GRI GM-34
Geosynthetic Institute's (GSI) EIA (PVC + KEE) Specification

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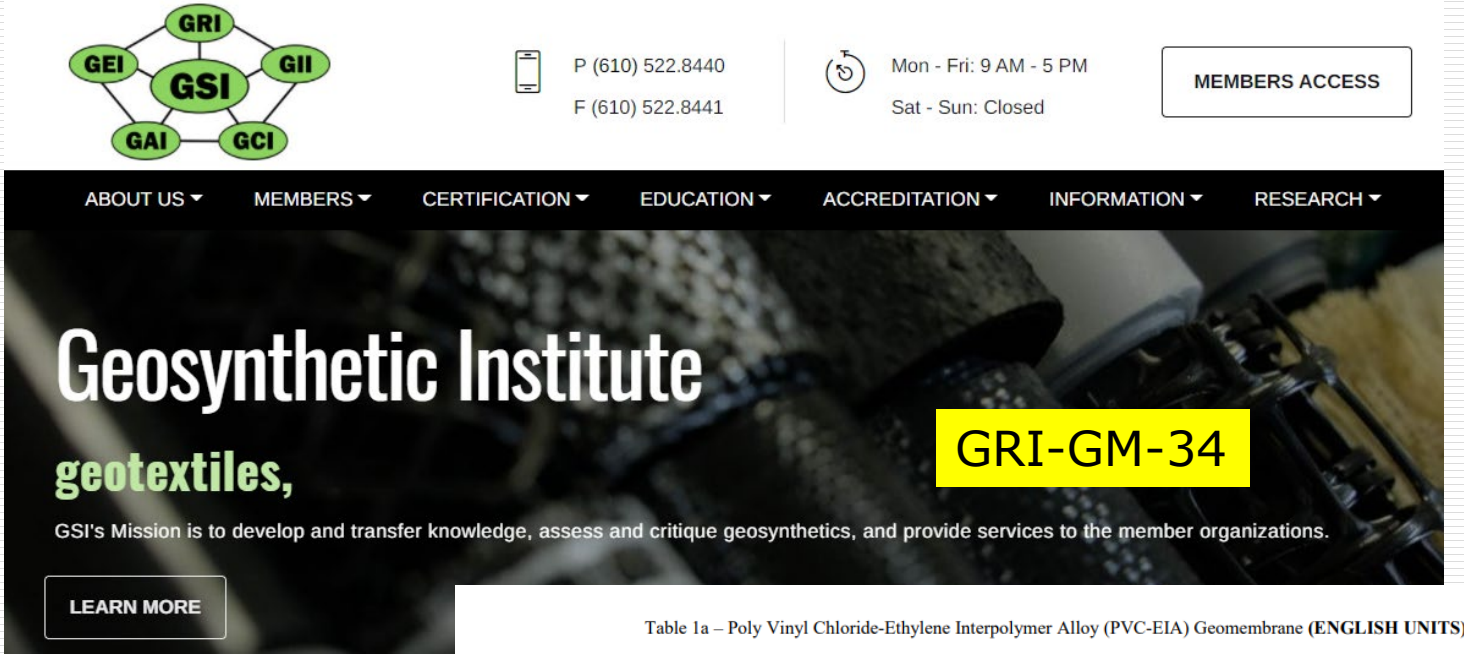
GSI's EIA Specification

- Original draft 1995
- Revision 9: July 13, 2022
- Twelve materials from five companies tested at GSI
- Please note: We have no field exhumed samples for a performance evaluation of Ethylene Interpolymer Alloy (EIA) with respect to time and environment



Physical (3)

Mechanical (6)

Chemical (1)

Endurance (3)

Since 1995

Rev:9

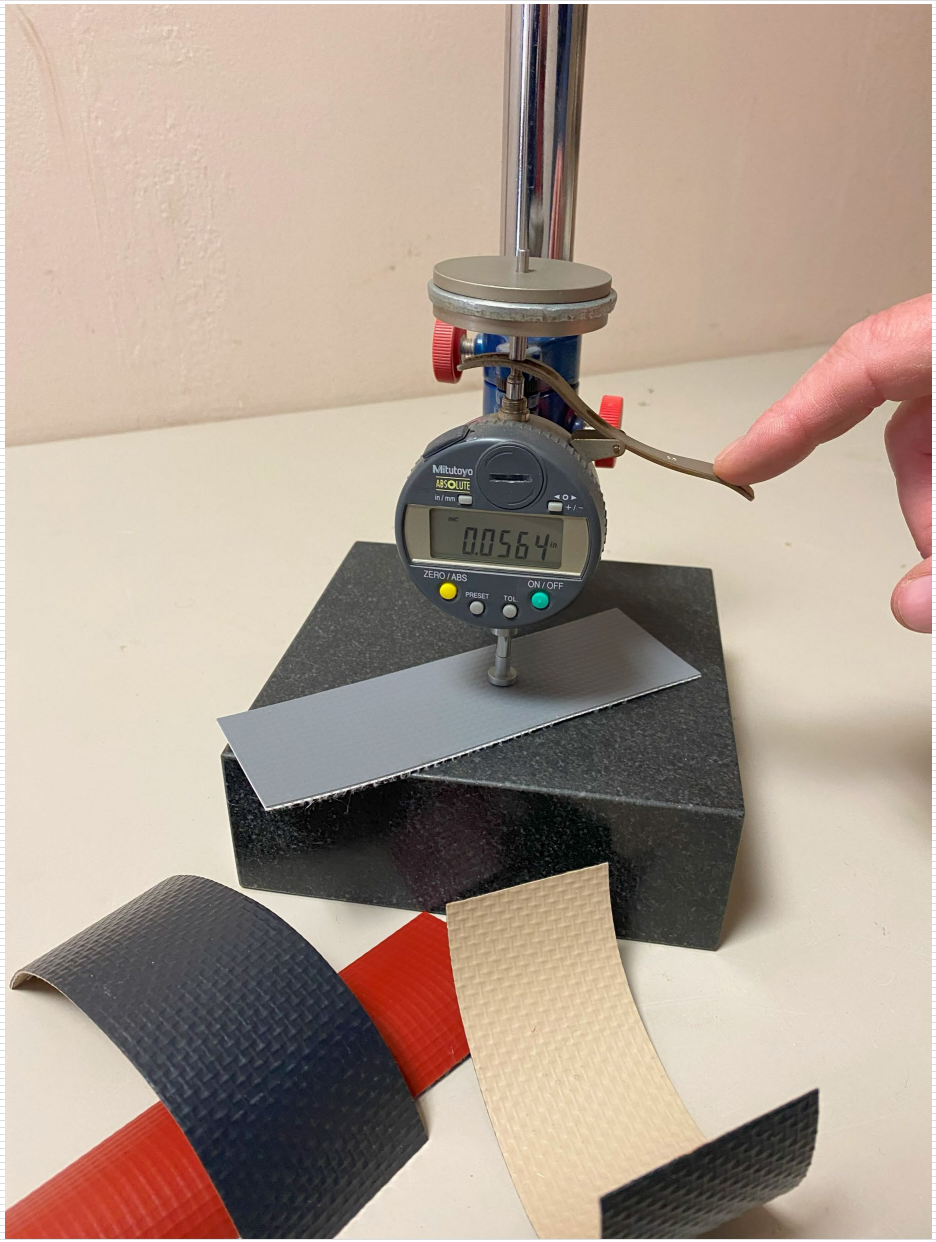
Table 1a – Poly Vinyl Chloride-Ethylene Interpolymer Alloy (PVC-EIA) Geomembrane **(ENGLISH UNITS)**

System Properties (Composite EIA plus scrim)	Test Method	**English Imperil** 30 mil			**English Imperil** 36 mil			**English Imperil** 45 mil			**English Imperil** 60 mil			Testing Frequency (minimum)
Thickness (min. ave.) - mils • lowest individual of 10 values - %	D751	nom. -10			nom. -10			nom. -10			nom. -10			per roll
Fabric Scrim Type	NA	Polyester			Polyester			Polyester			Polyester			per roll
Finished Coated Mass/Unit Area (min. ave.)	D 751	28 osy			30 osy			40 osy			56 osy			per roll
CONDITION *(1)*	------	S	M	T	S	M	T	S	M	T	S	M	T	-----
Grab Tensile Properties (min. ave.) *(2)* • strength • elongation	D751	200 lbs. 20%	200 lbs. 20%	200lbs. 20%	200 lbs. 20%	200 lbs. 20%	200 lbs. 20%	250 lbs. 20%	250 lbs. 20%	250 lbs. 20%	250 lbs. 20%	250 lbs. 20%	250 lbs. 20%	50,000 lbs.
Trouser Tear Resistance (min. ave.) *(2)*	D 5884	35 lbs.	30 lbs.	25 lbs.	55 lbs.	50 lbs.	45 lbs.	60 lbs.	55 lbs.	50 lbs.	65 lbs.	60 lbs.	55 lbs.	50,000 lbs.
Hydrostatic Burst (min. ave.)	D 751	350 psi	300 psi	250 psi	550 psi	500 psi	450 psi	700 psi	650 psi	600 psi	800 psi	750 psi	700 psi	50,000 lbs.
Puncture Resistance (min. ave.)	33	125 l	s.	75 lbs.			150 lbs.	275 l			300 lbs.	275 lbs.	250 lbs.	50,000 lbs.
Ply Adhesion (min. ave.) *(2)*			in.			15			s./in.			20 lbs./in.		50,000 lbs.
Dimensional Stability (max. ave.) *(3)*						1.0			1.0%			1.0%		50,000 lbs.
EIA Only Properties														
1H-NMR Determination of PVC and KEE content	815		0% 0%			PVC 3 KEE			PVC 30% EE 10%			PVC 30% KEE 10%		per each formulation
Chlorinated water resistance star fold at 50°C *(4&6)* Pass/Fail after 90 days by GRI GM16 and ASTM D882 strip tensile properties	GM24	Pas	cracks ed) retained 80%			bserved) 80%			retained 80%			Pass (i.e., no cracks observed) retained 80%		per each formulation
Oven Aging at 85°C *(6)* Pass/Fail after 90 days by GRI GM16 and ASTM D882 strip tensile properties	D 5721		Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%		per each formulation
UV Resistance *(5&6)* Pass/Fail after 10,000 light hours by GRI GM16 and ASTM D882 strip tensile properties	D 7238		Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%			Pass (i.e., no cracks observed) retained 80%		per each formulation

MQC

(1) (S) Severe, (M) Moderate, (T) Typical
(2) Regardless of machine direction (MD) or cross machine direction (XMD).
(3) Incubated at 100°C ± 1°C for one hour.
(4) Incubated at 50°C ± 1°C at 10 ppm chlorine concentration in distilled deionized water. Samples are dried and solution is changed once a week during incubation.
(5) The conditions of the UV Fluorescent exposure method should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(6) Tested on unreinforced geomembrane specimens (EIA Only) via ASTM D882

Thickness ASTM D751



Dead Mass micrometer
5 conditioned specimens
0.375” (9.52 mm) dia. PF
3.4 psi (23.5 kPa) 6 oz (170 g)

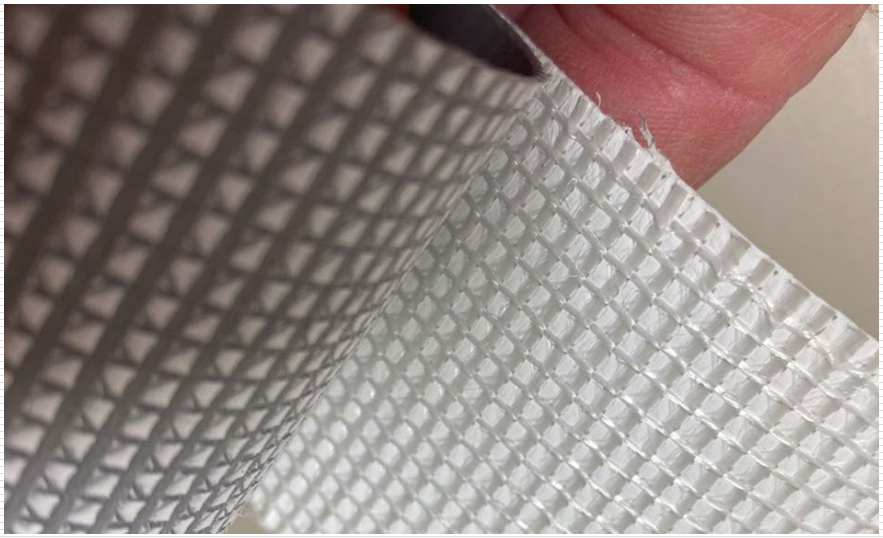
Nominal = Minimum Average

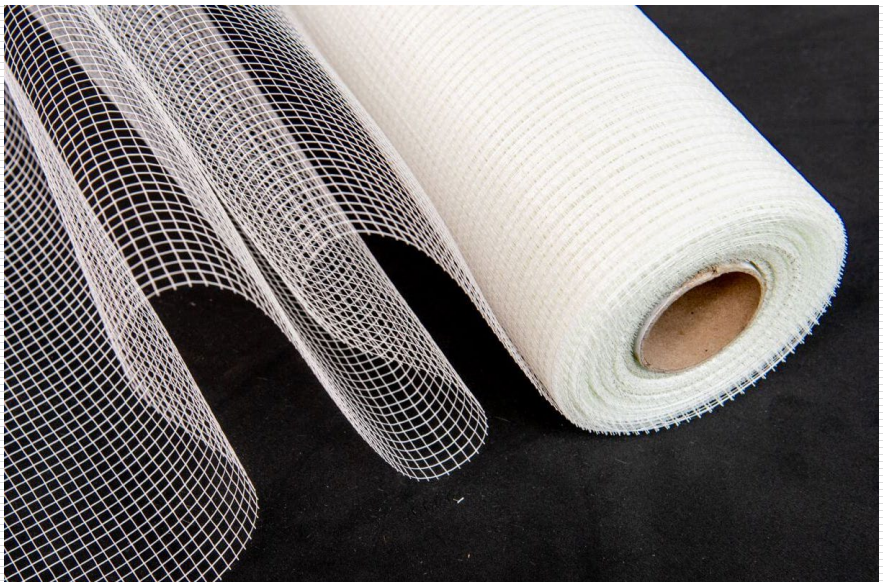
With lowest of 5 at -10%

Four Categories:
30, 36, 45 & 60 mil (0.76, 0.91, 1.13 & 1.52 mm)

Frequency: per roll

Fabric Scrim Type





GRI GM34 requires a Polyester (PET) scrim

Both nylon and polyester rate well for strength and durability. But when we make a direct comparison, nylon is stronger and elongates more than polyester. Nylon has slightly lower abrasion resistance and a lower resistance to acidic environments. Polyester has a lower resistance to alkali environments

Density:
Nylon 1.1 g/cm3
Polyester 1.3 g/cm3

Note: Nylon is more expensive than PET

Mass per Unit Area ASTM D751

Balance to 0.01g precision
5 conditioned specimens
6” by 6” (150mm by 150mm)
Die cut specimens 0.01” (0.25mm)

Minimum Average

Four Categories:
28-56 osy (949-1899 g/m2)

Frequency per roll

CONDITIONS

within Four (4) Thickness Categories

Severe (S)
Moderate (M)
Typical (T)

Ground Pressure

Subgrade Cond.	Low ground-pressure equipment ≤ 25 kPa (3.6 psi)	Medium ground-pressure equipment > 25 to ≤ 50 kPa (>3.6 to ≤ 7.3 psi)	High ground-pressure equipment > 50 kPa (> 7.3 psi)
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 450 mm (18 in.) in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 150 mm (6 in.) above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High (Class 1)	Very high (Class 1+)	Not recommended

Differentiate via four (4) mechanical (tensile, tear, burst & puncture) survivability criteria

Applications

Grab Tensile ASTM D751

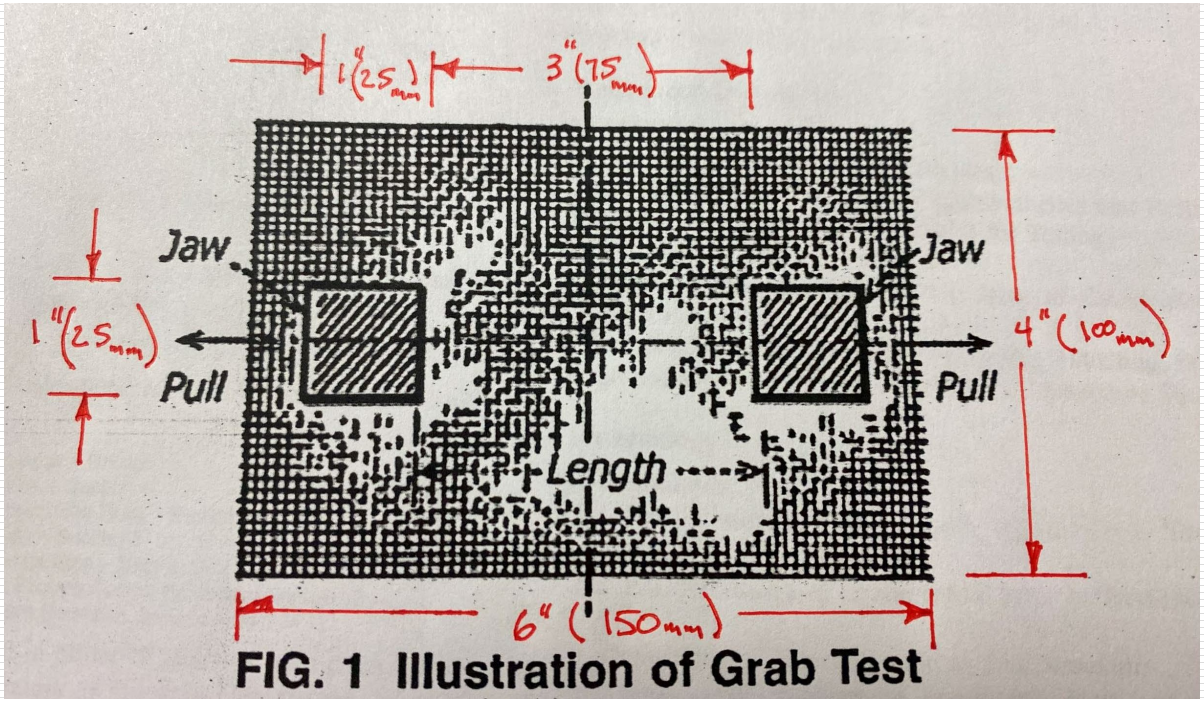
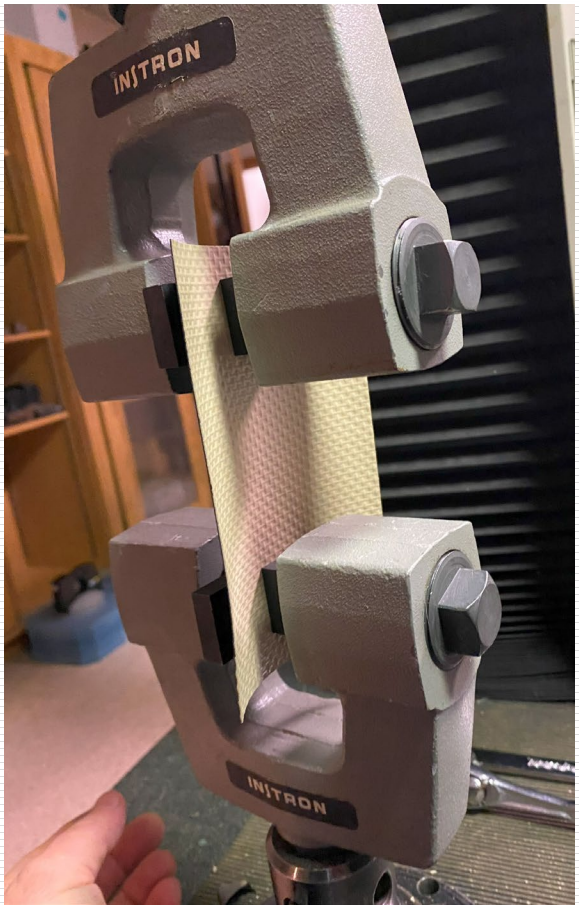


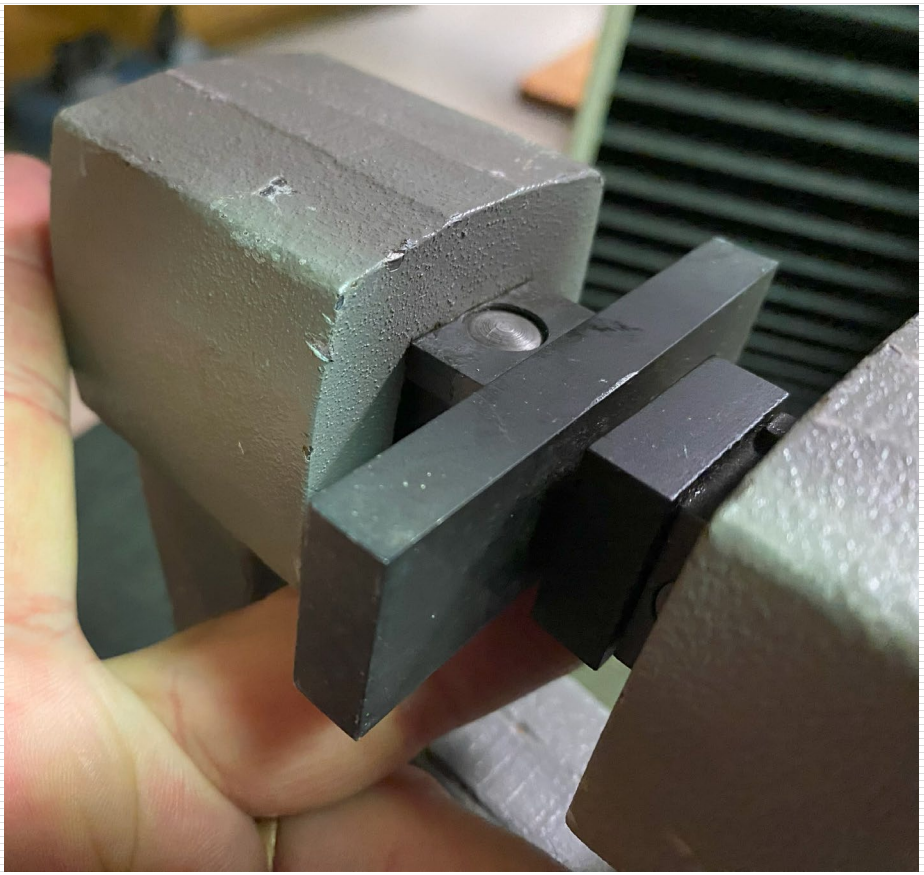
FIG. 1 Illustration of Grab Test

This is not a ASTM D4632 Grab tensile test
5MD & 5X-MD conditioned specimens
4” by 6” (100mm by 150mm)
12 in./min. (300 mm/min.)
Gauge Length 3” (75mm)
Minimum Average
Four Categories plus three conditions:
200-250 lbs (890-1112 N) strength & 20% elongation
Frequency every 50,000 lbs (22,680 kg)

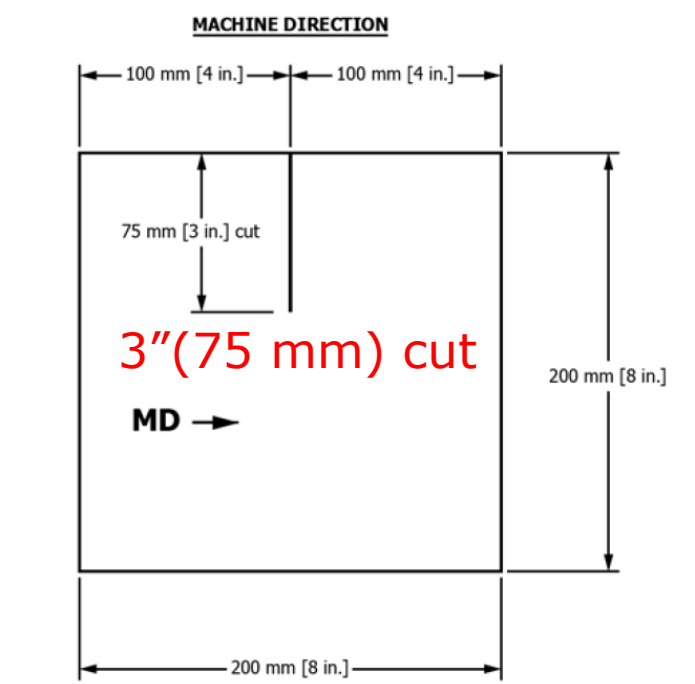
Grab Tensile ASTM D751



Grab Tensile ASTM D751



Trouser Tear ASTM D5884



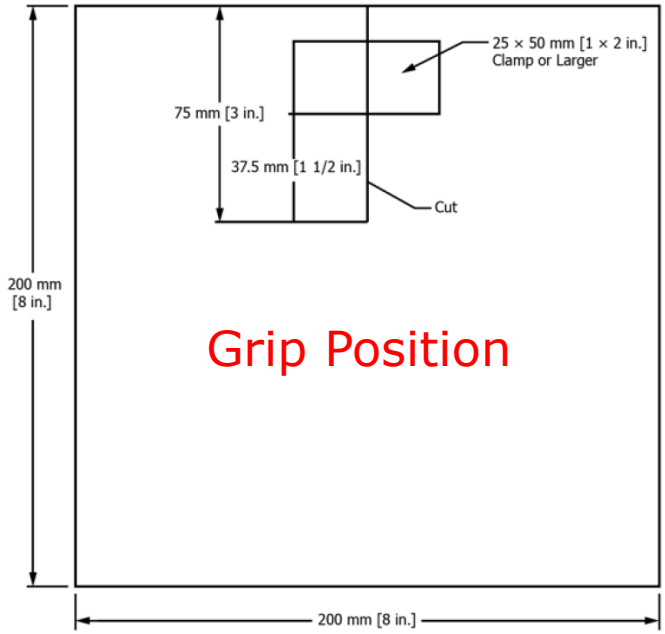
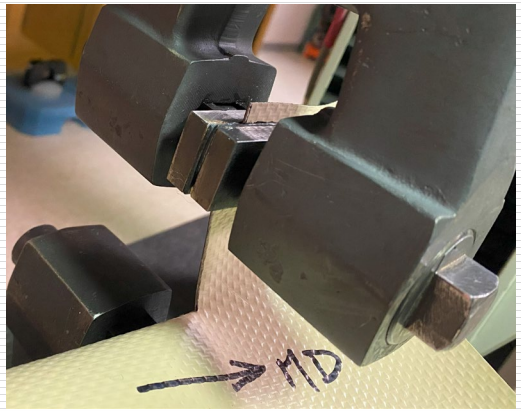
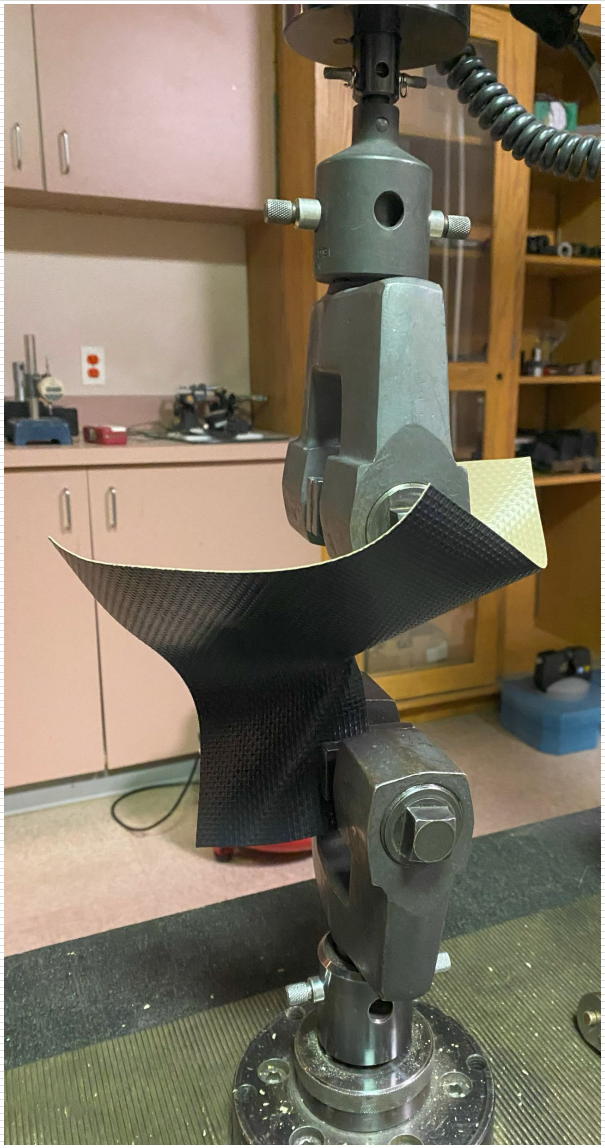


FIG. 2 Location of Clamps

This is not an ASTM D751 test (4” x 8”) 100 mm by 200mm specimen
3” (75 mm) cut/slit
1” by 2”+ (25mm by 50mm+) grips
5 MD & 5 X-MD conditioned specimens
8” by 8” (200 mm by 200 mm)
Minimum Average
Four Categories plus three conditions:
35-65 lbs (156-289 N)
Frequency every 50,000 lbs (22,680 kg)



Trouser Tear ASTM D5884



Hydrostatic Burst ASTM D751

This is not a ASTM D3786 diaphragm burst device
5 conditioned specimens
5” by 5” (125mm by 125mm)
Minimum Average
Four Categories plus three conditions:
 350-800 psi (2413-5516 kPa)
Frequency every 50,000 lbs (22,680 kg)

ASTM D4833 Index Pin Puncture

5 conditioned specimens
4” by 4” (100mm by 100mm)
Minimum Average
Four Categories plus three conditions:
125-300 lbs (556-1334 N)
50,000 lbs (22,680 kg) frequency

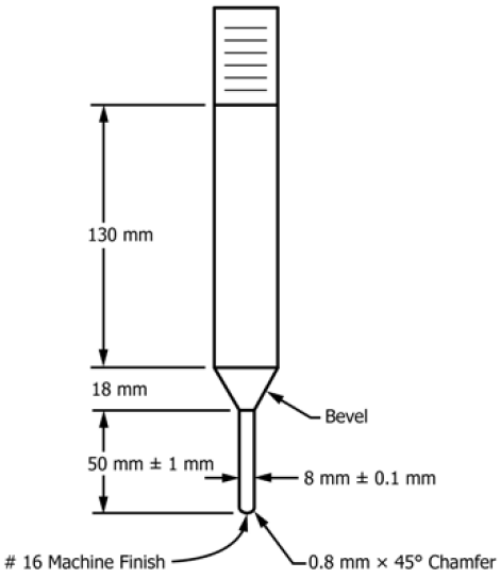
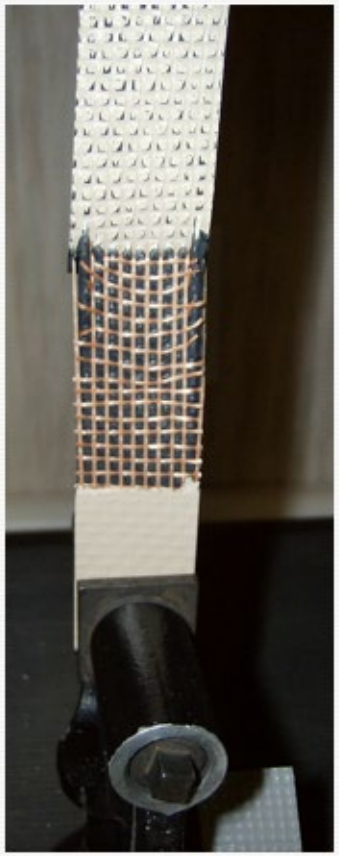
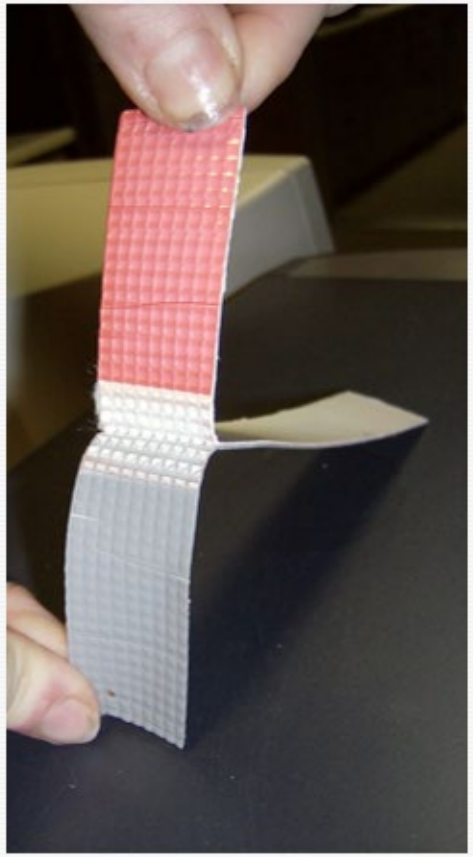


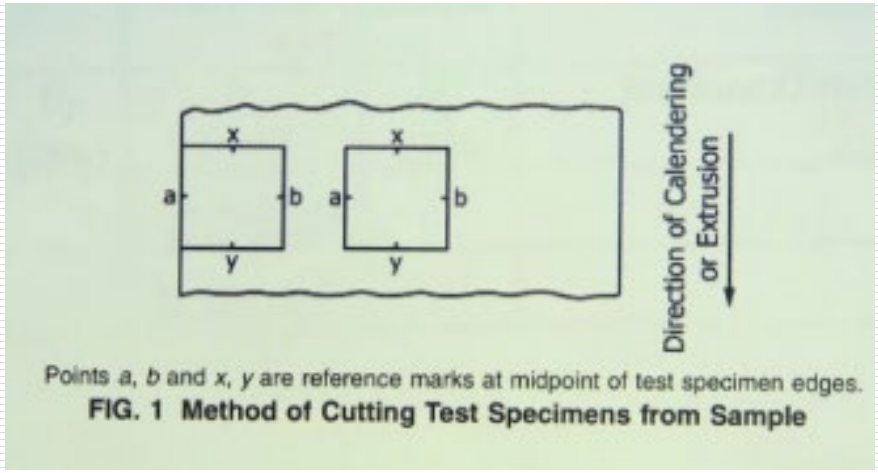
FIG. 3 Test Probe Detail (Not to Scale)

Ply Adhesion ASTM D6636

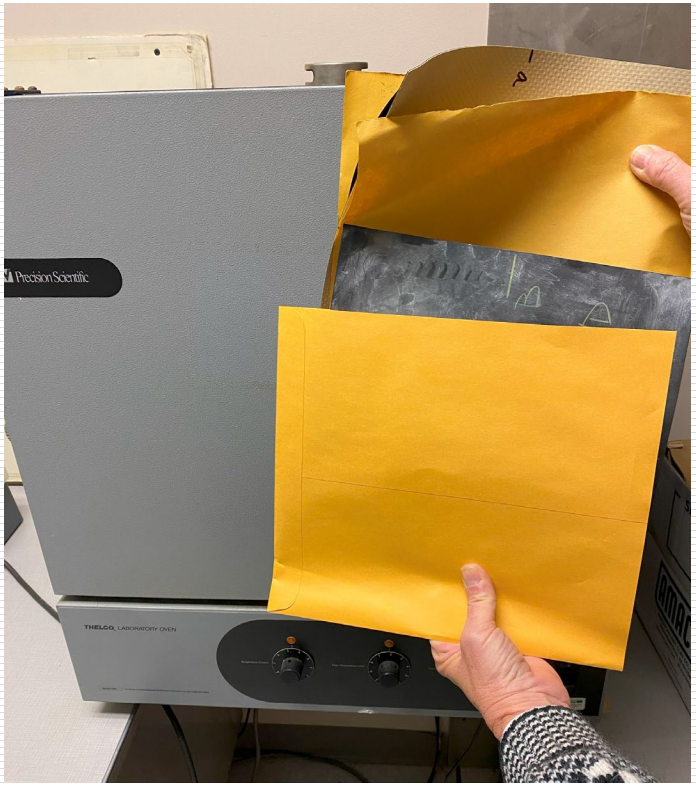
5 conditioned specimens
1” by 8” (25mm by 200mm)
2 in./min. (50 mm/min.) over 4” (100 mm)
Minimum Average of highest force recorded
Four Categories plus three conditions:
15 ppi (2.6 N/mm) ply adhesion is not tearing
Frequency every 50,000 lbs (22,680 kg)

Dim. Stability ASTM D1204



Points *a*, *b* and *x*, *y* are reference marks at midpoint of test specimen edges.

FIG. 1 Method of Cutting Test Specimens from Sample

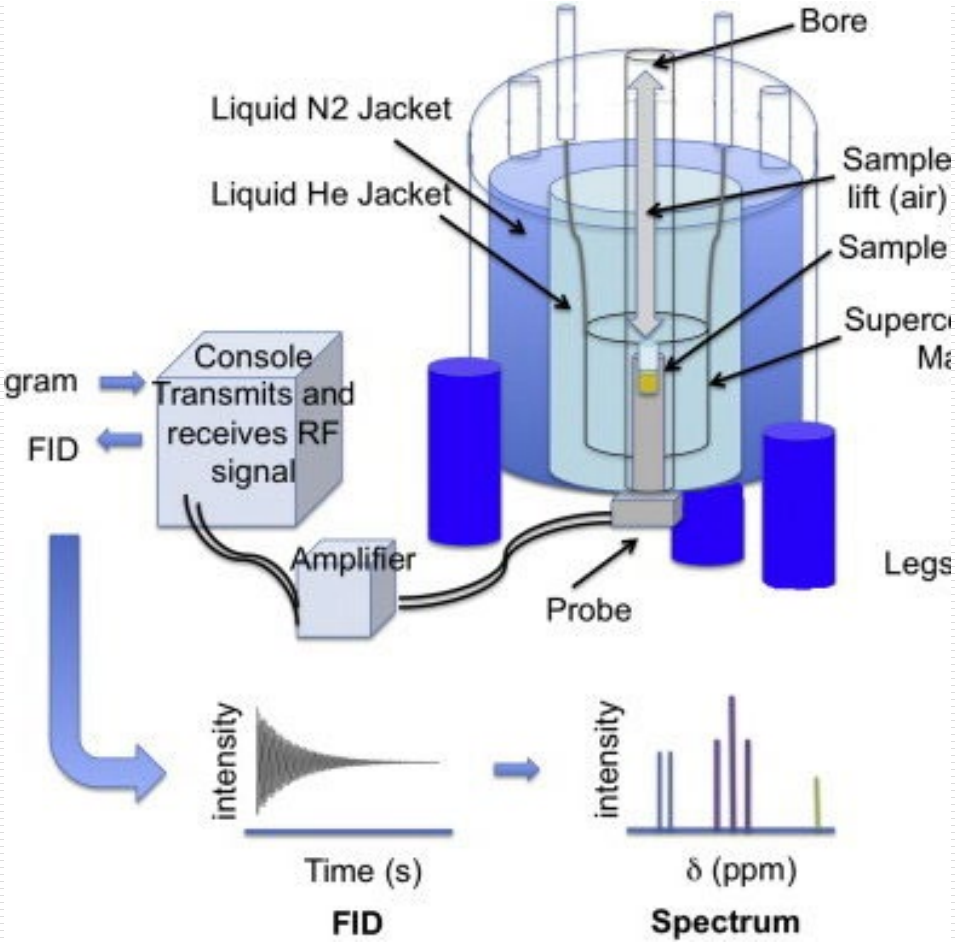


2 conditioned specimens
10” by 10” (250 mm by 250mm)
Talc and Cardboard
1 hour in 100°C Force Air Oven
Gauge Length 3” (75mm)
Minimum Average 1%

Chemical Fingerprinting and Endurance Testing

1. There is a big delineation in Table 1a & 1b
2. You do not want to test EIA geomembranes with scrim for the following four tests
    - H-NMR
    - Chlorine
    - Oven
    - QUVA
3. Conducted on nonreinforced ply of EIA geomembrane
4. Test performed on a per formulation basis
5. Definition of a formulation?
6. Preferably conducted on a 30 mil (0.75mm) ply

ASTM D8154 Nuclear Magnetic Resonance Spect. (H-NMR)



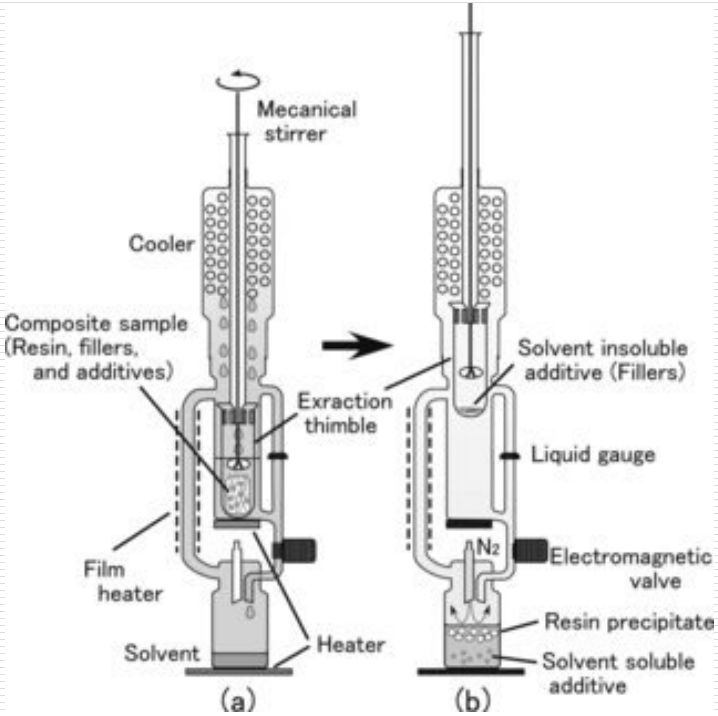
PVC 30%

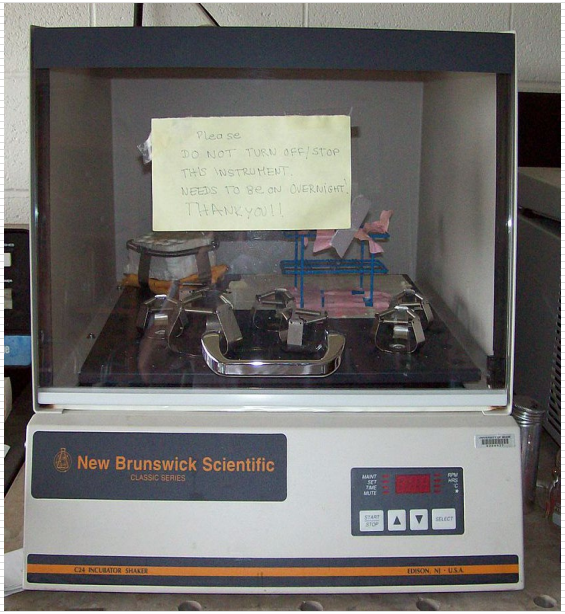
&

KEE 10%

Thank you Cooley Inc.
Has supplied a list of five (5) Universities that conduct this test

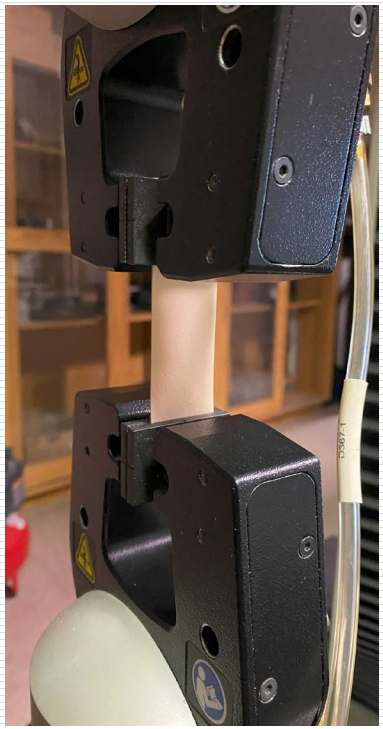
Extraction, 70-80% Effective





We need to standardize technique going forward!

Strip Tensile ASTM D882



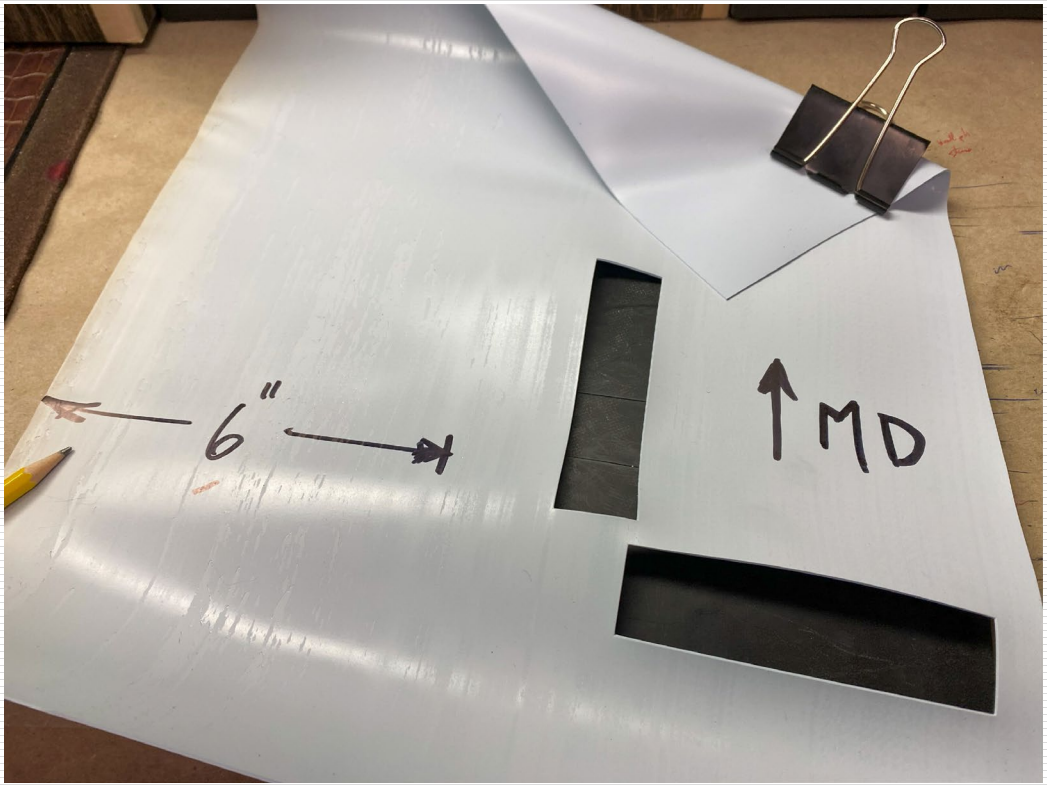
ASTM E4 CRE Device w/ good grips
5 conditioned specimens
1.0” (25 mm) wide die cut specimen
GS=GL= 2.0” (50mm)

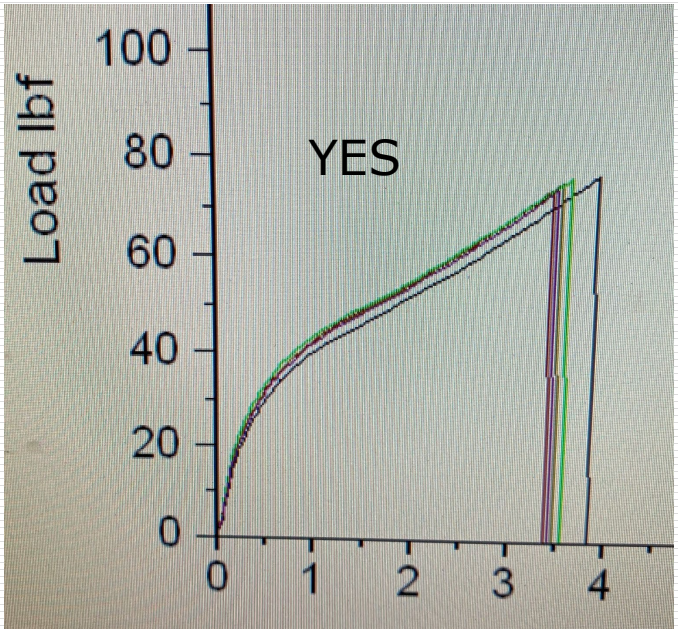
Minimum Average Strength & Elongation

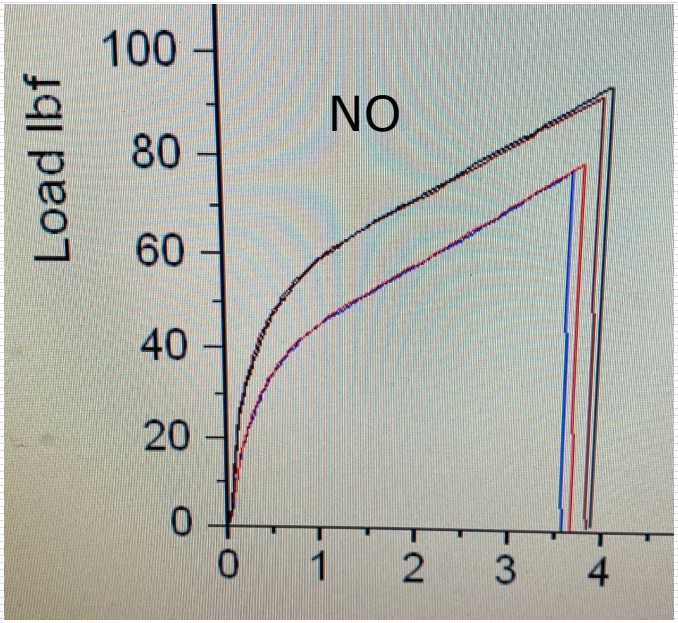
ISOTROPY
5% ?

4 Specimens
2 MD
2 X-MD

Traceability very important!

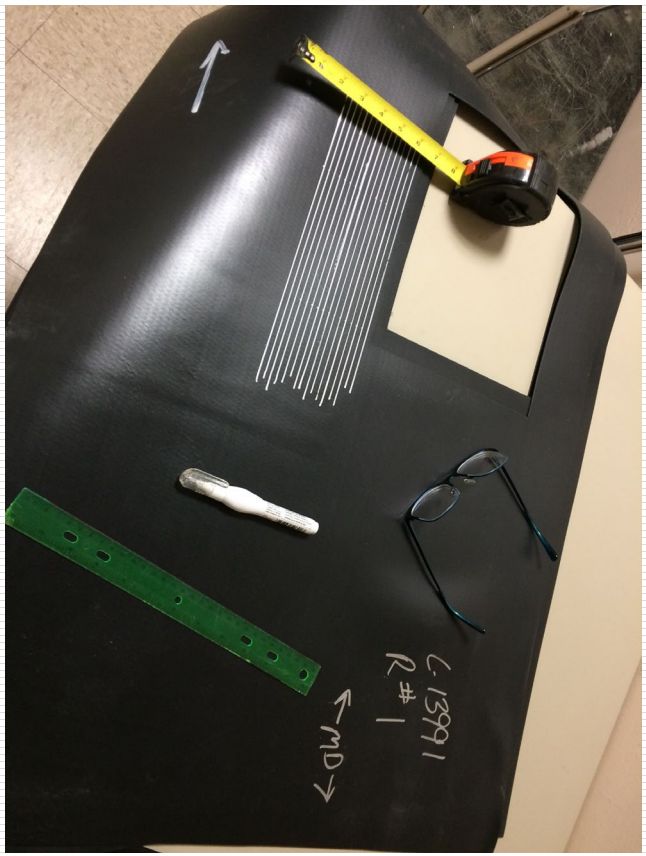


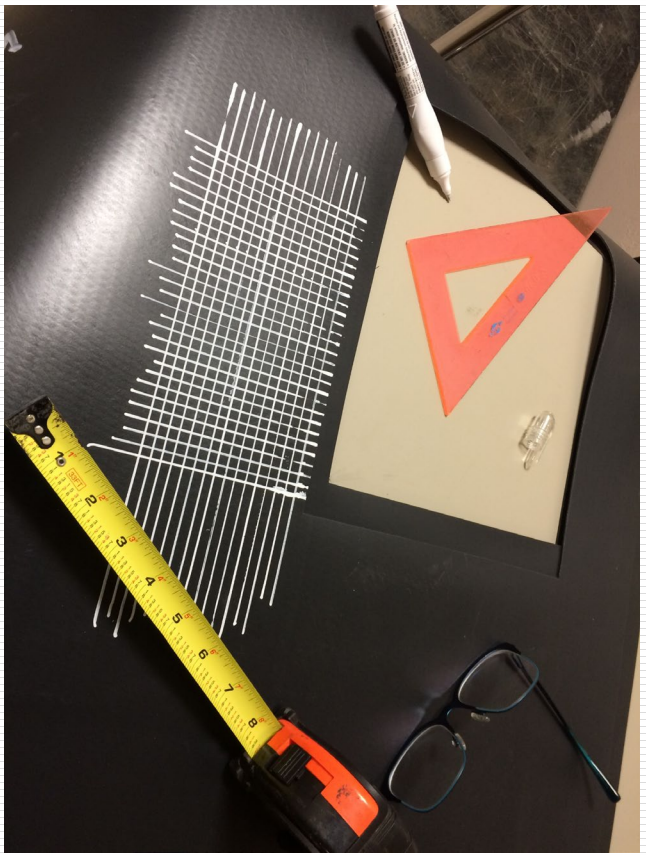


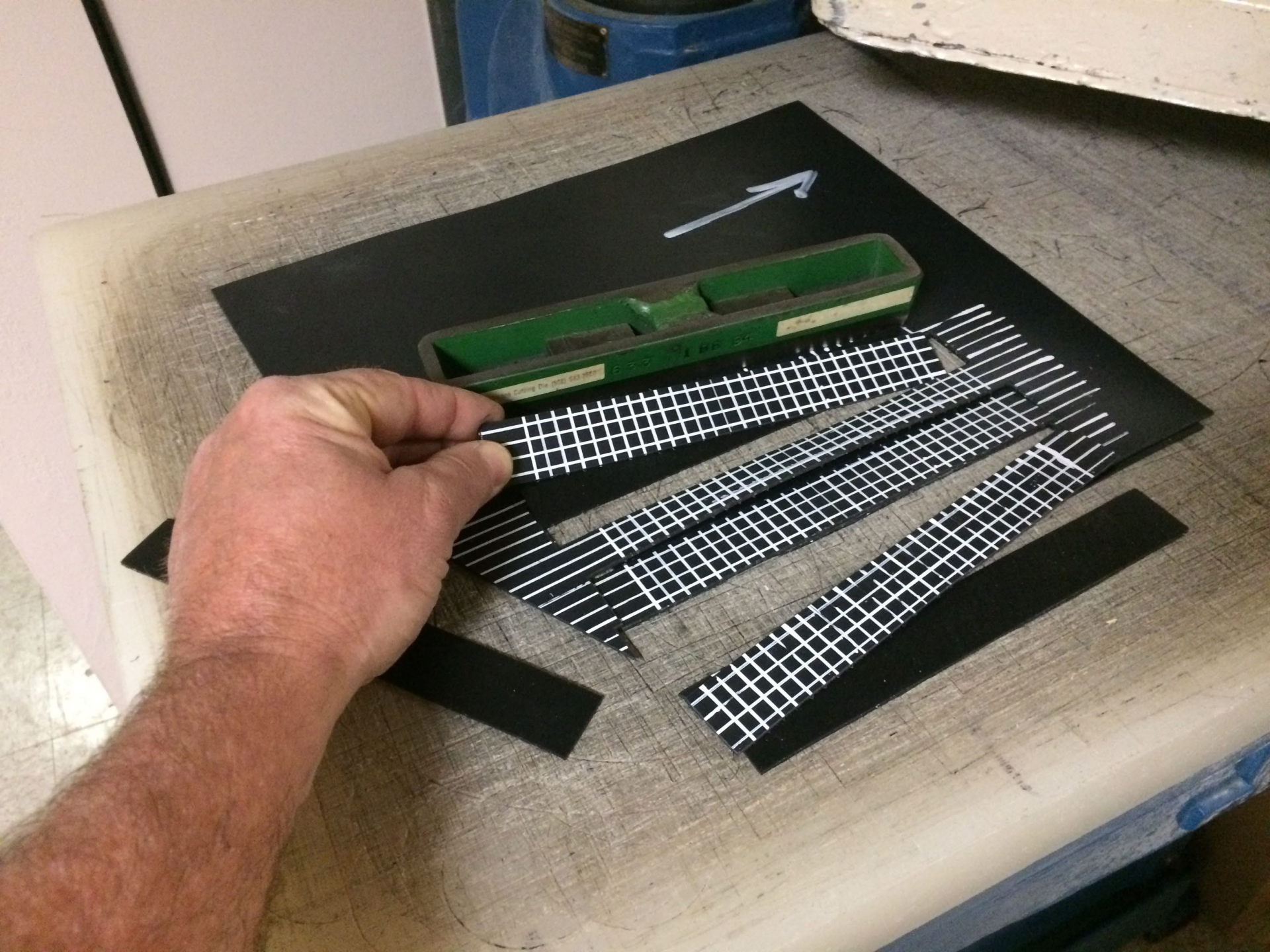


If "NO" may double the amount of Testing

Preparing Specimens with X-Y white marking on PVC surface

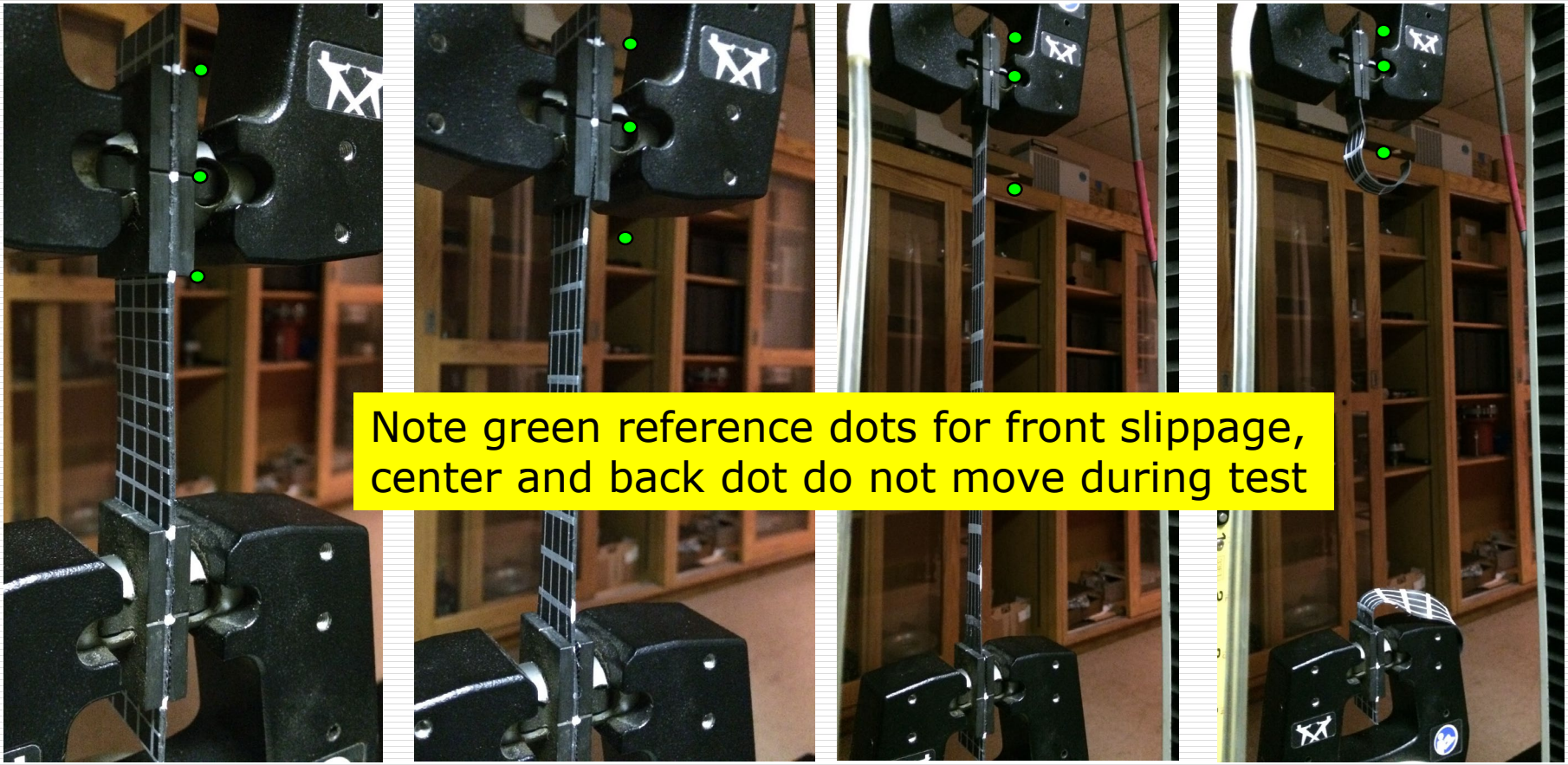







INSTRON
1 kN

Serrated Steel Grip Faces

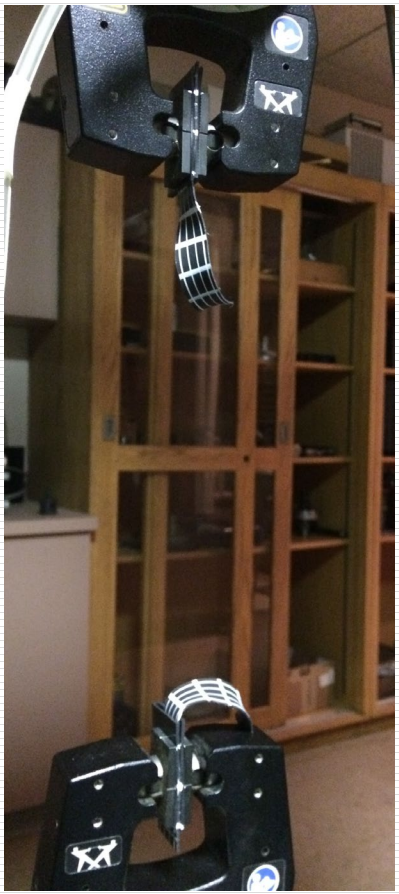


Start of Test

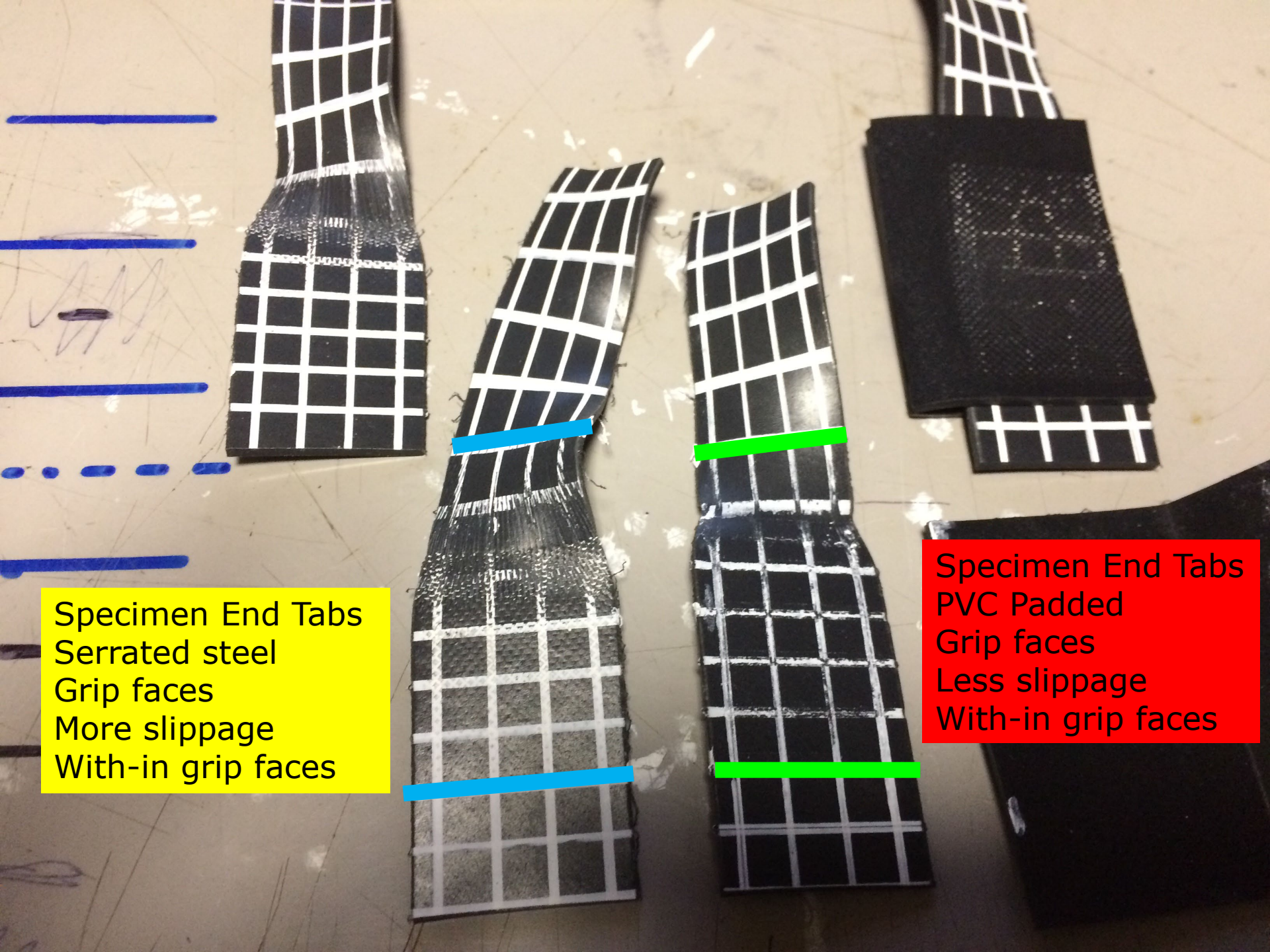
End of Test

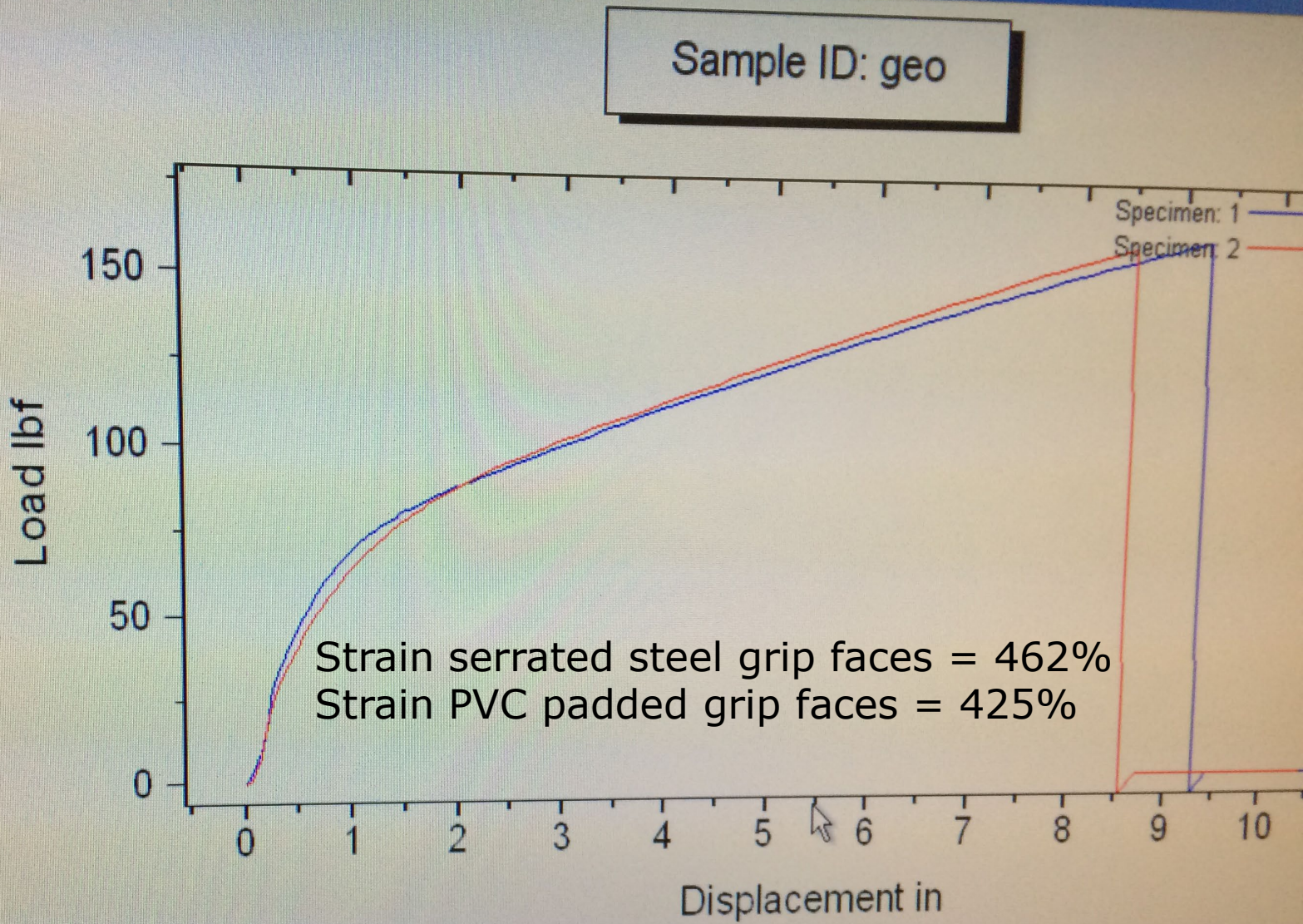
PVC Padded Grip Faces

Start of Test



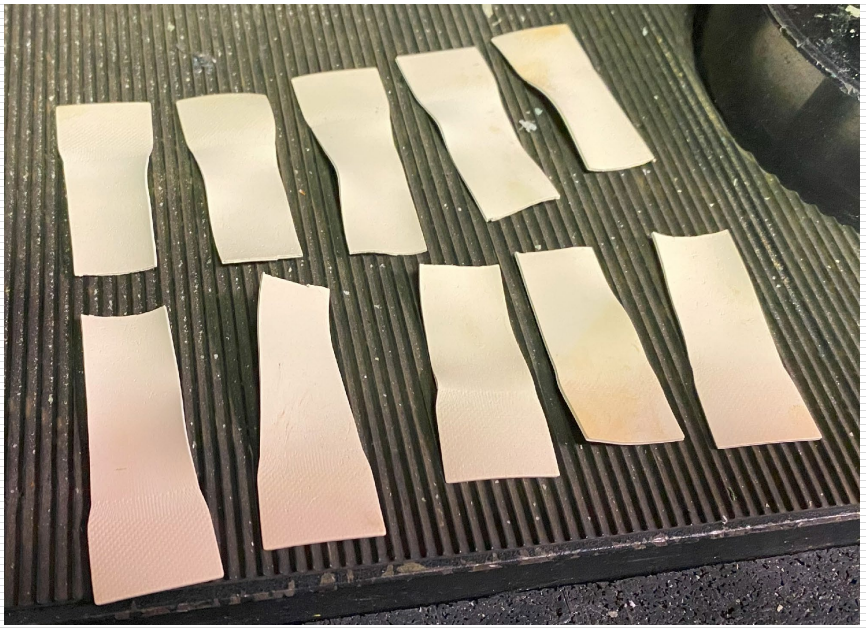
End of Test

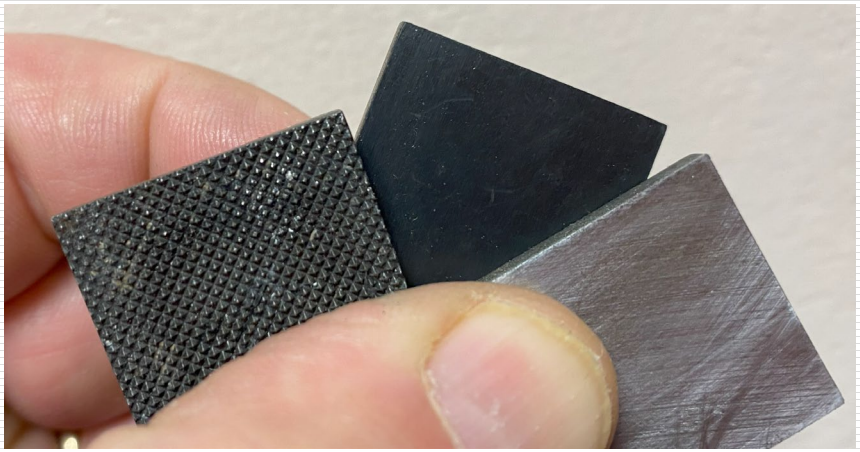

Specimen End Tabs
Serrated steel
Grip faces
More slippage
With-in grip faces
Specimen End Tabs
PVC Padded
Grip faces
Less slippage
With-in grip faces



Test Results

Sp No	MAX.LOAD (lbf)	MAX.DISP (in)	BRK.LOAD (lbf)	BRK.DISP (in)
1	162.0	9.242	162.0	9.242
2	159.6	8.504	159.6	8.504

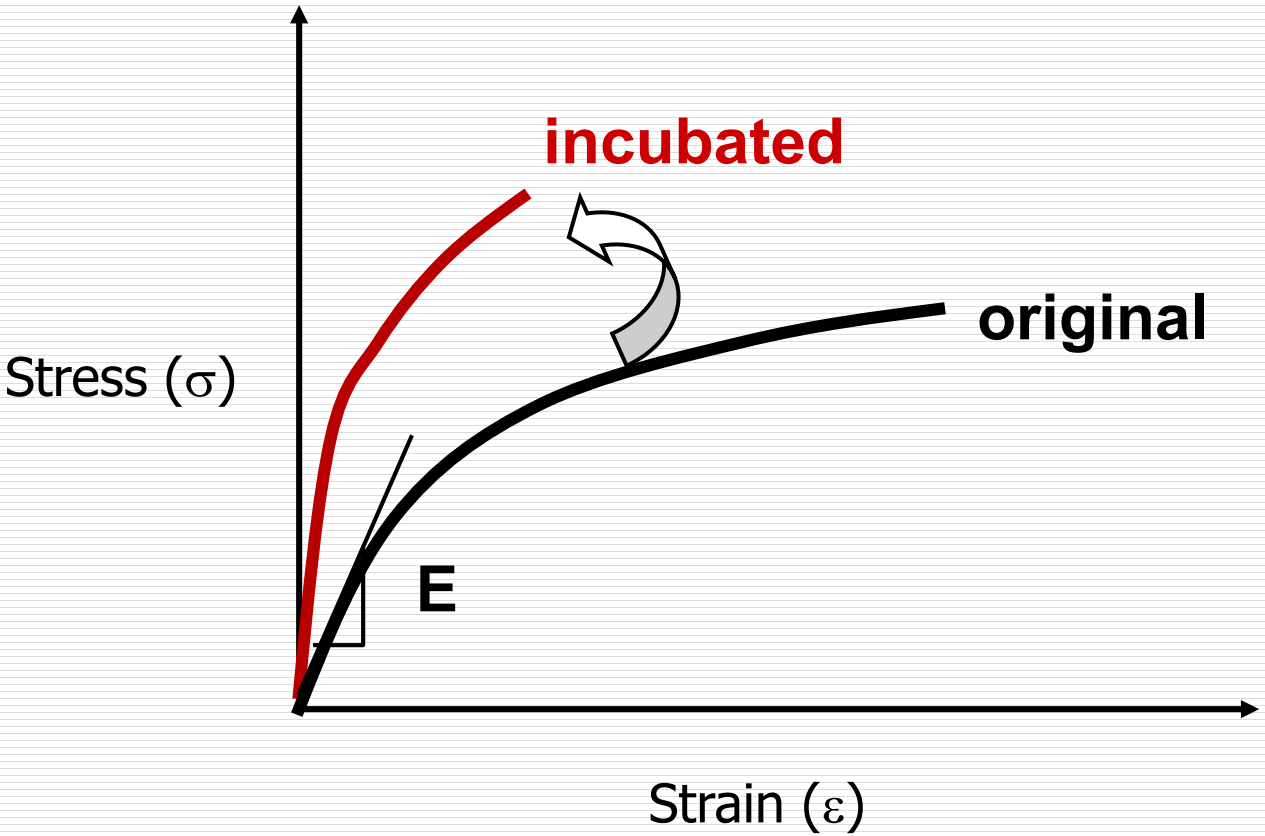




1. Grip face and or clamp can not initiate the failure
2. At start of test there should be no tension on the specimen
3. Must have failure (rupture) within the gauge length
4. Be consistant

In General

Exposure will cause ductile-to-brittle behavior

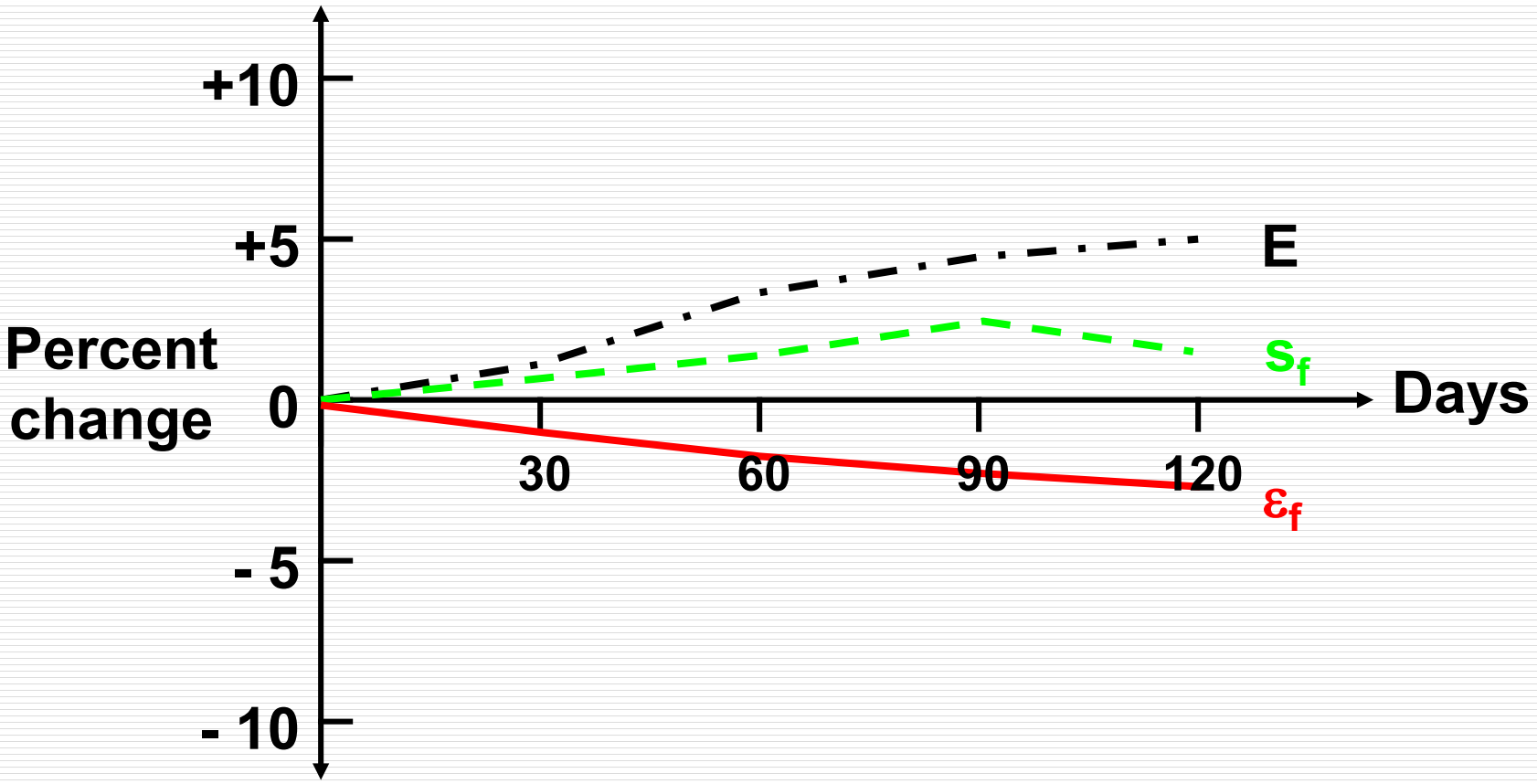


ε_f decreases

E increases

σ_f increases

Hypothetical Response



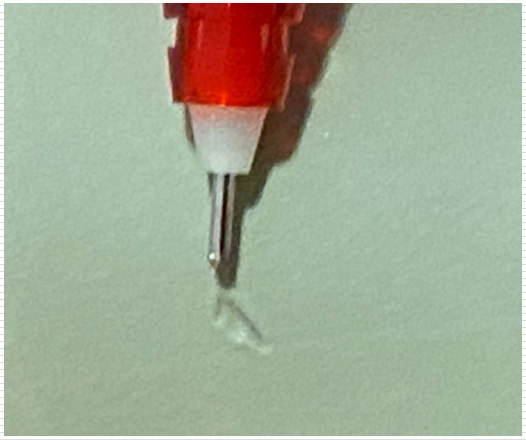
Specimen Preparation

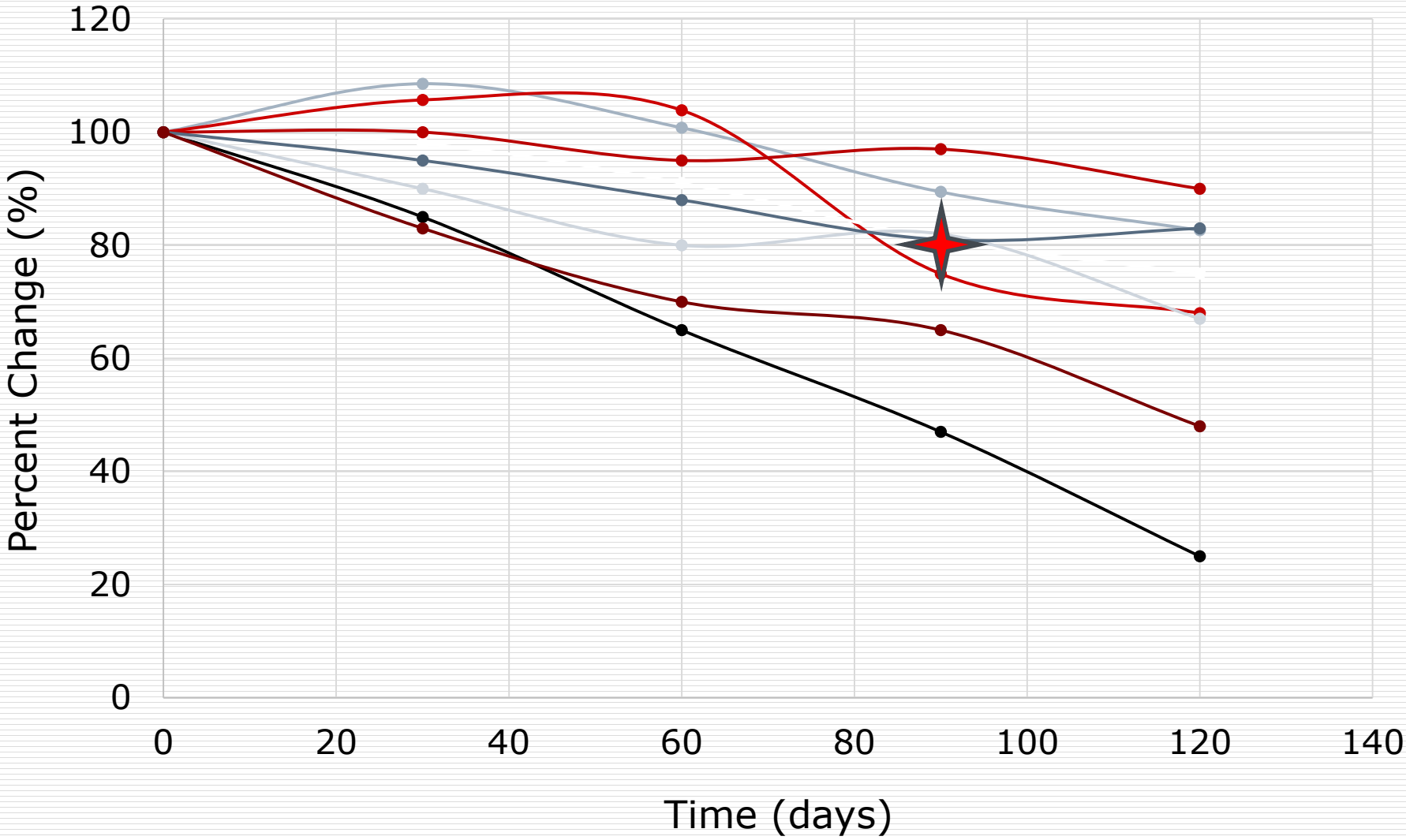
GRI GM24 Chlorine Aging 50°C, 90 days & 10 PPM ASTM D882 strip tensile


CLEAN MONTHLY
SEE INSTRUCTION MANUAL
FOR PROPER FLUSH
CAUTION
HOT
SURFACE
ATTENTION
SURFACE
CHAUD
OFF
228

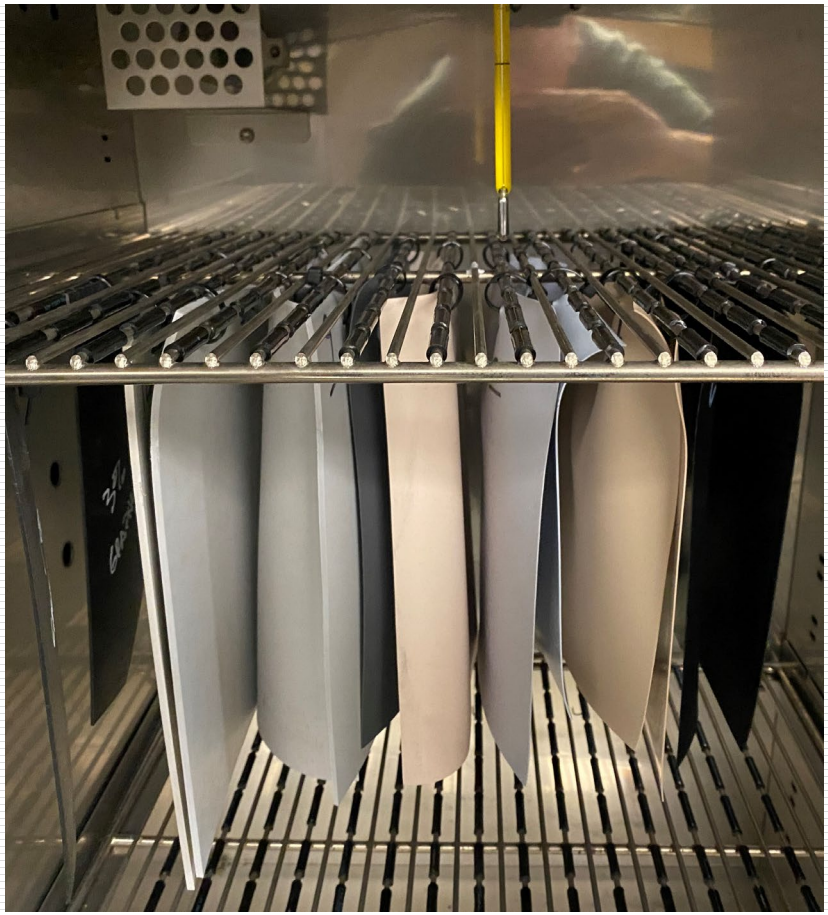

ints®
Goal Setting
Decision Making

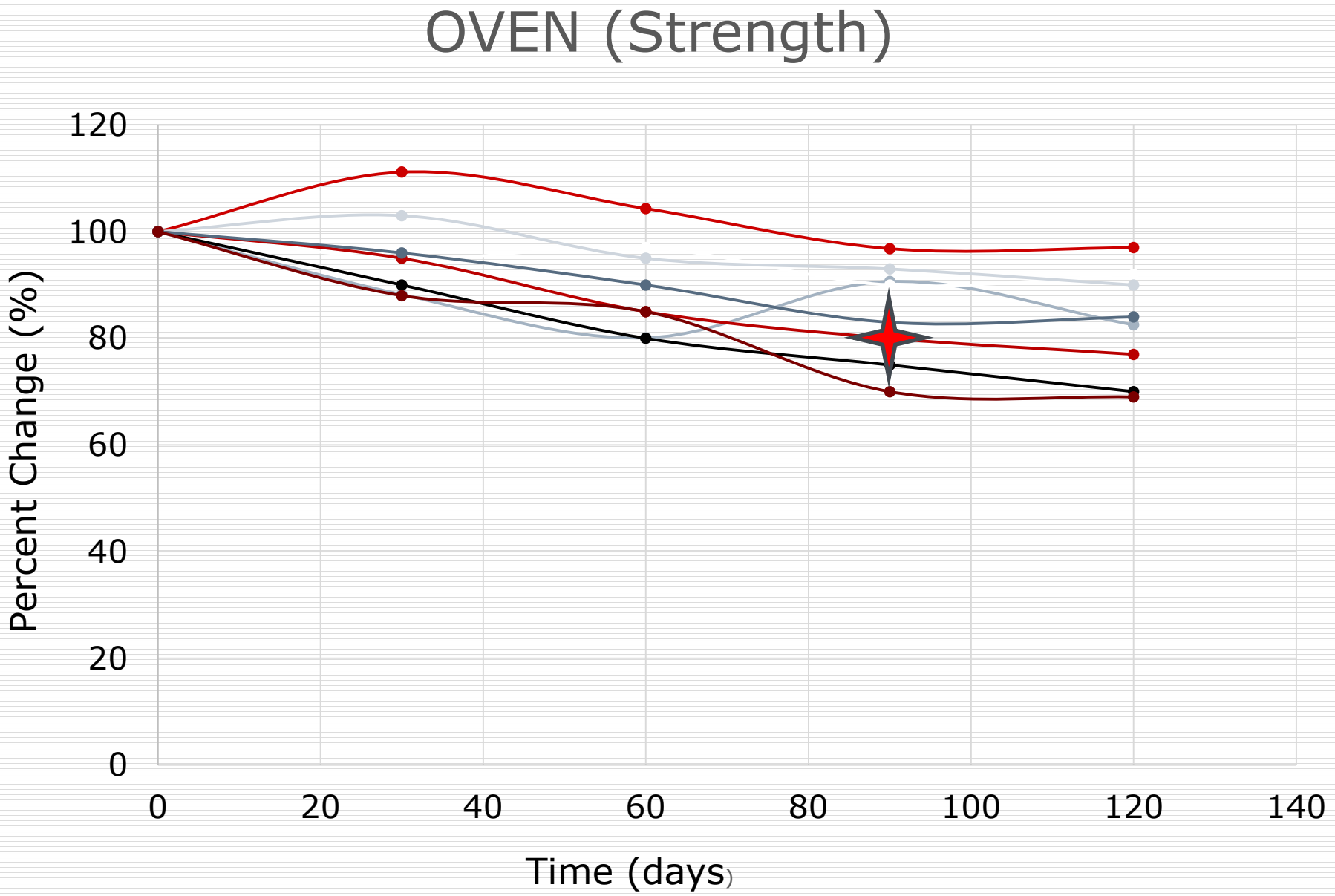
Observations

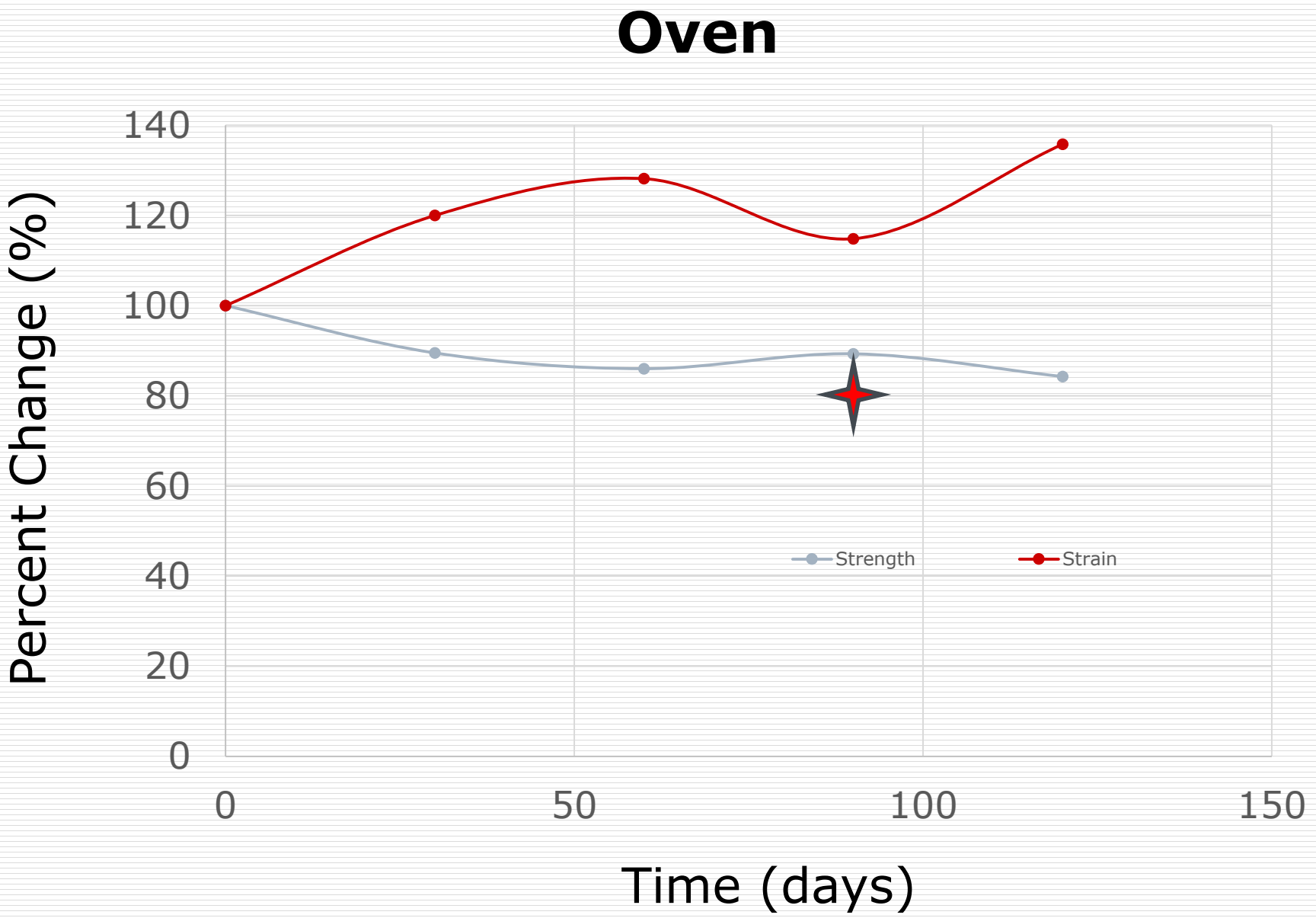



CHLORINE (Strength)
120
100
80
60
40
20
0
Percent Change (%)
0
20
40
60
80
100
120
140
Time (days)

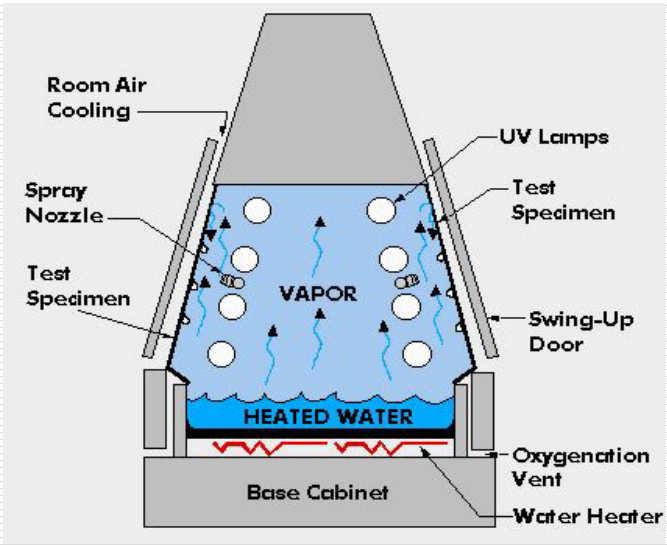
ASTM D5721 Oven Aging
85°C 90 days
ASTM D882 strip tensile

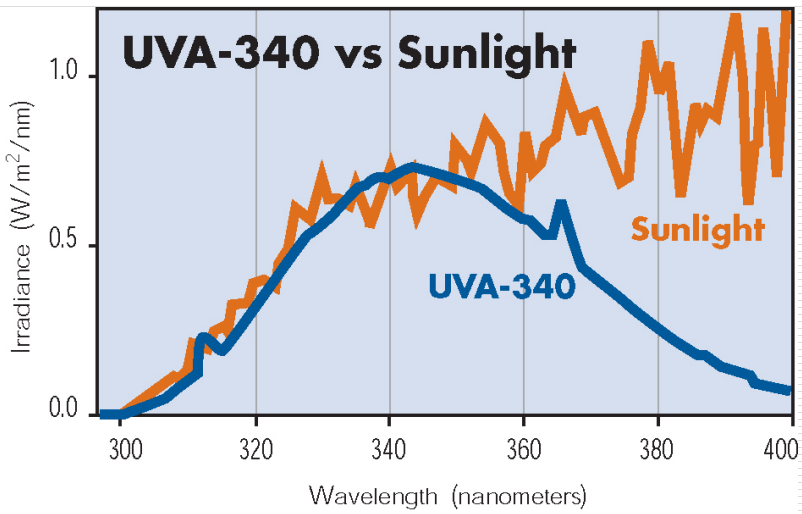



OVEN (Strength)
120
100
80
60
40
20
0
Percent Change (%)
0
20
40
60
80
100
120
140
Time (days)

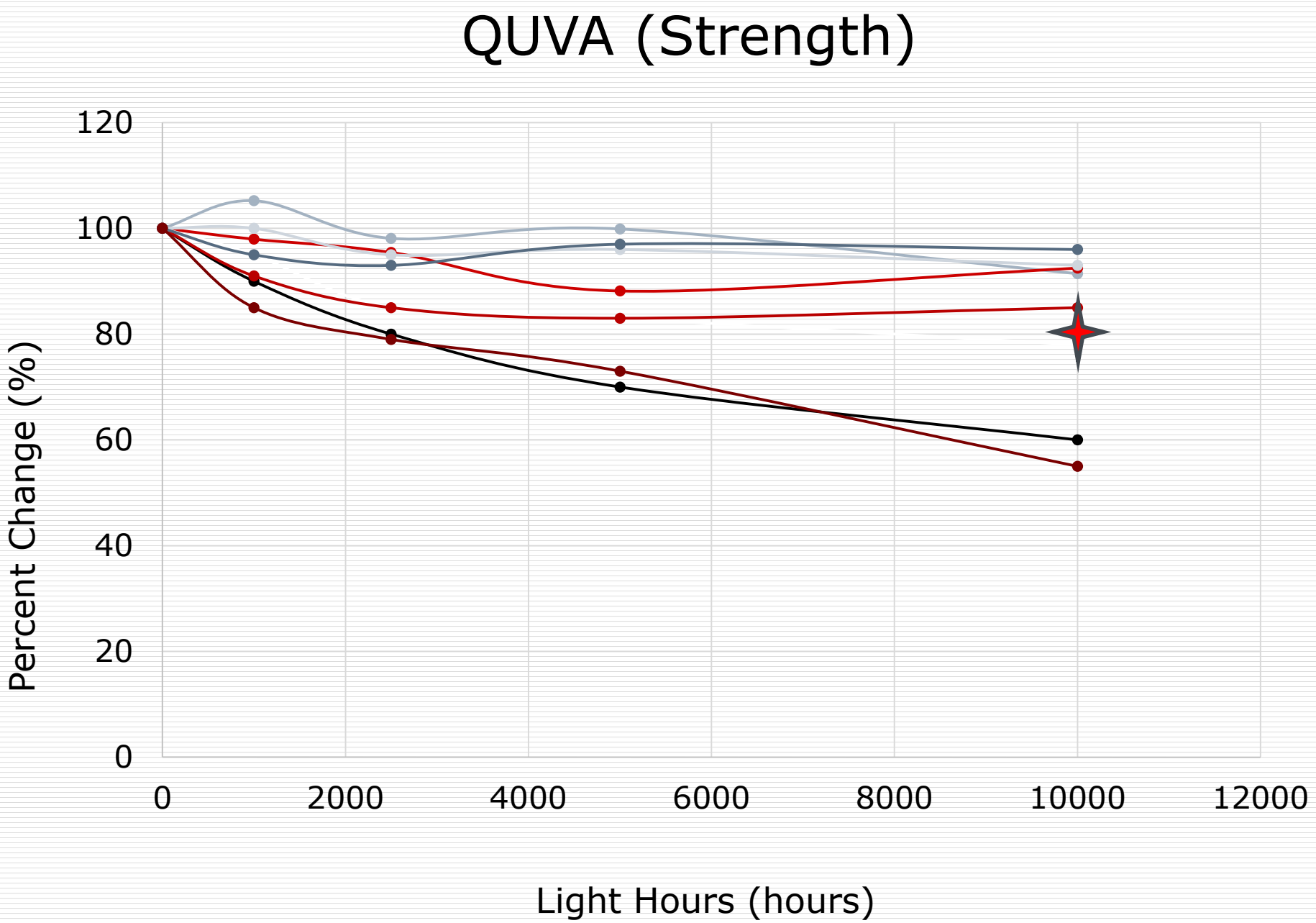

Oven
Percent Change (%)
140
120
100
80
60
40
20
0
0
50
100
150
Time (days)
Strength
Strain

ASTM D7238 QUVA
75°C for 10,000 light hours
ASTM D882 strip tensile





Method & Practice


QUVA (Strength)
120
100
80
60
40
20
0
Percent Change (%)
0
2000
4000
6000
8000
10000
12000
Light Hours (hours)

Questions-Discussion

Thanks for the opportunity