InstroTek® Inc.
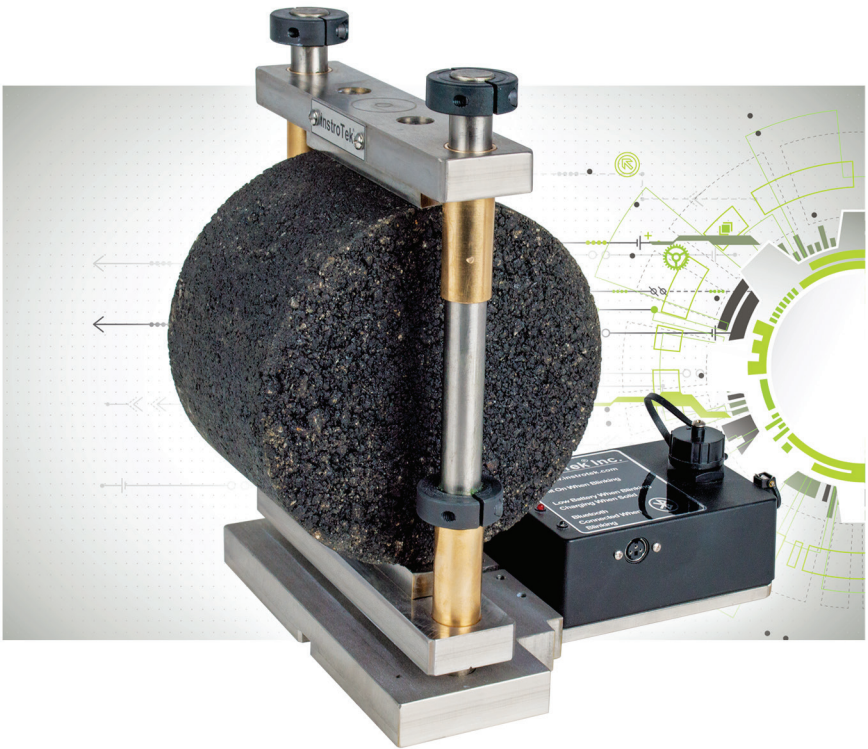
innovators in instrumentation technology

Smart-Jig™

Digital Data Collection for Asphalt Loading Tests

OPERATING MANUAL

www.InstroTek.com

Important

****

PRECAUTIONS WHEN USING THE Smart-Jig

1. The Smart-Jig is rated to measure loads up at 45 kN (10,000 lbs.). Exceeding this load could damage the load cell and void the warranty.

2. Users must be properly trained to use the load frame supplying the load. Always use your internal laboratory safety procedures when working with and around this unit to avoid any crush hazards.

1. Table of Contents

****

1. Introduction

Smart-Jig is the first TSR breaking head that is designed to independently collect data for each tensile strength test performed in the lab. The Smart-Jig's integrated high-precision load cell collects data at a rate of 100 Hz. Graph paper, graphing pens or printers are no longer required. Simply place the Smart-Jig breaking head into your existing load frame and add your sample. Start the app and connect to the Smart-Jig. Once the test starts, all the data is transferred via Bluetooth to any connected Windows or Android device. The Smart-Jig application collects, plots, prints and stores the data directly on your PC, tablet or smart phone. The results can be easily emailed directly from the application. The Smart-Jig app displays accurate peak tensile load and strength information, eliminating the potential for errors from manual determination. The Smart-Jig satisfies the requirements of moisture damage testing using the indirect tensile strength (AASHTO T283 and ASTM D4867) as well as ASTM D6931 for determining the indirect strength of asphalt mixtures. This device allows users to perform state-of-the-art tests such as the indirect tensile asphalt cracking test (IDEAL-CT) with optional displacement transducers.

Smart-Jig is wireless and powered by a rechargeable battery, which ensures quick and easy loading and unloading of specimens and safe storage.

Specifications

- Load Capacity: 45 kN (10,000 lbs)
- Displacement Range: 25 mm (1.0 inch) (included with IDEAL upgrade)
- Power: 110/220VAC charger to convert to 12 VDC
- Battery: Rechargeable NiMH batteries (8-hour battery life)
- Data Collection Rate: 100 Hz (data points/second)

- Breaking Head Design: 100 or 150 mm (4 or 6 inch) diameter up to 110 mm (4.25 inches) thick specimens
- Report Formats: PDF and CSV
- Software Platforms: Windows Operating System or Android Operating System

2. Basic Operations and Getting Started

Equipment and Accessories

Smart-Jig and Accessories

1. Tablet
2. Jig
3. Knurled Contact Knob
4. Grease
5. Charger

Charging the Batteries

The batteries are shipped partially charged. The batteries are expected to last 8 hours after a full charge before recharging is necessary. If the Red LED is blinking slowly while the Smart-Jig is switched on, the batteries need to be charged.

The batteries must be charged with the supplied 12 VDC wall charger. Plug the wall charger cord into the charger port. Then, plug the wall charger into a 120 VAC wall outlet. The Red LED will turn on to signify it is charging. If the Red LED turns off with the power converter plugged in, the battery is fully charged.

NOTE: The batteries cannot be charged with a USB cord.

Meaning of LEDS

Green LED
- Blinking - unit is turned ON

Red LED
- Blinking – Low battery
- Solid – Battery Charging

Blue LED
- Blinking – Bluetooth connection established

3. Application User Guide

Communicating with Smart-Jig

The Smart-Jig can be used with either Android-based or Microsoft Windows-based devices with Bluetooth technology. The Smart-Jig is configured by default to communicate with the Android tablet included in Smart-Jig kit. It is recommended to use the Smart-Jig with the Android application to automatically receive any updates to the app.

Using the Android Application

When the application (app) starts, the Smart-Loader Splash Screen below will appear:

Connecting to the Smart-Loader Application

The Smart-Loader application connects with the Smart-Jig using Bluetooth. To connect the Smart-Jig to the Smart-Loader app, turn on the Smart-Jig and the tablet. Open the Smart-Loader app on the tablet.

The Android software will attempt to connect with the Smart-Jig automatically. If it is successful, the following screen will appear:
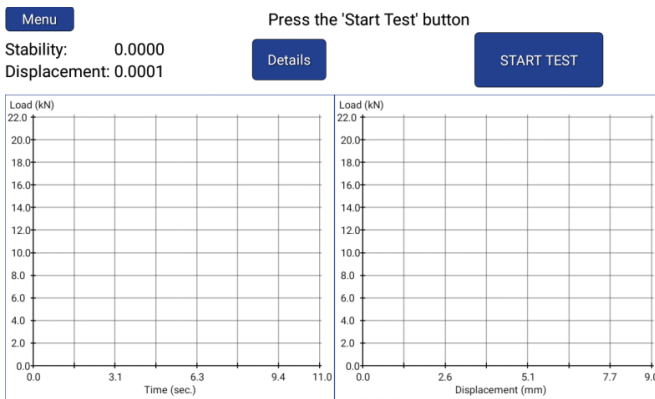
If the software cannot connect, the following screen will appear:
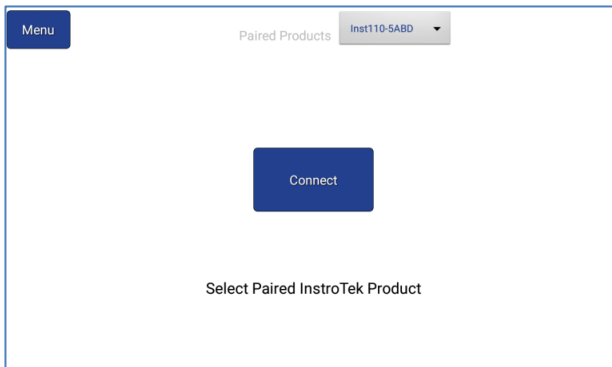
1. Check that the Smart-Jig is turned on. The GREEN LED on the device will flash.
2. At the top of the screen is a box with a list of "Paired Products", which are Smart-Jigs already configured with the tablet, such as "Inst110-5ABD" in the picture above. Tap the arrow to display the list and choose the Smart-Jig to connect.
   **NOTE**: The Smart-Jig serial number, which is stamped on the base of the jig, will be part of the name. In the example, the serial number is 110.
3. Press 'Connect' to pair to the device. A successful pairing will result in the BLUE LED flashing and the software advancing to the test screen with a "Start Test" button.

NOTE: Bluetooth devices must be paired through the Android's system settings. General instructions for pairing a Bluetooth device in an Android tablet are provided in a later section.

Using the Windows Application

The Smart-Loader Splash Screen below will display when the Windows application starts:
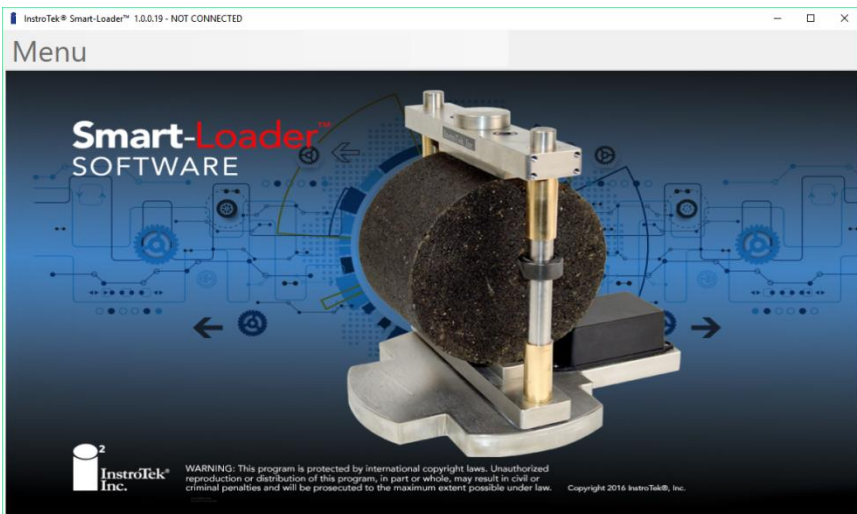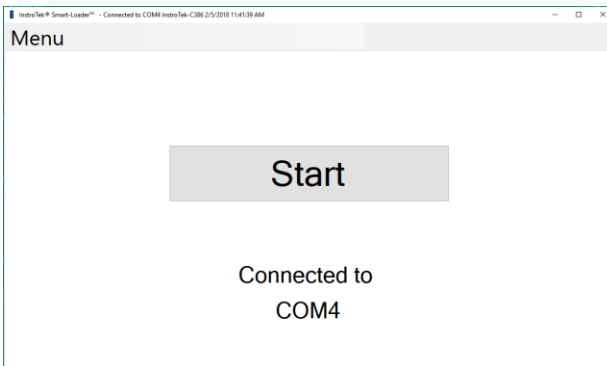
Connecting to the Smart-Loader

The Smart-Loader software can connect to the Smart-Jig fixture in two ways:

1. Bluetooth Connection
2. USB cable (backup if batteries are discharged or Bluetooth is not enable on your Windows PC)

The computer software will attempt to connect with the Smart-Jig automatically. If it is successful, the following screen will appear:


If the software cannot connect, the following screen will appear.
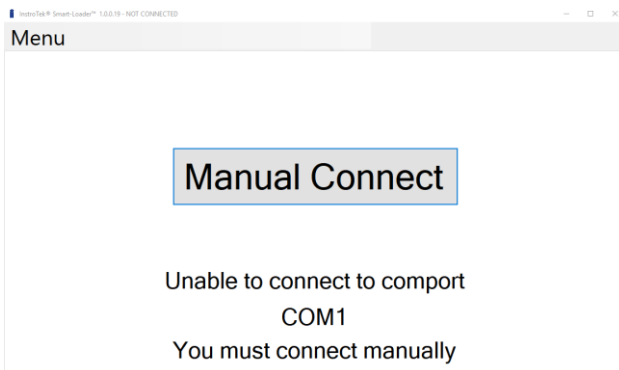
Make sure the Smart-Jig is turned on. The GREEN LED on the device will flash. Press the 'Manual Connect' to search for all paired and wired COM ports (connections).

**NOTE**: Bluetooth devices must first be paired through the Window settings. General instructions for pairing a Bluetooth device in Windows in provided in sections 7 and 8.
If using a USB cable, it must be plugged for the Smart-Loader software to find appropriate COM port.

After the search is completed, COM ports found will be displayed in a dropdown box used to select the device to which to connect.
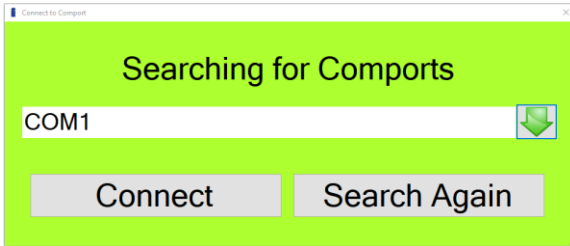
Wired devices show up as COM ports (i.e., COMxx). Bluetooth devices show up as InstroTek devices (i.e., COM InstXXX).

Select the COM port you wish to connect to and press the "Connect" button. If the software does not connect with the Smart-Jig, select a different COM port.
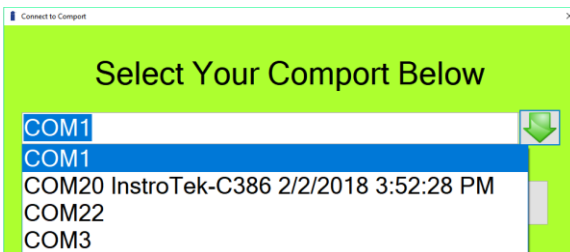
After the device has connected successfully, pressing the "Start" button will enable the Smart-Jig to start acquiring data.

Smart-Loader Menu

Connect/Disconnect – Connect or Disconnect from a paired Bluetooth device.

Settings – Enter specimen information and set data acquisition parameters.

Calibration Values – Display raw ADC values and current values of load and displacement used for calibrating the device.

Company – Load company logo to be displayed on the PDF report. The logo must be a bitmap file and it will be scaled to 131 by 71 pixels.

Open Saved File – Open previous test to view the data and graphs.   Up to 4 CSV or XLS files may be opened and compared at one time.
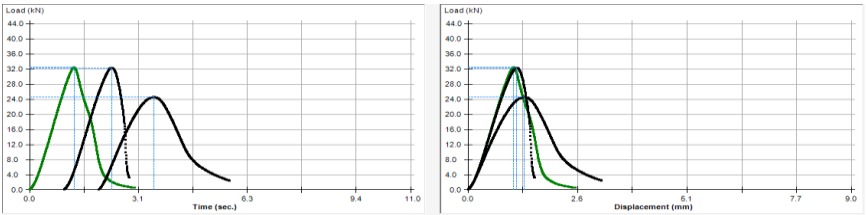
4. Smart-Jig Operation

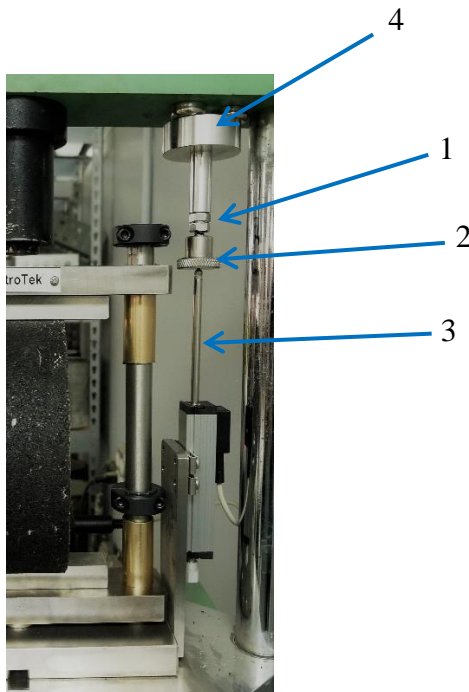## Setting up a Test to Measure Tensile Strength (AASHTO T 283)

1. Place the Smart-Jig in the load frame like an uninstrumented Lottman jig.
2. Align the Smart-jig in the load frame centered under the load point.

   NOTE: Two screws are included to align the Smart-Jig in the Pine Marshall Press.

   NOTE: LVDT is not required for this test.

## Setting up a Test to Measure the IDEAL-CT Value (ASTM D 8225)

NOTE: A video is available on YouTube to show the setup process for the IDEAL-CT. Search "Smart-Jig Setup" and select the video from InstroTek.

1. Place the Smart-Jig in the load frame like an uninstrumented Lottman jig.
2. Align the Smart-jig in the load frame centered under the load point like the diagram above.
   NOTE: Two screws are included to align the Smart-Jig in the Pine Marshall Press.
3. Set up and align the LVDT in its optimal range with the metal rod.
   a. Turn on the Smart-Jig and the tablet. Open the Smart-Loader app on the tablet. The tablet should automatically connect with the Smart-Jig. If it does not connect, see Section 3 for instructions.
   b. Access the Calibration screen by selecting *MENU* and then *Calibration Values*. The calibration screen will be displayed, as in the figure below.
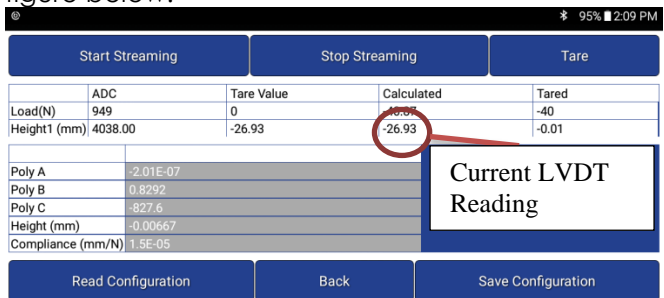
   c. Insert a 150 mm diameter specimen into the jig and raise the jig until it is within 3 mm (1/8 inch) of the load point.
   d. Move the magnetic base (item 4) to align the knurled contact knob (item 2) with the tip of the LVDT (item 3).
   e. Loosen both the bolts (item 1) on the knurled contact knob. Then, move the knob down until the LVDT (item 3) makes contact with the metal

knurled contact knob (item 2). The LVDT should be compressed by at least 3 mm
but not more than 6 mm, as indicated in the calibration screen of the tablet.

    f. Tighten the bolts (item 1) firmly against the magnetic base to lock the knurled contact knob into place.

4. Confirm proper operation of the Smart-Jig.
   a. Insert a 150 mm diameter specimen into the jig with **softest** mixture available.
   NOTE: A mix design specimen with the highest asphalt content generally should be a soft mixture.
   b. Run a test with the load frame following the instructions in Section 5.
   c. Verify the results with the examples below.
      i. Smooth Curve that starts at 0.
      ii. Final load is **less than** 0.5 kN (115 lbs)
      iii. Final displacement is **greater than** 8 mm.
      iv. Gradual decrease in load after peak.

Good Plot

Final Load and Displacement

Bad Plot
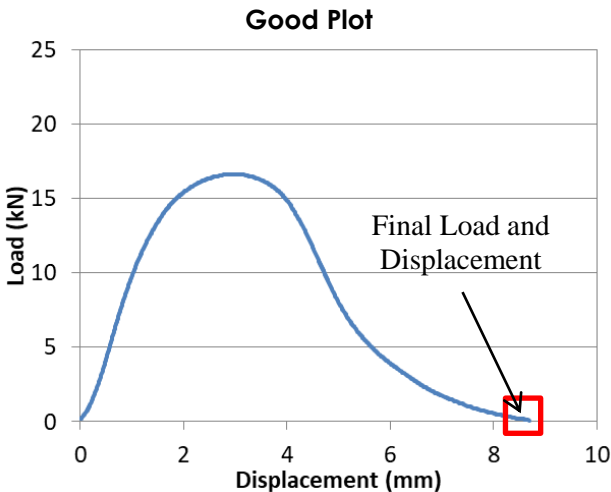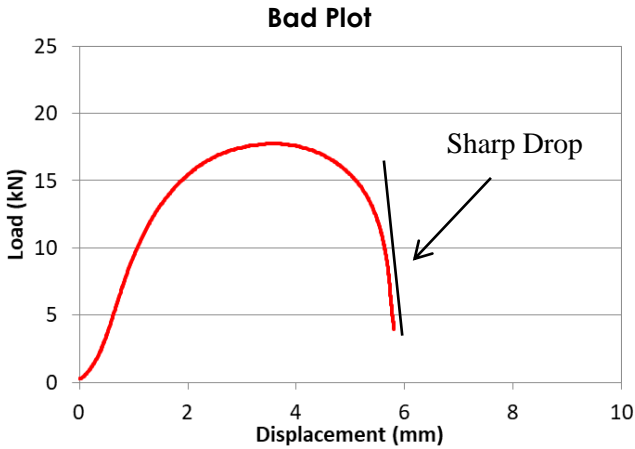
1. Solutions if verification fails.
   a. Readjust the height of the metal rod following instructions in Step 3.
   b. On Pine Marshall Press, hold "Limit Override" Switch during test. Switch is on the bottom of the machine.

CAUTION- Incorrect use of the Limit Switch can damage the motor on the load frame. Do not hold the UP or DOWN switch on the Pine Marshal Press, while holding the Limit switch. Refer to manufacturer's manual for operation of the Limit switch.

5. Performing a Test

1. Connect the Smart-Jig and application using Bluetooth.
   NOTE: The Blue LED light should slowly flash to show proper communication.
2. Before each test, guide rods and bushings **must be greased** to ensure smooth operation.
   a. Apply a thin layer of grease to the posts of the Smart-Jig.
   b. Lift the top crossbar up and down 3 times to evenly spread the grease.
   NOTE: **Failure to grease the rods each time can lead to greater variability of the peak tensile strength.**
3. Remove any loose mixture that is between the bottom crossbar and the base of the jig.
4. Press *Start* in the app to run a test.
5. Enter the following information on the *Settings* page:
   a. Specimen dimensions
   NOTE: The specimen dimensions must be entered before testing for an accurate calculation of the specimen strength.
   b. Specimen Project and Specimen IDs
6. Optional information on the *Settings* page:
   a. Start and Stop Loads
      i. Start Load – minimum required load to start recording data
      ii. Stop Reduction (%) – criterion to stop recording data after a given percentage decrease from peak load (for a peak load of 10 kN, 90% requirement would stop at 1.0 kN)
      iii. Stop Reduction (kN/lbf) – criterion to stop recording data after load drops below a given load.
         Recommended Criterion
         1) 1.0 kN for AASHTO T 283
         2) 0.1 kN for IDEAL-CT
   b. Check that the desired units (SI or English) are selected.

c. For the IDEAL test, select "Use Height Sensor" and set "Averaging Filter" to 750 ms.

Accept

Sample Diameter (mm): 150.00
Thickness(mm): 62

Project ID: S9.5C
Sample ID: 1
Technician: ATL
Max SG: 2.450
Voids: 7.0
%AC: 6.0
Temperature: 25   °C ▾

Start Load (kN): 0.200000
Stop Reduction: 0.10   kN / lbf

☑ Use Height Sensor   Averaging Filter
                                                    750 ms ▾
Speed Rate (mm/min): 50.00

Height Units   Load Units
◉ Millimeters   ◉ KiloNewtons
◉ Inches   ◉ Pounds (Force)

◉ Light Theme   TSR_HT V1.02 110 : 10
◉ Dark Theme

7. Press the *Accept* key to accept the settings.
8. Press the *Start Test* button. The Smart-Loader software will start recording data after the "Start Load" criterion in the Settings is reached and will stop recording when the "Stop Load" criterion is reached.

WARNING
The Smart-Loader software does not control the load frame. You must follow your manufacturer's manual for the proper setup and use of the load frame to prevent damage to the Smart-Jig and your load frame!

9. Set the load frame to apply the correct displacement rate and then start the load frame.

    a. AASHTO T 283, D 4867, and the IDEAL-CT (ASTM D 8225) - 50 mm/minute (2.0 inches/minute) is the loading rate.

10. Stop the loading frame when the *Test Complete* pop-up screen appears on the app.

11. When the test has finished, the Stability and Peak Displacement will be shown along with the graphs of the results. The results are automatically saved as a ".csv" file and a PDF in the folder "Downloads".
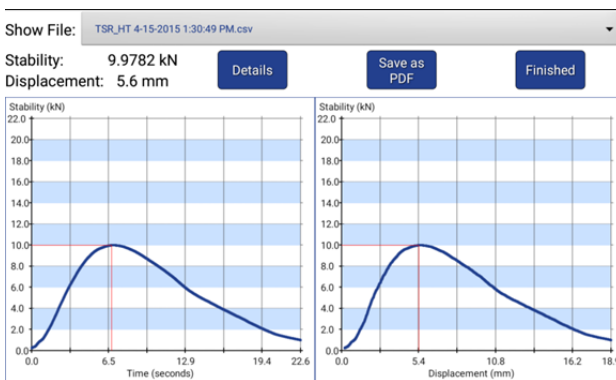
12. Press Details to show results calculated from the test data. The results include IDT Strength, Total Energy and Energy to Peak from the Load-Displacement curve, and CT Index from the IDEAL-CT test procedure.

Stability	9.9782 kN		2243.19 lbf		Diameter	150 mm
IDT Strength	705.814 kPa		102.37 PSI		Thickness	60 mm
Peak Displacement	5.4 mm		0.213 in.		Max SG	
Flow	22.05		0.01 in. units		Voids	
Total Energy	100.44		Joules		% AC	
Energy to Peak	30.88		Joules		Temperature	21

Displacement of the Peak Load after the Peak				Cracking Test Index		Corrected
at 85%	8.14 mm		0.32 in.	703.03		680.351
at 75%	9.239 mm		0.364 in.			
at 65%	10.184 mm		0.401 in.			

[Back]

13. The ".csv" and PDF files can be emailed directly from the tablet if a Wi-Fi network is available. Additionally, the files can be transferred to a Windows PC by using the included USB cable and navigating to the "Download" folder of the tablet in Windows Explorer.

6. Software Updates

Android Application

1. Uninstall the factory version.
   a. Select "Settings" in the Android device.
   b. Select "Applications", then "Application Manager", and finally "InstroTekSmartLoader".
   c. Select Uninstall
2. Install the version available on Google Play
   a. Search for "Smart Loader" or "InstroTek" in the Google Play store on most Android devices.
   b. Download the application. The application can run on either a tablet or a phone, but a tablet is recommended.
   c. Occasionally connect the device to WiFi to download any available updates.

Windows Application

1. Download the Smart-Loader software from the InstroTek's website at:

https://www.instrotek.com/pages/purchased-software

2. Save the msi file to the desktop of your computer.
3. Run the msi file and file follow the on screen instructions. Contact your in-house computer technical support if you have difficulty installing the software.

7. Android Troubleshooting

1. Smart-Jig does not show up in the list of "Paired Products".
    a. If you have not paired with the device
        i. Pair with it (see section below).
    b. If you have paired with it.
        i. Unpair from the device through you system settings. (see section below)
        ii. Pair with the device again
2. Cannot connect with the Smart-Loader App
    a. Bluetooth
        i. Make sure you have paired with the device.
        ii. Turn off the device, wait 10 seconds, turn it back on.
        iii. Unpair from the Smart-Jig device in the system settings. Pair with the device again.
        iv. Make sure you are within 20 feet of the device.
3. Device says connected but no values received.
    a. The pairing information may have become corrupt.
        i. Unpair from the device through you system settings, Pair with the device again.

Pairing with Bluetooth Devices

1. Turn on the Smart-Jig.
2. Swipe down the Settings menu at the top of the screen.
3. Enable Bluetooth on your Android device.
4. Search for available Bluetooth devices.
    a. Open the "Settings" and tap the "Bluetooth" option.
5. Select the device that starts with "InstXXX". The numbers (XXX) will be the serial number of the Smart-Jig stamped on the side of the jig.
6. Accept the given key and let your system finish pairing with the device.

Unpairing with Bluetooth Devices

1. Open your Bluetooth Settings.
   a. Open the settings screen and tap the "Bluetooth" option.
2. Tap the device you wish to remove.
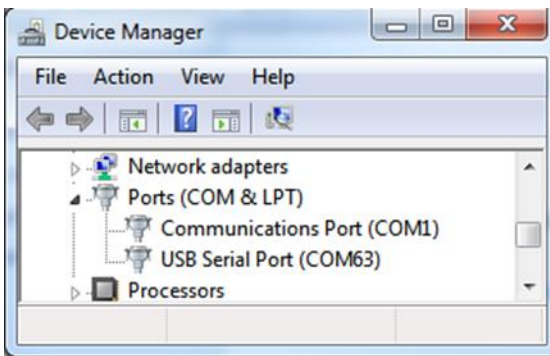3. Select "Remove Device".

8. **Windows Troubleshooting**

1. Smart-Jig does not show up in the list of COM ports.
   a. If you have not paired with the device
      i. Pair with it (see section below).
   b. If you have paired with it.
      i. Unpair from the device through you system settings. (see section below)
      ii. Pair with the device again
2. Cannot connect with the Smart-Loader
   a. Bluetooth
      i. Make sure you have paired with the device.
      ii. Turn off the device, wait 10 seconds, turn it back on.
      iii. Unpair from the Smart-Jig device in the system settings. Pair with the device again.
      iv. Make sure you are within 20 feet of the device.
   b. Wired
      i. Check that you are connecting with the correct COM port.
      ii. Turn off the device, wait 10 seconds, turn it back on.
3. Device says connected but no values received.
   a. The pairing information may have become corrupt.
      i. Unpair from the device in the system settings, and pair with the device again.

Pairing with Bluetooth Devices

1. Turn on the Smart-Jig.
2. Enable Bluetooth on your Windows device.
3. Search "Bluetooth" in *Start* menu.
4. Select "Add Bluetooth device".
5. Select the device that starts with "InstXXX". The numbers (XXX) will be the serial number of the Smart-Jig stamped on the side of the jig.
6. Accept the given key and let your system finish pairing with the device.

Finding the correct COM port:

1. Open Device Manager.
   a. Press the "Start" Button.
   b. Type "Device Manager" in the search bar.
   c. Click on "Device Manager".
2. Click on the arrow for "Ports (COM & LPT)".
3. Find the COM port listed for "USB Serial Port". The correct COM port is COM63 in the figure below.

Unpairing with Bluetooth Devices

1. Search "Bluetooth" in *Start* menu.
2. Select the device you wish to remove.
3. Select "Remove Device".

9. Example Files

CVS File:

```
InstroTek® SCB Smart Loader®,,
'',
Project ID:,A-22,
Sample ID:,1,
Technician:,ATL ,
Date:,1/15/2018 12:37,
Max Specific Gravity:,,
Voids:,3,
AC:,4,
Temperature:,22°C,
Frequency:,200 Hz,
Rate:,sensor,
Start Load:,0.1,
Stop Reduction:,'90%,
Thickness:,50.1,
Diameter:,150,
Ligament:,58.9,
Time (Seconds),Load (kN),Deformation [mm]
0.025,0.02681,0
0.05,0.02651,-0.00001
0.075,0.02651,-0.00001
```

```
7.9,0.10146,6.43276
7.925,0.10055,6.45267
7.95,0.09902,6.47524
AB9112EB,,
```

XLS File:

InstroTek® TSR Smart Loader©

Project ID:	4 in
Sample ID:	O3
Technician:	ATL
Date:	/2018 9:58:43 AM
Max Specific Gravity:	50
%Voids:	3
AC:	10
Temperature:	22 °C
Frequency:	200 Hz
Rate:	50 mm/min
Start Load:	0.1
Stop Reduction:	'90%
Thickness:	63
Diameter:	100
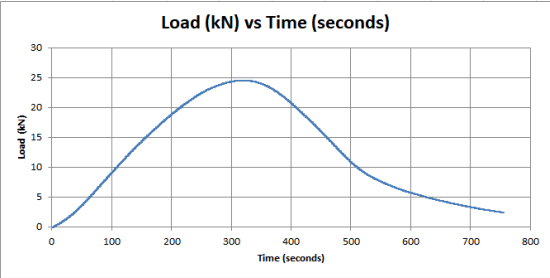
Time (Seconds)	Load (kN)	Constant Rate (mm
0	0.1352322	17.45416625
0.005	0.1823067	0.004166667
0.01	0.2302371	0.008333333
0.015	0.2781675	0.0125
0.02	0.3278097	0.016666666
0.025	0.3774519	0.020833333
0.03	0.4288059	0.024999999
0.035	0.4810158	0.029166666
0.04	0.5340816	0.033333333
0.045	0.5897151	0.037499999
0.05	0.6453486	0.041666666
0.055	0.7035498	0.045833332
0.06	0.7626069	0.049999999
0.065	0.8242317	0.054166665
0.07	0.8892801	0.058333332
0.075	0.9534726	0.062499999
0.08	1.0219446	0.066666665
0.085	1.0912775	0.070833332

Load (kN) vs Time (seconds)

Load (kN) vs Displacement (mm)
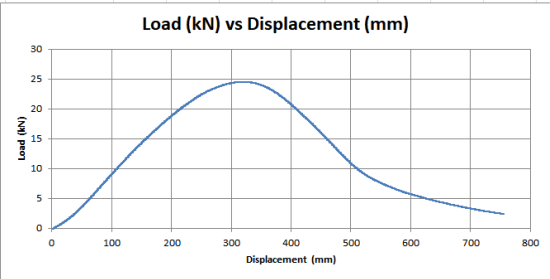
10. Calibrations

The Smart-Jig can measure the load and displacement applied to the jig during a test. A calibration should be performed every 12 months or after any repairs.

To view the current calculated value and, if necessary, modify the calibrations, go to Menu and then Calibration Values. In this menu, the calibration constants are stored.

The Smart-Jig load cell is calibrated and verified over the range of values from 10 – 45 kN. The calibration and verification are performed over the range of values generally encountered for asphalt mixtures in both the tensile strength (AASHTO T 283) and IDEAL-CT (ASTM D8225). The load calibration is a bilinear. The lower segment (line) covers 0 to 10 kN and the upper segment (line) covers 10 to 45 kN. To calibrate the load, apply the loads provided in this menu and enter the ADC counts. The app will calculate all calibration constants necessary for the load (i.e., lower and upper segment slopes and intercepts, hysteresis, and ADC lower limit (intercept of the bilinear lines)). InstroTek offers a calibration cylinder (part #228.0010) and an instruction guide to calibrate the Smart-Jig in the field. Calibration will require a calibrated 45 kN load cell and a load frame capable of reaching 45 kN and holding a load.

The height calibration is linear with only a slope value. The displacement range of the transducer is 25 mm.

11. Index

12. Warranty

InstroTek, Inc. extends a 1-year warranty on the Smart-Jig™ to the original purchaser of this equipment. This warranty covers defects in material, workmanship, and operation under the conditions of normal use and proper maintenance.

This WARRANTY DOES NOT cover the replacement of the parts due to improper setup.

InstroTek will replace, free of charge, any part found to be defective within the warranty period.

This warranty is void if inspection shows evidence of abuse, misuse or unauthorized repair.

This warranty covers replacement of defective materials and workmanship only. It does not cover shipping charges, duties or taxes in the transport to and from the factory or authorized service center.

InstroTek's liability is in all cases limited to the replacement price of its products. InstroTek shall not be liable for any other damages, whether consequential, indirect, or incidental arising from use of its product.

If return of the product is necessary, please include return shipping directions, contact name, phone & fax number and a description of the action needed.

Call InstroTek, Inc. for shipping details at (919) 875-8371. If return of the product is necessary, please include return shipping directions, contact name, phone & fax number and a description of the action needed.

Contact Information

InstroTek® Inc.

Contact us for top quality, best value and superior service!

email: **sales@instrotek.com** ✦ visit: **InstroTek.com**