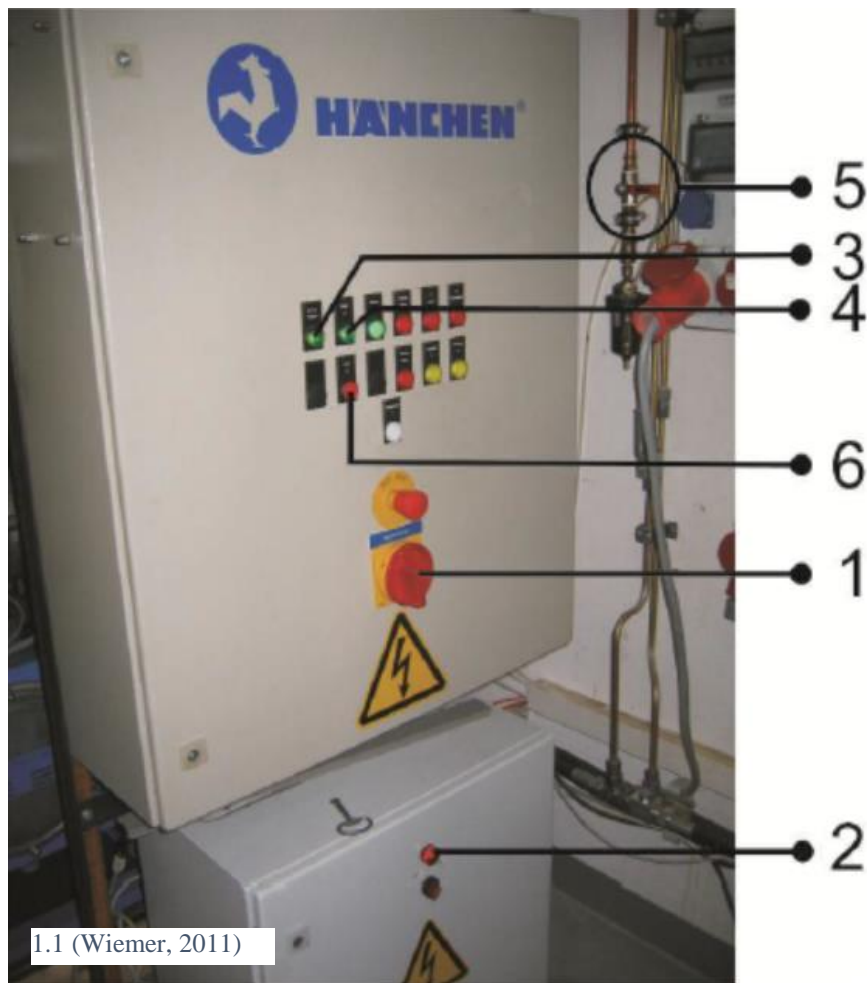


1 Turn on the cyclic triaxial (DTTD)		Fig	Check
Always make sure to turn on the DTTD at least one hour before usage. The hydraulic oil needs to warm up to reach the desired viscosity			
1.1	Turn on the adaptive real time controller: “Hauptschalter”	1.1 (1)	
1.2	Turn on the electricity button on the pneumatic pressure regulator.	1.1 (2)	
1.3	Push —Not-Aus Freigabe—	1.1 (3)	
1.4	Turn on the pump by pushing the button “Pumpe ein”	1.1 (4)	
1.5	Turn on the gas pedal on the wall to the right.	1.1 (5)	



2 Sample preparation		Fig	Check
All items of equipment required for cell assembly are outlined in Figure 2.1			
2.1	Weigh a sample holder for moisture content and write it down		
2.3	Get frankie (water de-aerator and vacuum) prepared		
2.4	Connect sample holder to frankie	2.2	
2.5	Sample holder prep		
2.6	Put bottom pedestal and larger bottom O-ring on	2.3	
2.7	Put 2 O-rings on the bottom and the top of the sample holder		
2.8	Check the membrane for holes		
2.9	Turn on the vacuum pump with the membrane inside the sample holder **NOTE if the membrane is not sucking it needs new filter strips with silicone gel inside the sample holder.	2.4	
2.1	Make sure the membrane is sealed		
2.11	Prepare the stamp cover with silicone spray (in cupboard)		
2.12	Unwrap sample		
2.13	Place sample holder over the stamp		
2.14	Trim the sample flat		
2.15	Wet 4 strips of filter paper and two circular bits with distilled water and place over the top of the sample.	2.4	
2.16	Carefully push the sample out with the stamp		
2.17	Put the sample holder carefully over the sample, then break the other end of the sample off, then trim flat	2.5	
2.18	Put wet filter paper on the other end of the sample		
2.19	Put sample in the cell	2.6	
2	Fix the stamp in position. Make sure upper pore pressure is in line with the lower pore pressure (red handle)		
2.2	NOTE: DON'T TOUCH STAMP AFTER THIS AS IT WILL TWIST SAMPLE		
2.21	Attach the upper membrane and o rings to the stamp		
2.22	Remove the bottom pedestal		
2.23	Attach bottom O-rings and membrane		
2.24	Clean any dirt form the sample off the cell using a wet paper towel		
2.25	Grease up the 2 large o rings (to properly seal the cell cover)		
2.26	Put bottom O-ring cell cover top o-ring and top cap on and fix nuts and bolts	2.7	
2.27	Ensure the side pressure valve is open so that air can flow out of the cell and no side pressure is induced		

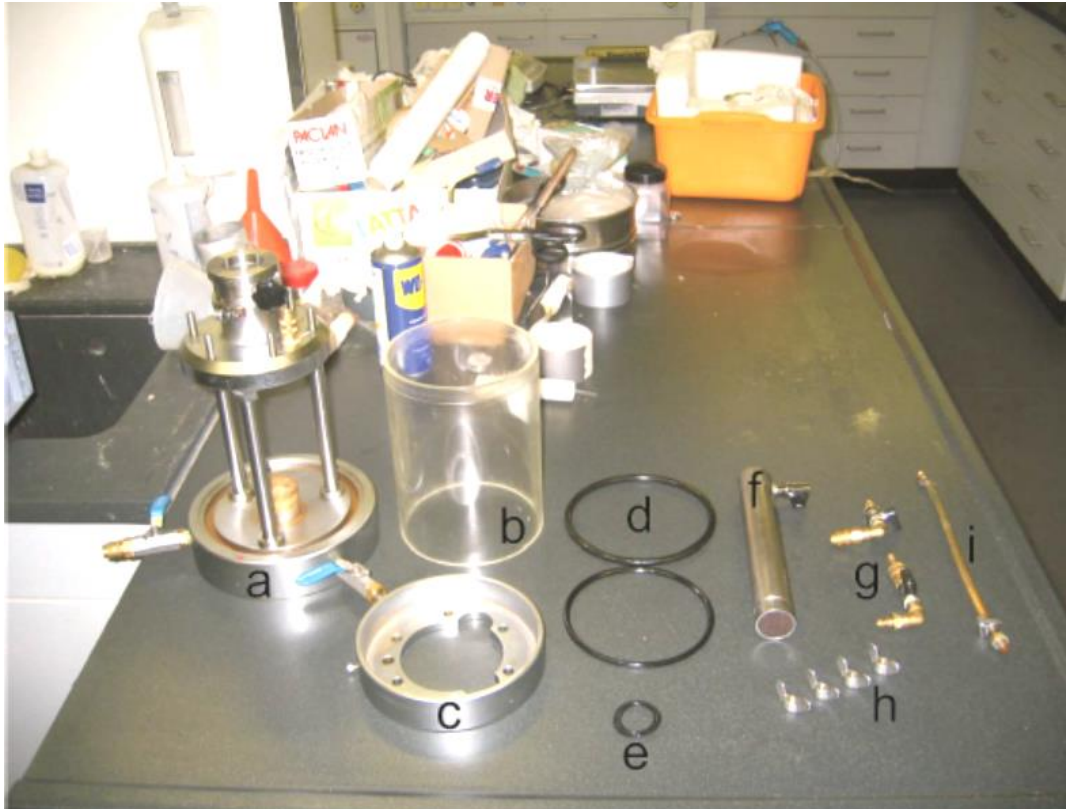
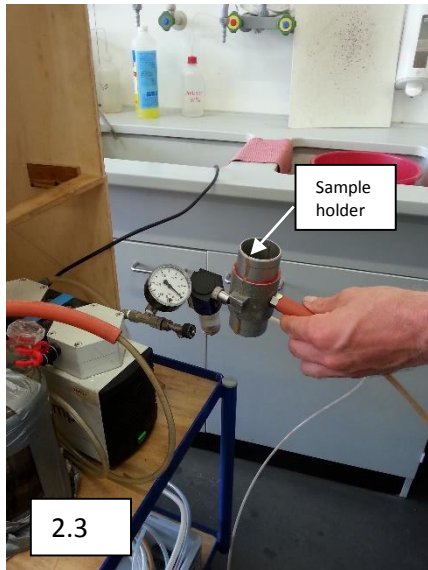


Figure 2.1. a) cell b) cylinder c) cover plate d) o-rings e) o-rings for specimen holder f) stamp g) oil/side pressure valve h) screws i) upper pore pressure tube. Photo: Wiemer, 2011.

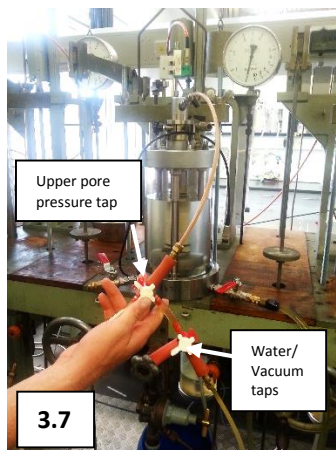
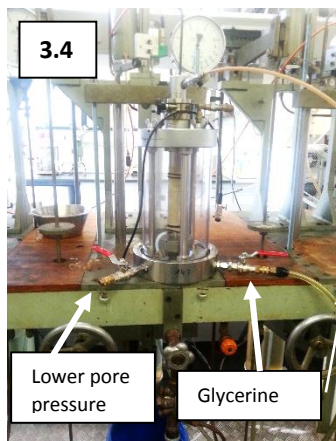
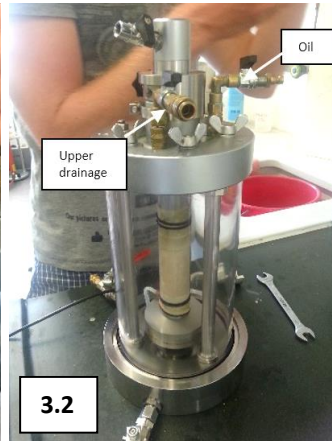
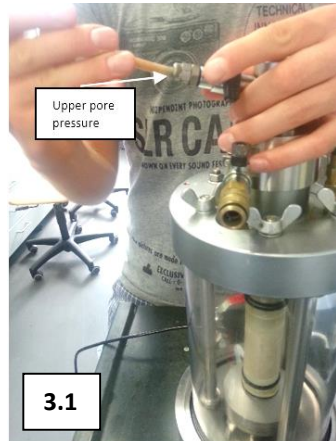


Figure 2.2. “Frankie” or the portable shelf with de-aired, distilled water and vacuum pump (Wiemer, 2011).



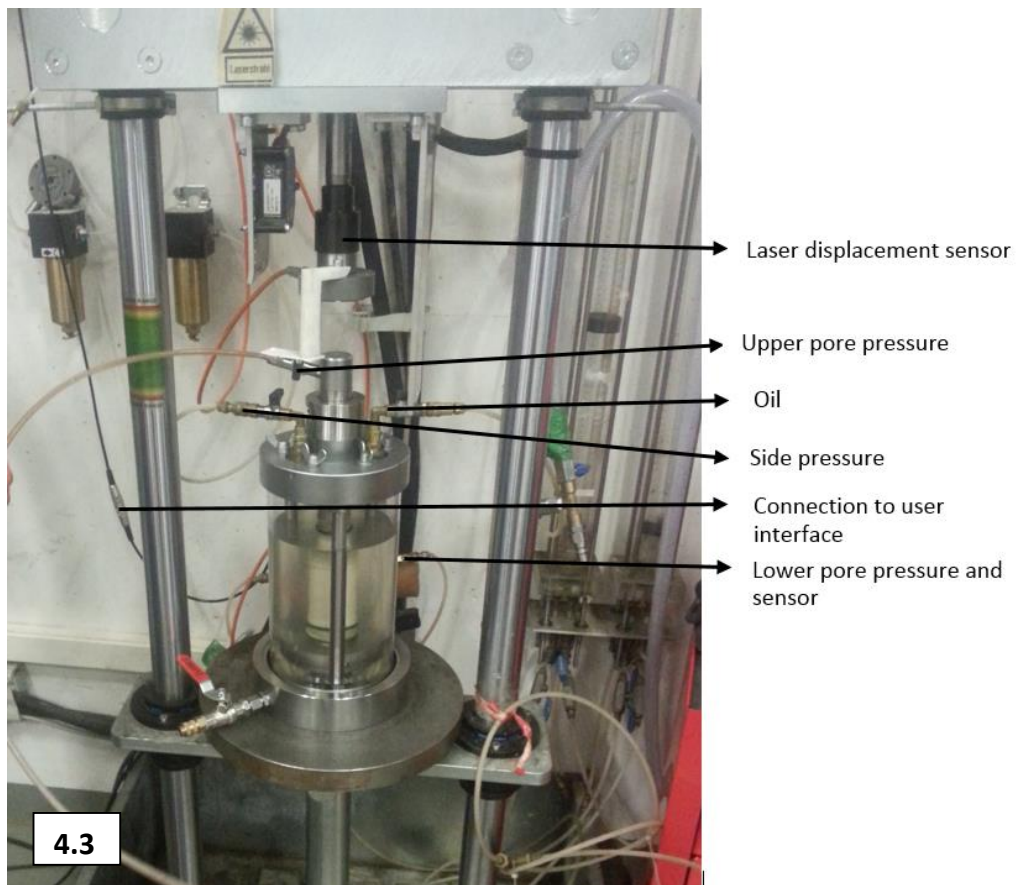
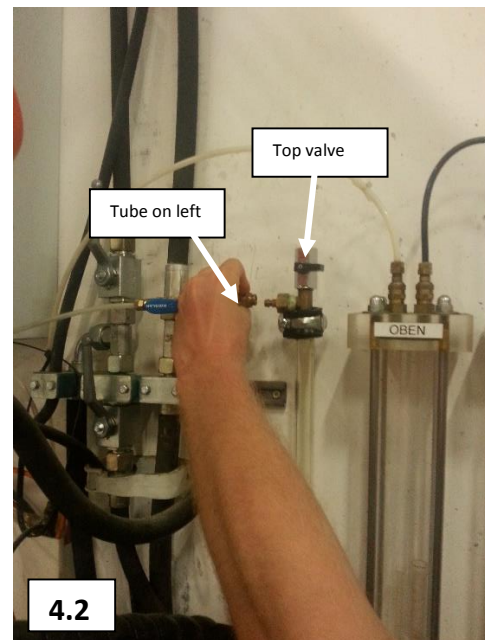
3	Saturation	Fig	Check
3.1	Connect the upper pore pressure	3.1	
3.2	Connect the oil (gold tap)	3.2	
3.3	Connect the upper drainage (other gold tap)	3.2	
3.4	Measure the height of the stamp with the calipers to obtain a sample height. Take three readings and an average	3.3	
3.5	Carry the cell to the saturation chamber		
3.6	Connect the glycerine	3.4	
3.7	Close glycerine air pressure (turn orange knob right)		
3.8	Open upper drainage		
3.9	Turn gold tap until the dial reaches 1-1.5 kPa	3.5	
3.10	Oil will then flow into the cell		
3.11	Fill until the level reaches the glycerine reaches the lower O-ring	3.6	
3.12	Close glycerine by turning orange knob left then gold dial so dial reaches 0		
3.13	Close the side pressure (take tube out and turn knob) (top of cell)		
3.14	Connect upper PP to the left part of the triple junction	3.7	
3.15	Connect lower PP tube	3.7	
3.16	Open water at frankie and close	3.8	
3.17	Connect lower PP to cell	3.9	
3.18	MAKE SURE VACUUM IS EMPTY: REMOVE WATER BY UNSCREWING BOTTLE SCREW BACK ON - HAS TO CLICK		
3.19	Connect vacuum to power		
3.20	Open upper PP using 2 hands so the stamp does not disturb the sample		
3.21	Open water supply		
	Apply side pressure of 30 kPa by:		
3.22	open glycerine		
3.23	apply pressure (turn orange knob on)		
3.24	Turn gold knob SLOWLY until the dial reaches 30 kPa		
3.25	Apply vacuum pressure (turn small black knob right then turn green power switch on)	3.10	
3.26	NOTE: MAKE SURE VACUUM DOESN'T OVERFLOW WITH WATER - IF IT DOES - CLOSE WATER SUPPLY AT FRANKIE THEN AT TRIPLE JUNCTION		
3.27	Wait a while so that the reading on the vacuum dial can stabilise at 95% and also until no air bubbles are moving into the cell		
3.28	Turn on water supply at triple junction		
3.29	Wait 30 minutes for the de-aerated water to fill de-aerated pore spaces		
3.3	Close the lower PP		
3.31	Close glycerine		

3.32	Remove pressure so stress remains inside cell		
3.33	Close the water supply		
3.34	Disconnect tubes and connect glycerine back up	3.11	
3.35	Take triaxial downstairs with max folder and camera		

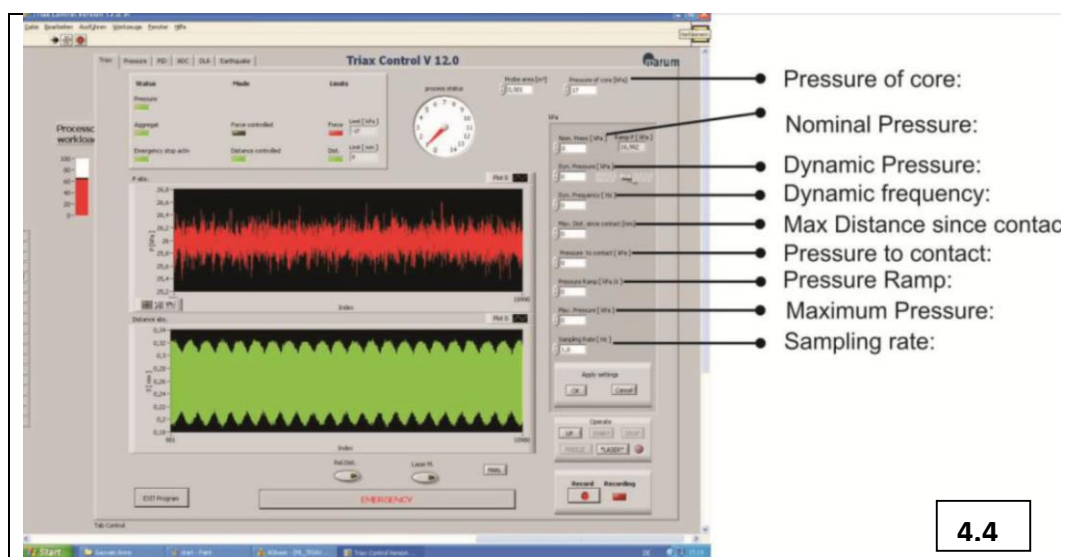




4	Triaxial set-up	Figure	Check
4.1	Turn on red valve behind the machine (gas connection to MARUM)	4.1	
4.2	Place cell on the loading frame		
4.3	Connect user face computer to the triaxial (black cord)	4.3	
4.4	Make sure there is enough oil: disconnect tube on the left, open the top valve, and fill with low viscosity oil, leaving several cm's space at the top. Connect the tube on left back again, and close the upper valve	4.2	
4.5	Centralise the cell using the 3 points and make sure lower pore pressure valve faces the transducer		
4.6	Connect the oil, side pressure, upper pore pressure and lower pore pressure to corresponding marked tubes	4.3	
4.7	Connect stamp	4.3	
4.8	Put metal cone on top		



5	Software set-up	Figure	Check
5.1	Open ML Triax 15.1 software (Kreiter et al, 2010a & 2010b)		
5.2	Click button red B		
5.3	Click button green C		
5.4	Click start tab		
5.5	Click Triax control 15.1		
5.6	Click Configure GDS sensor		
5.7	Click Triaxial tab then enter the following details: Pressure of core (kPa) = 17, Nominal pressure (effective stress pressure, in this case 240 kPa), Dynamic pressure (kPa) = 0, Dynamic frequency (Hz) = 0.01, Max Distance since contact (mm) = 20, Pressure to contact (kPa) = 20, Pressure ramp (kPa/s) = 0.1, Max pressure (kPa) = 1000, Sampling rate (Hz) = 1000	4.4	
5.8	Click MAN		
5.9	Click up and down: move stamp up and down to warm up oil so it migrates around the cylinder		
5.1	NOTE: make sure there are no small cycles under stress EXT and P tabs. These result from the machine warming up. If there are cycles leave for half an hour to warm up		
5.11	Decrease the rate of stamp movement and bring it to 1 cm above the cell		
5.12	Put white plastic lever in line with displacement laser, and check that it is in range		
5.13	Click start		
5.14	Click laser AM and relative distance		



4.4

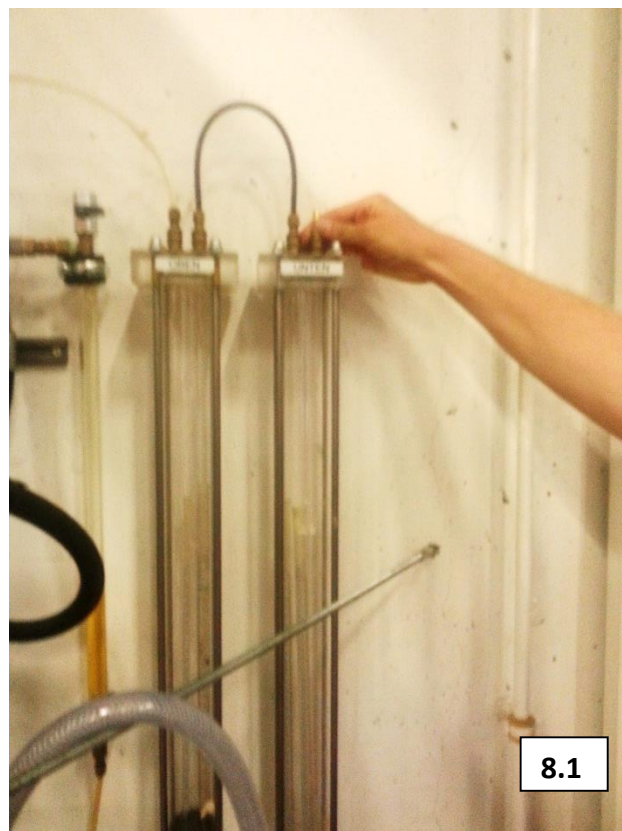
6	Consolidation	Figure	Check
6.1	Click Pressure >> enter a value of 30 kPa for side pressure		
6.2	Click Triax >> nom pressure = 30 kPa >> apply		
6.3	Click pressure ramp		
6.4	Open all valves:		
6.5	Pore pressure valve		
6.6	Upper pore pressure valve DON'T BUMP WHITE LASER		
6.7	Open side pressure and oil		
6.8	Unlock the stamp by turning the wheel slowly and test to make sure it is unlocked		
6.9	Enter decimating value of 1000. If X corresponds to the decimating factor, the software will calculate the mean of X data points before displaying and/ or recording them		
6.10	Click Record >> save as test number date and test		
6.11	Click Smartcon >> the side pressure is already at 30 kPa so apply 210 kPa with a 0.1 ramp to reach an effective stress of 240		
6.12	Click activate normal stress and side stress		
6.13	Click run smart con >> the side pressure and distance should increase with time		
6.14	Type the ramp pressure into nominal pressure >> apply setting		
6.15	CHANGE FROM EXTERNAL TO INTERNAL: click INT and the box should go from green to yellow		
6.16	nominal pressure = 0, max pressure = 900, sampling rate = 1000, everything else stays the same		
6.17	DOUBLE CHECK EVERYTHING		
6.18	Click apply settings >> Click ok >>The ramp settings should go to zero		
6.19	Click smartcon		
6.2	Deactivate nominal pressure activate middle one		
6.21	Run smartcon >> should see the yellow line increase		
6.22	Close oil for consolidation overnight so it doesn't overflow		
6.23	Open oil		
6.24	Click stop recording		
6.25	Note the displacement incurred		
6.26	Close lower and upper drainage		
6.27	Decrease decimating value to 10		
6.28	Click pressure >> zero the pore pressure		
6.29	Enter decimating value of 100 then click record saturation		

6.3	Click smartcon >> step 30 >> ramp 0.2 >> only activate SCSP then run smartcon		
6.31	Click Pressure, and check that pore pressure is increasing. If pore pressure doesn't reach 30 the sample is not fully saturated. Pressure must be returned to original value to before opening drainage to increase back pressure, before running the saturation test again from		
6.32	Click smartcon >> step negative 30		
6.33	Open upper and lower drainage to get back to 0 to allow the pore pressure to decrease		
6.34	Stop recording		
6.35	Change decimating value to 10		
6.36	Close drainage again		
6.37	The pressure should be a constant value >> if pore pressure is dropping consolidation is not complete		

7	Shear stress test	Figure	Check
7.1	Change decimating value to 1000		
7.2	Click record		
7.3	Save as: test name (Tau.ave and date)		
7.4	Click Smartcon >> normal stress = (value), ramp 0.05 kPa/s >> Click run smartcon		
7.5	Normal stress should increase. Leave for 2 hrs according to Anderson 2013		

8	Cyclic stress test	Figure	Check
8.1	Click Stop recording		
8.2	Change the decimating value to 1		
8.3	Change nominal pressure to shear stress		
8.4	Click Start recording		
8.5	Save as: cyc_name_date		
8.6	In box on right >> enter dynamic pressure = (value) , enter dynamic frequency = 1		
8.7	Click Apply settings >> Should see an increase in P and S		
8.8	NOTE: Type 0 in dynamic pressure and frequency if something goes wrong so you can stop experiment immediately		
8.9	Test stopped at 15 mm strain (failure according to Anderson (2015).		
8.1	Click stop recording		
8.11	Click freeze		
8.12	Click pressure >> decrease side pressure step wise by 50 kPa to 50 KPA GREATER THAN BACK PRESSURE		

8.13	Once reached 50 kPa above back pressure, open upper drainage then lower drainage		
8.14	Reduce upper pressure to 0 >> speed up by opening unten tap	8.1	
8.15	Once pressure is below 30 kPa, side pressure can be reduced to 30 kPa		
8.16	Close stamp		
8.17	Close oil		
8.18	Close side pressure		
8.19	Close pore pressure		
8.2	Decrease side pressure to 0		
8.21	Move stamp up >> MAN (Triax) up >> if this doesn't work use emergency button		
8.22	Test stopped at 15 mm strain (failure according to Anderson (2015)).		



9	Equipment disassembly	Figure	Check
9.1	Connect lower oil port		
9.2	Connect air pressure >>> make sure it is closed first		
9.3	Attach tube and side pressure		
9.4	Open side pressure and pump air inside to remove oil until air bubbles can be seen in the pipe		
9.5	Detach glycerine and reattach where it was originally connected on the bench		

9.6	Detach and clean everything		
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