFRARED SENSORS

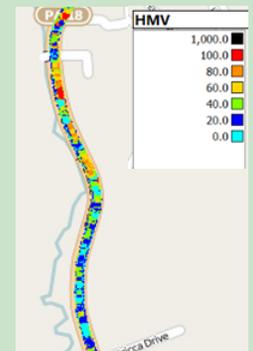
The infrared sensors help operators work at optimal mat temperatures and avoid tender zones. However, wind and water may cool the surface of the mat; and heat from the drum and/or the roller engine may also affect the infrared sensor. Thus, the indicated temperatures need to be understood in the context of the project environment.

This graph (left) shows how the GPS/infrared data displays the temperature at any spot when that area is rolled.

ACCELEROMETERS

The accelerometer mounted on the frame of the roller drum measures the average stiffness of all the materials within a distance of 2 to 4 feet below the ground surface. It is the uniformity of the stiffness value that is of interest.

This graph (right) illustrates the high degree of variability encountered on this project. The upper portion of the map indicates an overall larger stiffness value than the lower portion of the map. On a project where the stiffness values were more consistent, it may be possible to detect individual hard or soft anomalies (soft spots, utility trenches, shallow rock, etc.) in real time, allowing corrective action to be taken, if warranted, in a timely manner.



State Transportation Innovation Council (STIC)
(717) 214-8685 RA-pdPennDOTSTIC@pa.gov
www.moderndot.pa.gov

