

REFERENCE GUIDE FOR THE SOIL COMPACTOR ANALYZER

by

Stephen Sebesta
Assistant Research Scientist
Texas Transportation Institute

Wenting Liu, P.E.
Associate Research Engineer
Texas Transportation Institute

and

Gerry Harrison
Assistant Research Specialist
Texas Transportation Institute

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TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

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ACKNOWLEDGMENTS

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INTRODUCTION

The Soil Compactor Analyzer (SCA) attaches to the automatic tamper used for Test Methods Tex-113-E and 114-E and uses rapid sampling of the hammer displacement to measure impact velocity. With the known mass of the hammer and the determined velocity, energy can be determined.

INSTALLATION

[Figure 1](#) shows the large components of the SCA hardware, and [Figure 2](#) shows the installed SCA. To install the device, perform the following:

1. Disconnect power from the automatic tamper.
2. Slide a neoprene washer over the threads of the SCA's sensor, and then insert the sensor through the top of the sensor mount. Secure the sensor with a jam nut, being careful not to over-tighten. The sensor should have slight play to account for shock and vibration encountered during the tamper operation.
3. Attach the connection cable to the sensor's electronics housing.
4. Slide the SCA magnet assembly over the top of the hammer shaft. Secure the magnet assembly to the shaft by loosening the two screws that secure the magnet to the SCA magnet assembly, tightening the cap screw, and retighten the two screws securing the magnet.
5. On the top of the automatic tamper, mark the positions of the three eccentrics before removing the three bolts and washers securing the guide rods. Lower each rod and remove the eccentrics.
6. Lower the hammer shaft, ensure the nine set screws at the base of the sensor mount are flush with the bottom, and then carefully set the SCA sensor mount on top of the tamper while guiding the sensor rod into the magnet. [Figure 3](#) shows the necessary alignment of the sensor rod, magnet assembly, and hammer shaft.
7. Re-install the eccentrics and guide rods, ensuring the eccentrics are in their original positions. Washers and longer bolts are supplied with the SCA to reach through both the SCA bottom plate and the tamper top plate. Tighten the three guide rod bolts securing the SCA frame to the tamper.
8. Set the SCA control box and computer in a suitable location, and attach the sensor cable to the box-mount receptacle on the front of the box.
9. Connect the computer DC power cord and the USB cord from the front of the control box to the computer.
10. Attach the AC power cord to the power module at the back of the control box, and then plug the power cord into a 110 VAC power outlet.

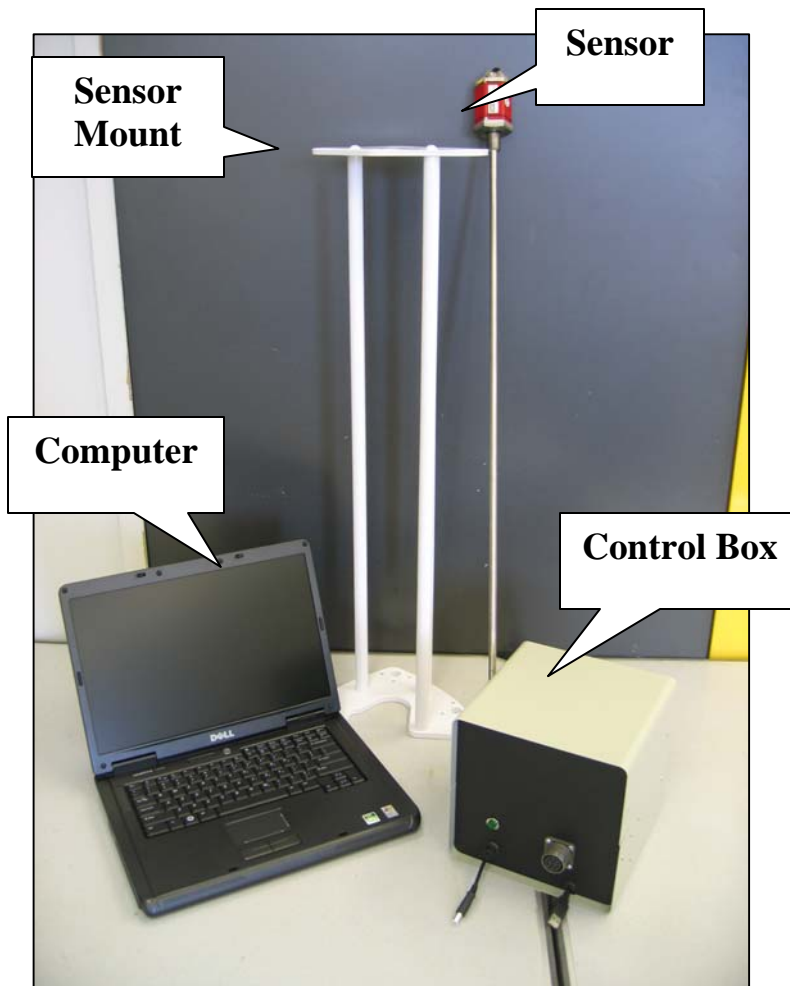


Figure 1. Large Components of SCA Hardware.

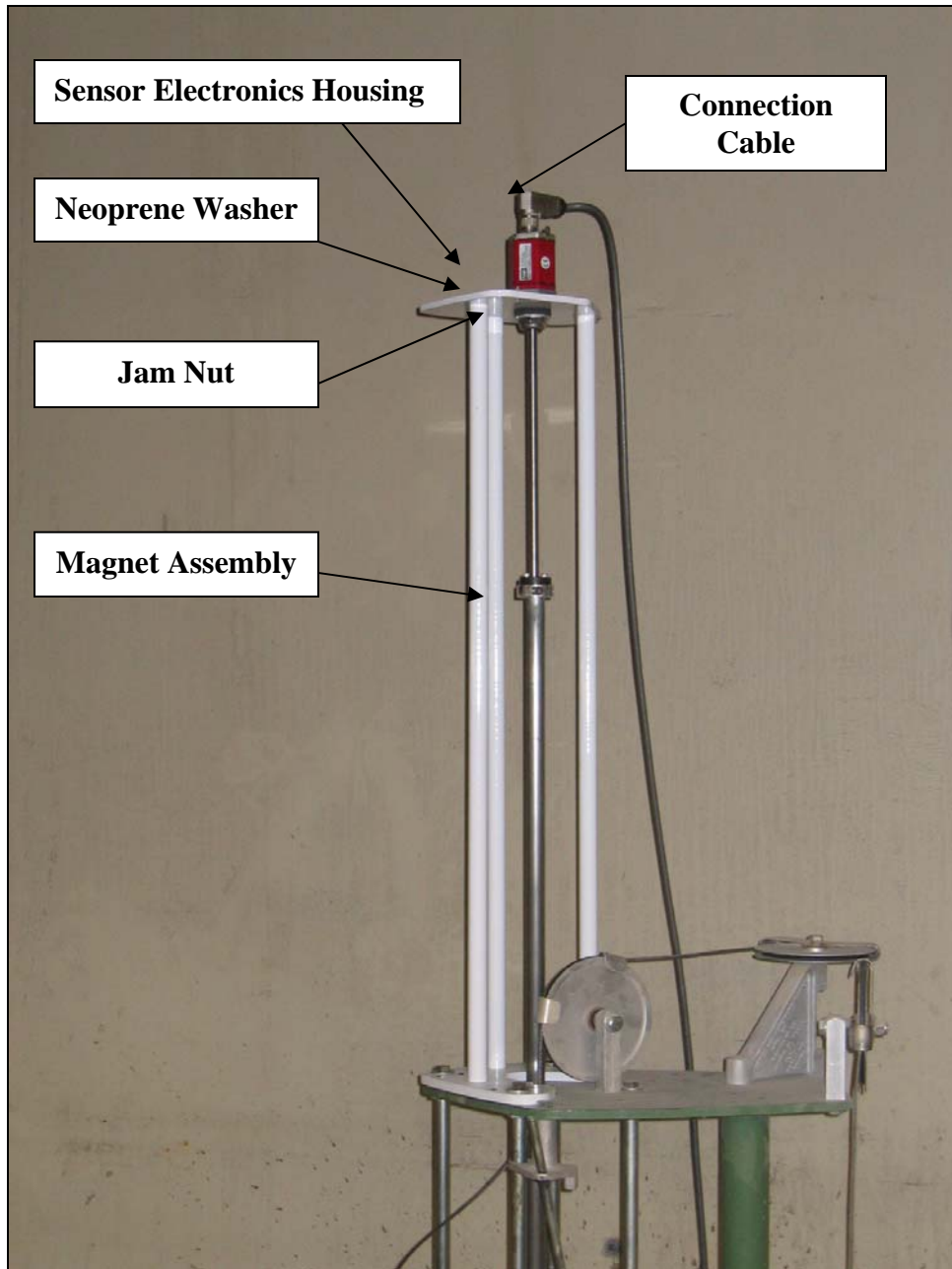


Figure 2. View of SCA Components Installed on Automatic Tamper.

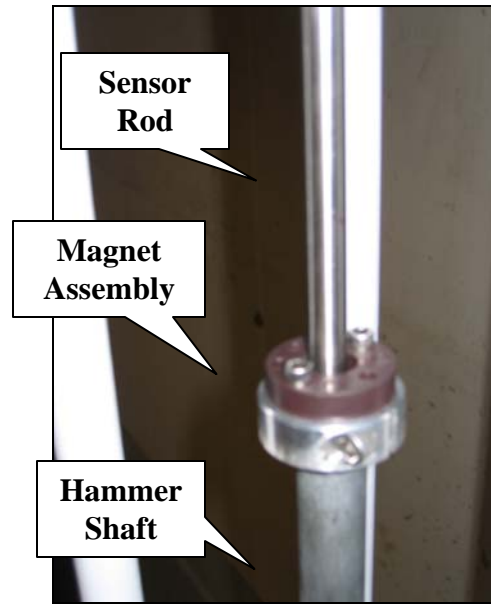


Figure 3. Concentric Alignment of Sensor Rod, Magnet, and Shaft.

ADJUSTMENT

The goal of adjustment is to establish hammer operation with minimal rubbing between the shaft and magnet. A few iterations through the adjustment procedure may be necessary to obtain optimal operation.

1. Use a level to gauge the nearness of the hammer shaft to the vertical. Ideally, the shaft will be plumb (See [Figure 4](#)).
2. Use a level to check how close the sensor rod is to plumb (See [Figure 4](#)).
3. Loosen the guide rod bolts and then adjust the set screws in the bottom plate of the SCA sensor mount until the vertical alignment of the sensor rod matches that of the hammer shaft (See [Figure 5](#)).
4. Slide the sensor mount horizontally to the location that best centers the SCA sensor rod through the hole in the magnet.
5. Fully tighten the guide rod bolts. Additional clearance between the sensor rod and hammer shaft may be obtained by carefully turning the sensor rod assembly; use a wrench at the base of the sensor rod electronics to turn sensor rod.
6. Set up a compaction mold on the automatic tamper, and put a damping material (such as a sample bag) into the mold. Manually cycle the automatic tamper while checking for any signs of binding in the system.
7. When the cycling action appears free of any binding or excessive friction, plug the automatic tamper back in. Operate the tamper, again inspecting the operation for signs of binding or excessive friction. If erratic operation is observed, repeat the adjustment procedure.



Figure 4. Checking Plumb of Hammer Shaft (Left) and Sensor Rod (Right).

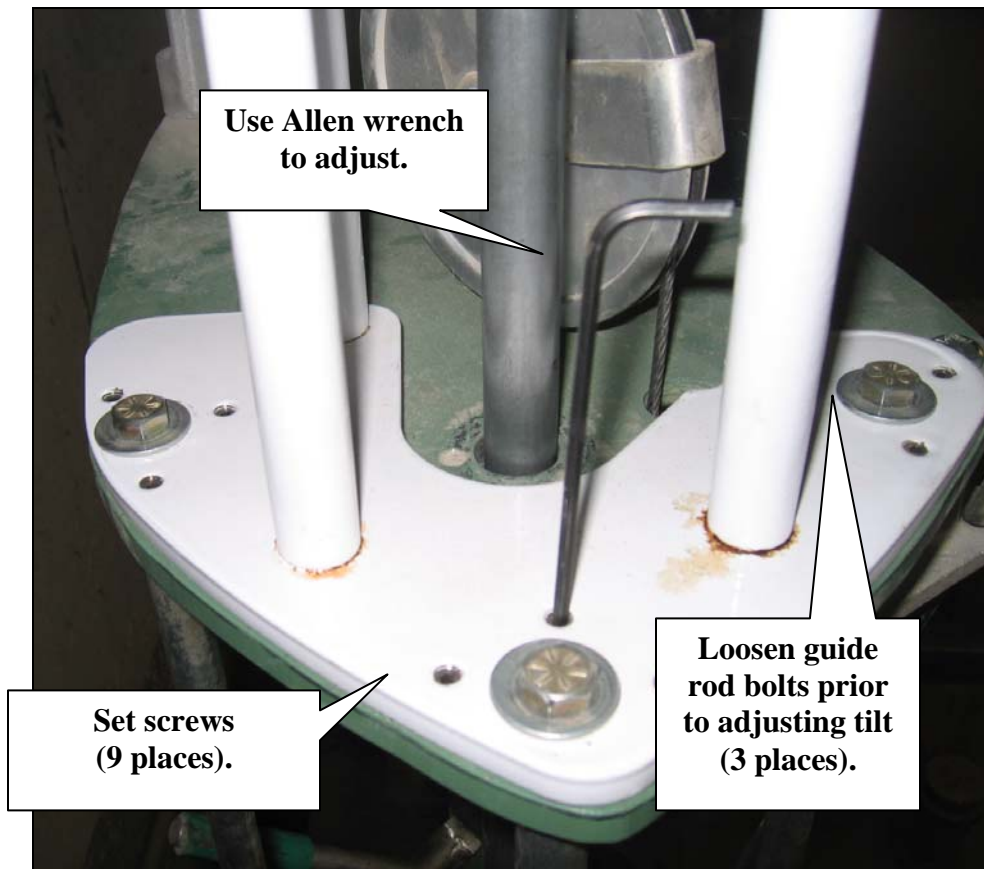


Figure 5. Adjusting Tilt of Sensor Mount to Establish Plumb of Sensor Rod.

SOFTWARE OVERVIEW

The SCA's Compaction Device Analysis System software allows the calibration of the sensor, data collection of hammer operation during sample compaction, and data review and recall so important hammer operational parameters such as lift height, drop height, and impact velocity can be reviewed. Additionally the system measures the sample height.

Upon launching the software, the main menu in [Figure 6](#) appears. The basic sequence of operation is:

1. Verify the sensor's operation (if you are using the system for the first time, calibrate the sensor).
2. Collect data.
3. Review data.

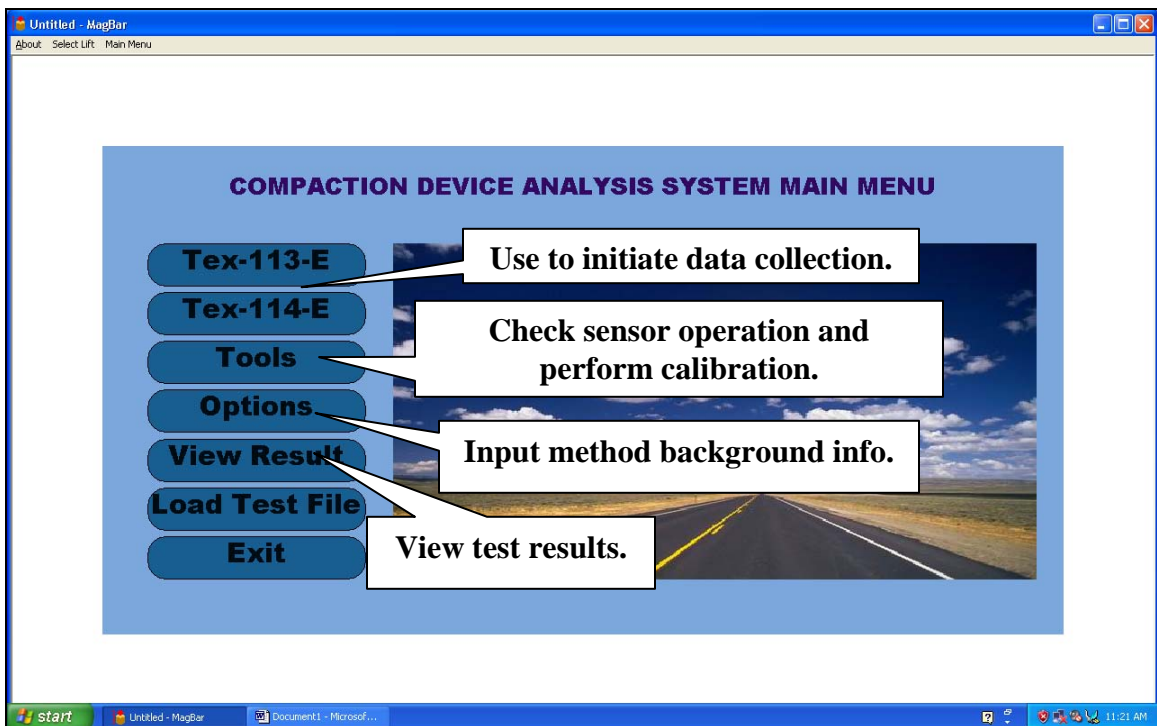



Figure 6. Main Menu.

Sensor Verification and Calibration

If you are using the system for the first time, the sensor needs to be calibrated. Bring up the options screen (shown in [Figure 7](#)) and check the test method information and the calibration block height. Make any necessary adjustments (particularly to the calibration block height—if a block with a height matching the default value is not available, locate a suitable calibration block and input its height). Press OK to return to the main menu.

Dialog

	Tex-113-E	Tex-114-E
Default hammer mass (lb)	10	5.5
Sample Diameter (in)	6	4
Mold Height (in)	8	6
Default lift height (in)	2	1.5
Number of lift	4	4
Number of drop	50	25
Calibration Block Height(in)	3	
Sensor Calibration Factor	2.9926	
Voltage @ Calibration Block (V)	1.07219	



Ver:02/21/08
HammerCheck

Cancel OK

Figure 7. Options Screen.

Next, press Tools to bring up the Tools menu (shown in [Figure 8](#)). To calibrate the sensor, set up the tamper's mold and base plate as if you are preparing to compact a sample. Next, set the calibration block inside the mold, and then manually lower the hammer to rest on top of the block. Press Calibration to initiate data collection for calibration. Press Calibration again after approximately 5 seconds to toggle off the calibration function.

The sensor should now be calibrated to the machine and will be able to reasonably measure sample height. Verify the sensor operation by pressing Start. The current position of the sensor will be displayed, which should match the calibration block height, typically to within ± 0.01 in. Alternatively, press the Average button to toggle on and off the averaging function, and the software will display the average position from the data collected.

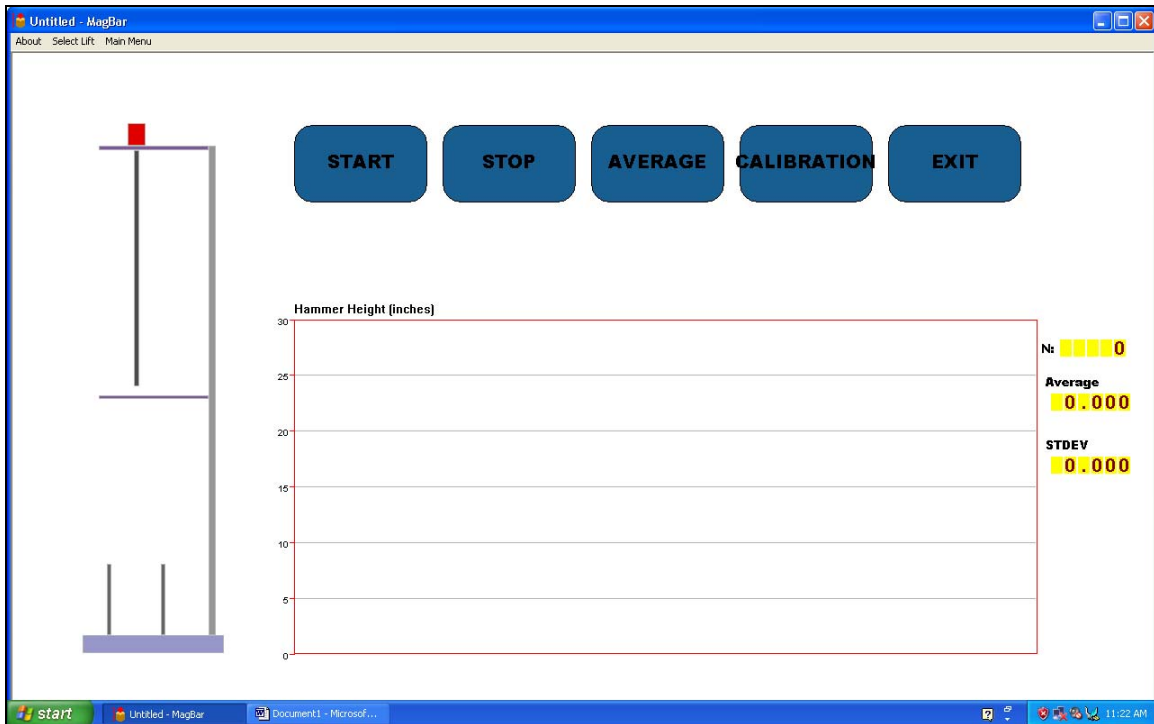


Figure 8. Tools Menu.

Data Collection

To collect data, press Tex-113-E or Tex-114-E from the main menu. The sample information screen shown in [Figure 9](#) appears. Input the appropriate information, and then press OK. The Select Lift Menu shown in [Figure 10](#) appears.

Two options exist for collecting data. The operator may manually initiate data collection at the beginning of each lift, or the operator may elect to have the software automatically update the current lift status and initiate operation. In both cases, the software automatically ceases data collection when the hammer remains idle, so currently all desired hammer drops must take place continuously in order for all data to be recorded.

To manually initiate data collection, press Lift-1 in the Select Lift Menu. To let the software automatically manage data collection, press Auto Run. After you make a selection, the data collection screen shown in [Figure 11](#) appears.

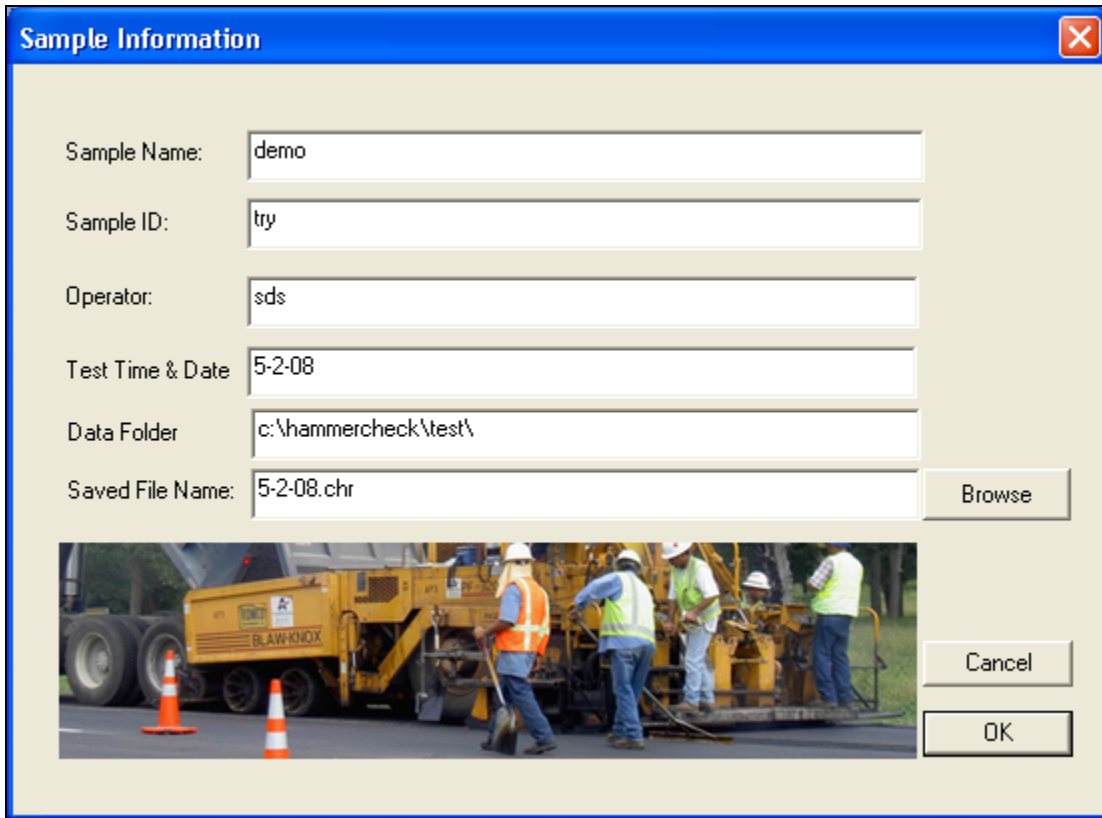


Figure 9. Sample Information Screen.

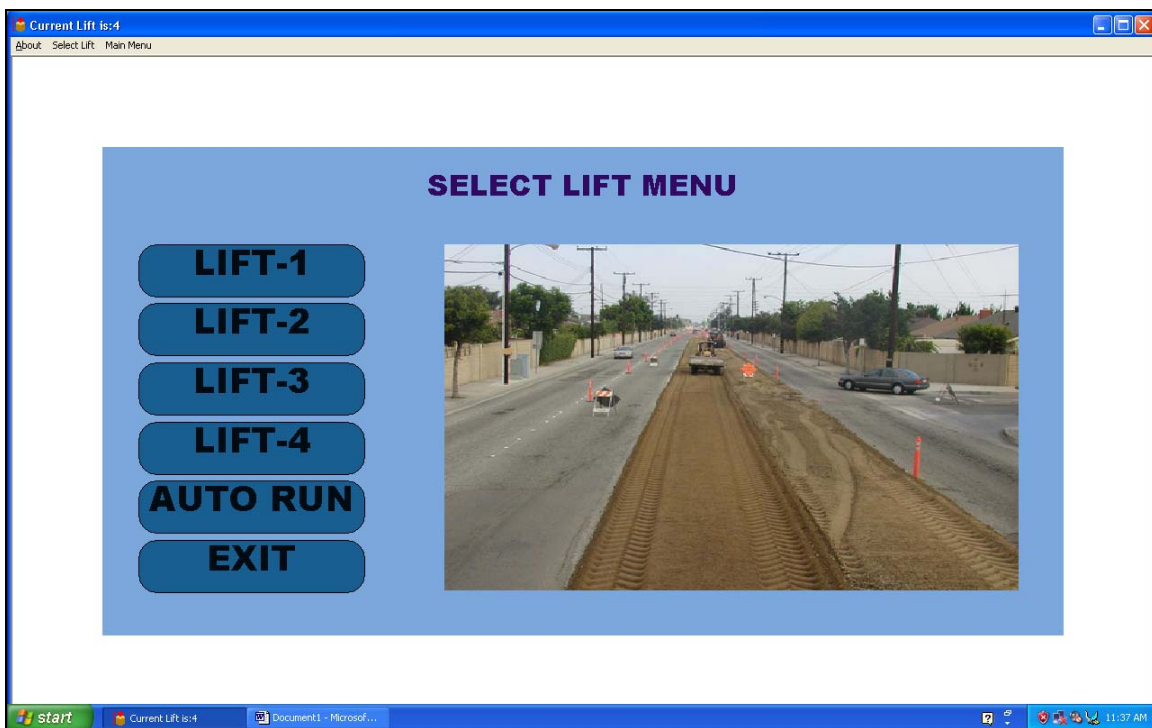


Figure 10. Select Lift Menu.

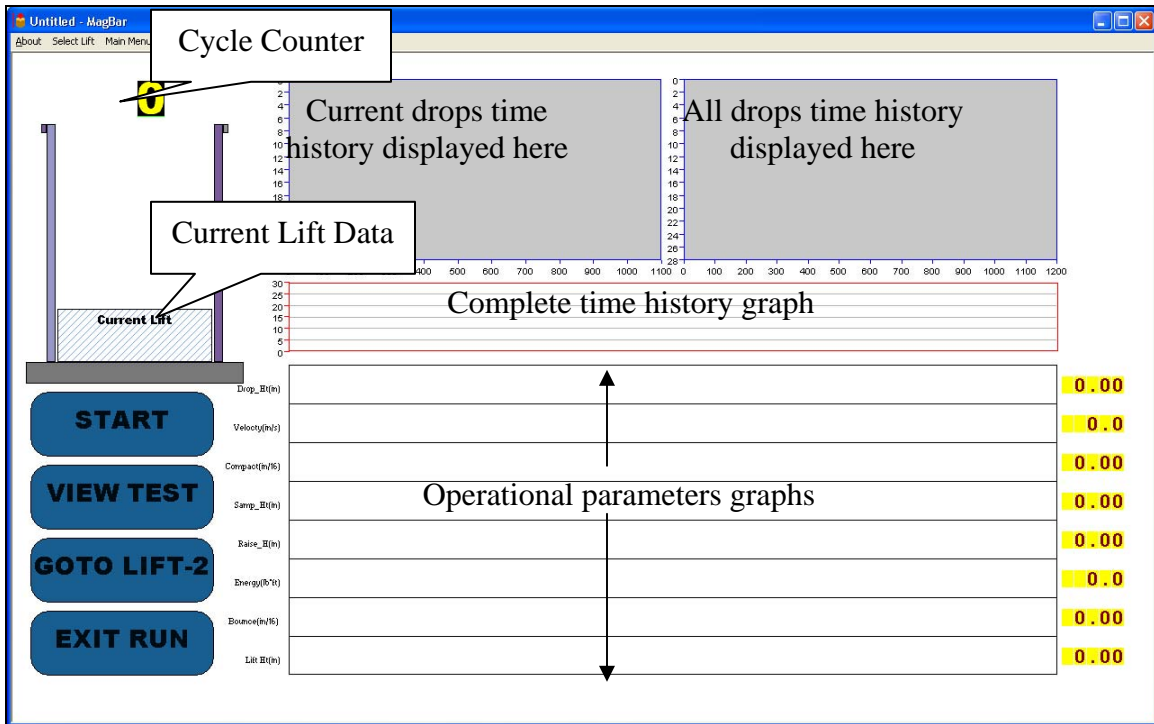


Figure 11. Data Collection Screen.

Note: In manual mode, the user must press Start to initiate data collection. In Auto Run mode, the software will automatically manage data collection.

Tools included in the data collection screen include a real-time graphical display of the current drop, a display overlaying all drops, a complete time history of the hammer’s position, and operational parameters including hammer drop height, impact velocity, compaction value (the amount of deformation occurring to the sample from the hammer impact), sample height, hammer raise height, hammer drop time, and a bounce value (the amount of bounce of the hammer off of the sample surface).

Additionally, in the upper left portion of the screen, a cycle counter is displayed, and the status of which lift is being compacted is displayed. Upon completion of a lift, the software displays the lift’s height and the total energy applied to the lift, in feet–pound-force (ft-lbf), in the current lift data section. For reference, the theoretical energy applied per Tex-113-E would be 750 ft-lbf per lift, with 50 drops/impacts per lift.

If desired, after completion of a lift the user may review the results from each drop of that lift by pressing the View Test button.

Data Review

Data may be reviewed during the sample production process as previously mentioned, which will display the operational parameters for each drop of the lift, or stored data may be recalled and reviewed. Reviewing stored data provides the additional option of reviewing the data on the basis of average values for each lift instead of values for every individual hammer drop.

To recall stored data press Load Test File from the main menu to bring up the file selection dialogue box (shown in Figure 12). After selecting the appropriate file and pressing Open, select View Result from the main menu. The result screen shown in Figure 13 appears.

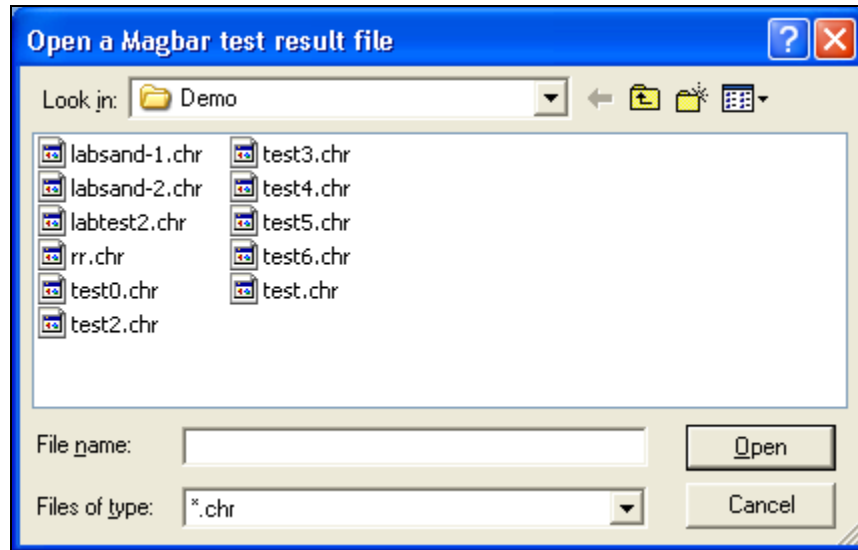


Figure 12. Load Test Screen.

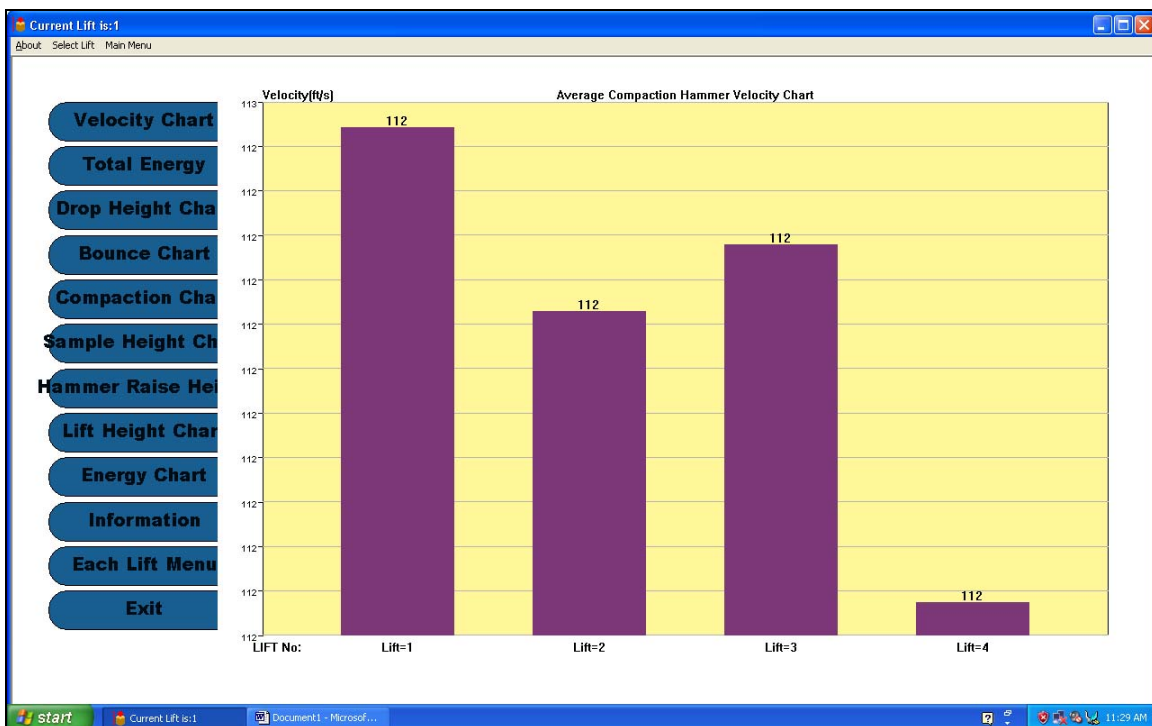


Figure 13. View Result Screen.

The view result screen as illustrated in [Figure 13](#) allows review of the following values for each lift:

- velocity – the average hammer velocity upon striking the specimen surface;
- total energy – the total kinetic energy applied to the specimen during the lift;
- drop height – the average height of the hammer drop from its highest point to the specimen surface;
- bounce – the average amount of bounce of the hammer off of the sample surface;
- compaction – the average amount of deformation occurring to the sample from the hammer impact;
- sample height – the average total height of the sample after the completion of each lift, taken from the last 10 drops of the lift;
- hammer raise height – the average height the hammer is lifted from the surface of the sample to its highest point prior to dropping;
- lift height – the average compacted height of each individual lift, taken from the last 10 drops of the lift;
- energy – the average kinetic energy produced by the hammer for each lift; and
- information – a tabular summary of the above parameters.

Pressing the Each Lift Menu button will toggle the software to display operational parameters for each drop of each lift, as [Figure 14](#) illustrates. Select which lift to view by using the drop-down menu in the upper left portion of the screen. Operational parameters displayed for each drop include:

- velocity – the hammer impact velocity,
- raising time – the time the hammer takes to be raised from the specimen surface to its highest position prior to dropping,
- drop height – the distance the hammer falls from its highest point to the sample surface,
- bounce – the amount of bounce of the hammer off of the sample surface after the impact,
- compaction – the amount of deformation of the sample from the hammer impact,
- sample height – the height of the sample,
- hammer raise height – the height the hammer is lifted from the surface of the sample to its highest point prior to dropping,
- lift height – the height of the individual lift,
- energy – the kinetic energy produced by the hammer's fall, and
- information – a tabular summary of the above parameters.

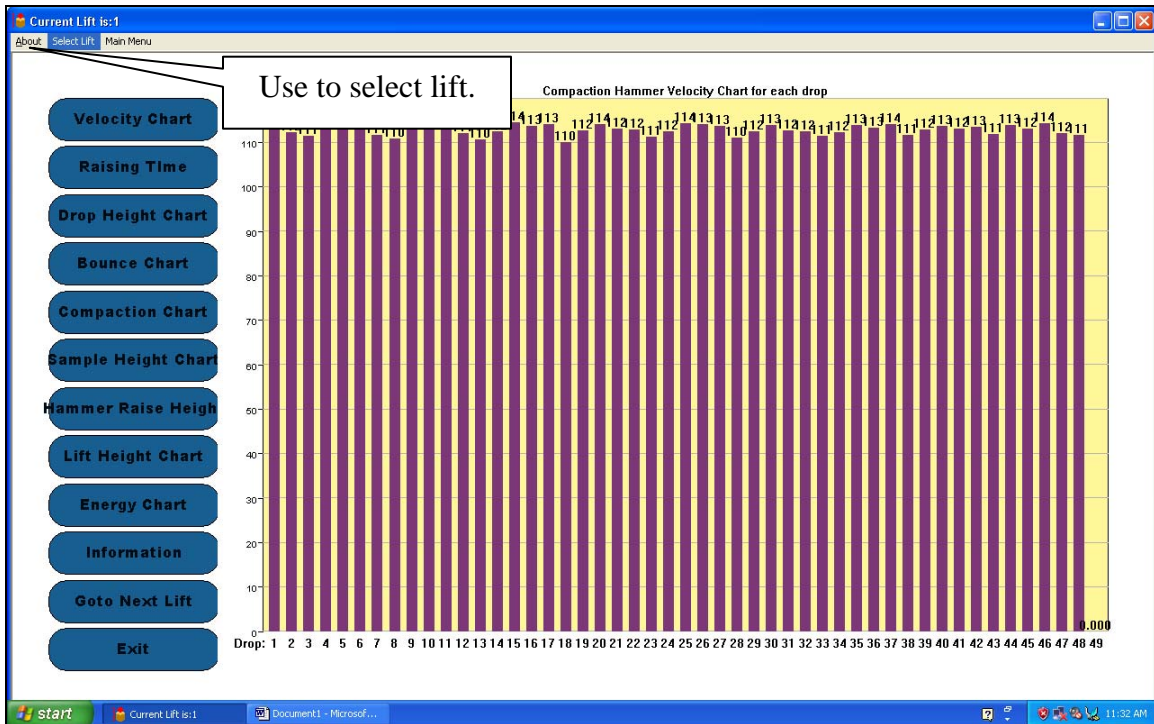


Figure 14. Each Lift Display Screen.

SUPPORT INFORMATION

The Texas Transportation Institute developed the SCA in cooperation with the Texas Department of Transportation and the Federal Highway Administration under research project 0-5135, “Improving Correlation between Field Construction of Soils and Bases and Laboratory Sample Construction Techniques.” For technical assistance, or for information about hardware or software updates, please contact the project director or one of the members of the research team. The project director was:

- Caroline Herrera, P.E., Texas Department of Transportation, (512) 506-5907, cherrer@dot.state.tx.us

Texas Transportation Institute researchers developing and testing the SCA include:

- Stephen Sebesta, (979) 458-0194, s-sebesta@tamu.edu
- Wenting Liu, P.E., (979) 845-5943, w-liu@tamu.edu
- Gerry Harrison, (979) 845-2365, gerry@tamu.edu

