

Axial DENT Development & Result

Asphalt Institute Summer Meeting

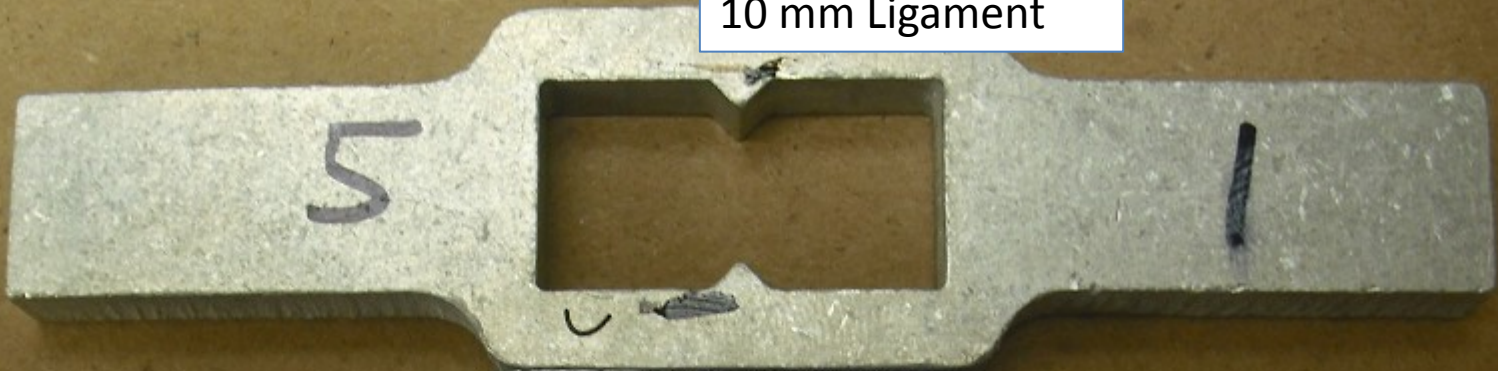
TAC Meeting August 9, 2017

Montreal, QC

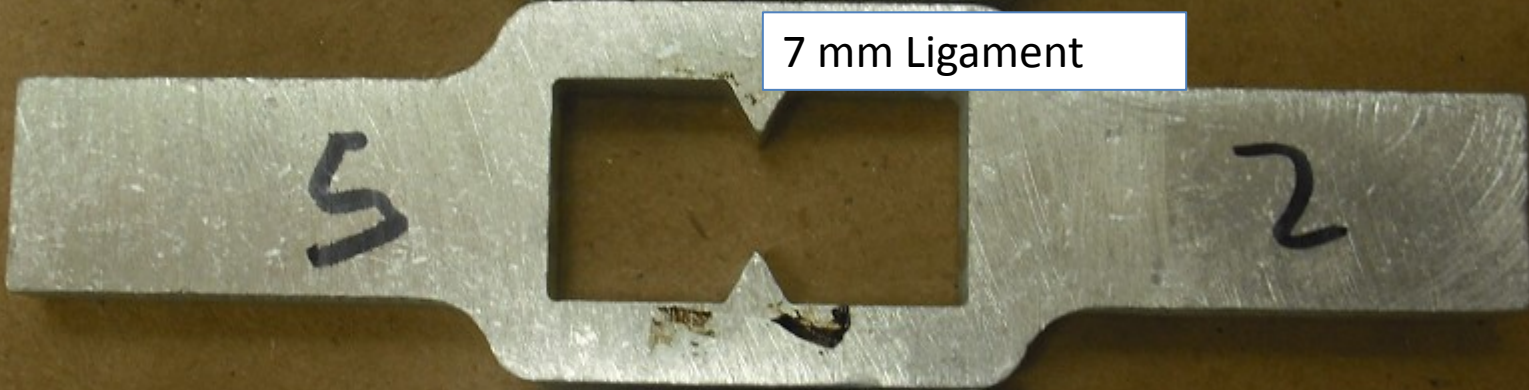
Axial DENT Test Procedure

- Test temperature the same @ 15°C
- 3 ligaments similar to Ontario procedure, but does not require a ductility bath and also requires less PAV residue
- Less than 20 gram of PAV residue required
- Due to difference in specimen gauge length I changed the pull rate from 50 mm/min to 24 mm/min
 - This was to make the strain rates between the ductilometer and the DSR the same

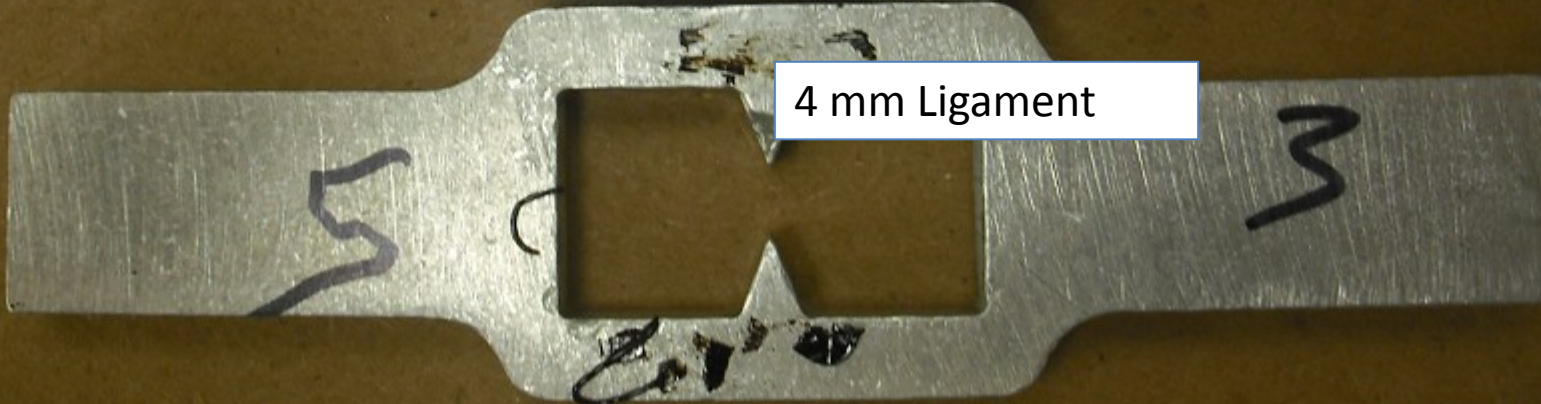
10 mm Ligament



7 mm Ligament

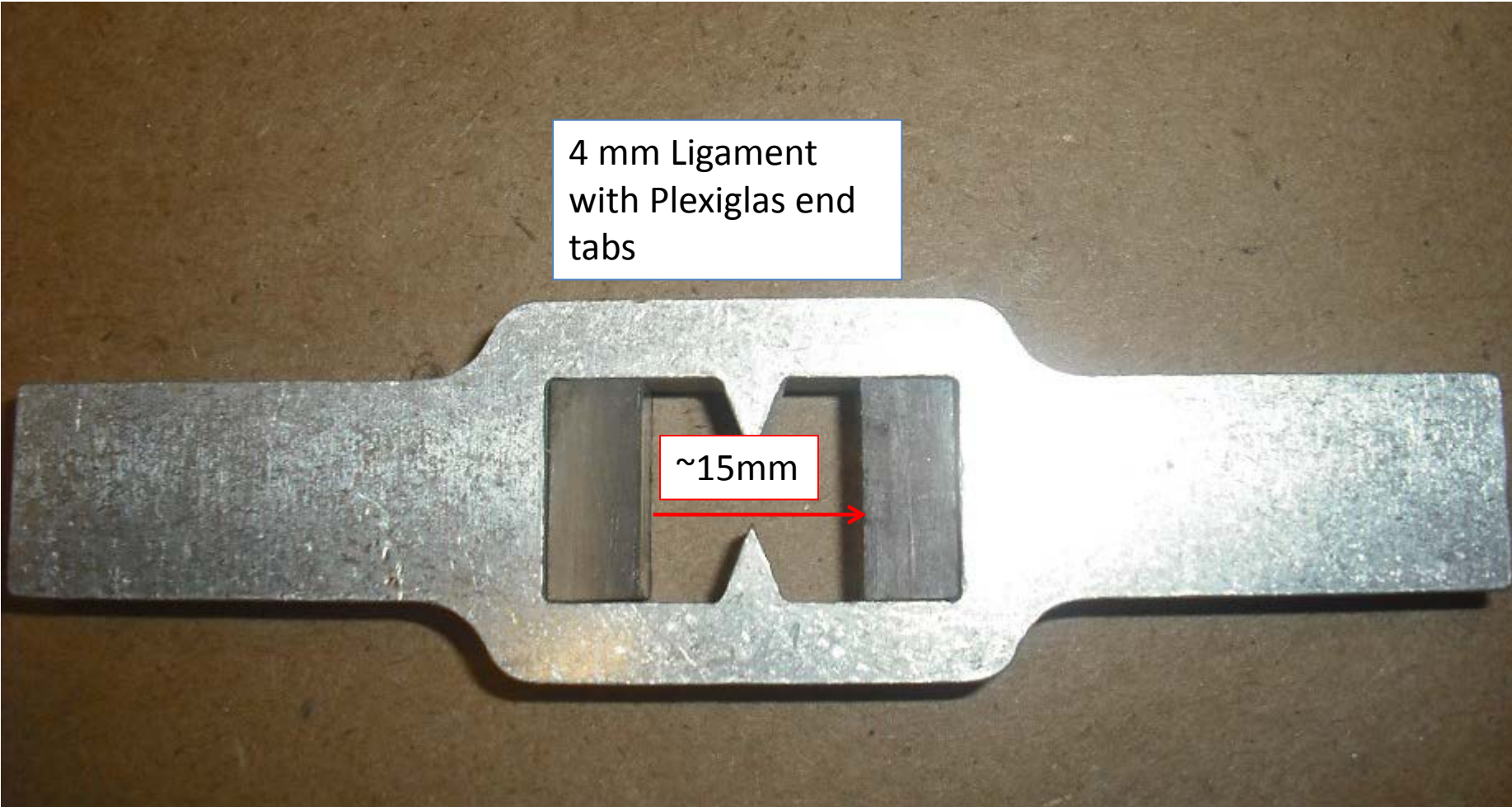


4 mm Ligament



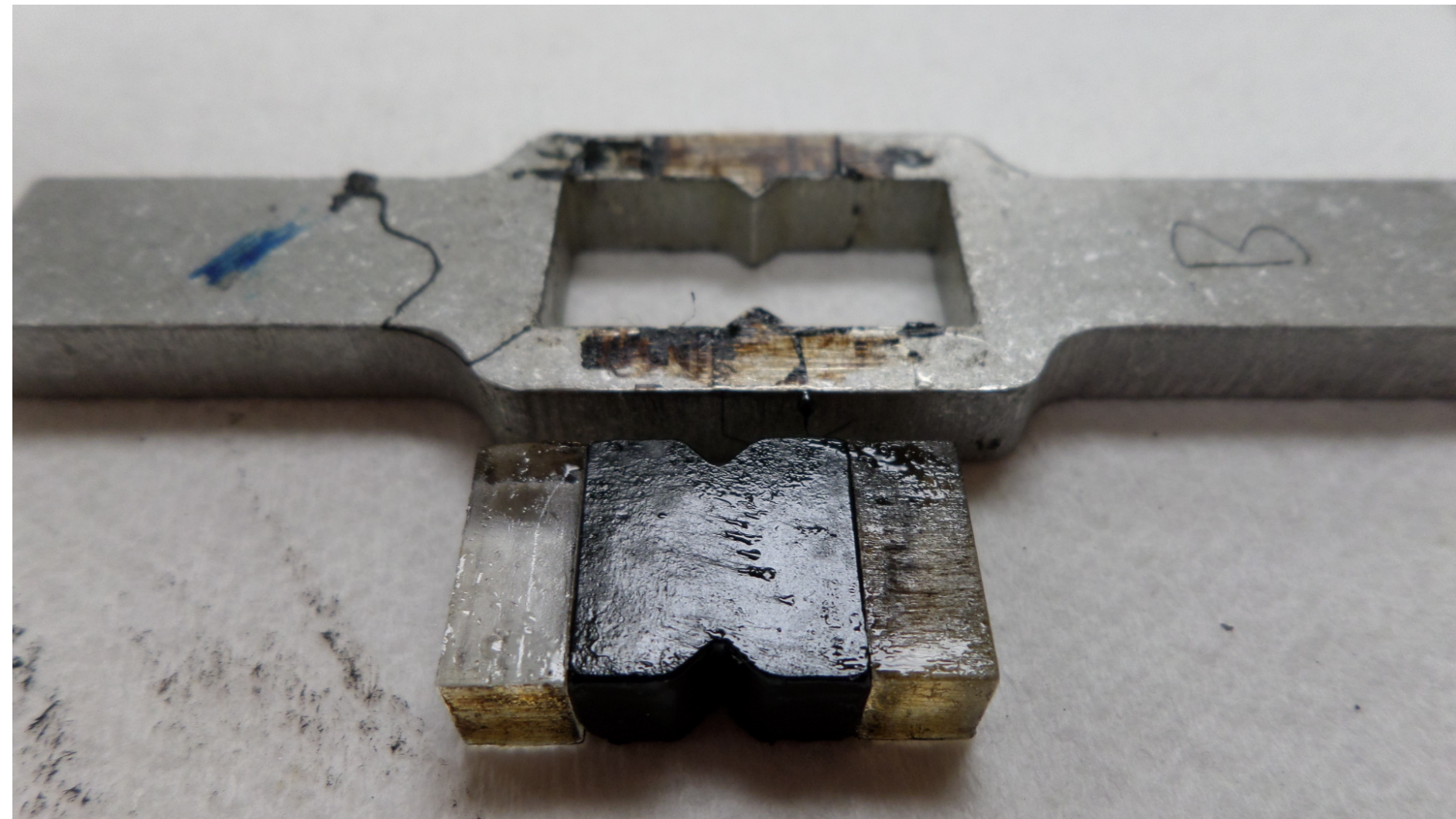
4 mm Ligament
with Plexiglas end
tabs

~15mm





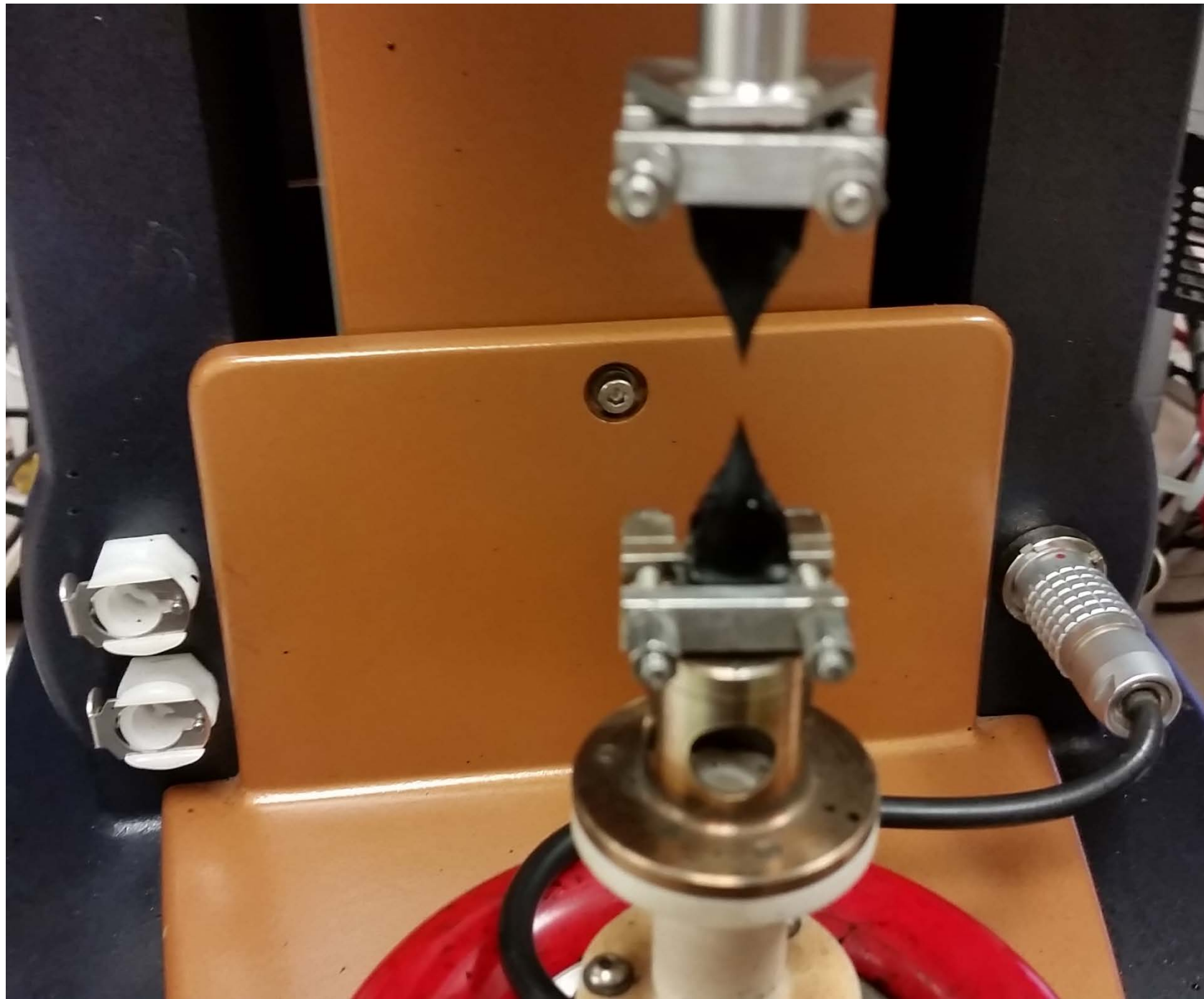
SHOWING SPECIMEN REMOVED FROM MOLD



SHOWING SPECIMEN MOUNTED IN DSR

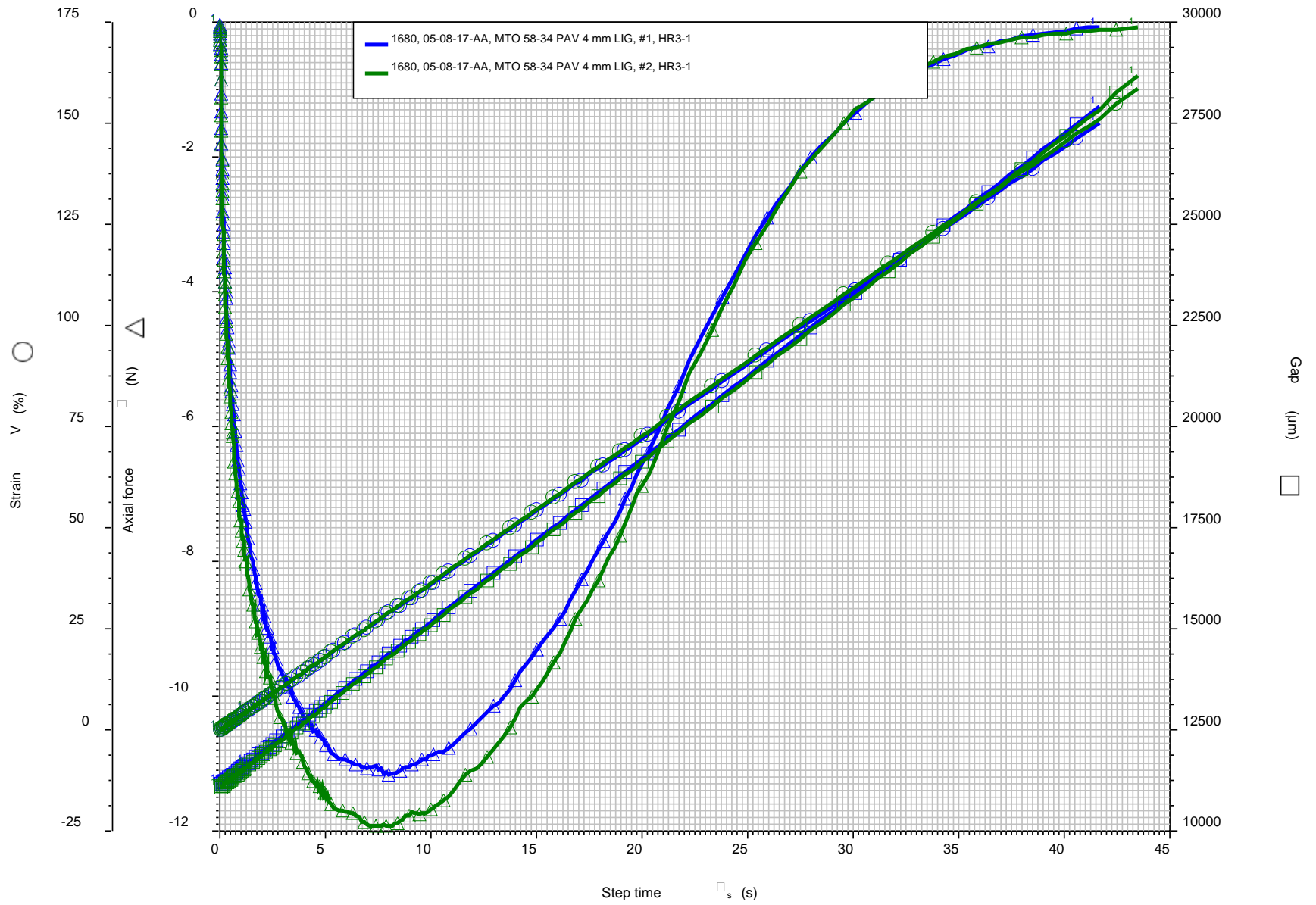




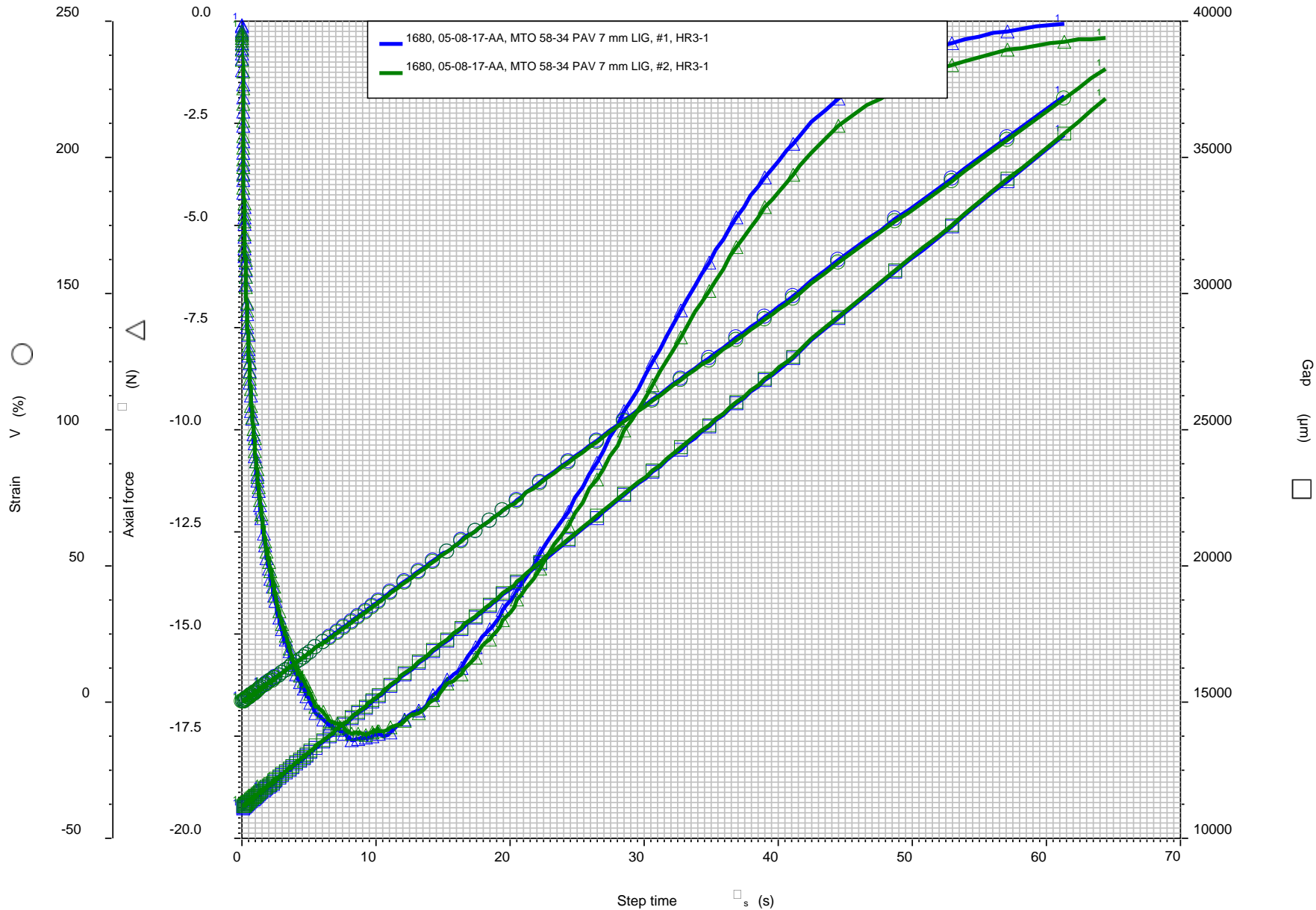




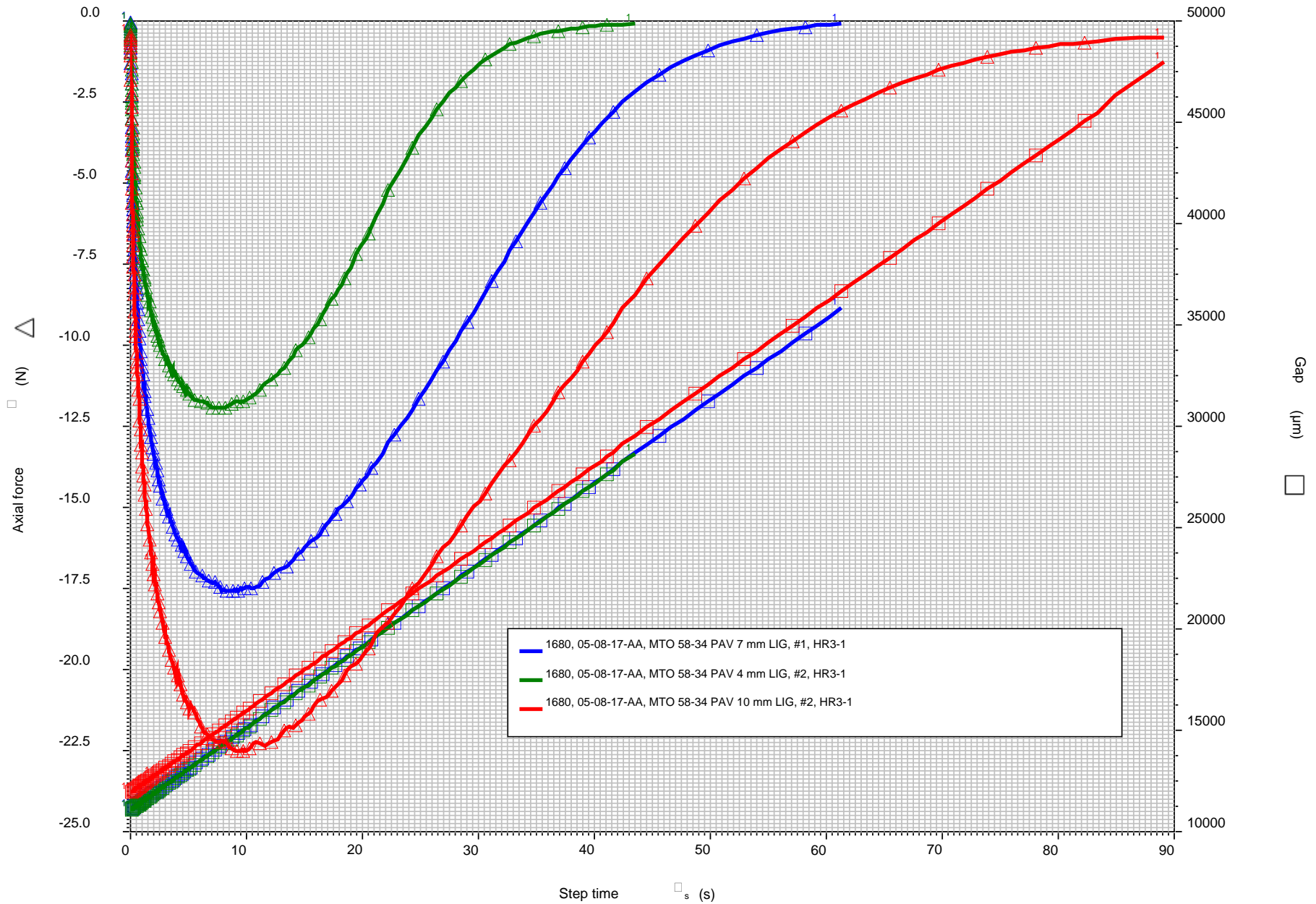
1680, 05-08-17-AA, MTO 58-34 PAV 4 mm LIG, #1, HR3-1



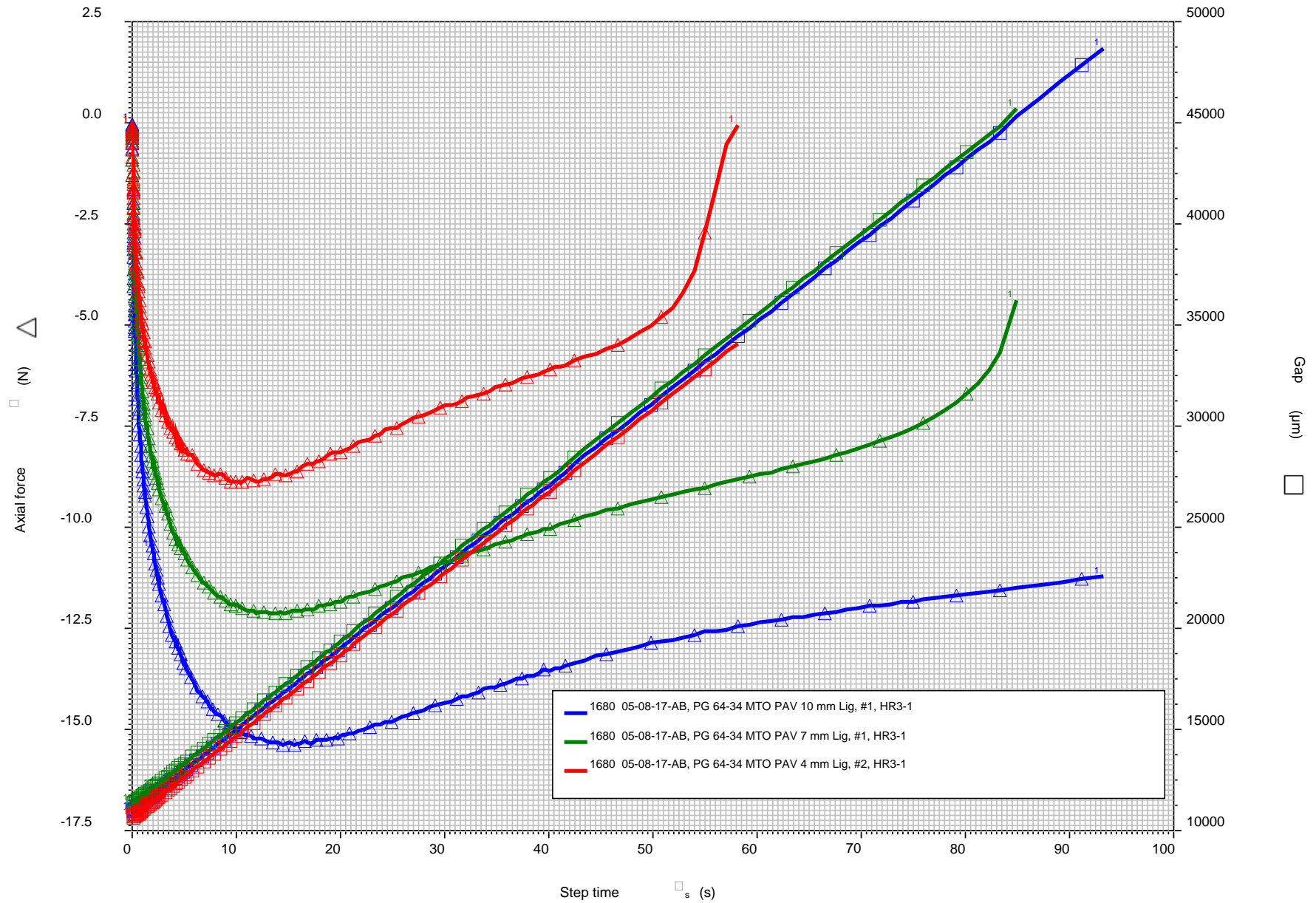
1680, 05-08-17-AA, MTO 58-34 PAV 7 mm LIG, #1, HR3-1



1680, 05-08-17-AA, MTO 58-34 PAV 7 mm LIG, #1, HR3-1



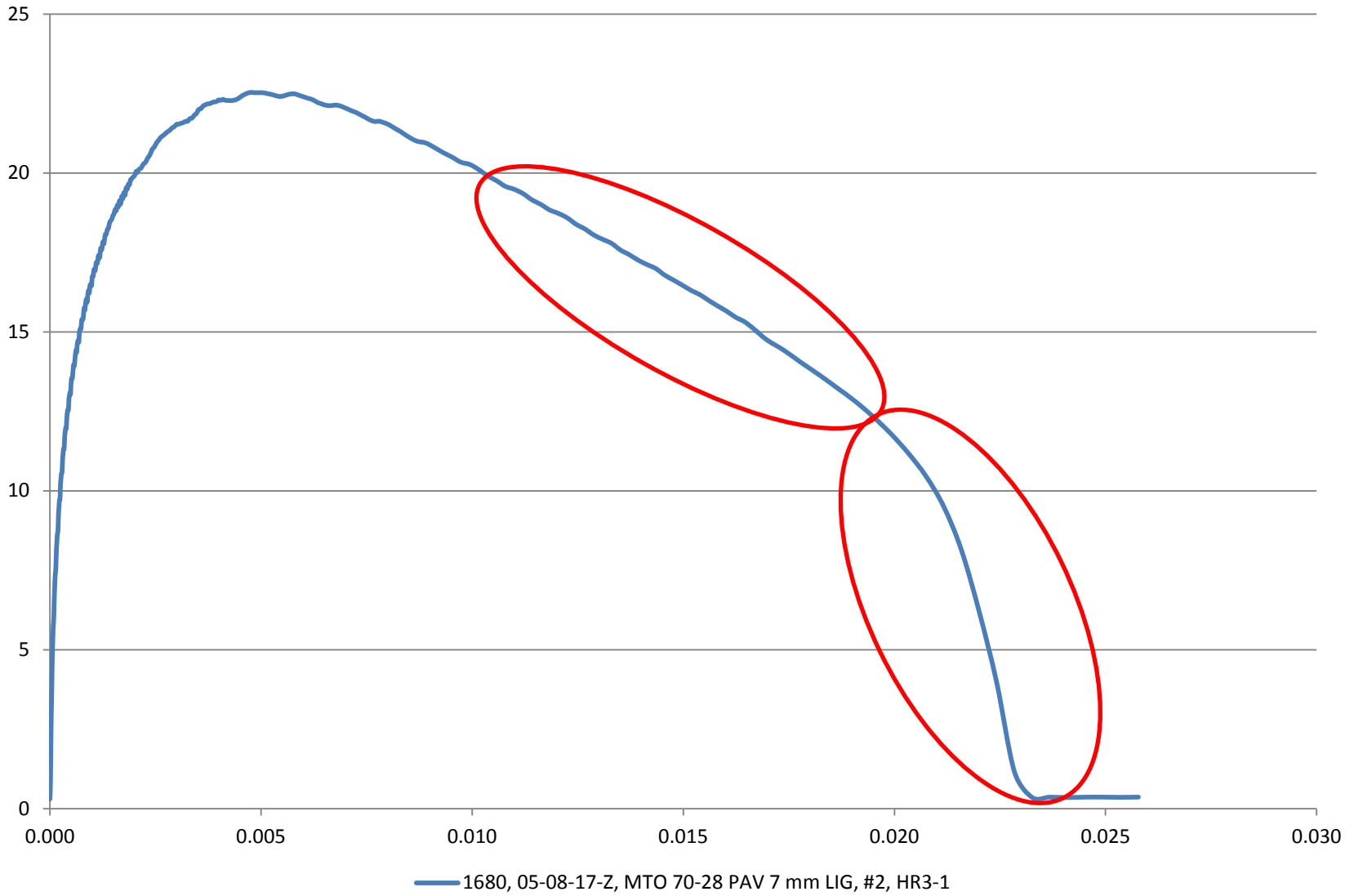
1680 05-08-17-AB, PG 64-34 MTO PAV 10 mm Lig, #1, HR3-1



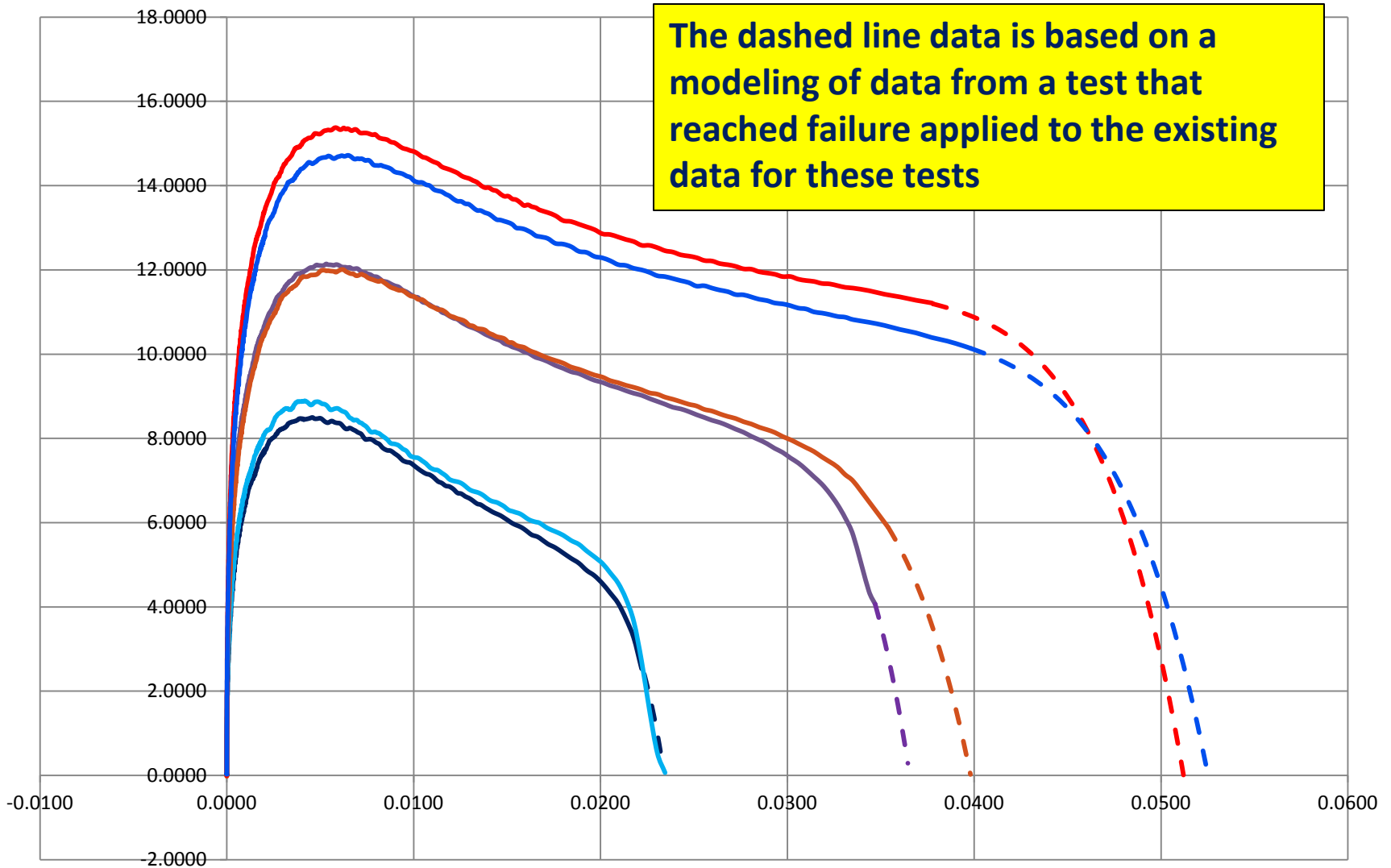
Comments

- Not all samples could be pulled to failure
- I therefore fit a mathematical model to results where the test did pull to failure and applied that same model to the incomplete data to extrapolate the results to failure

1680, 05-08-17-Z, MTO 70-28 PAV 7 mm LIG, #2, HR3-1



1680 05-08-17-AB, PG 64-34 MTO PAV SUMMARY PLOT



The dashed line data is based on a modeling of data from a test that reached failure applied to the existing data for these tests

- 1680 05-08-17-AB, PG 64-34 MTO PAV 4 mm Lig, #1, HR3-1
- 1680 05-08-17-AB, PG 64-34 MTO PAV 4 mm Lig, #2, HR3-1
- 1680 05-08-17-AB, PG 64-34 MTO PAV 7 mm Lig, #1, HR3-1
- 1680 05-08-17-AB, PG 64-34 MTO PAV 7 mm Lig, #2, HR3-1
- 1680 05-08-17-AB, PG 64-34 MTO PAV 10 mm Lig, #1, HR3-1
- 1680 05-08-17-AB, PG 64-34 MTO PAV 10 mm Lig, #2, HR3-1

DENT Test Reporting Sheet

PG 58 -28
 Grade: MTO PAV 58-28
 Sample :

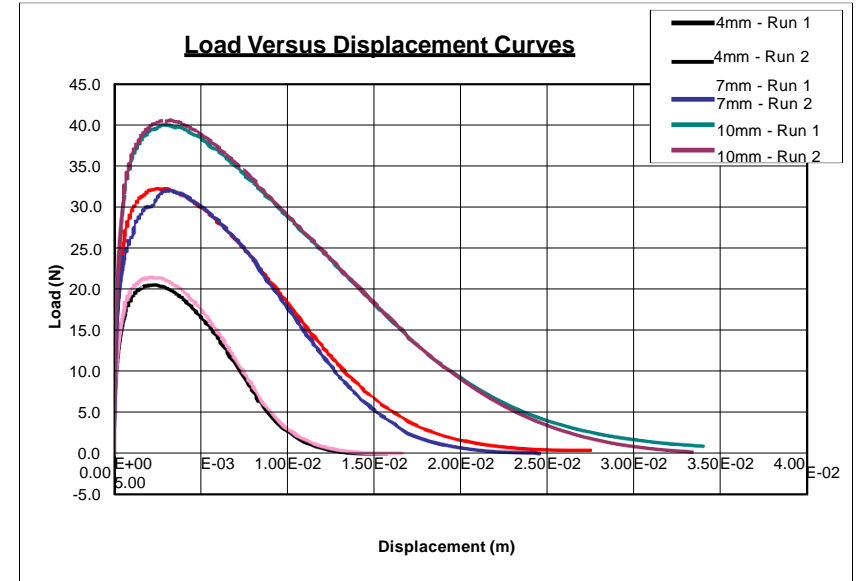
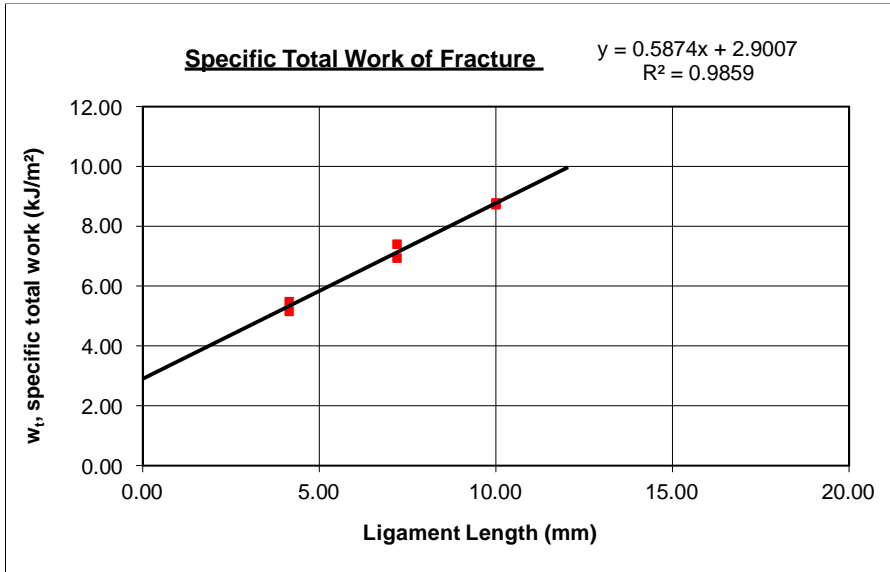
Test Temp. °C: 15°
 MTO Contract:

Date of Test: 1-Jun-17
 Tested By: GHR

RESULTS:

	Run 1			Run 2			
ℓ , measured ligament length	4.15	7.20	10.00	4.15	7.20	10.00	mm
ℓ , measured ligament length	0.00415	0.00720	0.01000	0.00415	0.00720	0.01000	m
B, measured sample thickness	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	m
W_t , total work of fracture	0.14	0.36	0.59	0.15	0.33	0.58	J
w_t , specific total work of fracture	5.15	7.40	8.78	5.48	6.94	8.73	kJ/m^2
w_e , specific essential work of fracture	2.90						kJ/m^2
βw_p , specific plastic work of fracture	0.59						MJ/m^3
P_{peak} , average for 4mm run	21.00						N
δ_t , CTOD, average	3.8						mm

CHARTS:



DENT Test Reporting Sheet

PG Grade: 58 -34

Test Temp. °C: 15°

Date of 5-Jun-17

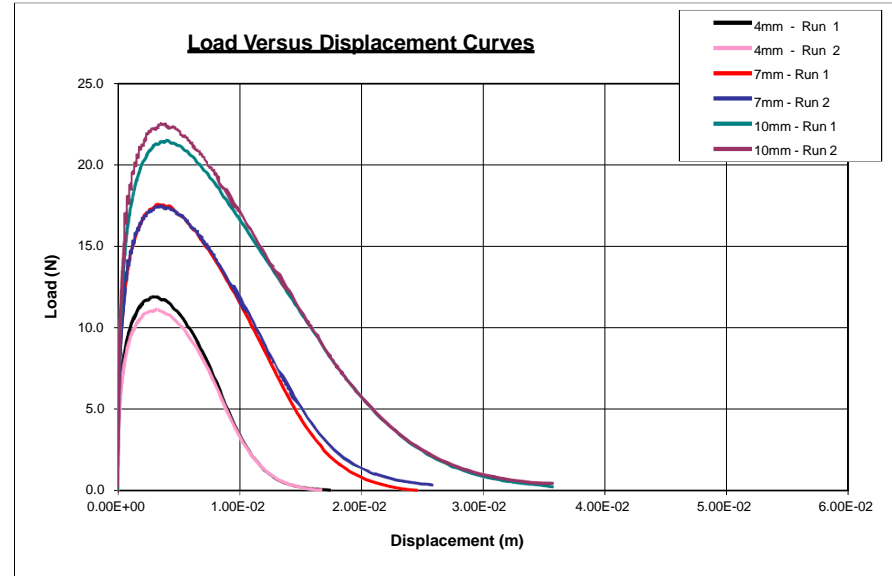
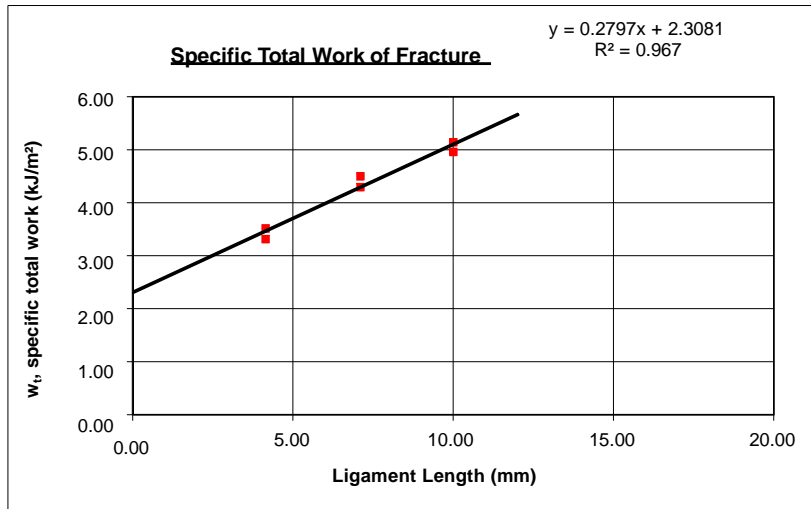
Sample: MTO PAV 58-34

MTO Contract:

Test:
Tested By: GHR

RESULTS:	Run 1			Run 2			
ℓ , measured ligament length	4.15	7.10	10.00	4.15	7.10	10.00	mm
ℓ , measured ligament length	0.00415	0.00710	0.01000	0.00415	0.00710	0.01000	m
B, measured sample thickness	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	m
W_t , total work of fracture	0.10	0.20	0.33	0.09	0.21	0.34	J
w_t , specific total work of fracture	3.52	4.30	4.96	3.32	4.50	5.14	kJ/m^2
w_e , specific essential work of fracture	2.31						kJ/m^2
βw_p , specific plastic work of fracture	0.28						MJ/m^3
P_{peak} , average for 4mm run	11.55						N
δ_u , CTOD, average	5.6						mm

CHARTS:



COMMENTS:

DENT Test Reporting Sheet

PG Grade: 70 -28

Test Temp. °C: 15°

Date of 5-Jun-17

Sample: MTO PAV 70-28

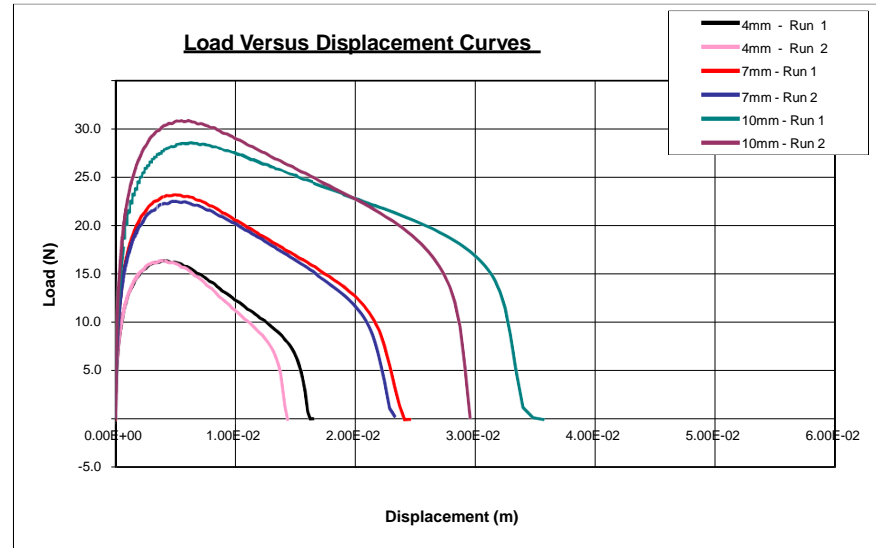
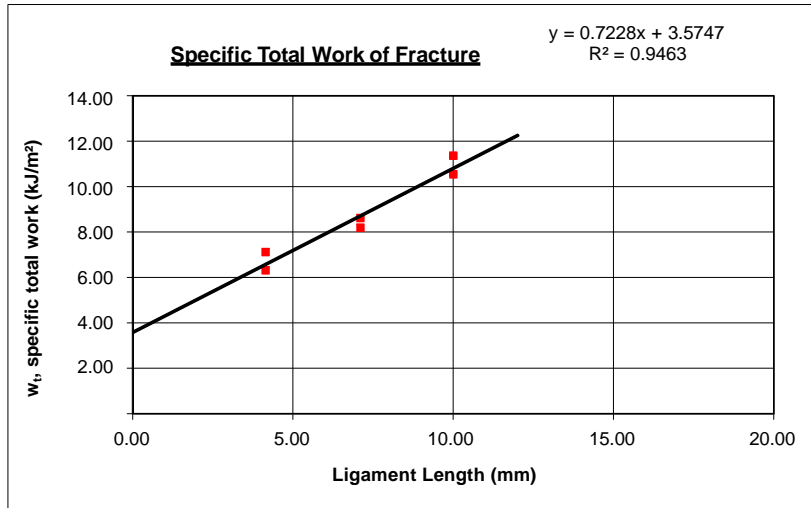
MTO Contract:

Test:
Tested By: GHR

RESULTS:

	Run 1			Run 2			
	4.15	7.10	10.00	4.15	7.10	10.00	
ℓ , measured ligament length	4.15	7.10	10.00	4.15	7.10	10.00	mm
ℓ , measured ligament length	0.00415	0.00710	0.01000	0.00415	0.00710	0.01000	m
B, measured sample thickness	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	m
W_t , total work of fracture	0.20	0.41	0.76	0.18	0.39	0.71	J
w_t , specific total work of fracture	7.13	8.62	11.36	6.32	8.19	10.55	kJ/m^2
w_e , specific essential work of fracture	3.57						kJ/m^2
βw_p , specific plastic work of fracture	0.72						MJ/m^3
P_{peak} , average for 4mm run	16.40						N
δ_t , CTOD, average	6.1						mm

CHARTS:



COMMENTS:

DENT Test Reporting Sheet

PG Grade: 64 -34

Test Temp. °C: 15°

Date of 2-Jun-17

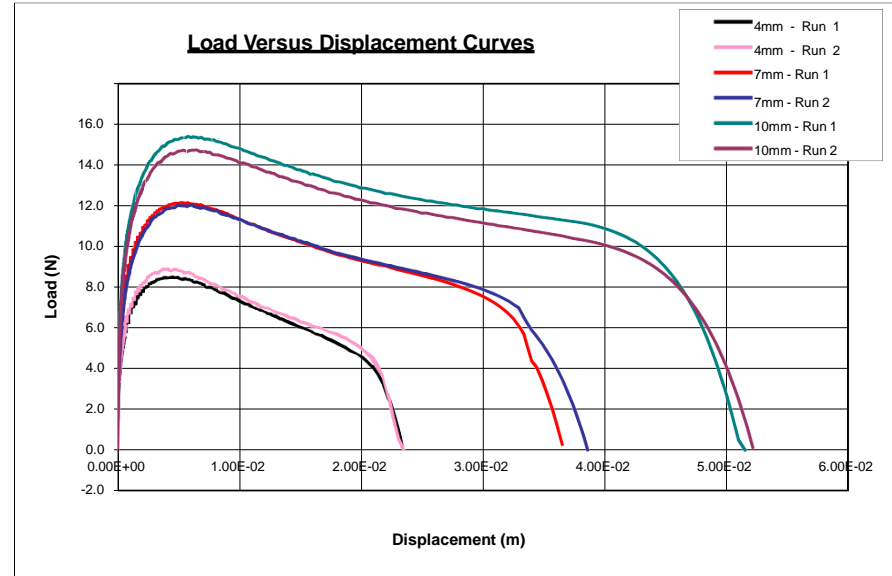
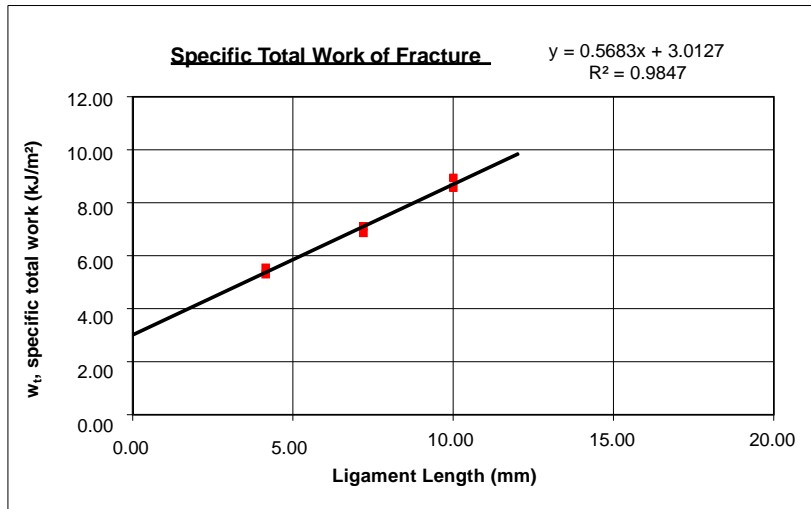
Sample: MTO PAV 64-34

MTO Contract:

Test:
Tested By: GHR

RESULTS:	Run 1			Run 2			
ℓ , measured ligament length	4.15	7.20	10.00	4.15	7.20	10.00	mm
ℓ , measured ligament length	0.00415	0.00720	0.01000	0.00415	0.00720	0.01000	m
B, measured sample thickness	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	m
W_t , total work of fracture	0.15	0.33	0.60	0.15	0.34	0.57	J
w_t , specific total work of fracture	5.30	6.86	8.94	5.55	7.12	8.57	kJ/m ²
w_e , specific essential work of fracture	3.01						kJ/m ²
βw_p , specific plastic work of fracture	0.57						MJ/m ³
P_{peak} , average for 4mm run	8.70						N
δ_{ctod} , CTOD, average	9.6						mm

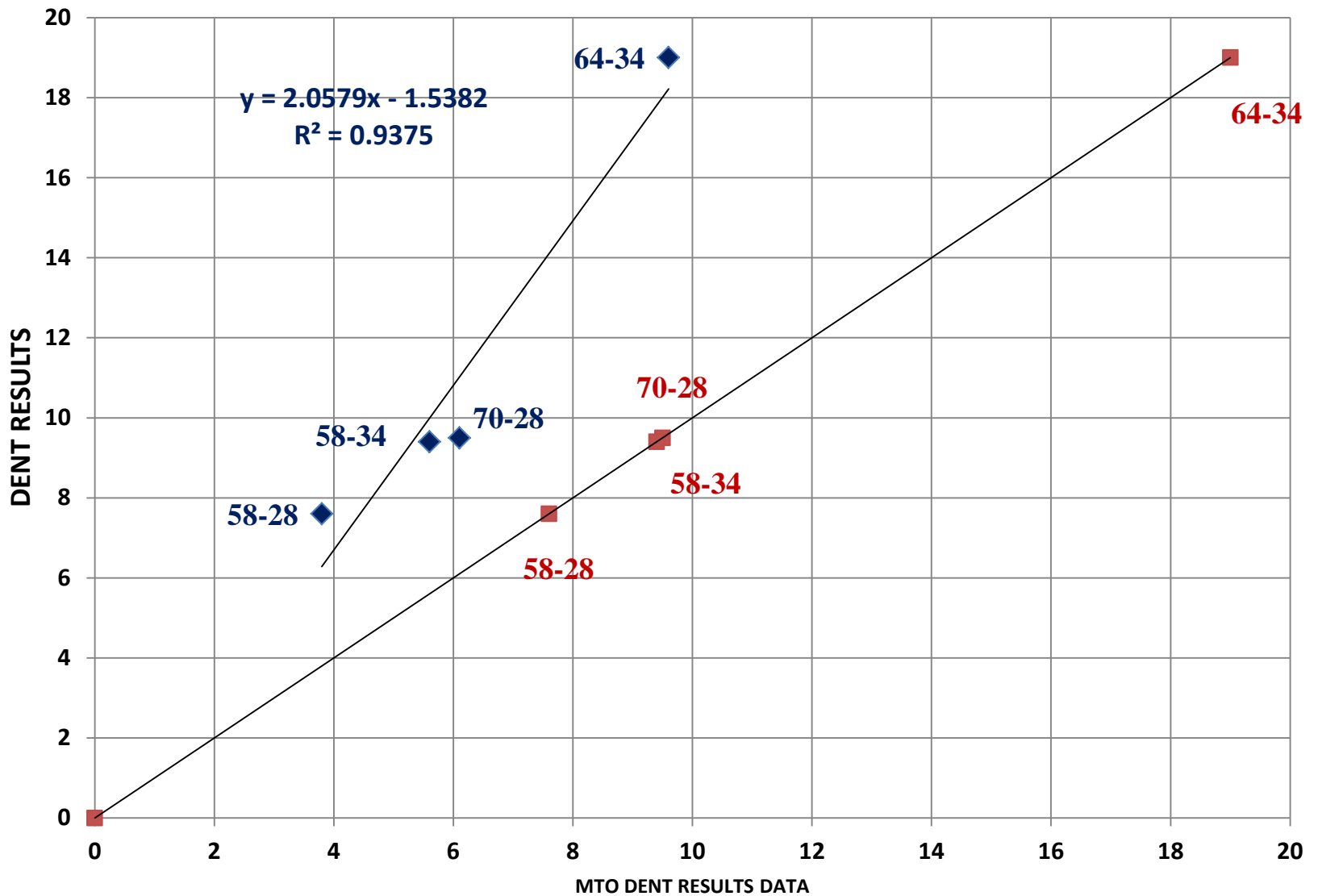
CHARTS:



COMMENTS:

Comparison of Results

Sample	MTO DENT @ 15°C	MTE Axial DENT @ 15C
64-34	19	9.6
70-28	9.5	6.1
58-34	9.4	5.6
58-28	7.6	3.8



◆ Series1 ■ line of MTO equalitu — Linear (Series1) — Linear (line of MTO equalitu)

SUMMARY COMMENTS

- In theory it is possible to replicate the conventional DENT test and results using much smaller samples on a DSR
- The DSR has limitations due to normal force transducer and pull distance
- Could these issues be worked out?
- Possibly with further changes in sample geometry
- Would the benefits be worth the effort?

