

Polymer Bonded Explosives  
XTX 8004 (80 wt% PETN-20 wt% PDMS)

**Mechanical Characterization of Mock  
Energetic Composite  
Experimental Procedure**

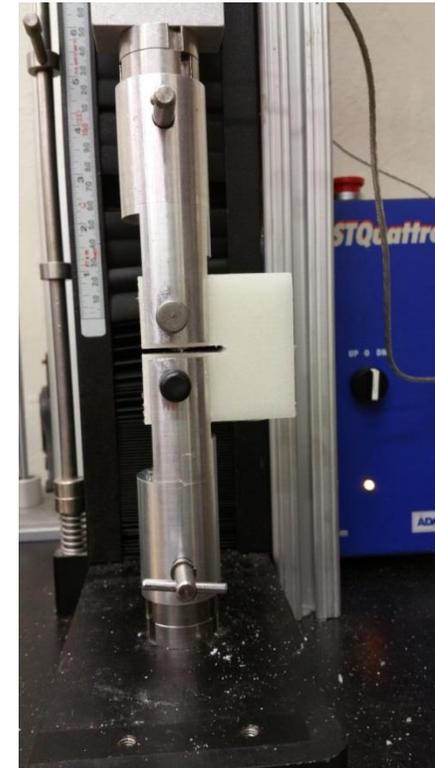
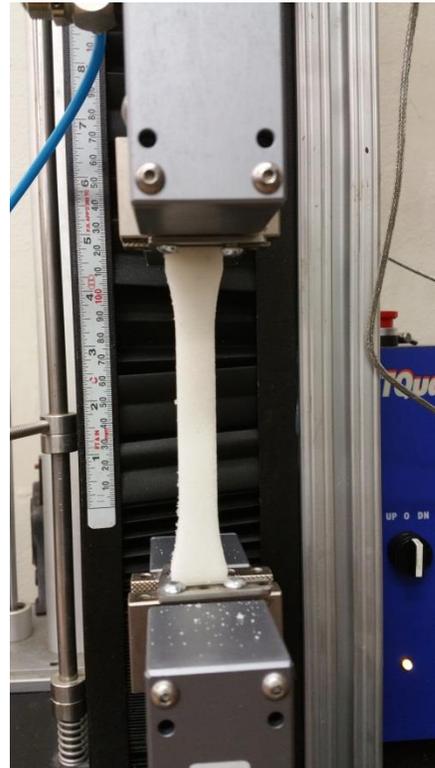
**Engin C. Sengezer**

Department of Aerospace and Ocean Engineering, Virginia Tech, Blacksburg VA

**AOE 3054 Experimental Methods**

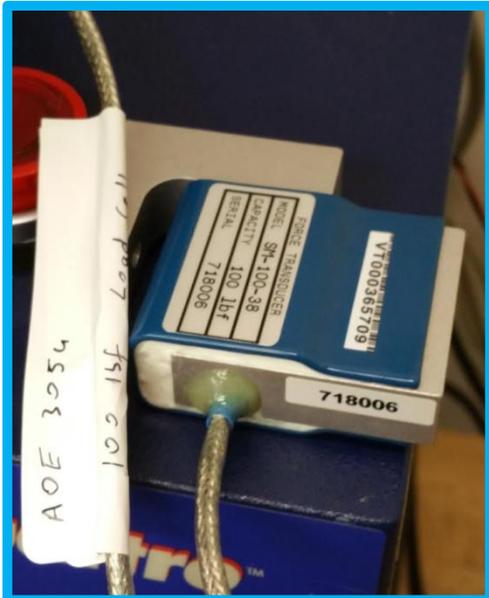
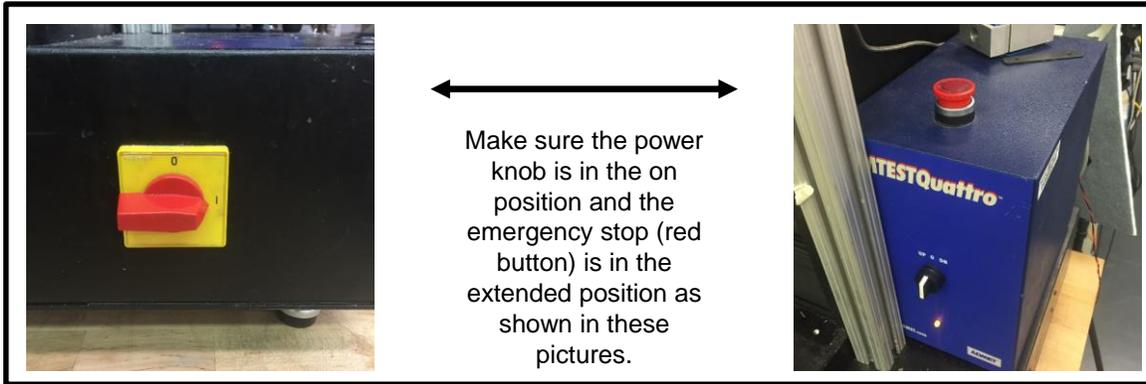
## The ADMET eXpert 7600 Universal Testing Machine and MTESTQuattro Software

- ▶ You will be using the ADMET eXpert 7600 Universal Testing Machine for this experiment.
- ▶ It is controlled via a computer running the MTESTQuattro software (it should already be running when you come to the lab, if not ask your TA to open it for you).
- ▶ The following slides will be a walk-through for using the frame to conduct the tension, compact-tension and compression tests



80 wt% particulate (sugar) -20 wt% PDMS

## Pre-Check

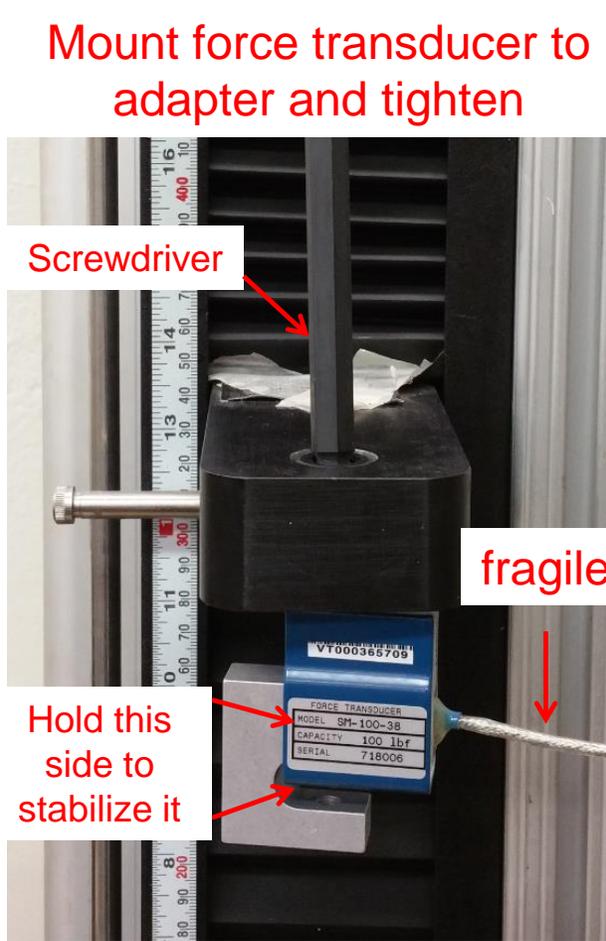
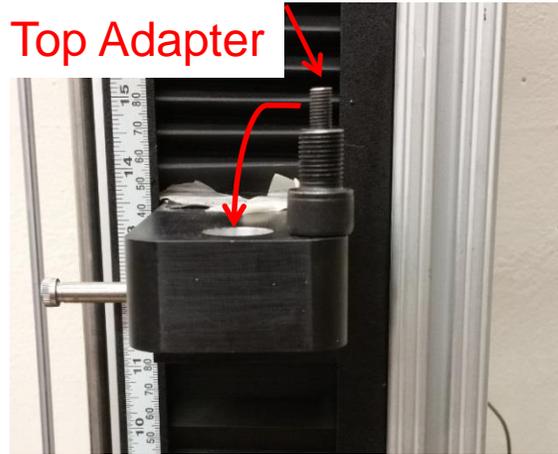


▶ Make sure 100 lbf Force Transducer is connected to MTEST Quattro Unit as shown.

▶ Make sure all group members are wearing safety glasses.



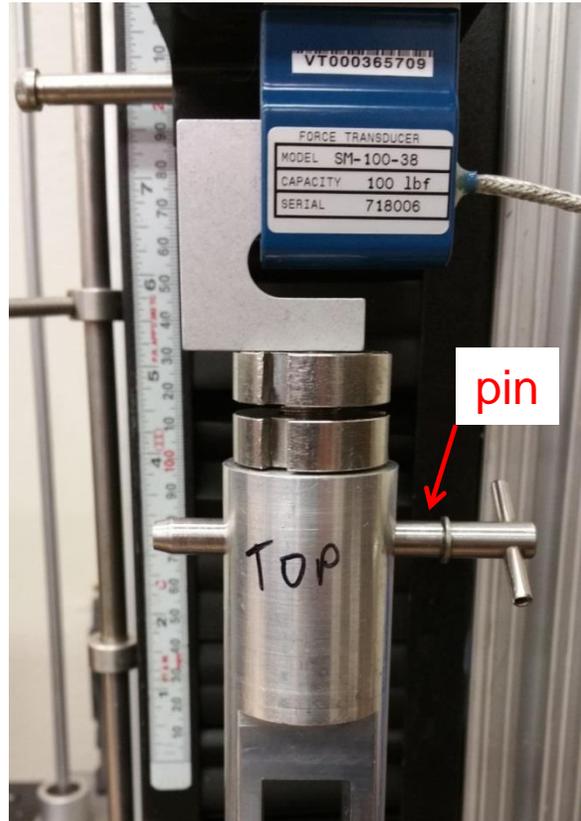
## 100 lbf Force Transducer Setup



## Compact Tension Clevis Setup



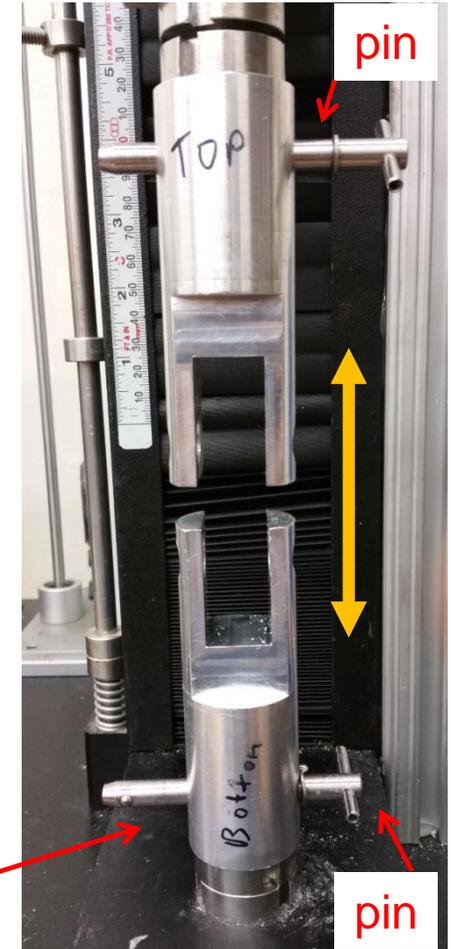
Mount lower adapter to load transducer and tighten



Mount top clevis to lower adapter



Mount bottom clevis to bottom adapter



Need to adjust distance between the clevises



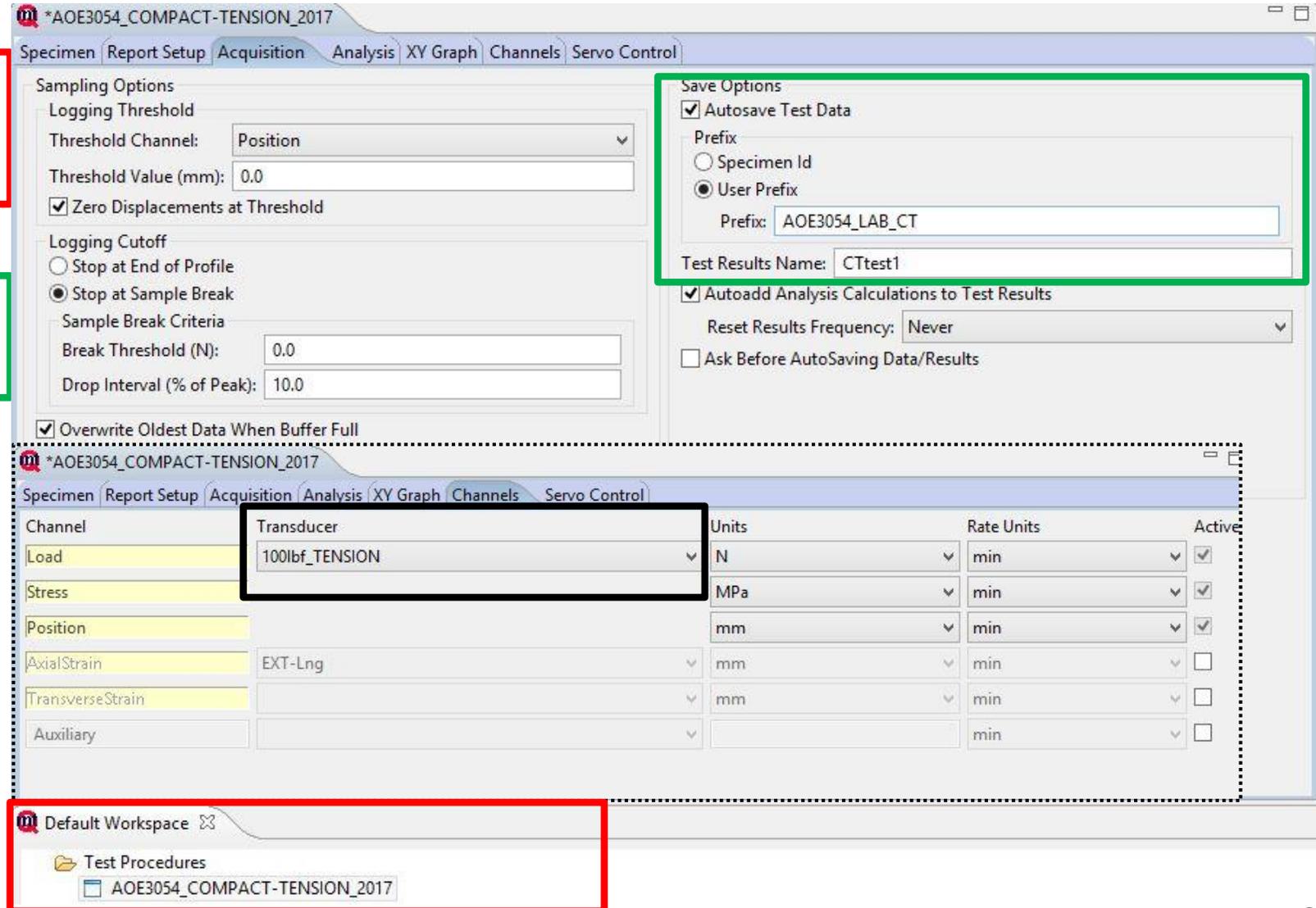
## Compact Tension Test Procedure

▶ Double click on **AOE 3054 COMPACT TENSION 2017** under **test procedures**

▶ Make sure **Autosave Test Data is checked** under Acquisition Tab

▶ Make sure **Transducer selected is 100lbf\_TENSION** under Channels Tab

▶ Keep units for the load [Newton] and the position [mm]



\*AOE3054\_COMPACT-TENSION\_2017

Specimen | Report Setup | Acquisition | Analysis | XY Graph | Channels | Servo Control

Sampling Options  
 Logging Threshold  
 Threshold Channel: Position  
 Threshold Value (mm): 0.0  
 Zero Displacements at Threshold

Logging Cutoff  
 Stop at End of Profile  
 Stop at Sample Break  
 Sample Break Criteria  
 Break Threshold (N): 0.0  
 Drop Interval (% of Peak): 10.0  
 Overwrite Oldest Data When Buffer Full

Save Options  
 Autosave Test Data  
 Prefix  
 Specimen Id  
 User Prefix  
 Prefix: AOE3054\_LAB\_CT  
 Test Results Name: CTtest1  
 Autoadd Analysis Calculations to Test Results  
 Reset Results Frequency: Never  
 Ask Before AutoSaving Data/Results

\*AOE3054\_COMPACT-TENSION\_2017

Specimen | Report Setup | Acquisition | Analysis | XY Graph | Channels | Servo Control

Channel	Transducer	Units	Rate Units	Active
Load	100lbf_TENSION	N	min	<input checked="" type="checkbox"/>
Stress		MPa	min	<input checked="" type="checkbox"/>
Position		mm	min	<input checked="" type="checkbox"/>
AxialStrain	EXT-Lng	mm	min	<input type="checkbox"/>
TransverseStrain		mm	min	<input type="checkbox"/>
Auxiliary			min	<input type="checkbox"/>

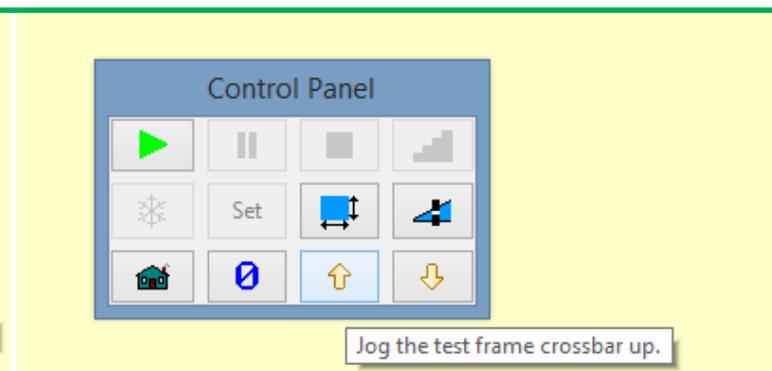
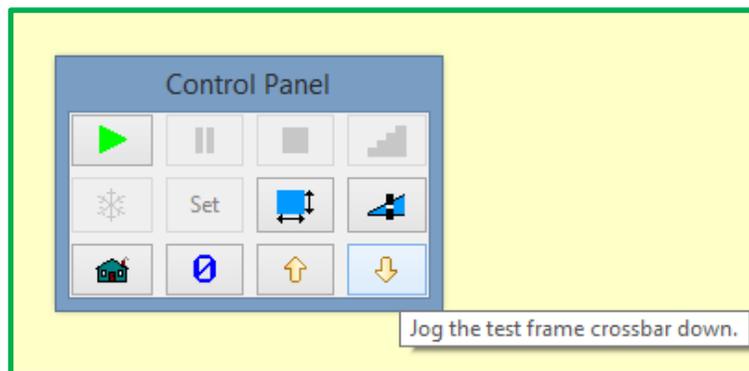
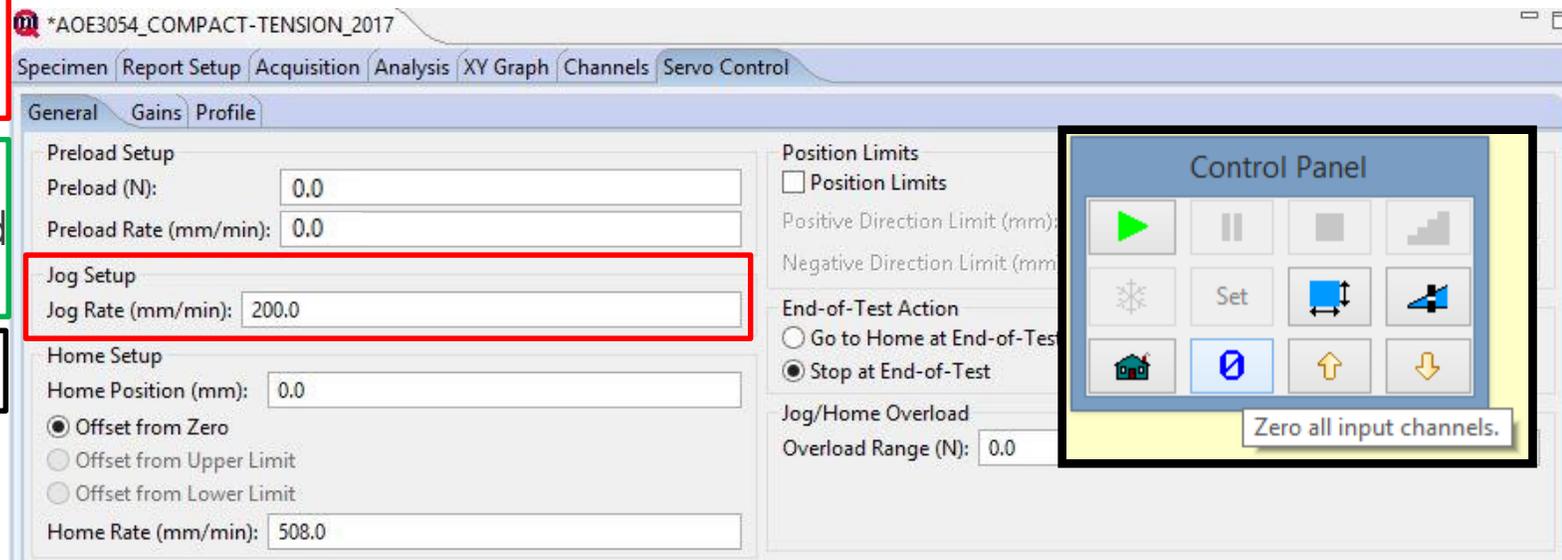
Default Workspace

Test Procedures

AOE3054\_COMPACT-TENSION\_2017

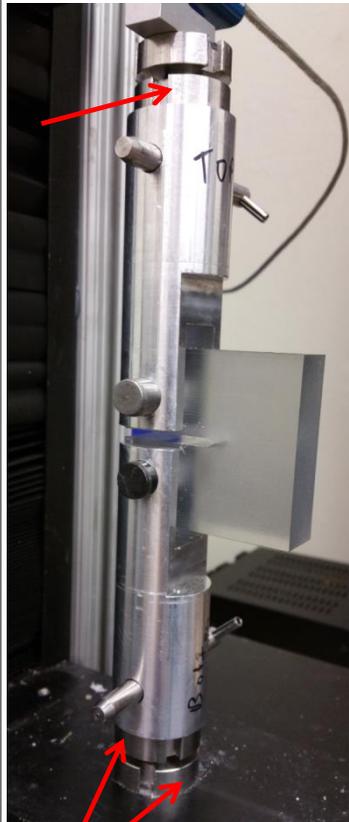
## Adjustment of the distance between the clevises

- Initially use 200 mm/min **jog rate** to move the clevises close to each other
- Then, reduce the **jog rate** to 20 mm/min and click crossbar up and down for fine adjustments
- Zero all input channels
- Mount rigid compact tension on the bottom clevis first, then on the top clevis



## Compact Tension Clevis Distance and Alignment Check

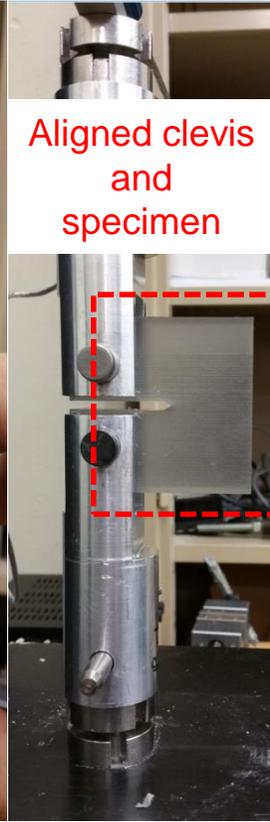
Specimens are **FRAGILE** Make sure you handle them gently



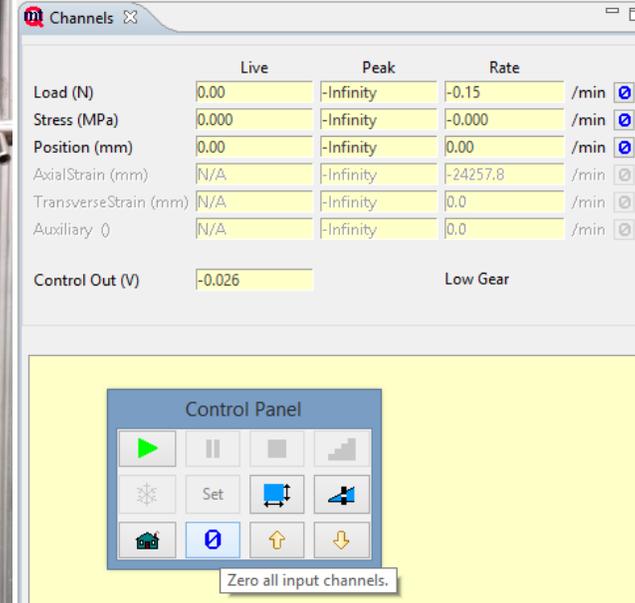
Do not tighten them hard, You can use your fingers to tighten



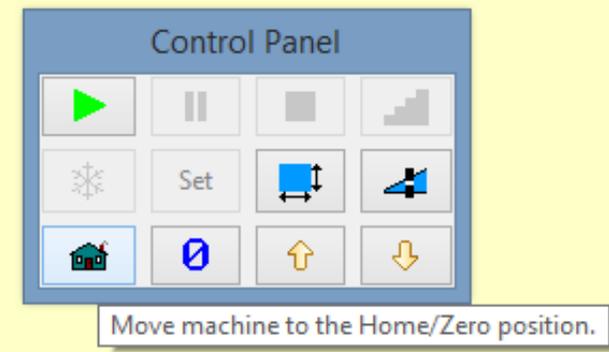
Use your fingers to align the specimen, **make sure you can rotate up and down easily**



Unmount the rigid specimen

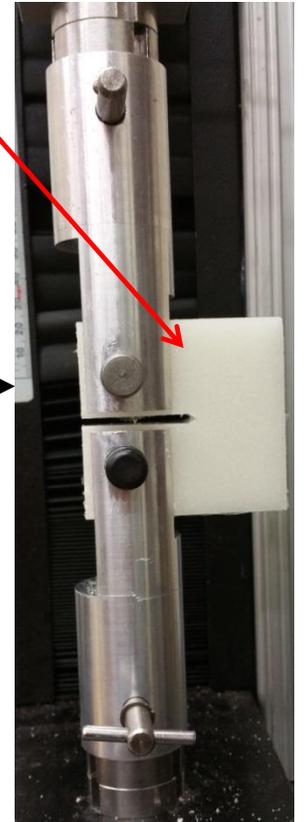


1<sup>st</sup> step) Click zero all input channels



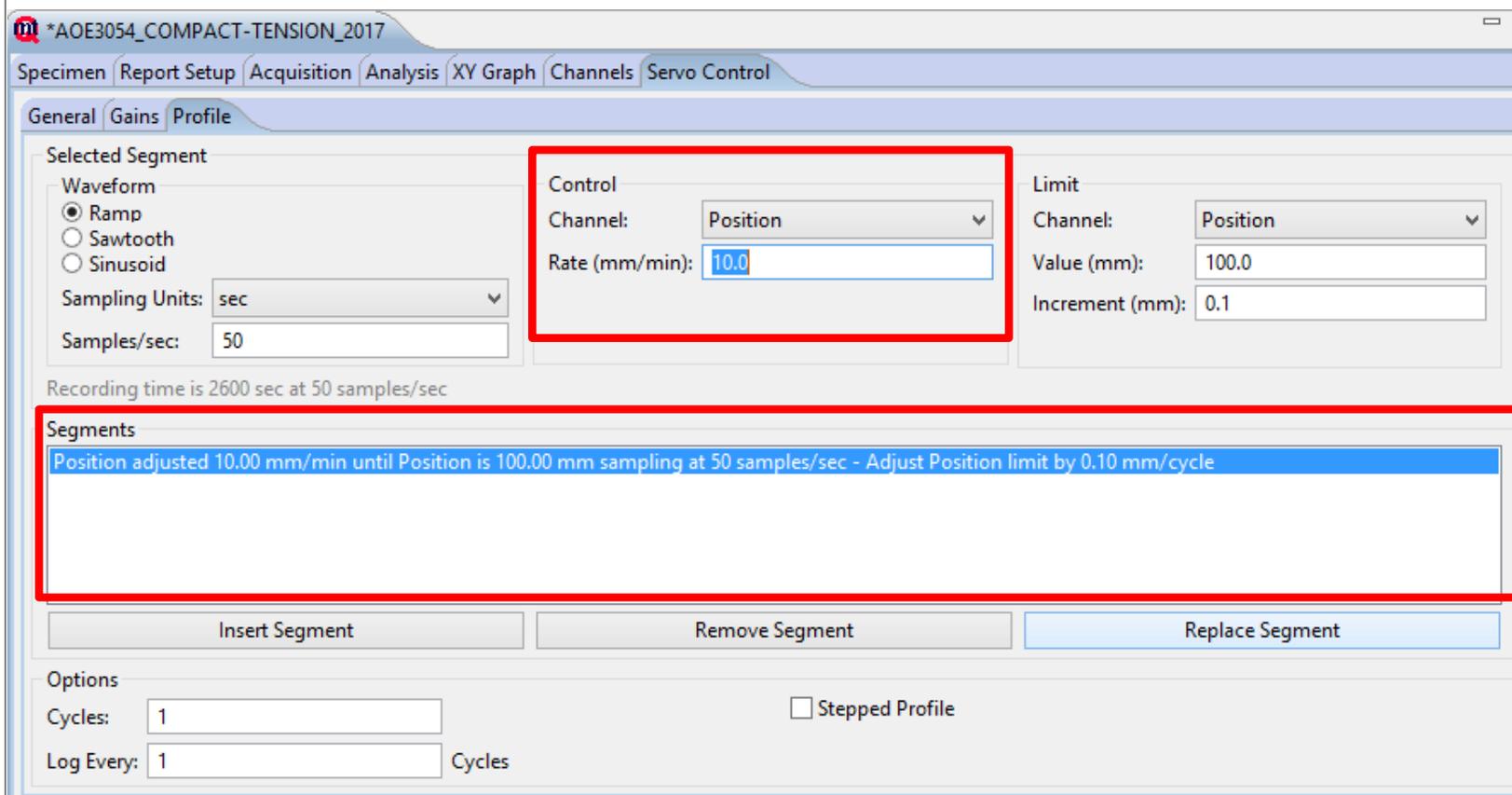
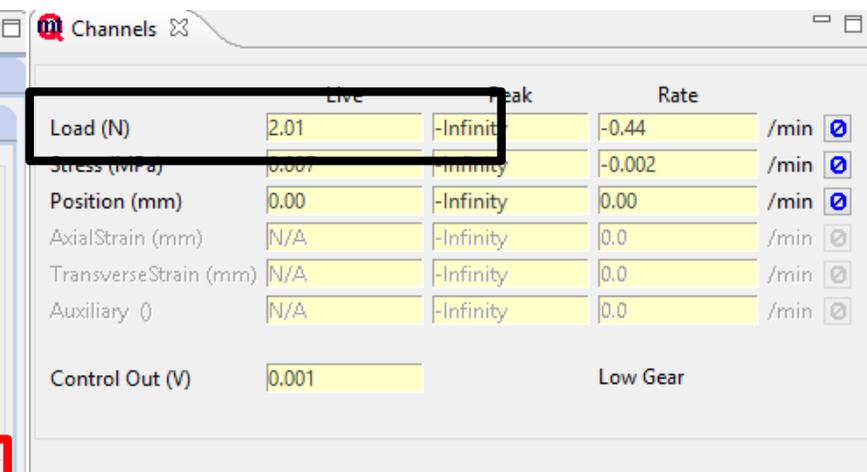
2<sup>nd</sup> step) Click Home/Zero Button

At last



Place your own specimen and align clevis and specimen vertically with fingers as before 8

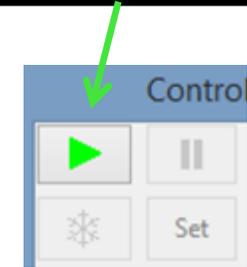
## Pre-Check for Compact Tension Test

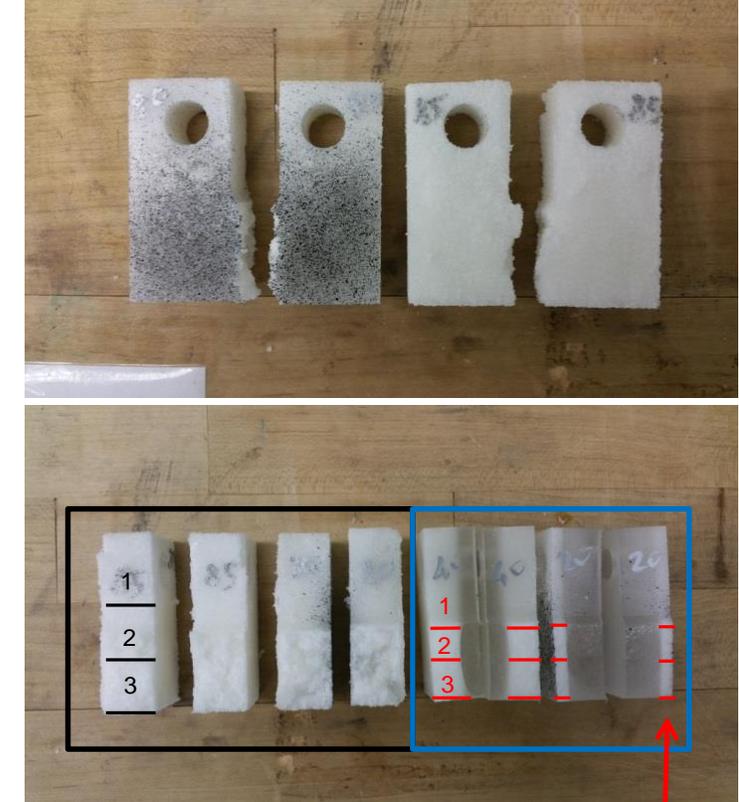
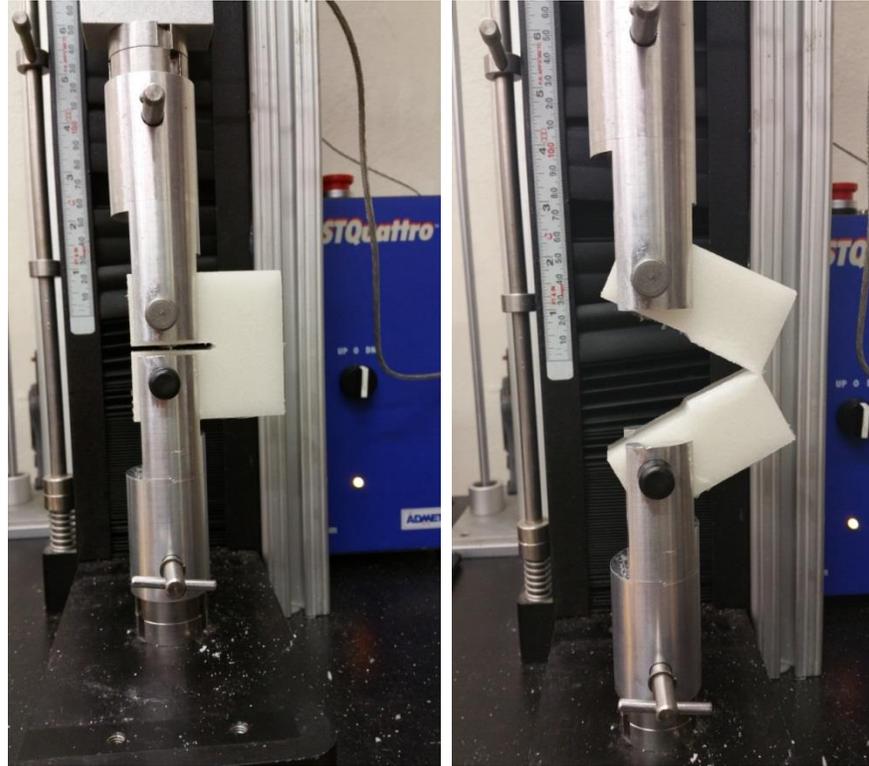
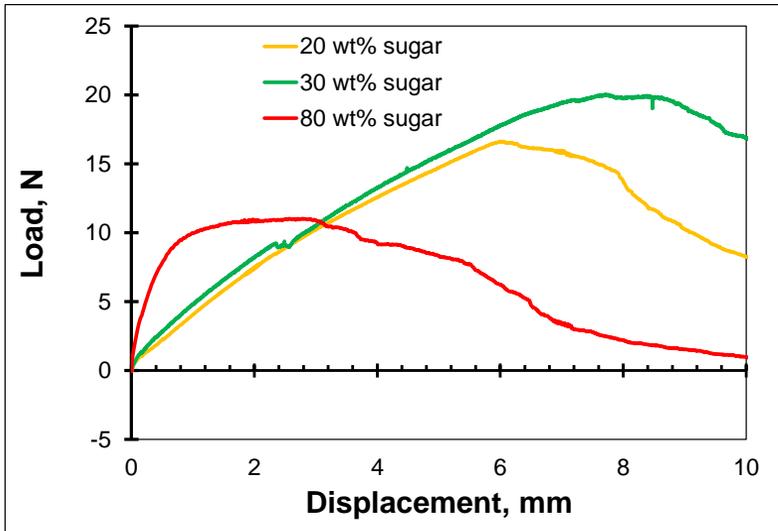
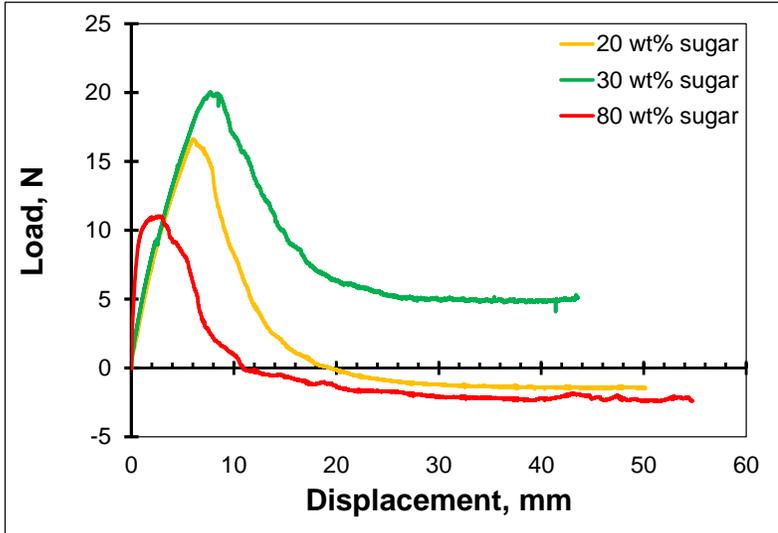
	Live	Peak	Rate
Load (N)	2.01	-Infinity	-0.44 /min
Stress (MPa)	0.00	Infinity	-0.002 /min
Position (mm)	0.00	-Infinity	0.00 /min
AxialStrain (mm)	N/A	-Infinity	0.0 /min
TransverseStrain (mm)	N/A	-Infinity	0.0 /min
Auxiliary 0	N/A	-Infinity	0.0 /min
Control Out (V)	0.001		Low Gear

- ▶ Make sure your cross head displacement rate is **10 mm/min**
- ▶ If not, click on **Replace Segment** after adjusting rate as **10 mm/min**

- ▶ Make sure to note the **preload acting on the specimen**
- ▶ **Do not zero the load**
- ▶ **Position needs to show ZERO** as you clicked zero all input channels before
- ▶ Finally, **Start the TEST**



## Fracture Toughness Compact Tension Testing

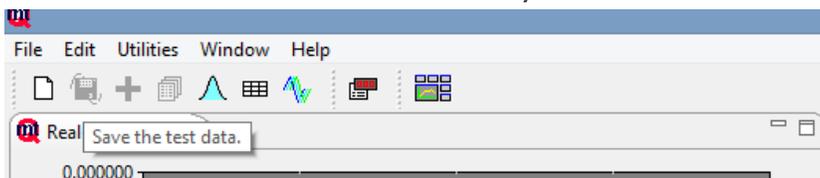
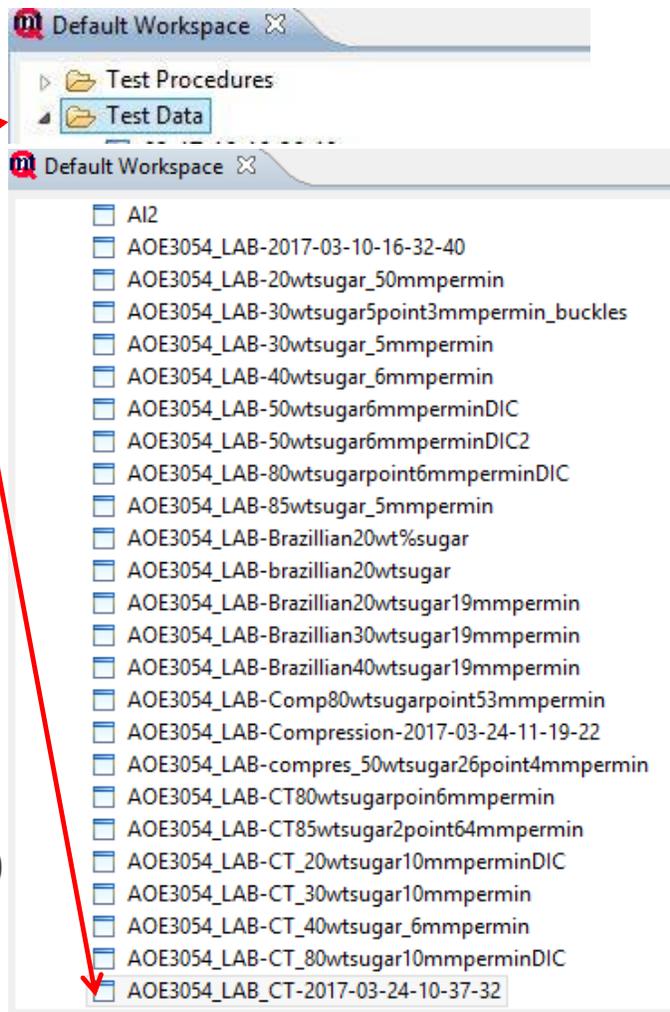


▶ Use the camera provided to take **images of fracture surface on your specimen, measure the specimen thickness at last**

▶ Make sure to measure and record the particulate sedimentation with a ruler **from top (1), middle(2) and bottom (3) for each side as shown** and provide the averaged value

## Data Saving for Compact Tension Test

- ▶ Make sure your test data is saved automatically
- ▶ Go to **Test Data**
- ▶ Find your test data, **always the last data** under **Test Data**
- ▶ To be sure it is your data, check **the date and time**
  - ▶ If not, save manually as below

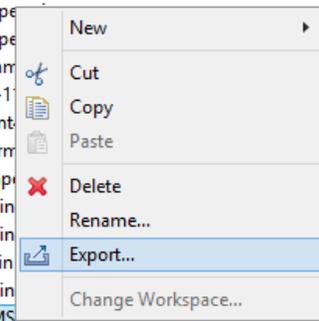


- ▶ If it is saved automatically, right click on test data and **rename your particulate wt% (e.g. 20wtSugarPDMS)**

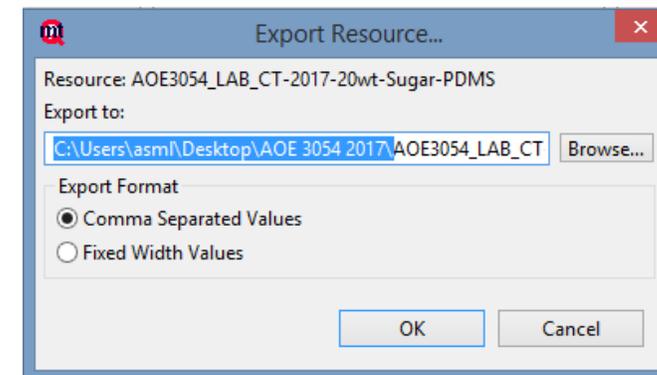


- ▶ Right click and export your data

- AOE3054\_LAB-50wtsugar6mmpmerminDIC
- AOE3054\_LAB-50wtsugar6mmpmerminDIC2
- AOE3054\_LAB-80wtsugarpoint6mmpmerminDIC
- AOE3054\_LAB-85wtsugar\_5mmpmermin
- AOE3054\_LAB-Brazilian20wt%sugar
- AOE3054\_LAB-brazilian20wtsugar
- AOE3054\_LAB-Brazilian20wtsugar19mmpmermin
- AOE3054\_LAB-Brazilian30wtsugar19mmpmermin
- AOE3054\_LAB-Brazilian40wtsugar19mmpmermin
- AOE3054\_LAB-Comp80wtsugarpoint53mmpmermin
- AOE3054\_LAB-Compression-2017-03-24-11-19-22
- AOE3054\_LAB-compres\_50wtsugar26point4mmpmermin
- AOE3054\_LAB-CT80wtsugarpoint6mmpmermin
- AOE3054\_LAB-CT85wtsugar2point64mmpmermin
- AOE3054\_LAB-CT\_20wtsugar10mmpmermin
- AOE3054\_LAB-CT\_30wtsugar10mmpmermin
- AOE3054\_LAB-CT\_40wtsugar\_6mmpmermin
- AOE3054\_LAB-CT\_80wtsugar10mmpmermin
- AOE3054\_LAB\_CT-2017-20wt-Sugar-PDMS



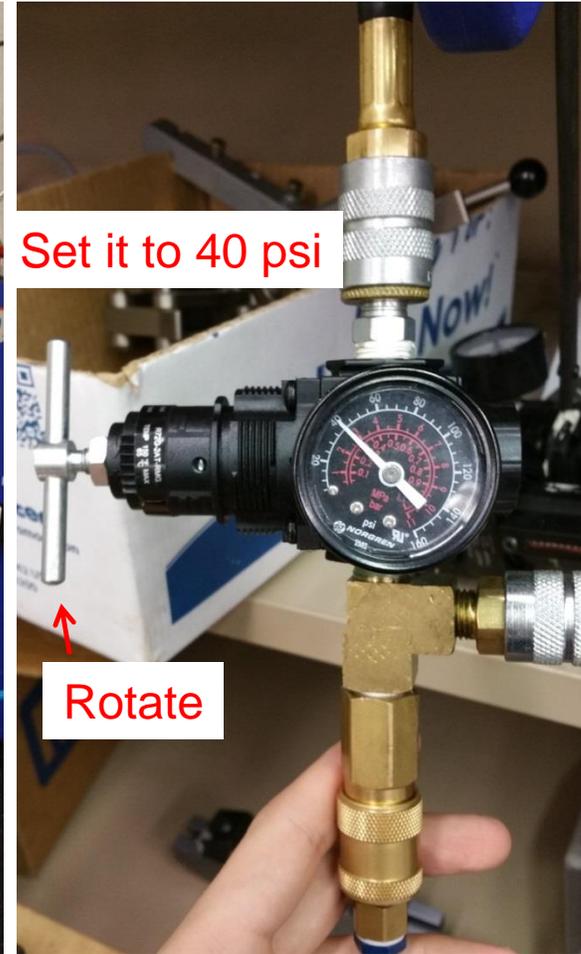
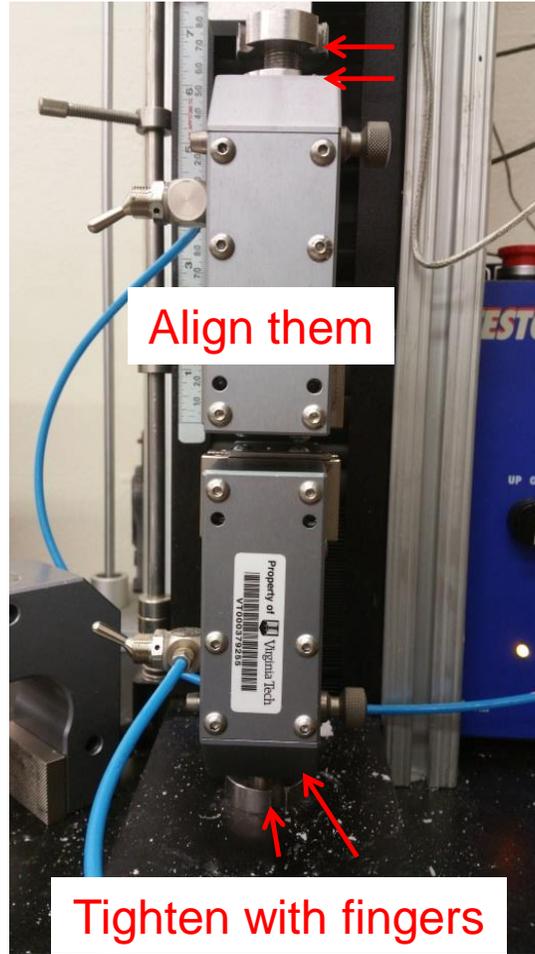
- ▶ Will be exported to specific folder on desktop



## Pneumatic Grip Setup for Tensile Testing



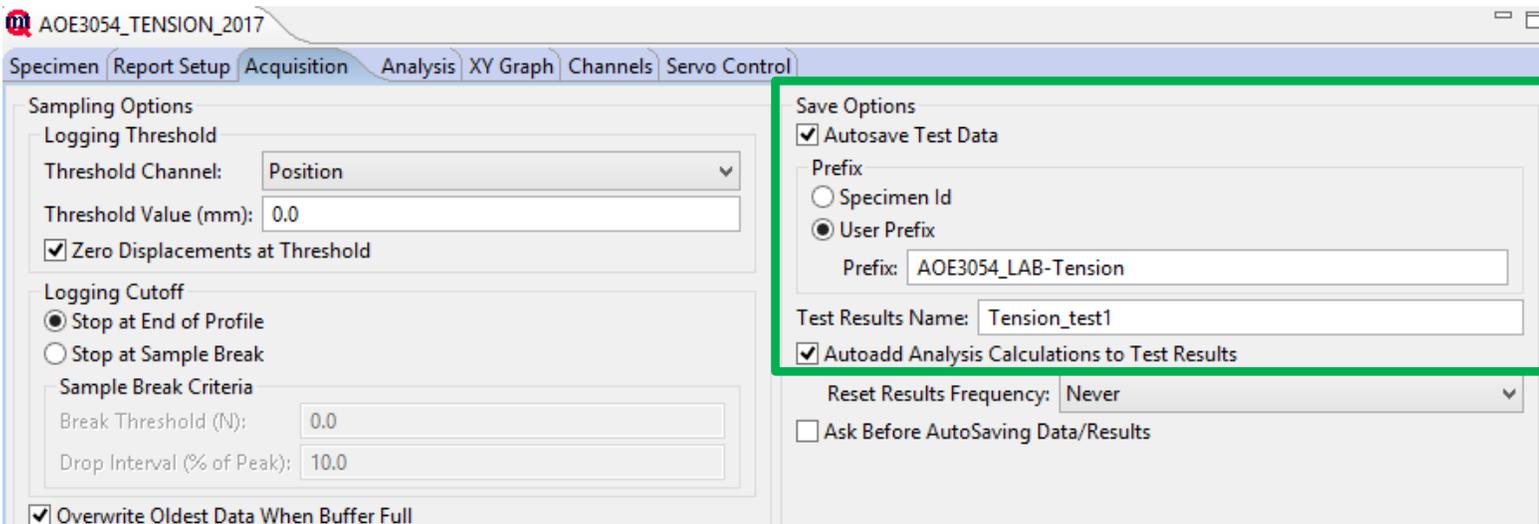
Compressed air regulator



Switch up closes the grips



## Tension Test Procedure



AOE3054\_TENSION\_2017

Specimen Report Setup Acquisition Analysis XY Graph Channels Servo Control

Sampling Options

Logging Threshold

Threshold Channel: Position

Threshold Value (mm): 0.0

Zero Displacements at Threshold

Logging Cutoff

Stop at End of Profile

Stop at Sample Break

Sample Break Criteria

Break Threshold (N): 0.0

Drop Interval (% of Peak): 10.0

Overwrite Oldest Data When Buffer Full

Save Options

Autosave Test Data

Prefix

Specimen Id

User Prefix

Prefix: AOE3054\_LAB-Tension

Test Results Name: Tension\_test1

Autoadd Analysis Calculations to Test Results

Reset Results Frequency: Never

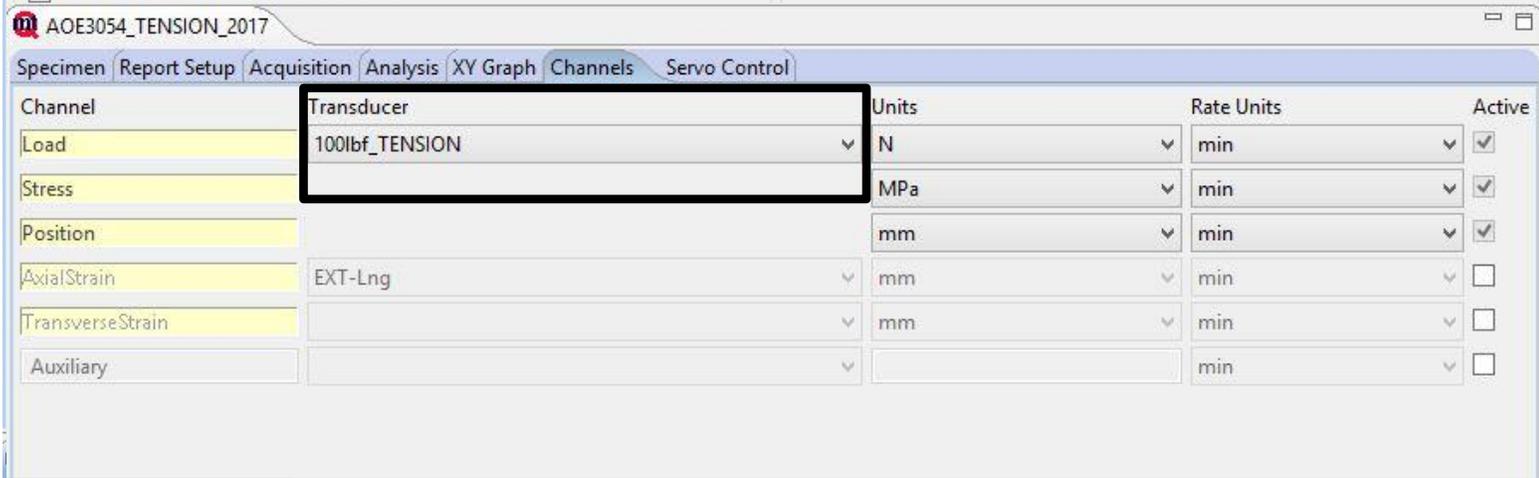
Ask Before AutoSaving Data/Results

▶ Double click on **AOE 3054 TENSION 2017** under test procedures

▶ Make sure **Autosave Test Data is checked** under Acquisition Tab

▶ Make sure **Transducer selected** is **100lbf\_TENSION** under Channels Tab

▶ Keep units for the load [Newton] and the position [mm]



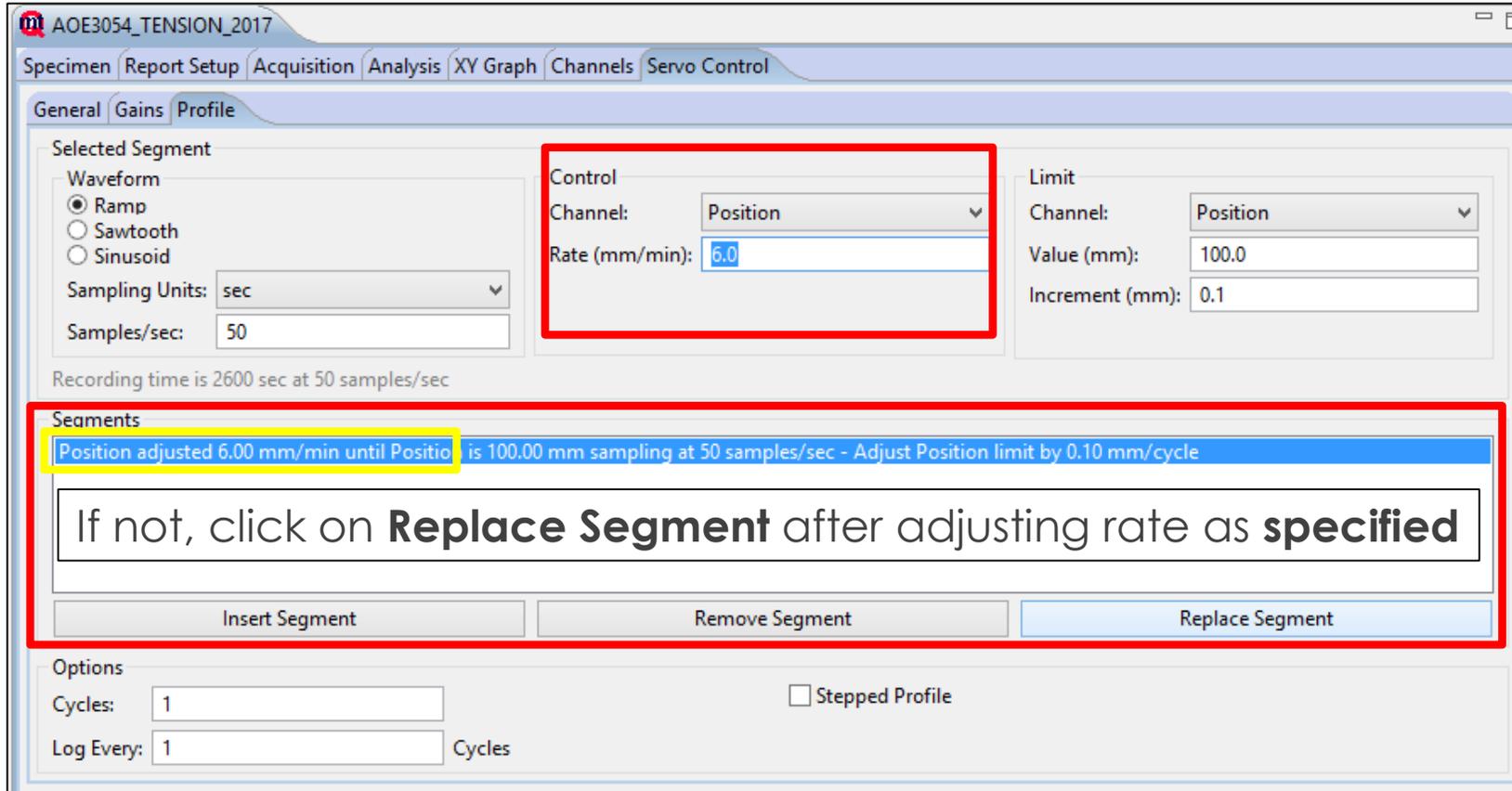
AOE3054\_TENSION\_2017

Specimen Report Setup Acquisition Analysis XY Graph Channels Servo Control

Channel	Transducer	Units	Rate Units	Active
Load	100lbf_TENSION	N	min	<input checked="" type="checkbox"/>
Stress		MPa	min	<input checked="" type="checkbox"/>
Position		mm	min	<input checked="" type="checkbox"/>
AxialStrain	EXT-Lng	mm	min	<input type="checkbox"/>
TransverseStrain		mm	min	<input type="checkbox"/>
Auxiliary			min	<input type="checkbox"/>

- Test Procedures
  - AOE3054\_COMPACT-TENSION\_2017
  - AOE3054\_COMPRESSION\_2017
  - AOE3054\_TENSION\_2017

## Pre-Check for Tension Test



AOE3054\_TENSION\_2017

Specimen Report Setup Acquisition Analysis XY Graph Channels Servo Control

General Gains Profile

Selected Segment

Waveform

Ramp

Sawtooth

Sinusoid

Sampling Units: sec

Samples/sec: 50

Recording time is 2600 sec at 50 samples/sec

Control

Channel: Position

Rate (mm/min): 6.0

Limit

Channel: Position

Value (mm): 100.0

Increment (mm): 0.1

Seamants

Position adjusted 6.00 mm/min until Position is 100.00 mm sampling at 50 samples/sec - Adjust Position limit by 0.10 mm/cycle

If not, click on **Replace Segment** after adjusting rate as **specified**

Insert Segment Remove Segment Replace Segment

Options

Cycles: 1  Stepped Profile

Log Every: 1 Cycles

► Double Check whether you have the correct displacement rate for your specimen

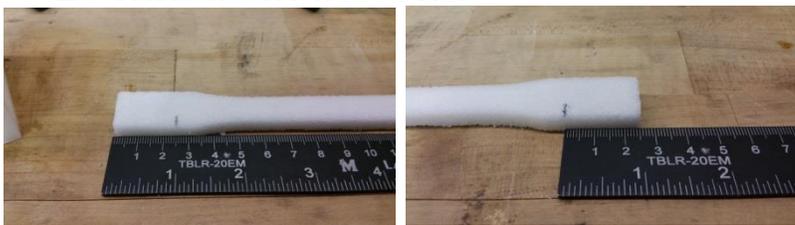
- Make sure your cross head displacement rate is
  - 6 mm/min for samples with particulate wt% ≤ 50
  - 0.6 mm/min for samples with particulate wt% > 50

## Adjustment of the distance between the pneumatic grips

Initially use 200 mm/min **jog rate** to move the clevises close to each other

Then, reduce the **jog rate** to 20 mm/min for fine adjustments (crossbar up/down)

Mark each side of dogbone specimens 25 mm from the end



Measure the specimen thickness and particulate sedimentation within gauge section (top, middle and bottom) and average them (**FRAGILE SPECIMENS!**)

**Zero all input channels**

Distance between the grips should be 115 mm



- ▶ Place the specimen to top pneumatic grip first, then bottom
- ▶ You will observe a **compressive force acting on the specimen** due to clamping

	Live	Peak	Rate
Load (N)	-3.58	-Infinity	-4.21 /min
Stress (MPa)	-0.040	-Infinity	-0.047 /min
Position (mm)	0.00	-Infinity	0.00 /min
AxialStrain (mm)	N/A	-Infinity	0.0 /min
TransverseStrain (mm)	N/A	-Infinity	0.0 /min
Auxiliary ()	N/A	-Infinity	0.0 /min
Control Out (V)	-0.029		Low Gear

	Live	Peak	Rate
Load (N)	-0.16	-Infinity	2.76 /min
Stress (MPa)	-0.002	-Infinity	0.031 /min
Position (mm)	0.24	-Infinity	0.00 /min
AxialStrain (mm)	N/A	-Infinity	0.0 /min
TransverseStrain (mm)	N/A	-Infinity	0.0 /min
Auxiliary ()	N/A	-Infinity	0.0 /min
Control Out (V)	0.036		Low Gear

▶ Click crossbar up one at a time to adjust the load to zero or very close to zero

▶ Note that preload value , **never set it to zero**

▶ If you click **crossbar up too long, you will break the specimen**

▶ Then, click to zero the displacement

▶ Then, click home/zero button

Control Panel

Log the test frame crossbar up.

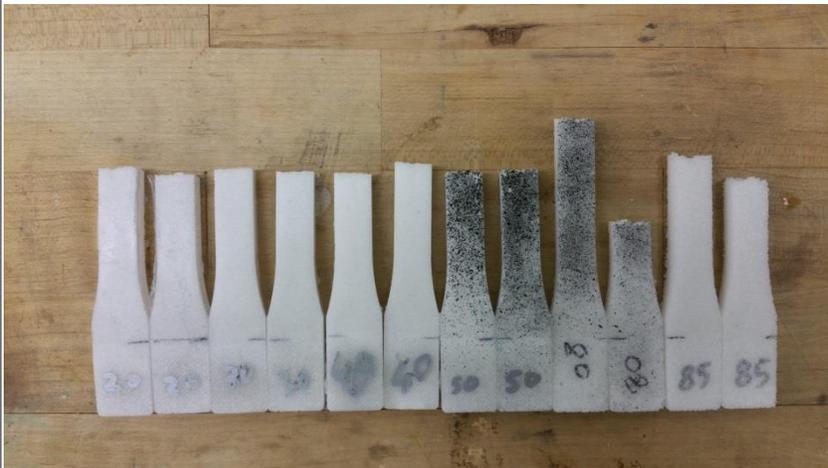
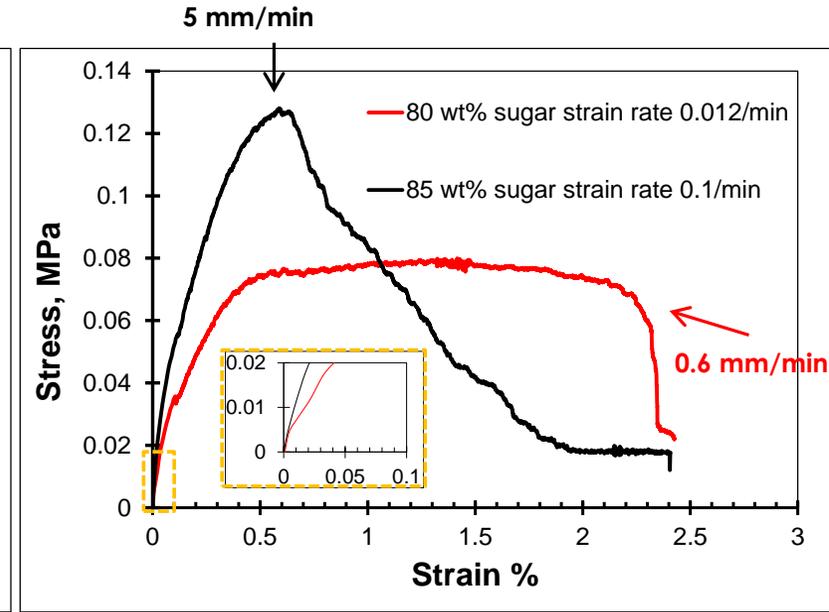
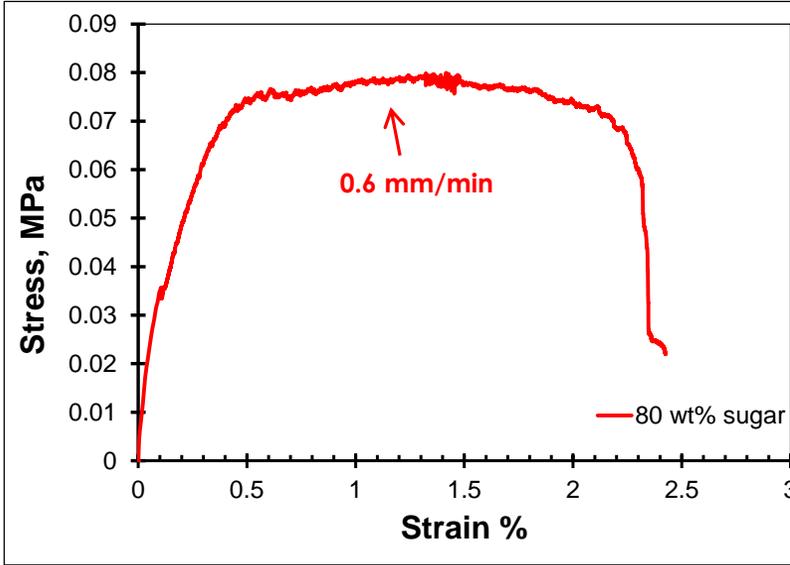
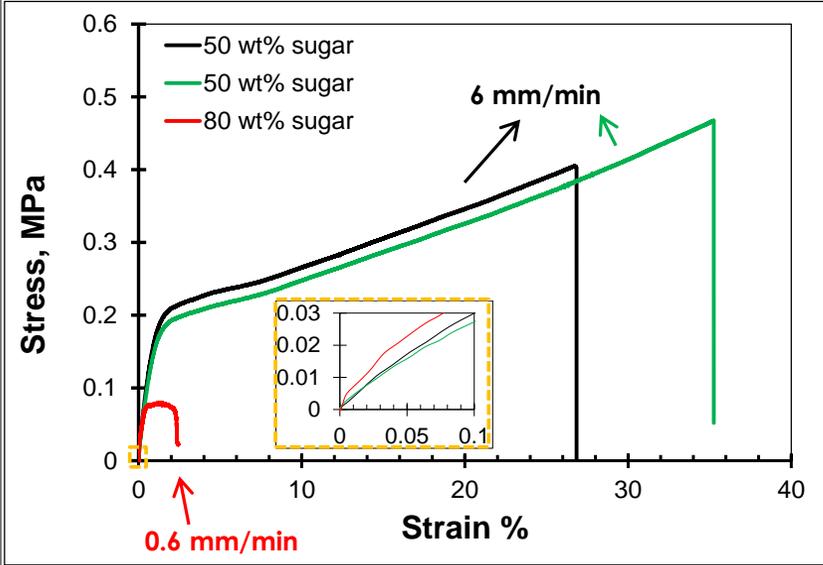
Stress (MPa)	-0.002	-Infinity	0.005 /min
Position (mm)	0.00	-Infinity	0.00 /min
AxialStrain (mm)	N/A	-Infinity	0.0 /min
TransverseStrain (mm)	N/A	-Infinity	0.0 /min

Zero the input channel.

Move machine to the Home/Zero position.

→ **FINALLY, START THE TEST**

## Tensile Testing

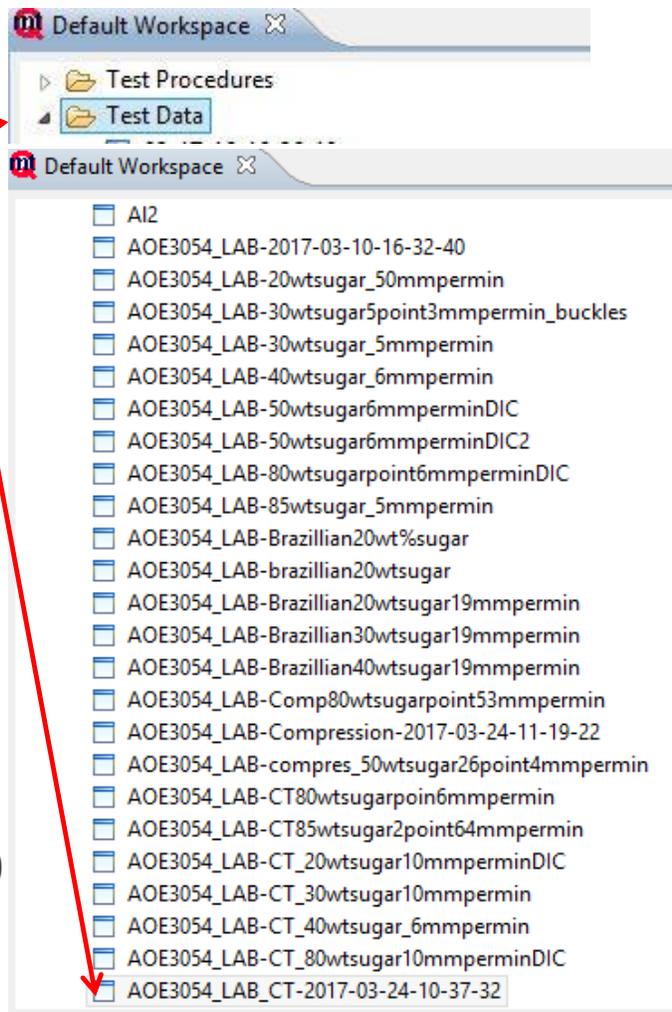


► Use the camera provided to take **images of fracture surface on your specimen, measure the specimen thickness at last**

► Again, make sure to measure and record the particulate sedimentation within gauge section **from top (1), middle(2) and bottom (3)** and provide the averaged value after the test and compare with your initial measurements before testing

## Data Saving for Tension Test

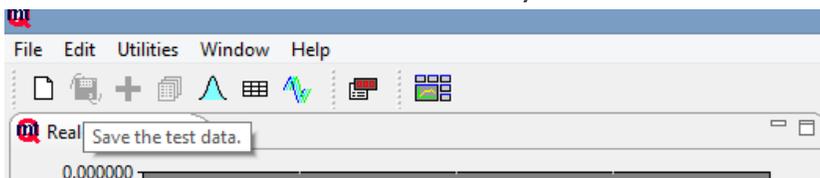
- ▶ Make sure your test data is saved automatically
- ▶ Go to **Test Data**
- ▶ Find your test data, **always the last data** under **Test Data**
- ▶ To be sure it is your data, check **the date and time**
  - ▶ If not, save manually as below



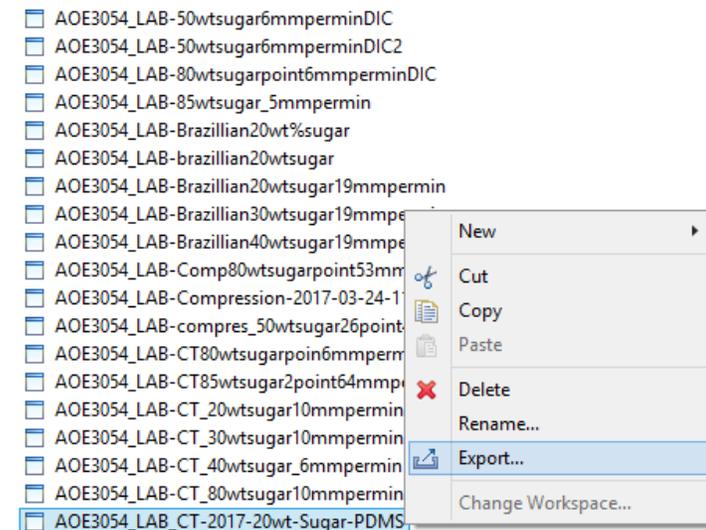
Prefix:

Prefix automatically will **change to AOE3054\_LAB-Tension under test data** instead AOE3054\_LAB-CT

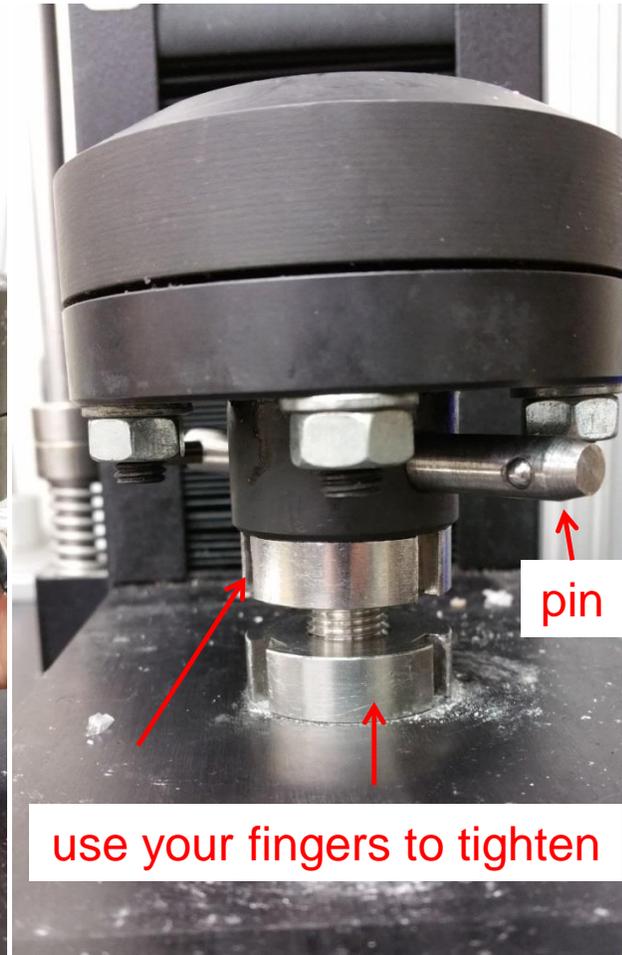
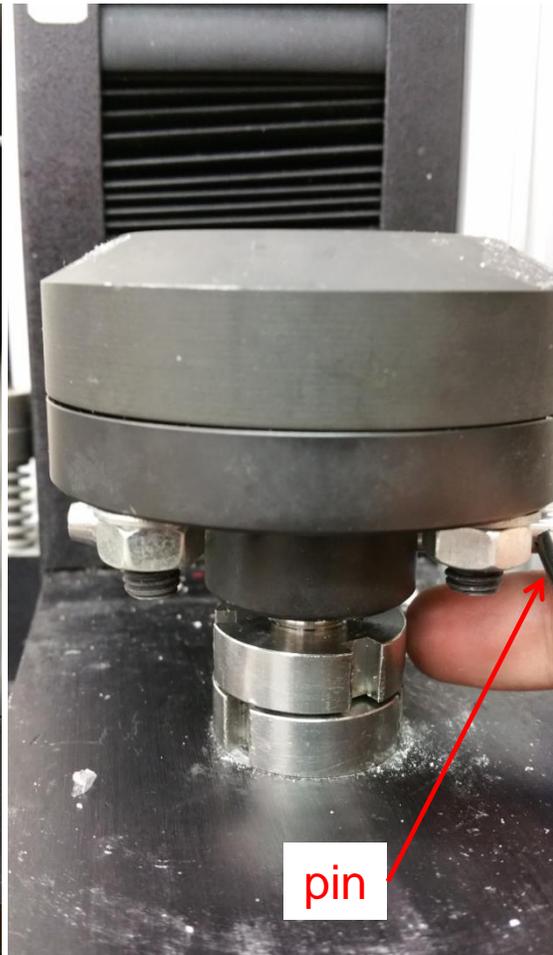
- ▶ Right click and export your data



- ▶ If it is saved automatically, right click on test data and **rename your particulate wt% (e.g. 20wtSugarPDMS)**



## Compression Platens Setup



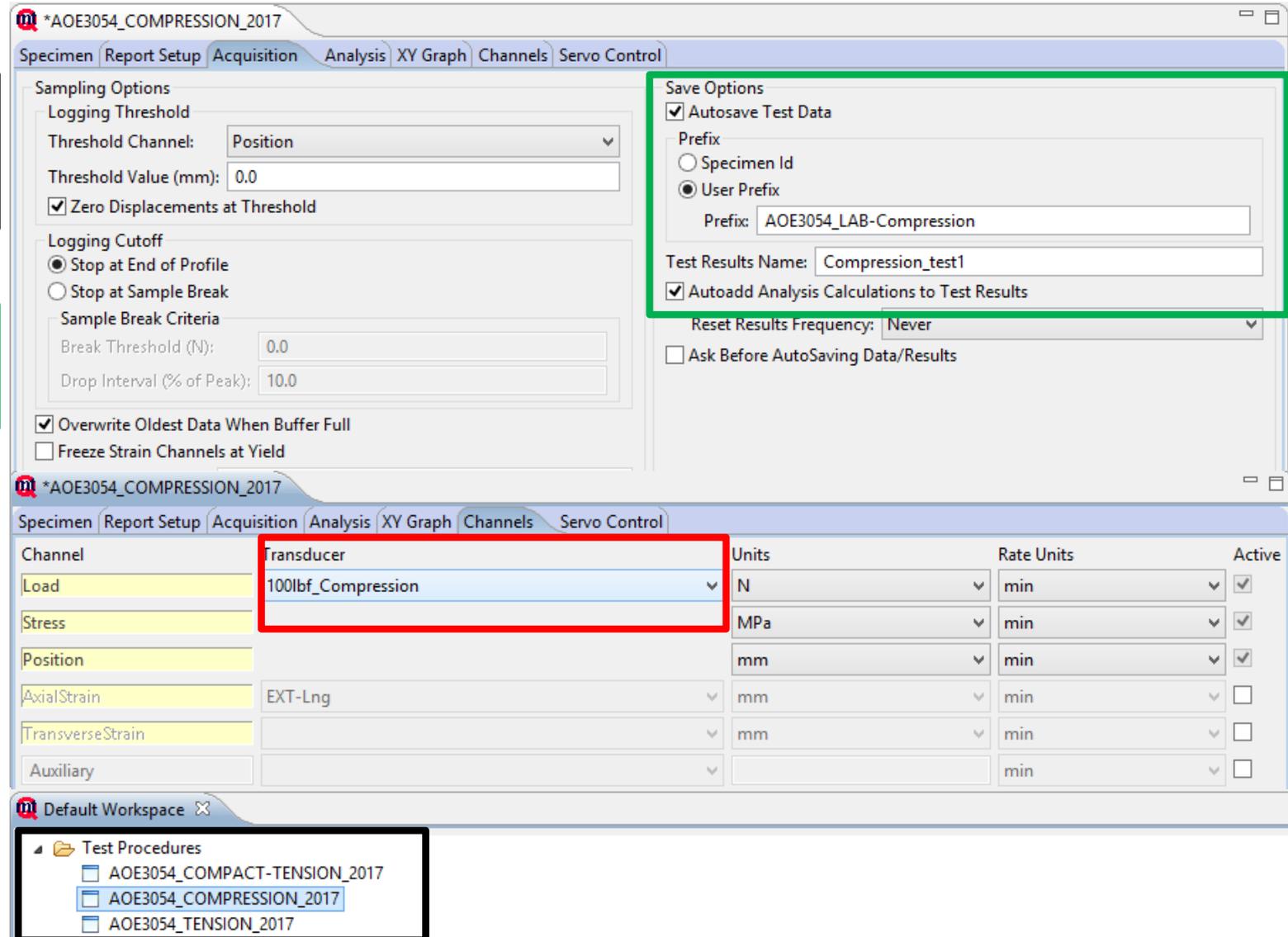
## Compression Test Procedure

▶ Double click on **AOE 3054 COMPRESSION 2017** under test procedures

▶ Make sure **Autosave Test Data is checked** under Acquisition Tab

▶ Make sure **Transducer selected** is **100lbf\_Compression** under Channels Tab

▶ Keep units for the load [Newton] and the position [mm]



**Save Options**

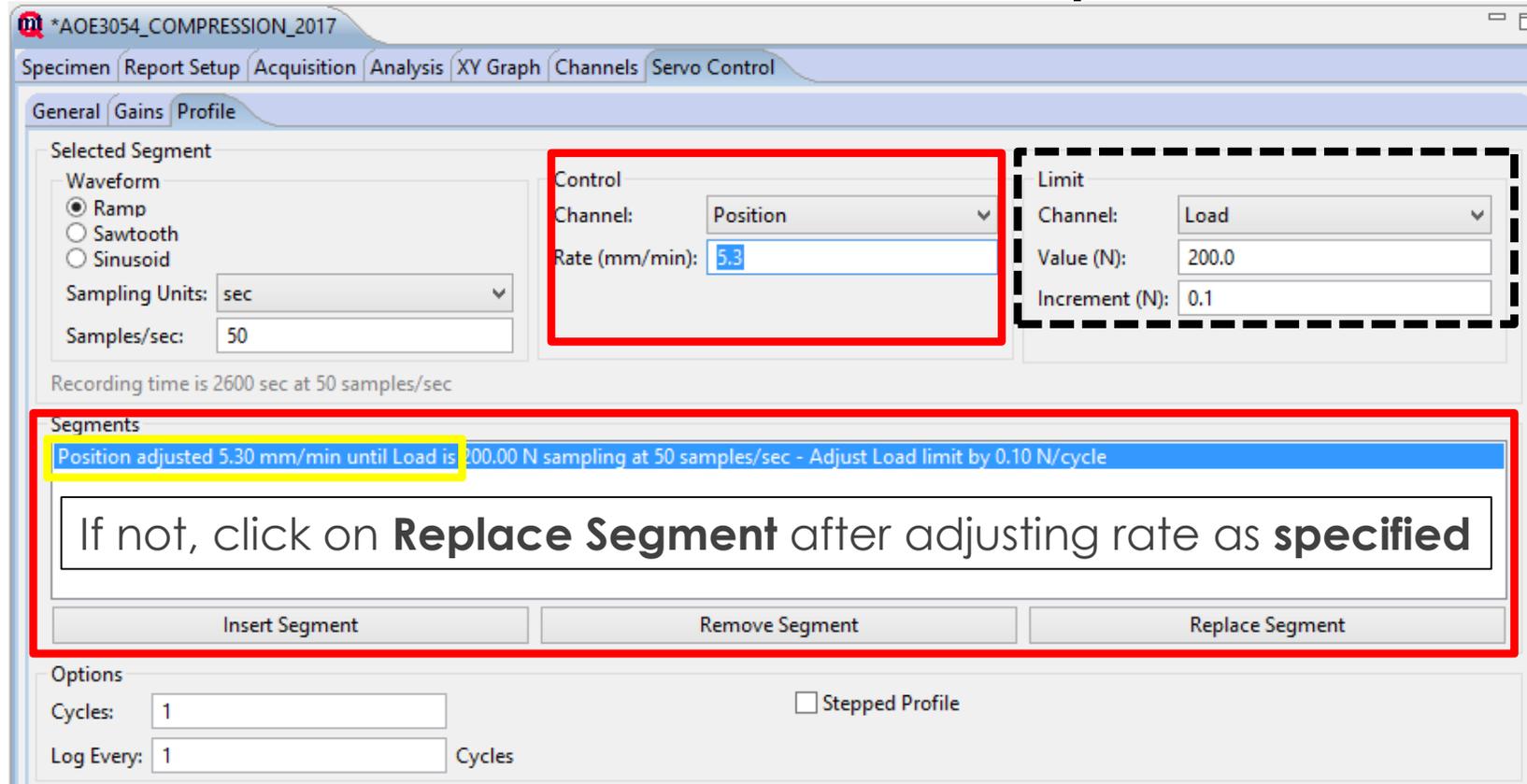
- Autosave Test Data
- Prefix:  Specimen Id  User Prefix
- Prefix: AOE3054\_LAB-Compression
- Test Results Name: Compression\_test1
- Autoadd Analysis Calculations to Test Results
- Reset Results Frequency: Never
- Ask Before AutoSaving Data/Results

Channel	Transducer	Units	Rate Units	Active
Load	100lbf_Compression	N	min	<input checked="" type="checkbox"/>
Stress		MPa	min	<input checked="" type="checkbox"/>
Position		mm	min	<input checked="" type="checkbox"/>
AxialStrain	EXT-Lng	mm	min	<input type="checkbox"/>
TransverseStrain		mm	min	<input type="checkbox"/>
Auxiliary			min	<input type="checkbox"/>

Test Procedures

- AOE3054\_COMPACT-TENSION\_2017
- AOE3054\_COMPRESSION\_2017
- AOE3054\_TENSION\_2017

## Pre-Check for Compression Test



Recording time is 2600 sec at 50 samples/sec

Segments  
Position adjusted 5.30 mm/min until Load is 200.00 N sampling at 50 samples/sec - Adjust Load limit by 0.10 N/cycle

If not, click on **Replace Segment** after adjusting rate as **specified**

Options  
Cycles: 1  Stepped Profile  
Log Every: 1 Cycles

- ▶ Do not change the load limit
- ▶ It is set as 200 N

- ▶ Double Check whether you have the correct displacement rate for your specimen

- ▶ Make sure your cross head displacement rate is
  - ▶ **5.3 mm/min for samples with particulate wt% ≤ 50**
  - ▶ **0.53 mm/min for samples with particulate wt% > 50**

## Adjustment of the distance between the compression platens

Initially use 200 mm/min **jog rate** to move the clevises close to each other

Then, reduce the **jog rate** to **20 mm/min** for fine adjustments

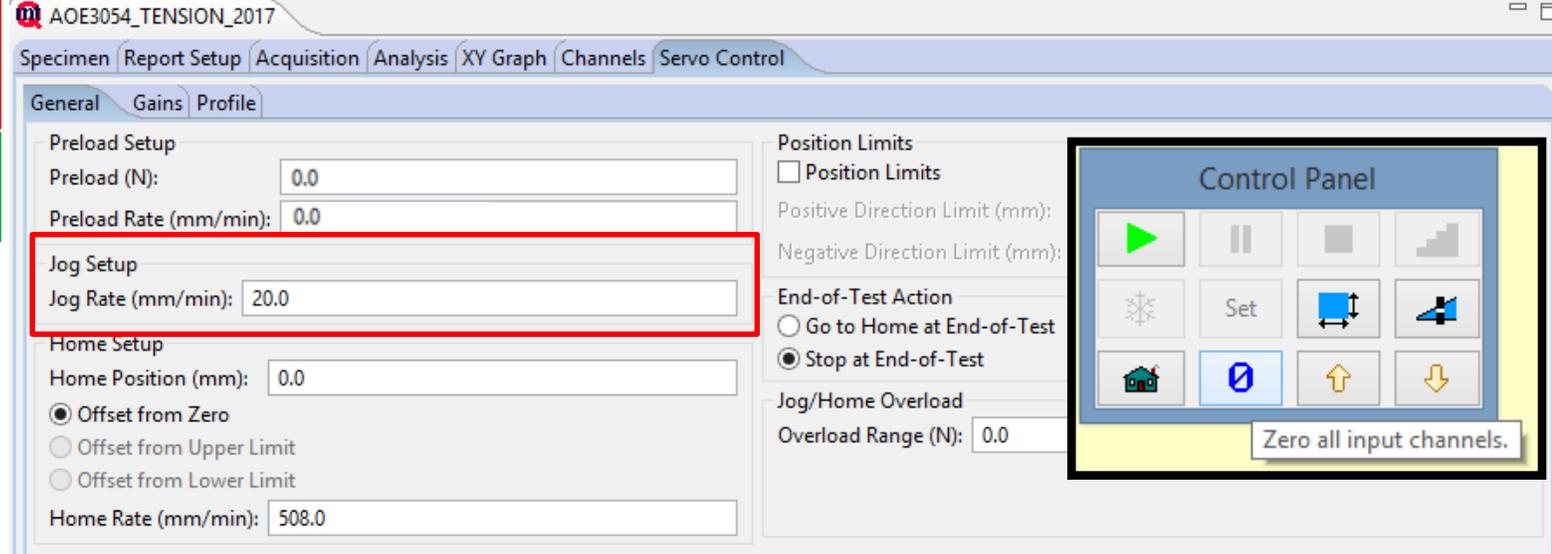
No need to measure dimensions of the compression samples (cylinder height and diameter is fixed as 44 mm and 19 mm, respectively)

Zero all input channels

Place the compression cylinder between compression platens as vertical as possible

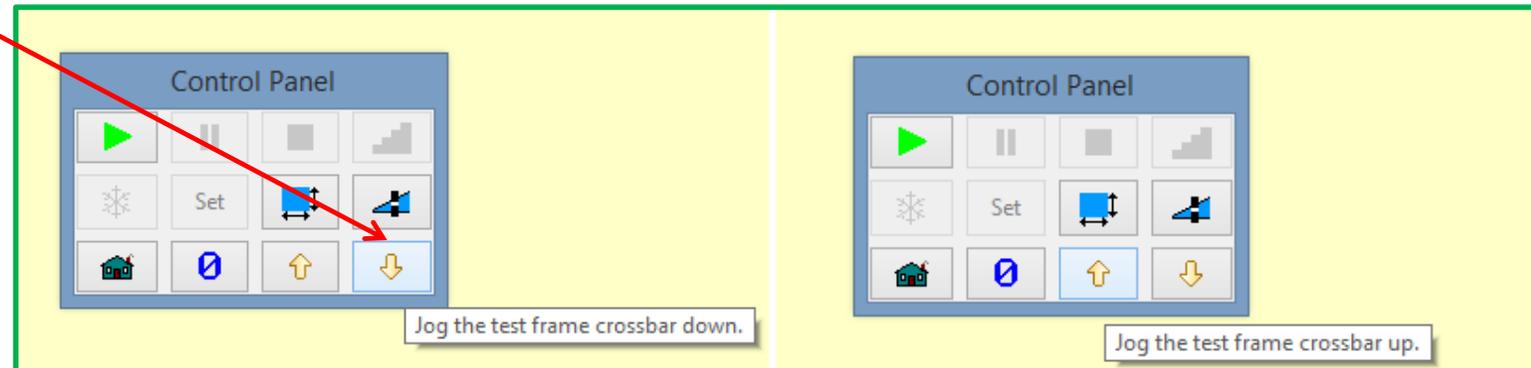
Apply some preload **no more than 2-3 N**

**Do not zero the preload** but set the position zero



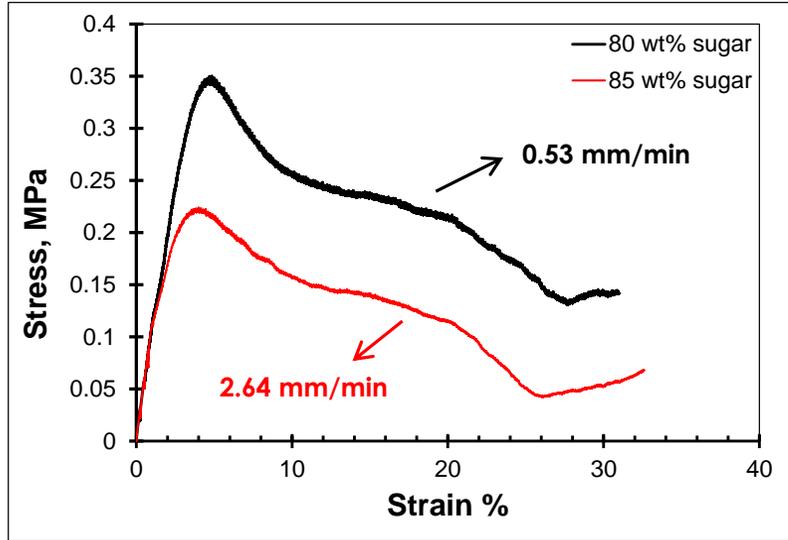
**Weight concentrations above 60 wt% particulate are FRAGILE SPECIMENS!**

	Live	Peak	Rate	
Load (N)	2.01	-Infinity	-0.44	/min
Stress (MPa)	0.007	-Infinity	-0.002	/min
Position (mm)	0.00	-Infinity	0.00	/min
AxialStrain (mm)	N/A	-Infinity	0.0	/min
TransverseStrain (mm)	N/A	-Infinity	0.0	/min
Auxiliary 0	N/A	-Infinity	0.0	/min

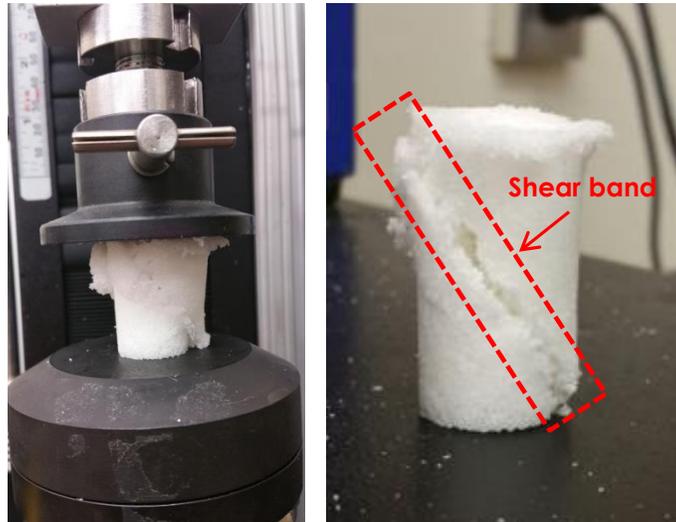


**Finally, READY TO START THE TEST**

## Compression Testing



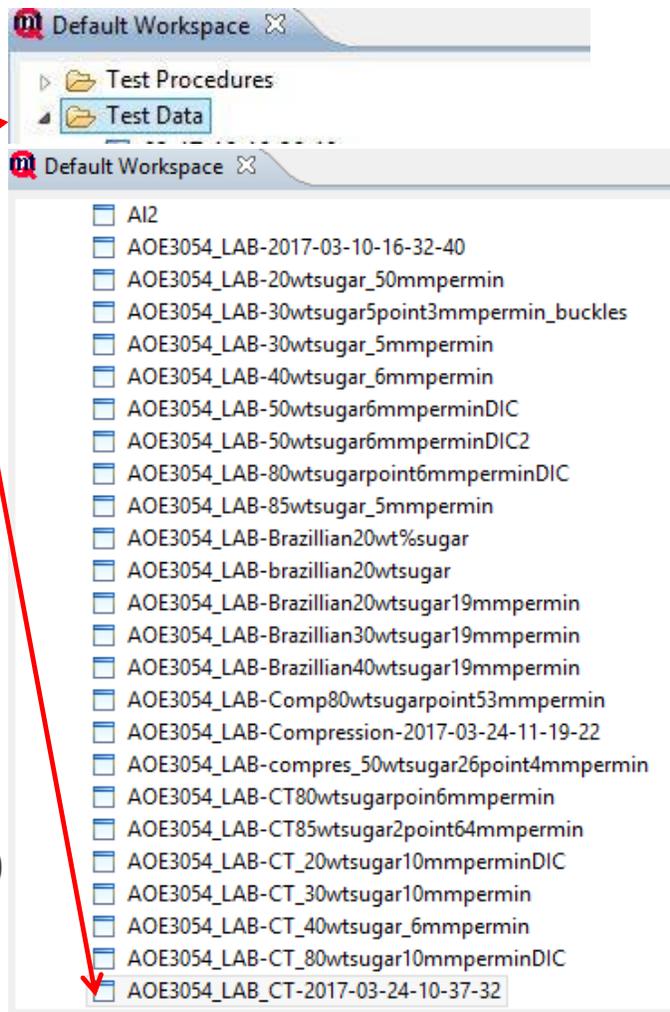
## Unmount Compression Platens



- ▶ Measure the shear band degree if the specimen fails
- ▶ Specimens with wt% < 50 may not fail at a set maximum compressive load of 200 N
- ▶ Specimens with wt% < 50 may also buckle if they are not placed vertically within the platens

## Data Saving for Compression Test

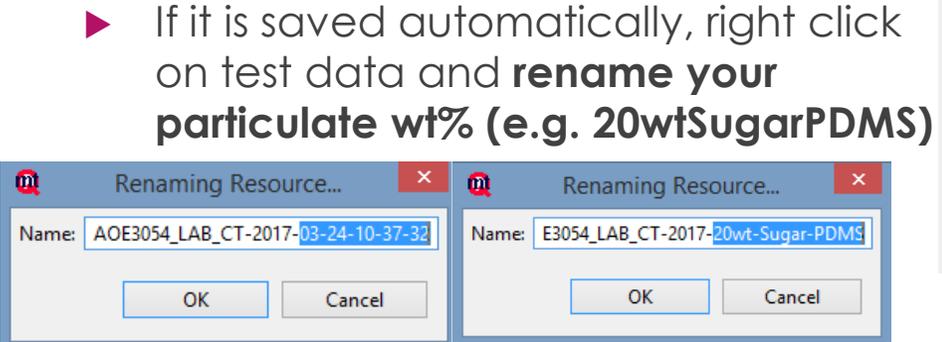
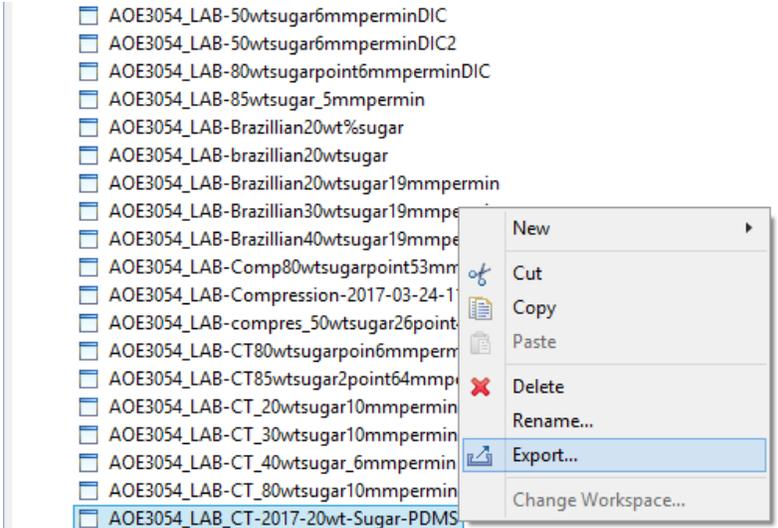
- ▶ Make sure your test data is saved automatically
- ▶ Go to **Test Data**
- ▶ Find your test data, **always the last data** under **Test Data**
- ▶ To be sure it is your data, check **the date and time**
  - ▶ If not, save manually as below



Prefix:

Prefix automatically will **change to AOE3054\_LAB-Compression under test data** instead AOE3054\_LAB-CT or AOE3054\_LAB-Tension

- ▶ Right click and export your data



# Mock PBX Testing – Experimental Procedures