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# Real-Time Smoothness Pocket Reference

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National Concrete Pavement  
Technology Center



 **SHRP2 SOLUTIONS**  
TOOLS FOR THE ROAD AHEAD

# Real-Time Smoothness System Setup and Daily Startup

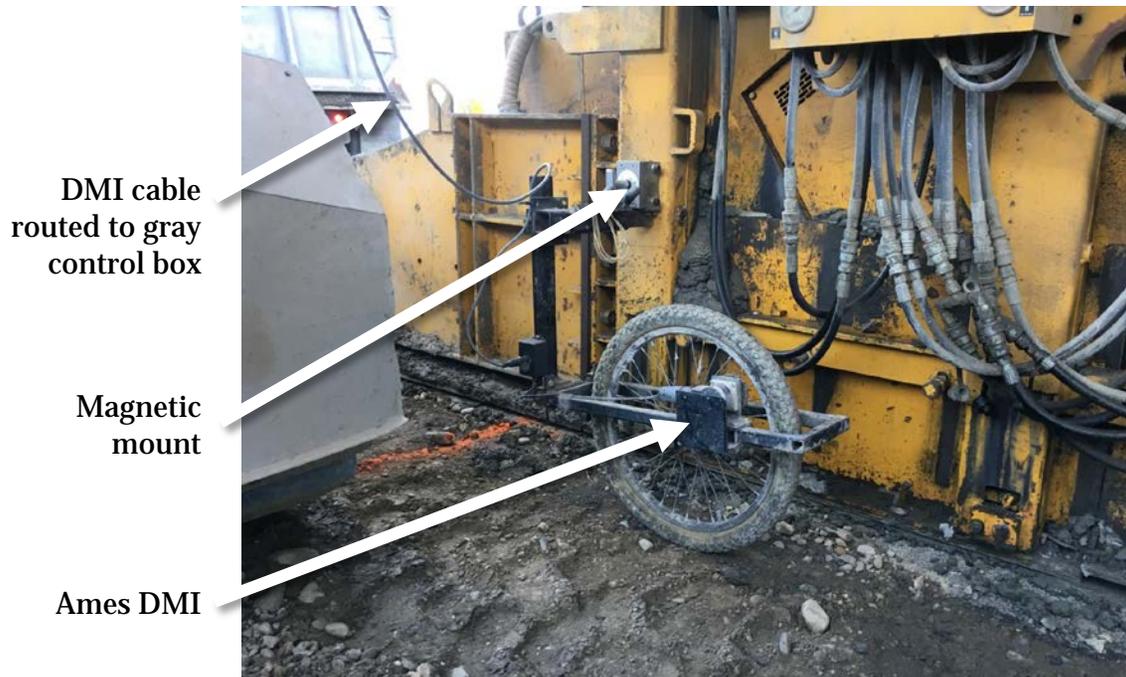
Install RTS systems according to the manufacturer's instructions, paying close attention to the following:

- Continuous power supply
  - Power to the RTS should be provided by the paver and should have a fuse with appropriate amperage to prevent damage to the system.
  - If possible, the power source should be continuous to allow proper shutdown of the RTS if the paver is turned off during collection of profile data.
- Cable connections tight and moisture-proof
  - Check cable connections at least every other day to ensure that they are tight.
  - If necessary, reroute cables to prevent direct spraying of water on connections.
- Cables routed clear of pinch points and able to accommodate leg barrel movements
- Cables routed along hydraulic lines and secured with zip-ties

# Real-Time Smoothness System Setup and Daily Startup

The cable connecting the distance measuring instrument (DMI) can be stretched and/or broken when the leg barrels are extended upward. This is typical at the end of a day's paving but can occur any time vertical control of the paver is interrupted.

Be prepared to unplug the DMI quickly or install the DMI in a location where the cable length will accommodate the leg barrel movement.



# Real-Time Smoothness System Setup and Daily Startup

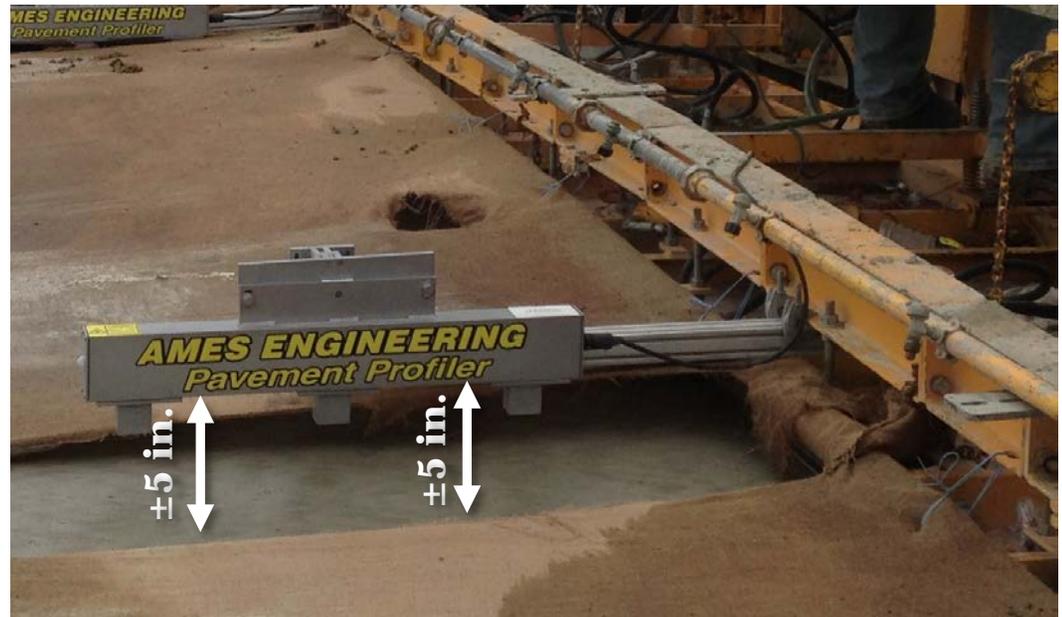
To avoid errors in distance measurement and to minimize damage to the DMI, install the DMI behind a paver track so that it is out of the zone of any concrete that may squeeze out below the paver side form.

Distance measuring device (DMI) connected and clear from paver track line obstructions



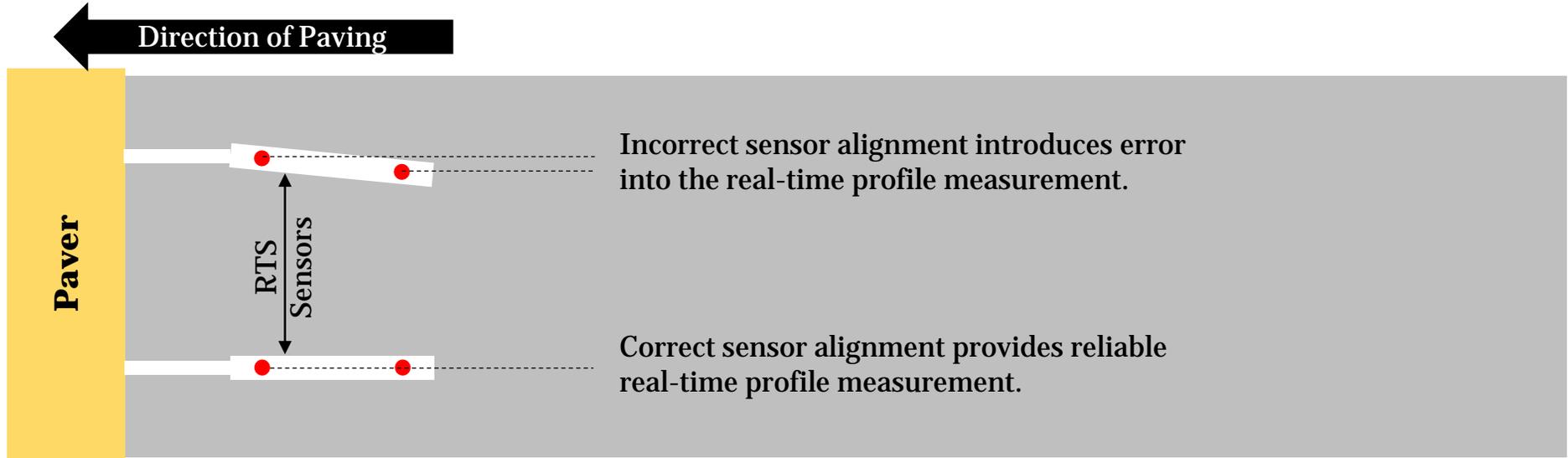
# Real-Time Smoothness System Setup and Daily Startup

- Sensors must be installed at the correct height:
  - GSI 6 in.  $\pm 1 \frac{1}{2}$  in. from top of slab to bottom of wire bail
  - RTP 5 in.  $\pm 1$  in. from top of slab to bottom of sensor beam
- Sensors must be installed near to level with the profile of the slab.



# Real-Time Smoothness System Setup and Daily Startup

- Sensors should be installed so that they will track parallel to the edge of the pavement.
- Misaligned sensors will result in measurement of different locations on the pavement; this will result in erroneous real-time IRI values.



# Real-Time Smoothness System Setup and Daily Startup

Ensure that there is no interference from burlap, artificial turf drags, or auto-float (if used).

Extend the drag so it trails behind the RTS sensors.

OR

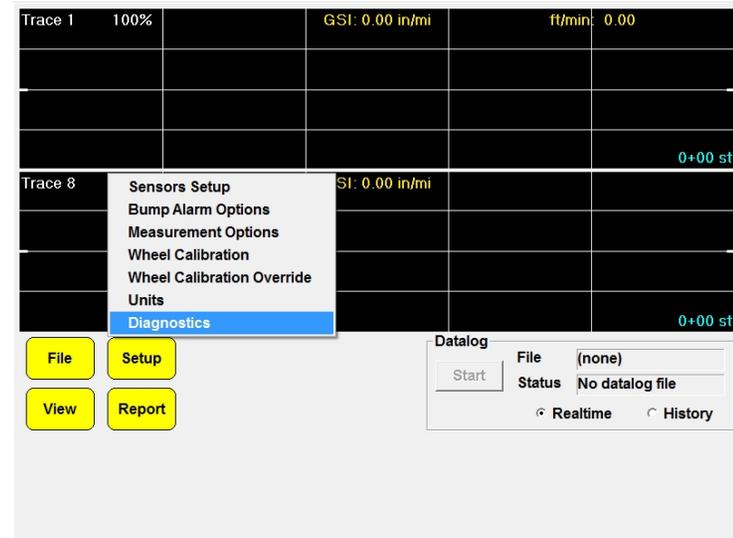
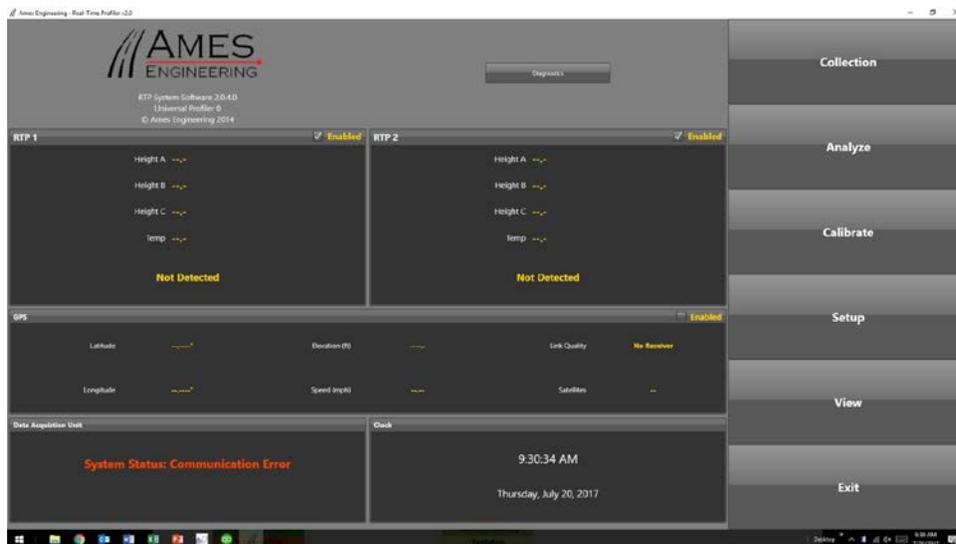
Create a slot of sufficient width in the drag underneath the RTS sensors.



# Real-Time Smoothness System Setup and Daily Startup

Operate the RTS system according to the manufacturer's instructions:

1. Connect all cables.
2. Power up the system:
  - **RTP** – Turn the key and push the button on the gray control box and open the RTP software.
  - **GSI** – Flip the toggle switch on the NAVPAC.
3. Check diagnostics to assure that all system components are working:
  - **RTP** – System status is shown on the opening software screen (photo on left below).
  - **GSI** – Select Setup and then Diagnostics to view system status (photo on right below).



# Real-Time Smoothness System Setup and Daily Startup

Input starting station and direction of paving (positive or negative).

**RTP** – Select Collection and input appropriate data.



**GSI** – Select File, then New Datalog.



# Real-Time Smoothness System Setup and Daily Startup

Start collecting real-time profile data at a predetermined station, which should be approximately 25 ft beyond the beginning of paving and after all initial adjustments have been made to the paver and/or trailing finishing pan:

- A key benefit of RTS systems is using the real-time feedback to adjust the paving process. Collecting data very near a header will often pick up bumps and dips, which can skew the IRI readings for the first 0.10-mile segment.
- The skewed IRI values are not representative of production paving beyond the header and can delay the ability to make appropriate paving process adjustments in a timely manner.
- These bumps and dips near a header are typically removed by hand finishing.

# Real-Time Smoothness System Setup and Daily Startup

**Ames RTP** – After providing input for data fields, press Start to begin collecting data at the designated Beginning Station location.



**Gomaco GSI** – After providing input for data fields in the New Datalog dialog box, select OK and press Start to begin collecting data at the Starting Station location.

Trace 1	100%	GSI: 0.00 in/mi	ft/min: 0.00
			100+25 st
Trace 8		GSI: 0.00 in/mi	
			100+25 st

File
Setup
View
Report

Datalog
File
07202017-1
Ready to log

Start
Stop

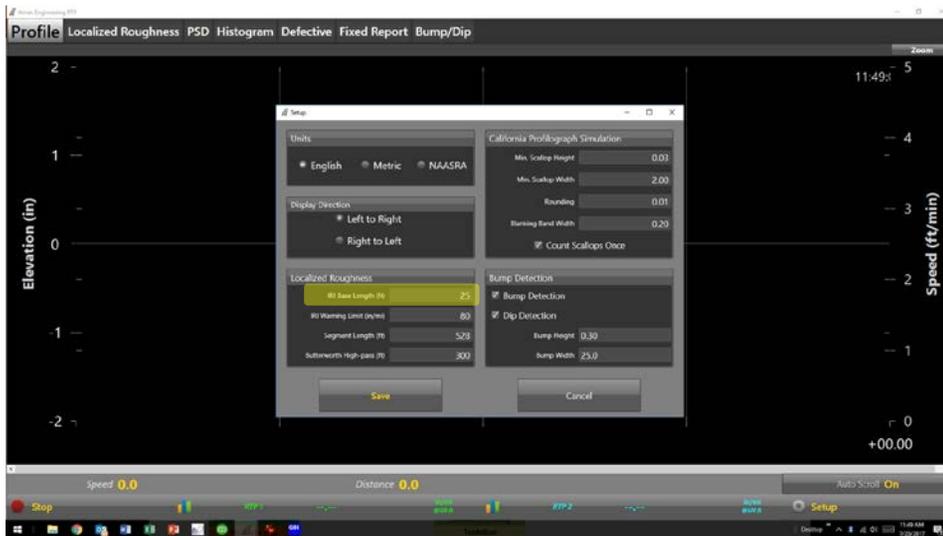
Realtime
History

# Real-Time Smoothness System Setup and Daily Startup

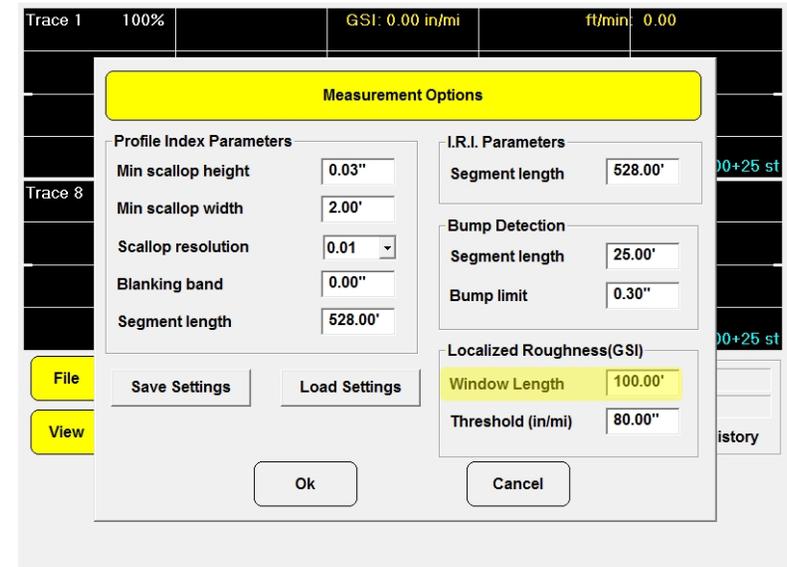
Set the measurement options to report IRI with a segment length of 100 ft.

- Note that setting the segment length at 100 ft will result in slightly higher IRI values than a typical reporting segment length of 528 ft.
- IRI values based on the 100 ft segment length will update sooner than those of a 528 ft segment length, allowing quicker evaluation of the effectiveness of paving process adjustments based on real-time IRI measurements.
- If desired, the IRI segment length can initially be set at 25 ft and incrementally adjusted at  $\pm 25$  ft intervals until a segment length of 100 ft is reached.

**Ames RTP** – From the profile viewing screen, select Setup, then input **IRI Base Length**.



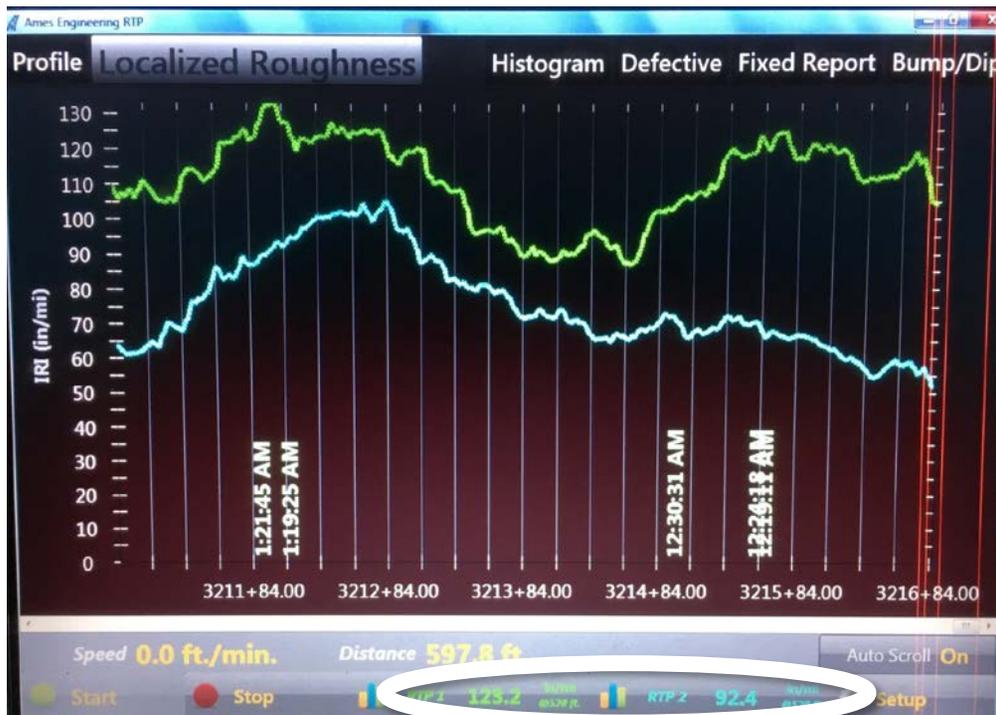
**Gomaco GSI** – Select Setup, select Measurement Options, and then input **Localized Roughness (GSI) Window Length**.



# Using Real-Time Smoothness to Improve Initial Smoothness

Monitor IRI results on a periodic basis (every 15 to 30 minutes):

- Once consistent paving is achieved, note whether the real-time IRI is improving.
- Focus on the real-time IRI with a 100 ft base length and not the actual bumps and dips in the profile.



# Using Real-Time Smoothness to Improve Initial Smoothness

- Monitor profile deviations for bumps and dips:
  - Large profile deviations can be seen on the RTS screen; note whether the hand finishers are correcting these profile deviations.
- Monitor profile data for systematic “patterns” of roughness that may be caused by a process in the paving operation:
  - Adjust any processes that may be causing these patterns to improve IRI values.
- Strive to lower the real-time IRI through uniform paving processes:
  - Eliminate events that cause profile roughness, such as stringline interference, nonuniform concrete, variable paving speed, excessive stops and starts, fluctuating concrete head, etc.
- Adjust materials and paving processes as needed to lower the real-time IRI.

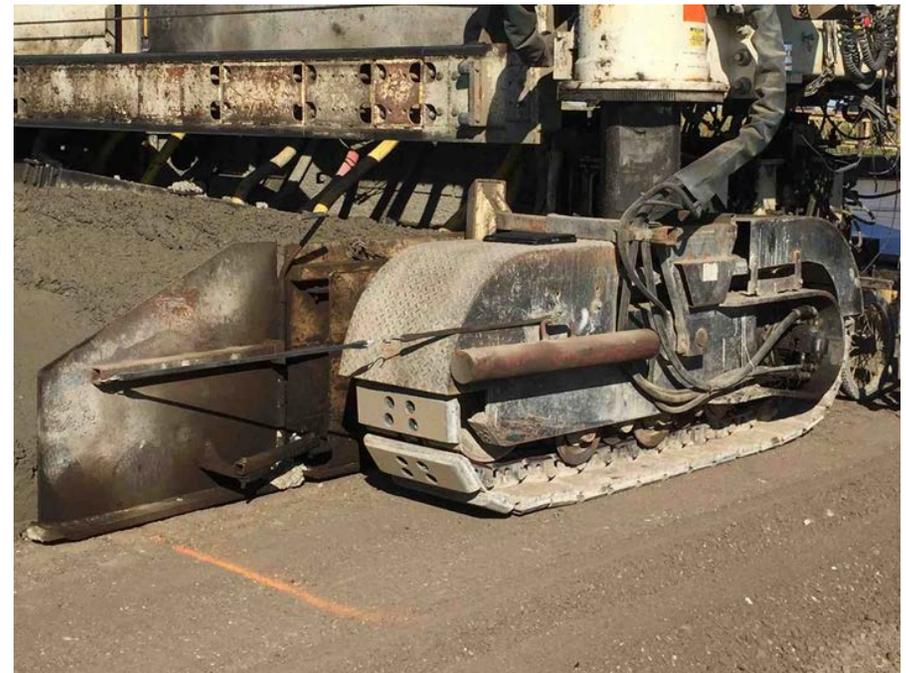
# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Concrete mixture workability and uniformity:
  - Mixture workability should be adjusted to provide the desired IRI without excessive vibration and all of the following characteristics:
    - Vertical edges behind the paver
    - Surface and edges mostly free from surface voids and without excessive slurry
  - Make appropriate adjustments to the mixture:
    - Aggregate proportions
    - Mixing time
    - Admixture dosage
    - Water content (only to the degree that the w/cm does not exceed that of the approved mixture design)
  - Once the optimal mixture workability is found, it is imperative to achieve batch-to-batch uniformity.



# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Segregation of the concrete mixture:
  - The combined gradation of the aggregates should produce a mixture which does not segregate when vibrated.
- Stringline or stringless 3D digital model:
  - The stringline or digital model automatically controls the paver's vertical adjustments. Any deviations in the stringline or digital model will be reflected in the real-time profile.
- Paver trackline:
  - Excessively rough and/or yielding paver trackline results in constant leg barrel movement, which makes it difficult for the paver to produce the profile dictated by the stringline or digital model.



# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Paver setup – angle-of-attack/lead/draft:
  - Lead or draft refers to intentionally having a longitudinal slope in the paving mold.
  - The paver should be adjusted so that the paving mold is as flat as practical.
  - Although lead/draft may help fill surface voids, it results in a hyper-sensitivity to nonuniformity within the concrete mixture, causing pavement roughness.
- Paving speed:
  - A constant uniform speed is ideal.
  - Excessive stops should be avoided.
  - Variable speed should be avoided.
  - In general, a slight slowdown is OK, but it is preferable to stop the paver rather than slow down too much.

# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Vibrator frequency:
  - Adjusting the vibrator frequency can impact the IRI.
  - Optimal vibrator frequency is unique for each mixture, paver, paving speed, and subbase type.
- Vibrator height:
  - Adjusting the vibrator height can impact the IRI.
  - Optimal vibrator height is unique for each mixture, vibrator frequency, and subbase type.
- Sensitivity of elevation controls (hydraulic, electronic, and/or stringless):
  - The sensitivity of elevation controls affects how quickly the paver responds to stringline or 3D model inputs.
  - Sensitivity adjustments can affect IRI and should be made in very small increments.

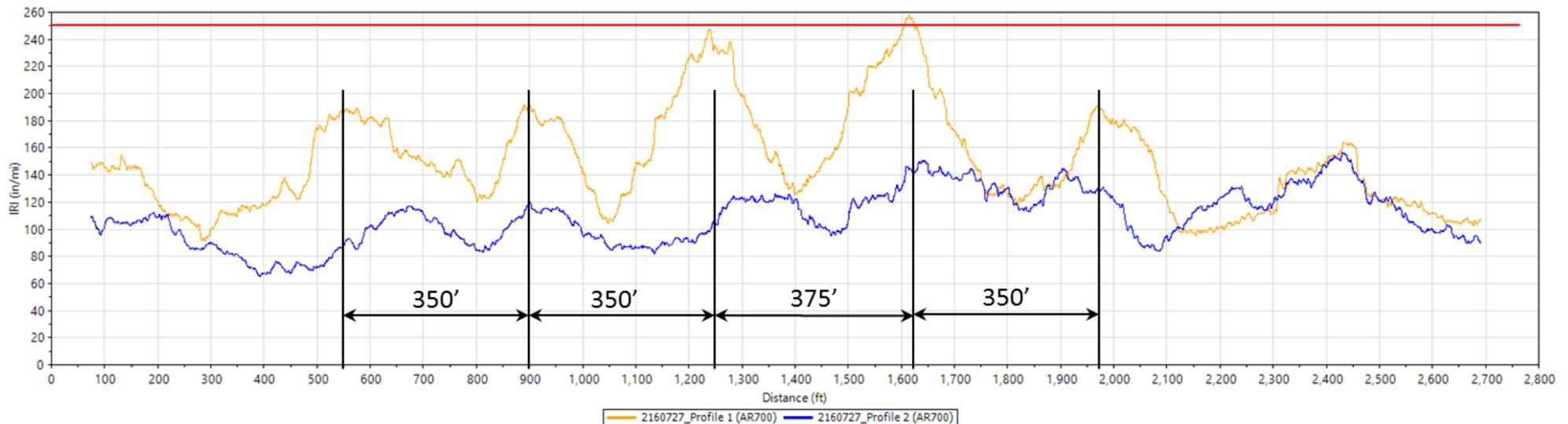
# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Concrete head uniformity:
  - Varying the head of concrete in the grout box influences the IRI.
  - Strive to maintain a uniform head.



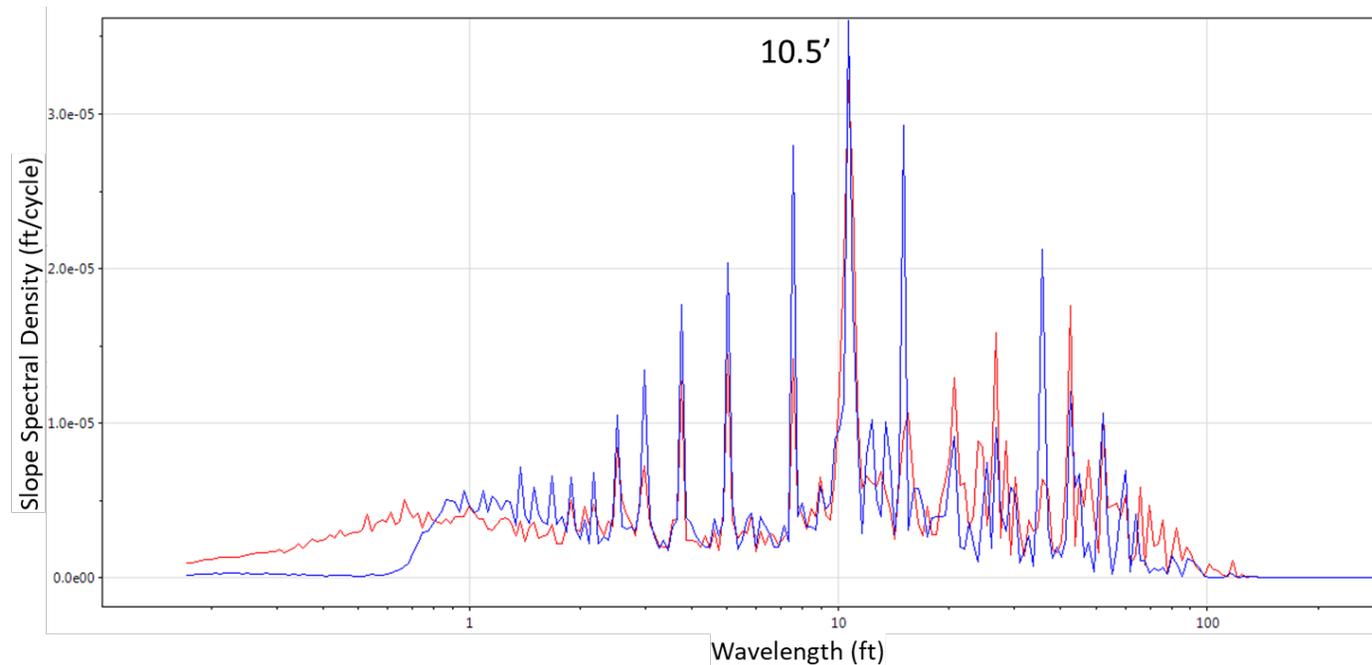
# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- 3D stringless controls:
  - Switch between robotic total stations at appropriate distance intervals.
  - Increasing roughness (IRI) has been observed as the distance between switching robotic total stations is increased.



# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Load spacing:
  - While not recognizable in real-time, load spacing can sometimes be identified in the real-time profile data through a power spectral density analysis.
  - Using a concrete spreader can minimize load-related impacts on initial smoothness.



# Primary Influences on Real-Time Smoothness that May Be Appropriate for Incremental Adjustments

- Dowel baskets or inserted dowels for jointed pavements.
- Transverse bar supports for continuously reinforced pavements.

Both of these influences on initial smoothness are difficult to mitigate. The most effective use of real-time smoothness data is to concentrate on eliminating the other factors that have been previously discussed.



# Real-Time Smoothness Daily Shutdown

Stop collecting profile data.

**Ames RTP** – Press the STOP button and exit the profile collection screen.



**Gomaco GSI** – Press the STOP button.

The screenshot shows the Gomaco GSI software interface. It features a data table with the following content:

Trace	Percentage	GSI	Speed
Trace 1	100%	GSI: 0.00 in/mi	ft/min: 0.00
			0+00 st
Trace 8		GSI: 0.00 in/mi	
			0+00 st

Below the table are several control buttons: 'File', 'Setup', 'View', and 'Report'. A 'Datalog' panel is also visible, containing a 'Stop' button, a 'File' field with the value '07272017-1', a 'Status' field with the value 'Logging', and radio buttons for 'Realtime' and 'History'. A blue arrow points to the 'Stop' button in the Datalog panel.

# Real-Time Smoothness Daily Shutdown

Save and transfer profile data:

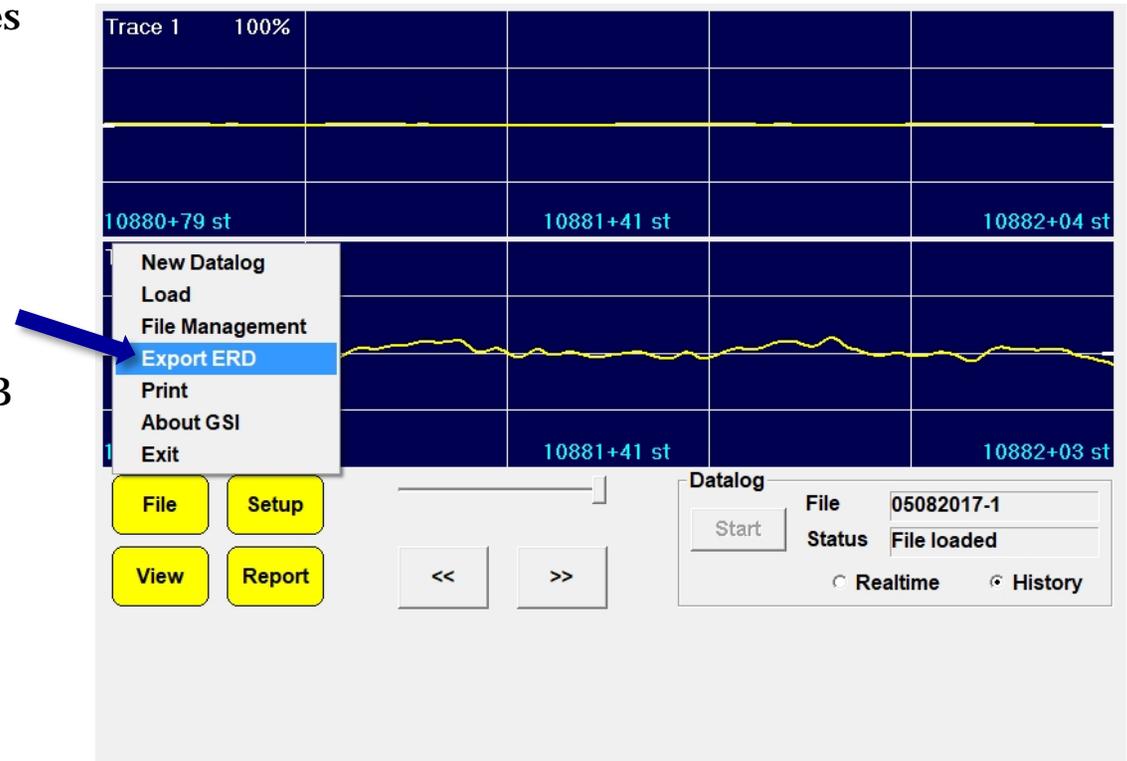
- **Ames RTP:**

- Files are saved automatically.
- Use a Windows application to select files for analysis.

- **Gomaco GSI:**

- Insert a USB drive in the GSI display module.
- Choose File and select Export ERD.
- The \*.ERD file will be copied to the USB drive.
- After exporting data, choose File and select Exit to shut down the system.

NOTE: This must be completed before disconnecting the cable, switching off NAVPAC, or powering down the paver.



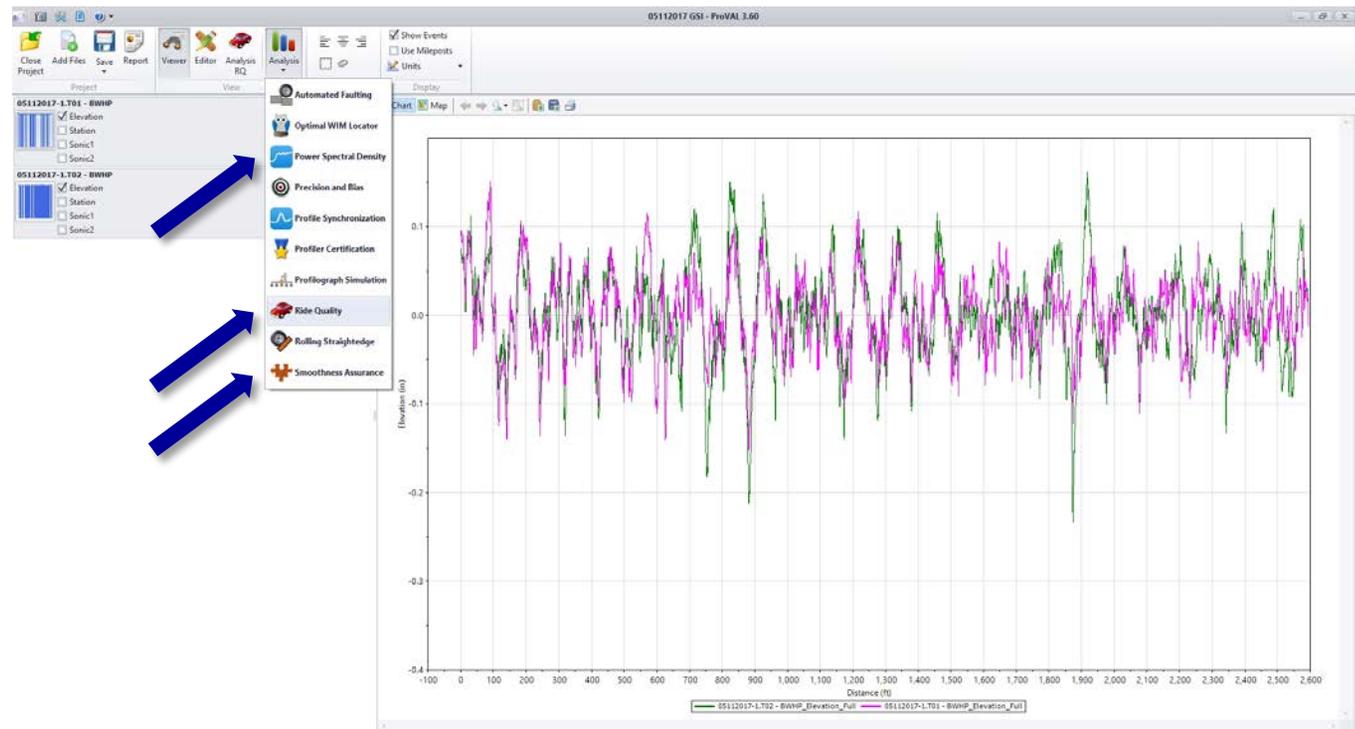
# Real-Time Smoothness Daily Shutdown

- Power down the system:
  - **GSI** – Flip the toggle switch on the NAVPAC to off.
  - **RTP** – Push the button on the gray control box and turn the key off.
- Remove RTS sensors prior to cleaning the paver.
- Disconnect cables and remove display (GSI) and laptop computer (RTP) prior to cleaning the paver:
  - Protect cable ends/connectors from excessive moisture during paver cleaning.
- Raise the DMI wheel so it is not in contact with the paver track (GSI) or ground (RTP) when moving the paver:
  - Disconnect DMI cable if necessary to accommodate leg barrel movement when raising and/or moving the paver.

# Real-Time Smoothness Data Analyses

Analyze real-time data in ProVAL:

- Download ProVAL software for free from <http://www.roadprofile.com/>.
- Use ProVAL for profile analyses:
  - Power spectral density
  - Ride quality
  - Smoothness assurance



# Real-Time Smoothness Data Analyses

As soon as hardened profile data are available, compare and analyze matched profile data sets for both real-time and hardened profile data in ProVAL. Use ProVAL for comparisons:

- Power spectral density
- Ride quality
- Smoothness assurance
- Viewer

