Racing Surfaces Testing Laboratory

907 National Avenue
Lexington, KY 40502
207.570.9869

LABORATORY TEST METHOD FOR TRIAXIAL SHEAR STRENGTH (ADAPTED FROM ASTM D4767)

Note:
This test is considered a consolidated-drained (CD) triaxial shear test. The ASTM D4767 procedure applies to consolidated-undrained (CU) triaxial shear tests, and has been adapted for the CD test.

1) Place at least 2000g sample in oven to remove moisture. Refer to the moisture removal procedure for details.

2) If the test is to be done at a specific temperature, turn on the **water bath** by flipping the switch for both the head and the base of the water bath, found on the backside of the unit. Set the water bath temperature to -5°C for a test at 0°C, 20°C for a test at 20°C, or 32°C for a test at 32°C. To set the temperature of the water bath select the current temperature using the arrow keys, press the ⏎ button which will allow you to adjust the temperature, scroll over using the side arrows and adjust the temperature up and down with the up and down arrows. Press the ⏎ button to set the temperature.

Moisture content (%)	Sand to add (g)	Water to add (g)	End Sand + Wet Weight (g)
8	1334	116	1450
10	1305	145	1450
12	1276	174	1450
14	1247	203	1450
16	1218	232	1450

3) Record the mass of a clean sample tin using **Ohaus 4000g ± 0.1g scale**. Use the chart to determine the amount of the material to place in the sample tin. If the sample contains rubber bits, remove any that are > 1 cm in length. Record the mass of the material in the sample tin.

4) Add the desired forming moisture content (ie 8%, 10%, etc.-Use chart above) to the sample tin using a **spray bottle of distilled water**. For synthetic material, use 4% moisture unless otherwise stated. Mix thoroughly.

5) Record the new mass of the sample and container as "Container Start Weight". Cover with **plastic wrap** to contain moisture as necessary.

6) Place thin layer of **vacuum grease** around **bottom cap**.

7) Prepare **sample mold**: a) stretch **membrane** over bottom of mold and slide **O-ring** over bottom of mold b) stretch membrane over top of mold c) secure sample mold onto bottom cap.

8) Place two pieces of 7.0cm diameter **filter paper** on top of the bottom cap. With a paintbrush, apply a dusting of baby powder to the inside of the membrane.

9) Turn on the **Instron** (or **Tritech**) **load frame** and the **air compressor**.

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10) Sample preparation: a) Cover the bottom o-ring with aluminum foil b) transfer 2 scoops (large spoon) of material to the inside of the membrane c) compact with hand **tamper** using 25 blows d) repeat (a) and (b) until material is level with the top lip of the mold – add/remove material as needed on the top surface to ensure that it is level. There should be a total of 6 layers. If, during compaction, it becomes clear that 2 scoops of material per layer is too much or too little, the amount of material per layer may be adjusted.

11) Collect any spilled material back into pan for weighing. Record the final mass of the container as "Container End Weight".

12) Place another two pieces of 7.0cm diameter filter paper on top of the sample.

13) Apply a thin film of vacuum grease to the **top cap**. Clear dirt from inside the top of the membrane – a slightly damp paper towel works well. Press the top cap into the remaining space at the top of the mold.

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14) Remove the sample mold: a) pull top of membrane up off the sample mold and secure an o-ring into the groove in the top cap. b) roll the bottom of the membrane off the sample mold and push the bottom o-ring down c) remove the split mold by removing the strap clamping and prying apart the mold at the top d) secure the bottom o-ring into the groove on the bottom cap and pull the membrane over the o-ring. Be sure there are no wrinkles or folds in the membrane around or under the o-ring, as this will make it easier for water to enter the sample.

15) Apply vacuum grease liberally to bottom of **Plexiglas shell** and to bottom large o-ring. Place onto **triaxial cell base**. Close all the valves on base except for the one furthest to the right and fill the cell to about 2 inches from the top with tap water. Clean off the top of the Plexiglas shell and apply vacuum grease.

16) Lift the pusher rod of the **triaxial cell cap**, and confirm that it will fall under its own weight. Confirm that the large o-ring is sitting inside the groove the triaxial cell cap. Put the pusher rod into the top cap of the specimen and lower the triaxial cell cap onto the Plexiglas shell. If running a test at a temperature other than ambient, make sure to use the cap with a copper coil.

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17) Secure the top of the triaxial cell with the LDVT rod in front and line up with tie rods. Tighten hand knobs on tie rods. Only tighten these rods by hand, do not use any tools.

18) Place the **3/4" diameter ball** onto the top of the piston and center the triaxial cell in the Instron load frame (or on the Tritech load frame). Bring the Instron crosshead down so that the ball is barely in contact with the S-beam load cell. Press "GL RESET" to zero the EXTENSION reading. If using the Tritech load frame, raise the platform using the double up arrow button until the ball is barely in contact with the S-beam load cell. There is no extension reading on this load frame.

19) Secure the **LVDT** into position and connect the signal line to the data acquisition system. Be sure the overhead line is connected.

20) Consolidated Drained (CD): Be sure that the right-hand side valve labeled "LOWER" is open. Any water that leaves the system during the test through these lines should be collected in a small container.

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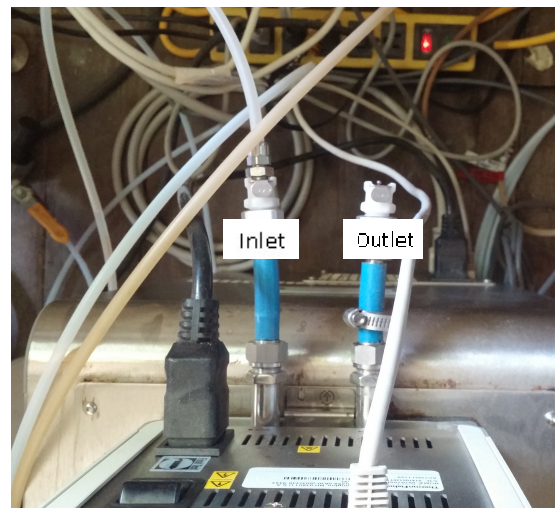Lexington, KY 40502
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21) Topping off & purging the cell: Inevitably, some water will be lost while preparing the triaxial cell for testing. The cell must be recharged with water to make up for the loss. a) purge water line b) attach the water line to the cell supply c) set the pressure to 2.5 psi d) open the valve to the cell supply e) secure the **purge fitting** into the **relief valve** at the top of the cell to allow air/water to exit. Continue to purge until all air is out of the cell supply connection and water starts to come out of the relief valve. Quickly remove the purge fitting from the relief valve.

23) If testing at a temperature other than ambient, first connect the tubes from the water bath to the cell in the following order: a) connect the tube that remains connected to the water bath **inlet port** to the load cell b) connect the loose tube to the other port on the load cell c) connect the other end of that tube to the **outlet port** of the water bath (closest to the front). After making these connections, water should begin to flow through the load cell. If the water does not begin to flow look at the water bath, if you see a triangle you will need to select that and press the ⏎ button to set the bath to circulate. Allow the temperature to equilibrate for one hour.

22) Confining Pressure: A complete set of triaxial test data consists of tests run at four different confining pressures (5, 10, 15, 20 psi). Dial the regulator to until the pressure inside the triaxial cell is correct. Be patient and make sure that the pressure is correct and not changing before starting the test.

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24) Data Acquisition: a) Open Labview (labview 8 for Instron, Labview 2012 for Tritech).0 b) Start the LabView VI (Triaxial 2.vi) c) click on the folder icon and choose the data filename in the format: "TRIAXIAL_PROJ#_SAMPLE_TEMP_#PCT_CONFINEpsi.dat". ie TRIAXIAL_OTC_14009_OTC_14009-Z_20C_4PCT_5psi.dat. You can confirm that the file name is correct by looking at the white box under the heading "select/specify output file." d) After the filename has been set, click Run. You should see an above-zero voltage reading on the LVDT channel and a near-zero voltage reading on the LOAD channel. If the load channel is reading a voltage larger than 0.020 volts, use the balance knob on the signal conditioner to zero the load channel. If both the load and displacement are 10 volts, completely close LabView. Open the grey plastic box to the left of the Instron (or under the Tritech load frame). Inside will be a small blue box with a green light. Disconnect and reconnect the black cord leading to the blue box until the green light starts flashing. Restart LabView, remembering to reset the data filename. If the last test was run with the other triaxial machine, open InstaCal. The USB should show up as Board 0. Right click on the USB number and change the board number to 1. Close InstaCal and reopen the LabVIEW application. Make sure that both boardnums match the board number in InstaCal.

25) Set the Instron "SPEED" to 0.853 mm/min and start the loading by pushing the grey extension button (with the down arrow). If using the Tritech load frame, check that the speed is set to 0.853 mm/min and start the loading by pushing to button with the single up arrow.

26) If there is water leaking from around the edges of the Plexiglas shell, there is probably some dirt on the o-ring. Try tightening the tie rods, being careful not to move the cell too much if the test is running. If the top cap is leaking from another location, there is nothing that can be done without disassembling the cell. Refer to the file "Maintenance of Triaxial Apparatus." If the test is at ambient temperature, and the pressure inside the cell can be maintained, the test can be completed with the leak. If the test is not at ambient, or the leak becomes large enough that the pressure in the cell drops, stop the test, fix the leak, and rerun the test.

27) For Synthetic tests continue logging data until the sample has displaced >=30mm on the Instron display from the start of the test (or the test has run for 35 min if using the Tritech load frame). If testing a dirt sample, not a synthetic one, the test can be stopped before the displacement reaches 30mm if it is clear that the load has begun to decrease or that the sample has failed (you will see the full curve on lab view). Stop on Labview then stop on the Instron or Tritech load frame.

28) Dial the pressure down to zero. If the water level in the supply water is low, secure the purge fitting into the relief valve at the top of the cell and allow some water to flow from the cell into the **supply water tank**. Break down the cell in the reverse of the assembly. Discard cell water into a bucket or drain. In the cases where moisture was collected from the "LOWER" drain lines, add this water back to the sample after the test. In most cases, this

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material will be used to prepare the sample for the next test.

29) Never prepare a sample for a test at a higher moisture content by adding water to a sample at a lower moisture content. Any small inaccuracies in the lower moisture content will create larger inaccuracies in the higher moisture content. The sample must be fully dried between tests at different moisture contents.

30) After tests at all four pressures have been run, the data must be brought into the excel data sheet to calculate the results. Go to the tab labeled "InputData." In the cell labled "Data File Path" put the file path of the folder the data file is in, followed by a "\" . Fill in cells B10 through B12 following the format shown in the cells.

31) Click on the button labeled "Load Data Files" to load the data files into the excel sheet. If this does not work, make sure that macros are enabled. Also make sure that

the file name which the macro is looking for matches the actual file name exactly. Common problems are .txt files instead of .dat files, spaces or typos in the file name, or forgetting to put a "\" after the file path.
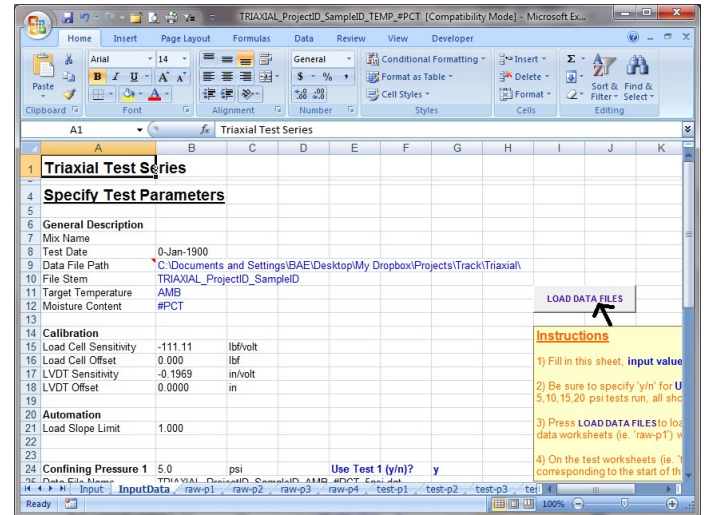
Revision No.	Date	Revision By	Description
1.0	24-Feb-2008	H. Brezowski	Created and issued procedure
1.1	17-Mar-2009	R. Beaumont	Adapted procedure for new Instron load frame
2.0	28-Mar-2009	C. Mahaffey	Revised procedure after running first test on new load frame
2.1	03-Aug-2009	M. Segee	Clarified several steps.
2.2	27-Jan-2010	J. Luo	Water temperature measurement added.
2.3	07-Jan-2011	M. Segee	changed confining pressure section, filename format, rearranged setup order, added how to fix if green light stops flashing, included information about different temperatures, leaks, when to stop a dirt test.
2.4	23-Apr-2012	M. Segee	small corrections and clarifications
2.5	5-22-2012	M. Segee	do not do heated triaxial with small leak
2.6	07-Jul-2012	M. Segee	Set waterbath to -5C for test at 0C.
2.7	26-Jun-13	M. Segee	Added instructions for Tritech load frame, clarified steps, added section about processing data.
2.8	27-Jun-13	M. Segee	Added pictures, clarified steps
2.9	28-Apr-14	H. Babbitt	Reformatted, updated lab address, updated water bath instructions.
3.0	25-May-16	H. Babbitt	Added instructions for new water bath.
3.1	07-June-16	H. Rubin	Added instructions for LabVIEW on new laptop.
4.0	06-June- 17	K. Dempsey	Changed instruction for adding the correct moisture content in step 3/4
4.1	26-Feb-19	H. Adams	Update address and phone number