i^2 InstroTek® Inc.

innovators in instrumentation technology

Smart Loader™

Asphalt Load and Tension Testing

OPERATING MANUAL

www.InstroTek.com

Restricted Menu Function Access Codes:

System Configuration

Device Configuration (2222)

Channel Configuration (3333)

Profile Configuration (Golden Tags) (1111)

Control Panel $\rightarrow$ Software (5555)

This page may be removed from the manual to prevent the unauthorized access to the restricted menu functions of the InstroTek SmartLoader.

SmartLoader Automated Load Frame for Measuring
Various Mechanical Properties of Asphalt Mixtures
For:
Illinois I-Fit (AASHTO TP124),
LSU Method (ASTM D8044),
Marshall (ASTM D6927),
IDEAL-CT, TTI Method (ASTM D8225),
Shear Bond Strength Test (Tex-249-F),
TSR (AASHTO T283)

Operation Manual Revision 7

IMPORTANT

WARNINGS WHEN USING THE
SmartLoader™

⚠️ DO NOT attempt any repairs while the unit is powered on.

⚠️ **CAUTION** DISCONNECT the unit from wall power before attempting any repairs.

⚠️ DO NOT operate this device without prior training.

⚠️ **DANGER** DO NOT insert any part of your body between the ram and crosshead to prevent crushing injuries.

⚠️ Follow all your other related facility safety instructions while operating this device.

⚠️ Maintenance on this device must be done by trained technicians.

⚠️ Call InstroTek, Inc. (919-875-8371) if you have any questions or before attempting any repairs.

DO NOT USE the 10kN Load Cell for TSR testing. Please contact InstroTek for information on different load cells and accessories for the SmartLoader.

IMPORTANT

1. Table of Contents

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1. Introduction

InstroTek SmartLoader™ is a load frame designed for conducting semi-circular bend (SCB) tests described in AASHTO TP 124 (recommended by University of Illinois, I-Fit) and ASTM D8044 (recommended by Louisiana State University). SmartLoader™ can also perform a variety of mechanical property tests on asphalt mixtures such as IDT strength, Marshall Stability, Shear Bond Strength (Tex-249-F), and IDEAL-CT.

The load and displacement parameters measured by the SmartLoader™ can be used to predict cracking performance of asphalt mixtures. The SmartLoader™ measures the load, the specimen vertical displacement with a high accuracy linear variable displacement transducer (LVDT) system, and an encoder for the displacement of the ram of the load frame.

The loading sequence is fully automated with microprocessor control of the loading ram such that the seating loads, rests, unload rates, and loading rates are all performed consistently. The load and displacement are measured with a built-in data acquisition system. All the functions of the SmartLoader™ system are automatically controlled and the results are displayed on a touch screen.

Machine Components

Fig 1. SmartLoader^{TM} Load Frame with SCB Jig

Reaction Bar

Load Cell

Loading Rod
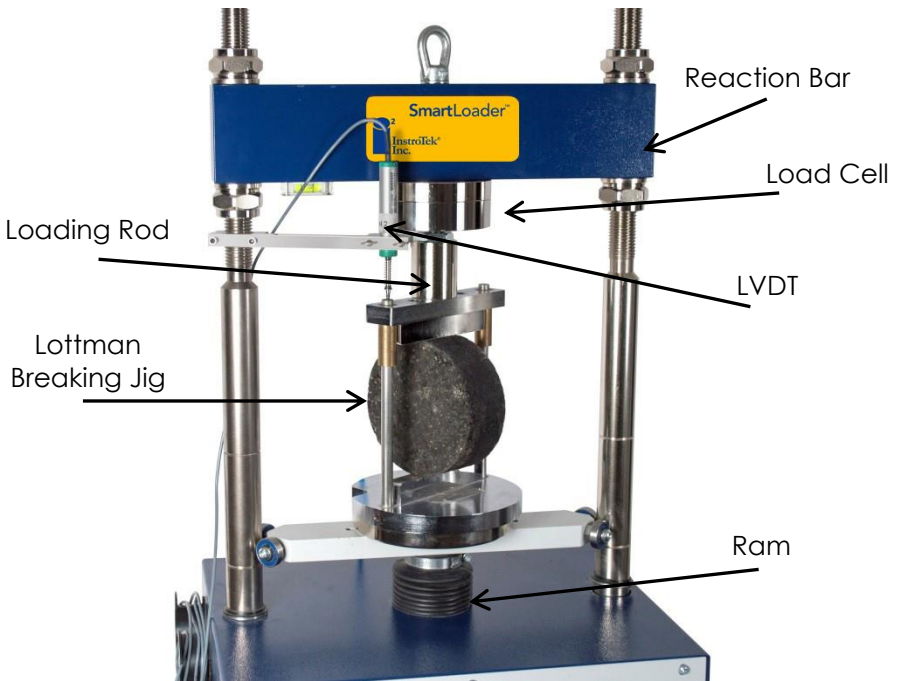
LVDT

Lottman
Breaking Jig

Ram

Fig 2. SmartLoader™ Load Frame with Lottman Breaking Jig

2. System Location

When setting up this unit, please select a location that can meet the minimum requirements below.

1. The unit is designed to be a bench-top unit. Provide adequate space for the user to utilize the control screen and insert any breaking jigs from the front of the load frame.

2. Set the unit on a level and stable surface. It is recommended that the unit be leveled before testing using the attached feet.

3. System Specifications

- Dimensions: 20" W x 18" L x 57" H
- Weight: 300 lbs.
- Displacement Speed: 0.01 – 51 mm (0.0004 – 2.0 inch) per minute
- Electrical Requirement: 120VAC, 150W, 1.5A
- Maximum Ram Travel: 100 mm
- LVDT Maximum Displacement: 25 mm
- Load Capacity: 10 kN (2,200 lbs.) and optional 50 kN (11,000 lbs.)

4. System Setup

The following steps will guide you through the required connection for powering up the unit:

1. Plug the power cord in the appropriately rated outlet (120VAC/15A).

2. Mount the load cell onto the threaded rod with the I-bolt (as shown in Figure 1).

3. Attach the loading rod to the load cell.

4. Mount the LVDT holder onto one of the reaction frame posts (as shown in Figure 1).

5. Plug either the 10 kN or (optional) 50 kN Load Cell into Channel 1, LVDT into Channel 2.

6. Ensure that the nuts on either side of the reaction bar are tightened by hand.

7. Power ON the SmartLoader™ using the switch located on the right side of the device next to the power cord.

8. The unit will perform a self-test and will show when ready.

9. If an alarm () is shown, please refer to the *Alarms* section.

Reaction Bar and LVDT Height Adjustment

The following steps will guide you through positioning the reaction bar and LVDT to work properly with the SCB or Lottman Breaking jig:

1. Loosen the top bolts of the reaction bar to allow the bar to move freely upward.

2. Enter the test menu .

3. Place the test jig on the ram by aligning the centering pin in the ram and the slot in the jig.

    NOTE: The centering pin can be removed if the jig does not have a slot.

4. Place an asphalt specimen in the test jig (see Figure 3).

5. Press the TEST Position button.

6. Raise or lower the reaction bar so that the loading rod is within 2 mm (thickness of a penny) but not touching the loading bar on the test jig and centered over the jig loading bar.

7. Tighten the top bolts of the reaction bar by hand.

8. Clamp the LVDT in the LVDT holder. Adjust the LVDT until it reads 2-5 mm while in the TEST position. This will allow sufficient clearance for the jig to slide in and out when in the HOME position with the LVDT in place.

NOTE: Tighten the LVDT holder thumb screws *finger tight* to prevent damaging the LVDT.

5. Jig Setup

The SCB jig is designed to comply with the requirements of both the I-FIT, and LSU SCB, standards. The difference in the jig for the standards is the spacing between the rollers. The I-FIT (AASHTO TP 124) test requires a 120 mm spacing while the LSU (ASTM D8044) test requires an 127 mm spacing.

1. Remove the two screws (5/32" Allen wrench) from the roller support, as shown in the circles in Figure 3.
2. Flip the mounting block around until it is oriented like the appropriate method.
    a. **I-FIT** – the mounting block *is flush* to the roller support.
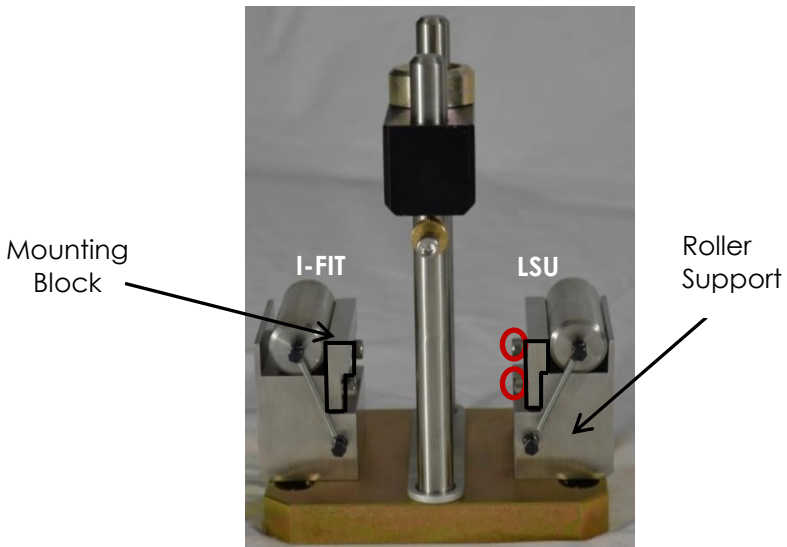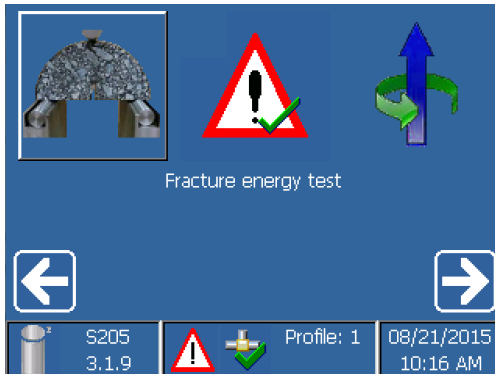   b. **LSU** – the mounting block *overhangs* the roller support.

Fig 3. SCB Jig Setup

NOTE: SCB Jig may look different but still functions the same.

6. Main Menu

The Main Menu allows the user to select the main functions of the machine.

The main functions are:

 Cracking Test Position

 Active alarms

 Ram Position

 System config.

 Test archive

 Control panel

Select an item with the touch-screen: Scroll through the menu or until the desired menu item is highlighted and select the item by touching the screen.

Select an item with the keypad: Scroll through the menu using the arrow keys or until the desired menu is highlighted. Push the Enter key to select an item.

7. Status Bar

The bottom of the main screen contains the status bar. The left side of the status bar provides the current software version installed on the machine. The center of the bar provides the current status of the machine. The right side provides the current date and time.

Status Symbols

   Machine is ready to test

   Running the test (automatic)

   Moving the ram (manually)

   Warning

8. Operation

This section will provide a general guide to set up, run, and record the data for a test in the SmartLoader™.

Sample Preparation for SCB

1. Prepare specimens according to the instructions in the relevant standard.

   a) **I-FIT –** AASHTO TP 124
   b) **LSU –** ASTM D8044

NOTE: Specimens may be prepared using the gyratory compactor, kneading compactor, cores cut from the field, or slabs from a laboratory compactor. Consistent air voids are necessary for consistent results.

2. Saw cut the specimens to the desired thickness. Measure the air voids of the circular disks.

   a) **I-FIT –** Gyratory-prepared specimen thickness shall be 50 ± 1 mm.
   b) **LSU –** Gyratory-prepared specimen thickness shall be 57 ± 1 mm.

3. Cut the specimens in half. Then, create a notch in the sample to the depth(s) specified in the standard.

   a) **I-FIT –** Notch width shall be 1.5 ± 0.1 mm and the depth shall be 15 ± 1 mm for all samples.
   b) **LSU –** Notch width shall be < 3.5 mm and the notch depth shall be 25, 32, or 38 mm ± 1 mm.

NOTE: A wet saw, tile saw, or table saw with a masonry bit may be used to consistently cut the notch.

4. Insert a specimen into the SCB Jig (Figure 4). Adjust the horizontal alignment bolt such that the specimen is centered on the roller supports. Raise the perpendicular alignment bar into the notch cut into the specimen to align it perpendicularly to the horizontal alignment bolt.

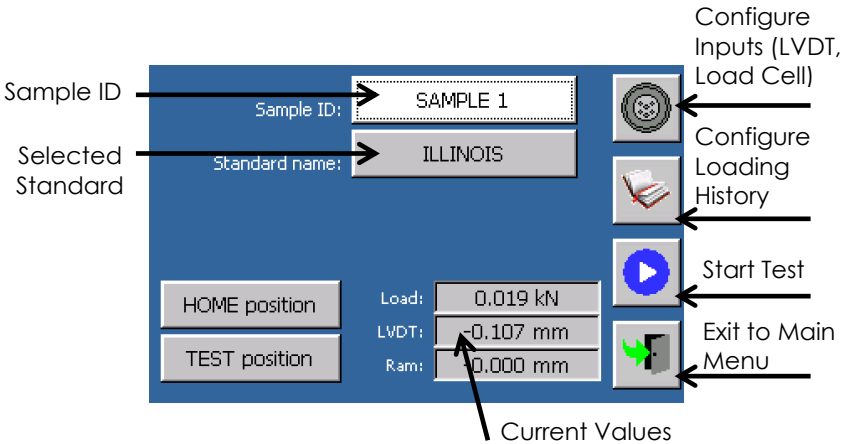**Sample Preparation for IDEAL-CT, TSR, and SBS tests.**

1. Prepare specimens according to the instructions in the relevant standards. If no standards are specified, ASTM D6925 or AASHTO T 312 can be used.

   NOTE: Specimens may be prepared using the gyratory compactor, or cores cut from the field or slabs from a laboratory compactor. The SBS Test requires the specimens be cut from pave site within 3 days of paving.

2. Specimens can be compacted or cut to the desired thickness.

   a) **IDEAL-CT –** A specimen with a diameter of 150 mm shall have a thickness of 62 ± 1 mm for 19 mm NMAS or smaller mixtures and 95 ± 1 mm for 25 mm and larger mixtures.
   b) **TSR –** A specimen with a diameter of 150 mm shall have a thickness of 95 ± 5 mm and a specimen with a diameter of 100 mm shall have a thickness of 63.5 ± 2.5 mm.
   c) **SBS –** A specimen with a diameter between 142 mm to 152 mm shall have a thickness no greater than 76 mm from the bonded interface to either side of specimen and no less than 38.1 mm below the interface.

9. Running the Test

1. Press [icon] to begin setting up a test.
2. The main test screen will be displayed (as seen below).

Sample ID → Sample ID: SAMPLE 1

Selected Standard → Standard name: ILLINOIS

Configure Inputs (LVDT, Load Cell)

Configure Loading History

Start Test

Exit to Main Menu

HOME position

TEST position

Load: 0.019 kN
LVDT: -0.107 mm
Ram: 0.000 mm

Current Values

3. Press the "*HOME position*" button to lower the ram to the home position where the jig can be inserted with a specimen already in the jig.

   NOTE: After "*HOME position*" is pressed, the ram will lower to the bottom of the stroke and then find the home position.

4. Insert a specimen into the test jig (Figure 5).
   a. **SCB -** Adjust the horizontal alignment bolt such that the specimen is centered on the roller supports. Raise the perpendicular alignment bar into the notch cut into the specimen to align the specimen perpendicularly to the horizontal alignment bolt.
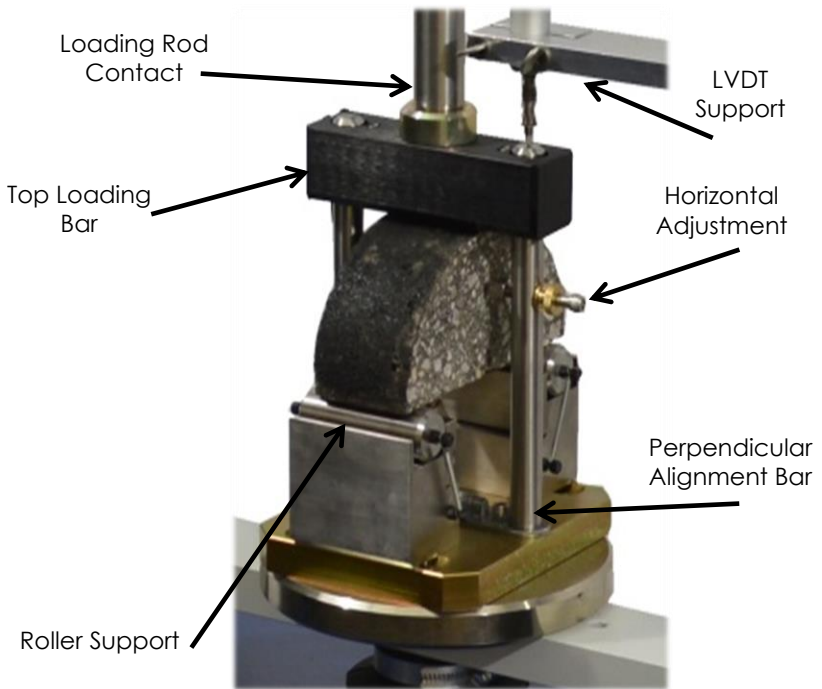
Fig 5. SCB Jig with Asphalt Specimen

b.   **IDEAL /TSR -** Insert a specimen into the Lottman Breaking Head jig (Figure 6). Raise the top loading bar and center the specimen on the bottom loading bar. Lower the top loading bar.

LVDT Support

Top Loading Bar

Bottom Loading Bar
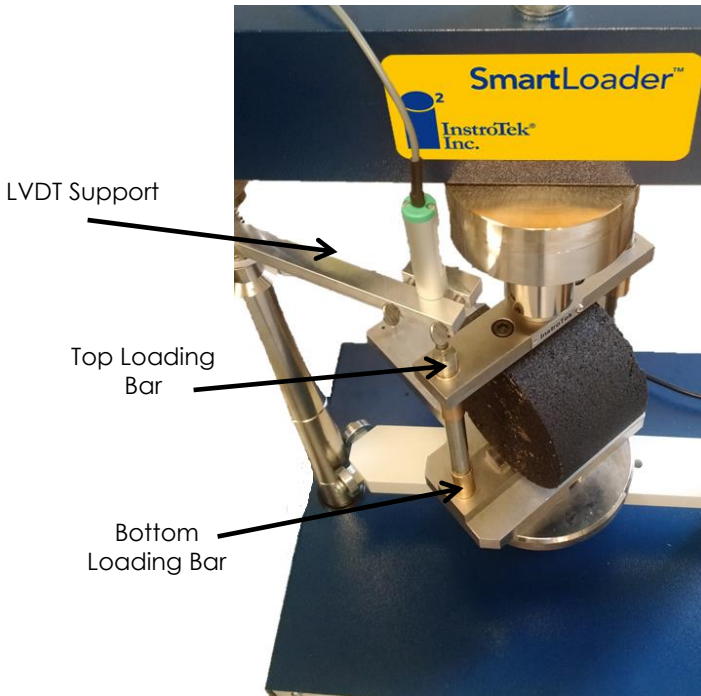
Fig 6. Lottman Breaking Jig with Asphalt Specimen

c. **SBS –** Insert a specimen into the Interlayer Shear
    Strength Device so that the bonded interface is directly
    between the shear gap of the sleeves.
    WARNING Position the jig so the loading rod contacts
    the load point and does not overlap onto the fixed
    Sleeve (Figure 7), any overlap may cause damage to
    the jig and/or load frame. Insert shims to
    accommodate for any difference in core diameter.
    Remove sleeve pin before performing test.
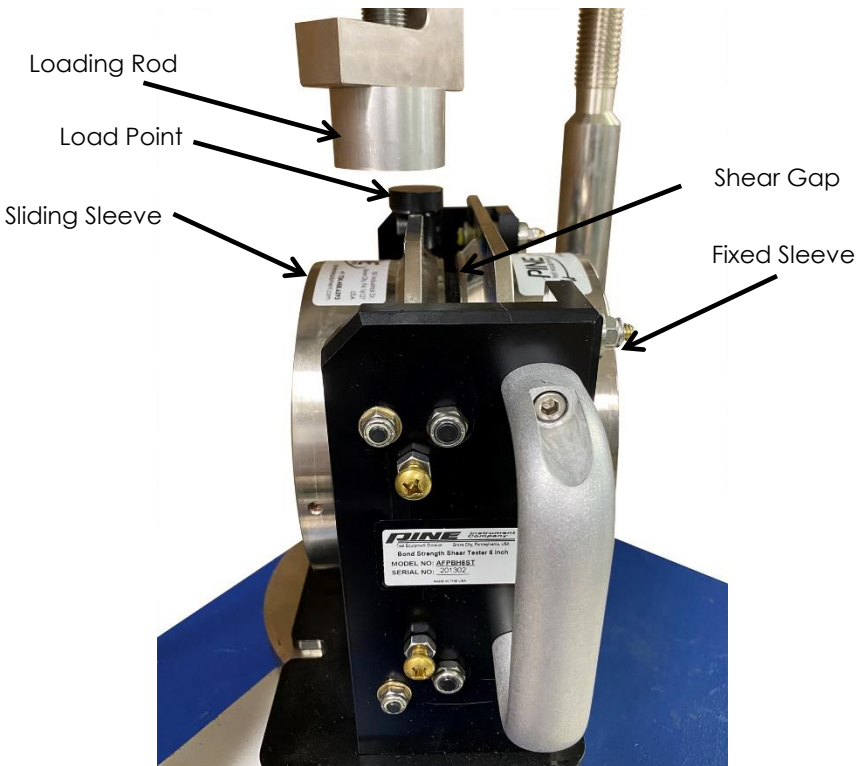
Fig. 7 Shear Bond Test Jig Positioning

5. Insert the test jig with the specimen into the test frame, if applicable, align the slot in the bottom of the jig with the centering pin on the machine ram.

   NOTE: The centering pin can be removed if the jig does not have a slot.

6. Confirm the specimen is centered in the jig.

7. Rotate the jig such that the LVDT is in the center of the guide post of the jig (see Figures 3 or 4).

8. Enter a Sample ID by touching the Sample ID Text box on the screen; an on-screen keypad will display. Press the enter key ⏎ when complete.

9. Select a standard (test method). By default, AASHTO TP 124 (I-FIT), ASTM D8044 (LSU), TSR, IDEAL-CT, and Marshall Stability are stored in the machine memory. To review the settings for each standard, ensure the standard you wish to review is selected in the Standard Name, then press to see the settings. (See Loading History Settings section for additional details. Up to 5 additional loading sequences can be entered by the user.)

10. Select the appropriate load cell by changing the system profile.
    a) Press , and then to select the Profile.
       i. **SCB:** 10 kN load cell – Profile 1
       ii. **IDEAL, TSR, SBS:** 50 kN load cell – Profile 2
    b) Change the Profile number to 1 or 2.

c) Return to the main test screen to confirm the changes by pressing . The bottom of the screen will show Profile #.
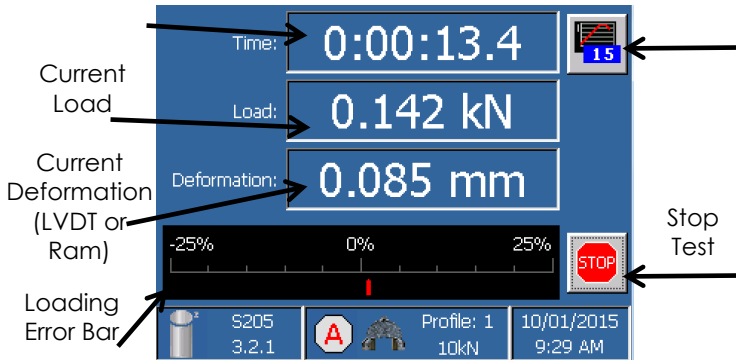
11. Confirm that the appropriate load cell in Step 10a is plugged into Channel 1.

12. Press the "*TEST position*" button to raise the ram and jig close to the loading rod.

   NOTE: The "*TEST position*" and "*HOME position*" can be changed in the device configuration menu (see System Configuration section) if the position is too close or too far away to the load rod.

13. Center and align the loading rod and the top plate of the jig.

14. Ensure that the nuts on top and bottom of the reaction bar are tight.

15. Check that a USB storage device has been inserted into one of the USB slots so the data can be saved.

16. Press to start the test.

17. The test status will be displayed on the screen below. The following figure is labeled to describe what each item represents. The values will change as the test progresses.

Run Time   Graphs

Current Load

Current Deformation (LVDT or Ram)

Stop Test

Loading Error Bar

Time: 0:00:13.4

Load: 0.142 kN

Deformation: 0.085 mm

-25%   0%   25%   STOP

S205
3.2.1

A

Profile: 1
10kN

10/01/2015
9:29 AM

1.   Press [STOP] at any time to stop the test.

10. Results

A summary of the test results will be displayed automatically at the end of the test.
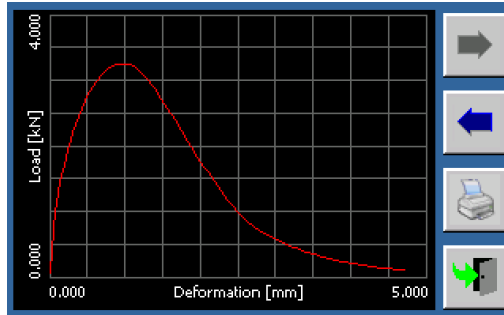
Further analysis of the results in .txt and .csv data files can be performed on a computer.

- AASHTO TP 124 (I-FIT) results can be analyzed using data provided by the University of Illinois (apps.ict.illinois.edu/software).
- IDT Strength, Marshall Stability and Flow, peak load and IDEAL-CT values are calculated in the SmartLoader Analysis software available from InstroTek.

11. Device Configuration

The machine is capable of different loading histories, such as the AASHTO TP 124 (I-FIT), ASTM D8044 (LSU), AASHTO T 283, IDEAL-CT, SBS (Tex-249-F), and Marshall Stability, as well as other loading histories. The machine can be programmed for different loading histories using the information in this section.

1.   Press on the main menu to enter the test.
2.   To review the parameters for a standard, press

 to see the parameters.

Loading History Parameters

Parameter	Description
Pre-load rate	Rate for applying the pre-load (seating load) (*mm/min* or *kN/sec*).
Pre-load force	Target load for the pre-loading to stop
Pre-load pause	Time that the pre-load is held so the user can adjust the specimen and record the pre-load
Pre-load release	Release of pre-load (*None*, *Timed*, and *Contact Load*)
Rate	Loading rate for test (*mm/min* or *kN/sec*)
Start load	Load level when data acquisition starts
Stop criterion	Criterion when machine stops loading (*Load*, *Time, or Percentage*)

Parameters and Test Methods

Parameter	Test Method					
Standard Name: Desired Name (Default Name)	I-FIT (AASHTO TP124)	LSU (ASTM)	IDEAL-CT (ASTM D8225)	TSR (AASHTO T283)	Stability-Flow (ASTM)	Shear Bond (Tex-249-F)
Pre-load Checkbox	Enabled	Enabled	Enabled	Disabled	Disabled	Disabled
Pre-load Rate	0.05 kN/sec	2 mm/minute	0.05 kN/sec	–	–	-
Pre-load Force	0.1 kN	0.045 kN	0.1 kN	–	–	-
Pre-load Pause	10 sec	15 sec	10 sec	–	–	-
Preload Release (None, Timed, Contact Load)	NONE	TIMED	NONE	–	–	NONE
Unload Rate (used if Preload release is "TIMED")	–	5 mm/min	–	–	–	-
Unload Time (used if Preload release is "TIMED")	–	6 sec	–	–	–	-
Rate	50 mm/min	0.5 mm/min	50 mm/min	50 mm/min	50 mm/min	5.0 mm/min
Start load	0.1 kN	0.1 kN	0.1 kN	0.1 kN	0.1 kN	0.1 kN
Stop Criterion (Load, Time, Percentage (reduction from peak load))	LOAD	Percentage	LOAD	LOAD	Percentage	Percentage
Stop criterion value	0.1 kN	25%	0.1 kN	1.0 kN	5%	25%
Load-Displacement	Checked	Checked	Checked	Un-Checked	Checked	Un-Checked
Profile	1	1	2	2	2	2

* Requires SCB breaking head
** Requires Lottman breaking head
*** Requires Interlayer shear strength head

12. Channel Allocation

The machine is capable of controlling loading rate by using: 1) displacement, or 2) force control. The load is recorded by the load cell. The recorded displacement can be measured using an encoder attached to the ram or an external LVDT, which is independent of the control method (recommended).

1. Select the appropriate *control* mode (displacement or force) in the test parameters menus.
   a. Force – select (kN/sec) in the Test Parameters.
   b. Displacement – select (mm/min) in the Test Parameters.
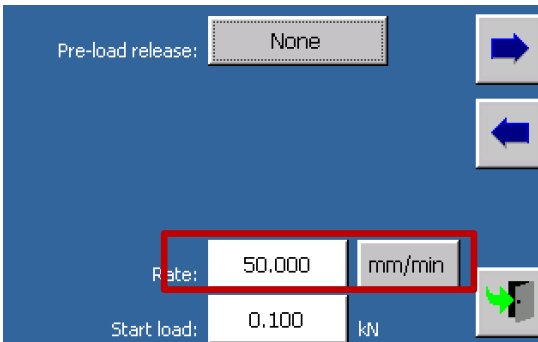
2. Select the appropriate data sources to acquire the displacement and load measurements. The displacement in the data file can be either for the ram or LVDT displacement.

   a. Press ⊚ on the main test screen to select the channel allocation.

   b. Press ▷ on the next screen to modify the channel allocation.

In the channel allocation, the channels can be changed by touching the channel numbers. The channel numbers correspond to the numbers on the connections on the left side of the machine.

    c. To output the LVDT displacement to the data file (*Recommended*), *Enable* the displacement channel (as seen in the following figure). Up to 3 additional displacement transducers can be installed in channels 3-5. To output the ram displacement, *Disable* the displacement channel.
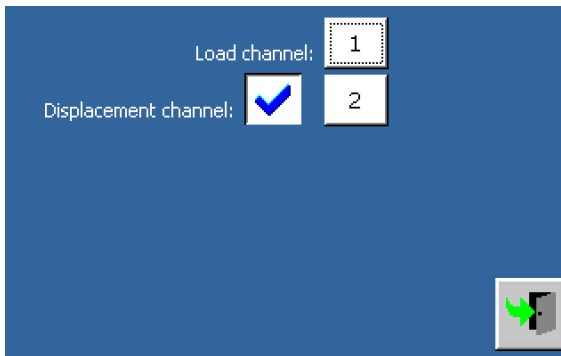
    d. Load Cell – change the Profile to match the load cell used

      i. Press to back up one screen.

      ii. Press to select the profile.
        1. 10 kN load cell – Profile 1
        2. 50 kN load cell – Profile 2
      iii. Plug the appropriate load cell connector into Channel 1.

e. Return to the main test screen to confirm the changes by pressing .

> i. LVDT position will be shown on this screen if the Displacement channel is *Enabled*. This can be verified by moving the LVDT in/out.
>
> ii. Load cell can be verified by pressing on the load cell by hand to see if the load changes.

f. Press to save changes. After 5 seconds, press and return to the test screen to verify changes.

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13. Data Storage and Printing

1. Press to enter the screen below to store and print the rut depth history.

Print the test results with a USB printer (PCL compatible)

Save the test results to the USB thumb drive.

Selection of the save/print mode

Print the results with a thermal printer (if equipped).

Return/Close the screen
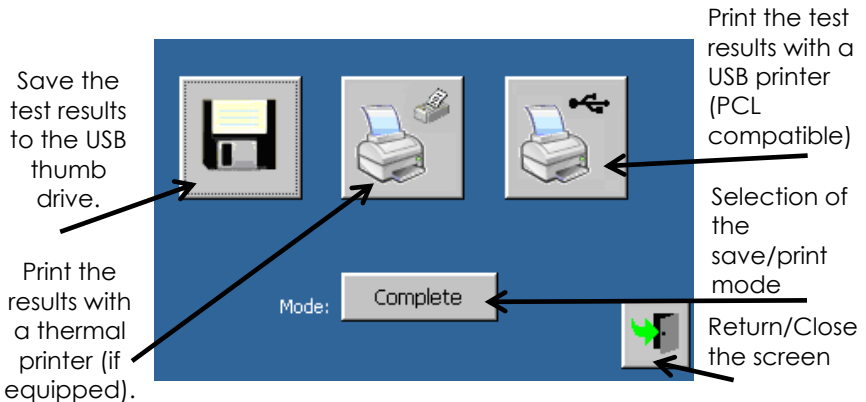
Mode: Complete

2. Select the ***Print mode*** (***Partial***: numeric values only – ***Complete***: numeric values and graphs). The print mode is ignored when the results are printed on a USB printer (PC compatible).

3. Press to print the test results using a thermal printer (if assembled on the machine).

4. Check that a printer (PCL compatible) is connected to the machine and press to print the test results on the USB printer.

5. Check that a memory device has been inserted into one of the USB slots and press to save the test data. Test results will be saved on the memory device. The file will

be named with the "test description" name (set in TEST SETUP) and will include the test date and time.

6. Press to return to the previous screen.

⚠ **14. Alarms**

Safety button pressed!

Reset alarm   Previous alarm   Next alarm   Return to main menu
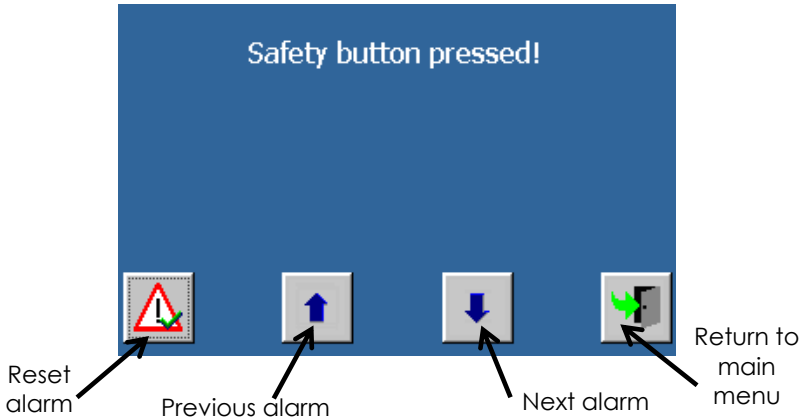
How to confirm and reset an alarm

1.   Scroll through the list of the active alarms until the desired alarm is shown.

2.   Press ⚠ to confirm and reset the alarm.

3.   If the alarm cannot be cleared, contact InstroTek for instructions.

🔝 15. Manually Position the Ram

This function allows the user to position ram. This function is useful for setting up the height of the ram for different testing jigs and positioning the ram for calibration of the load cell.
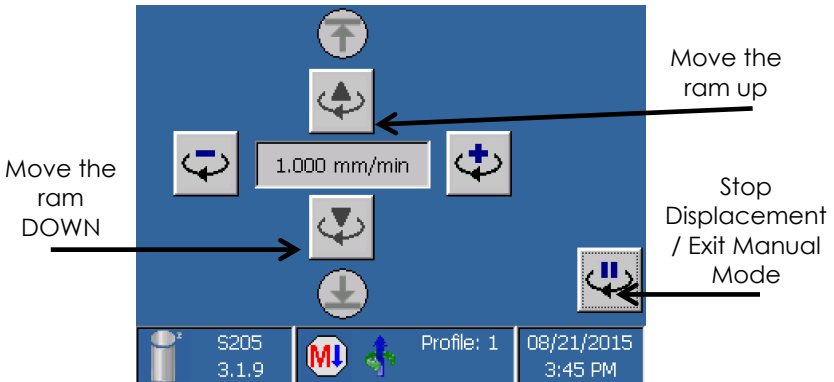
If this function is activated, the machine will move the ram up or down.

WARNING: The machine's load control is disabled. Proceed with caution. Check that movement of the ram will not damage any equipment or specimens.

To increase or decrease the displacement rate, use the arrow keys on the keypad ◀ or ▶ until the desired speed is shown. Pressing and holding the key will change the rate rapidly.

📁 16. Test Archive

This function allows the user to review any tests that are stored on the USB thumb drive currently attached to the machine. The same functions that are available at the end of the test are available in the Test Archive to review the test data. See Operation-Running a Test and Results for more information.

📄 17. System Configuration & Calibration

The section provides information on setting system parameters that are adjusted for optimal performance. The system configuration is divided into two sections: Device Configuration and Channel Configuration. The device configuration includes parameters that control the limits of the machine including the Home and Test positions and the data acquisition rate. The channel configuration allows the verification and calibration of the measurement sensors on the machine. Contact InstroTek for instructions on how to change parameters in the System Configuration not mentioned in this manual. These are set at the factory and should only be changed after contacting InstroTek.

1. Press 📄 on the main menu to enter System configuration. Then press 📄 to enter the Device configuration menu.
2. Enter the password (2222).

## Default System Configuration Parameters

Parameter	Value	Description
Run log file	Base	File that records PID settings and error for the loading history
Auto saving	Disabled	Allows data to automatically be saved to a USB thumb drive
Graph Acquisition	40 Hz	Data acquisition rate (1, 2, 5, 10, 20, 40 Hz)
Encoder speed	Enabled	If *Enabled*, the test is performed using the displacement rate determined by the encoder for the ram. If *Disabled*, the displacement rate is determined using the LVDT.
P-I-D Constants	2.5-4.0-0.08	Control parameters for displacement control
Manual speed	50.0	Displacement speed for moving to *Home* and *Test* positions as well as the default speed for the manual mode
Touch speed	5	Displacement speed for creating contact with the specimen
Position Return	Disabled	Moves the ram down to release the load when the test is finished.

HOME position	0.5	Displacement from the bottom of the stroke of the ram to the HOME position for setting up the jig and specimen
TEST position	7.5	Displacement from the bottom of the stroke of the ram to the TEST position for testing the specimen
Zero Time	0.5	Delay before zeroing the load
PID delay time	0.01	Delay between initial contact and PID control

18. Channel Configuration & Calibration

Follow the instructions below to verify and calibrate the measurement sensors, such as LVDT and load cell.

1. Press on the main menu to enter system configuration.

2. Select the appropriate profile.

   a. Press to change the profile. (Password – 1111).
   b. Select Profile 1 for 10 kN and Profile 2 for 50 kN load cells.
   c. Exit the profile menu.

3. If calibrating a load cell, change the manual rate to 0.01 mm/minute in the Device Configuration menu (see Section 17).

4. Then, press to enter the channel configuration menu. (Password - 3333).

5. Select the appropriate channel.
   a. Channel 1 is the calibration of the load cell.
   b. Channel 2 is the calibration for the LVDT.
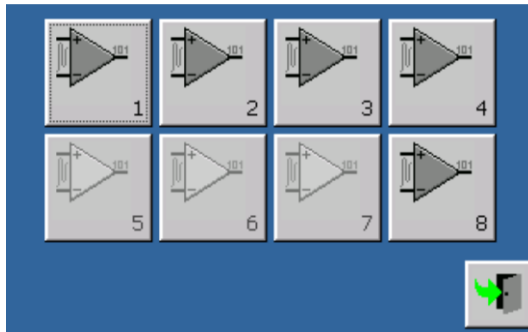
6. Select a desired channel to see the channel setup parameters below.

   NOTE: Do not change these parameters, unless instructed by InstroTek (1-919-875-8371).

7. Select to go to the calibration screen below.

[mm]	[Pts]
0.000	-16473
5.000	-15754
10.000	-15011
15.000	-14265
20.000	-13520

| 0.000 | -16473 | | Pts -12449 | |
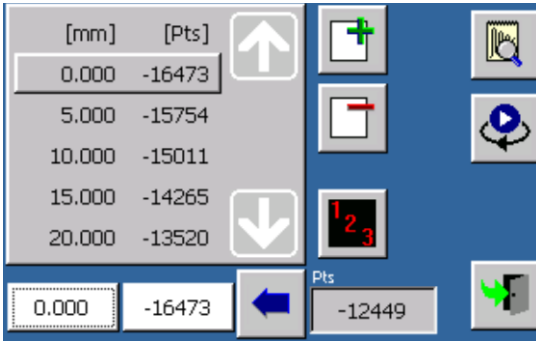
8. Select ![icon] to move the ram up/down for loading/unloading a load cell. The reaction bar can be moved to fit the verification equipment.

9. Select ![icon] to go to the verification screen below.

10. Select ![icon] to go back to the calibration screen (step 5). Press again to return to the channel setup screen (step 4).

11. Once the calibration or verification is complete, select ![icon] to save the data. If ![icon] is pressed, the data will not be saved.

19. Control Panel

The control panel menu allows the user to change the configuration of the machine.

Date and time.

International settings.
Units (Metric/English Standard)

Touch screen calibration.

Network connection.

NOTE: The following settings are set at the factory and should not be changed unless directed to do so by InstroTek.

Password change (password protected).

Software maintenance (password protected).

20. Maintenance

Maintenance of the machine is necessary for a long life and quality results.

1. After each test:
    a) Clean off the sample debris from the Ram and Machine top.

2. Daily after use:
    a) Clean any remaining dirt with a mild soap or household cleaner.
    b) DO NOT use solvents on the painted areas, load cell, LVDT, or the touch screen.
    c) If available, keep the unit covered to prevent dust and other deleterious materials from collecting on the unit.

3. Monthly:
    a) Inspect the following parts for excessive wear:
        i.   Ram Guide Rollers;
        ii.   Ram Dust Collar;
        iii. SCB Jig Guide Post;
        iv.   SCB Roller Support;
        v.   Loading Shaft Contact Point.

4. Annually:
    a) Clean all machine parts with a mild soap or household cleaner.
    b) Calibrate the following items:
        i.   Load Cell (ASTM E-4)
        ii.   External LVDT (ASTM D-6027)
    c) Check for updates to the firmware or testing software. Contact Instrotek for assistance.

21. Index

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