

# Weathering of Flexible Intermediate Bulk Container (FIBC) Materials

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the morning  
presentation.](#)

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the afternoon  
presentation.](#)

# Housekeeping

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- Our ongoing webinar series can be found at: [q-lab.com/webinarseries](https://q-lab.com/webinarseries)
- Our archived webinars are hosted at: [q-lab.com/webinars](https://q-lab.com/webinars)
- Use the **Q&A feature in Zoom** to ask questions live!



We make testing simple.



Thank you for attending our webinar!

We hope you found our webinar on *Weathering of FIBC Materials* to be helpful and insightful. The link below will give you access to the slides and recorded webinar.

You can help us continue to provide valuable and high quality content by completing our [3-question survey](#) about your webinar experience. Every piece of feedback is carefully reviewed by a member of our team.

We consistently hold seminars and webinars about weathering, corrosion, standards and more. The best way to keep up with news and events is by following us on [Facebook](#), [Twitter](#) and [LinkedIn](#).

Today's webinar was part of a weekly series on weathering and corrosion. You can register for the remaining webinars in the series or watch previous ones [here](#).

Click [here](#) to download the presentation. You'll find a link to the recording on the title slide.

# Weathering and Testing of FIBC Materials

# Flexible Intermediate Bulk Containers (FIBC)

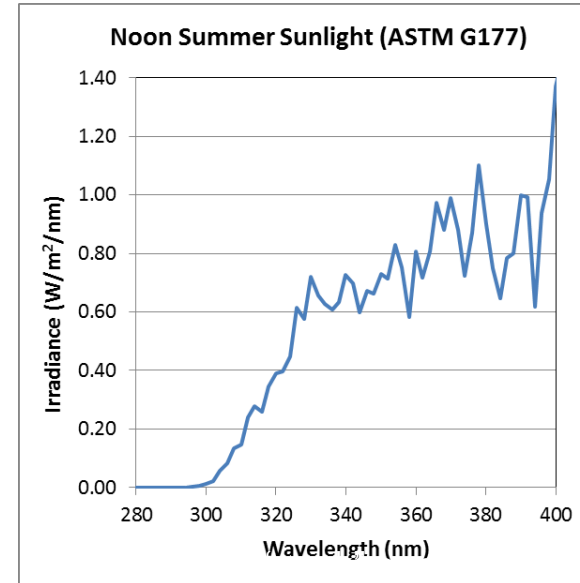
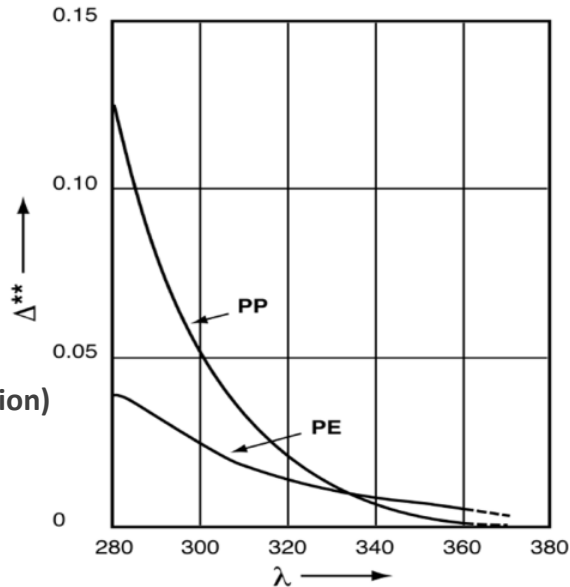
- Made from woven polypropylene fabrics
- Low price
- High risk and liability
- Used in many service environments
- Recycling and reuse concerns



# UV Light Degradation of FIBCs

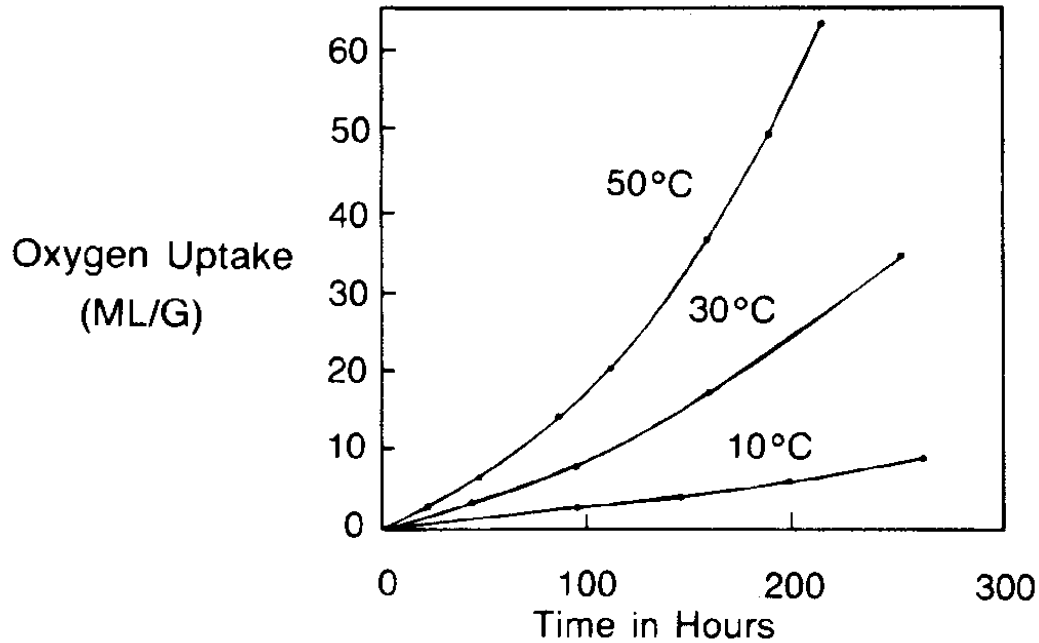
Without UV stabilizers, this happens fast!

↑  
Carbonyl Formation  
(measure of degradation)



# Temperature Effects

- Polyethylene degradation from oxidation is accelerated by higher temperatures
- Not all materials share this characteristic

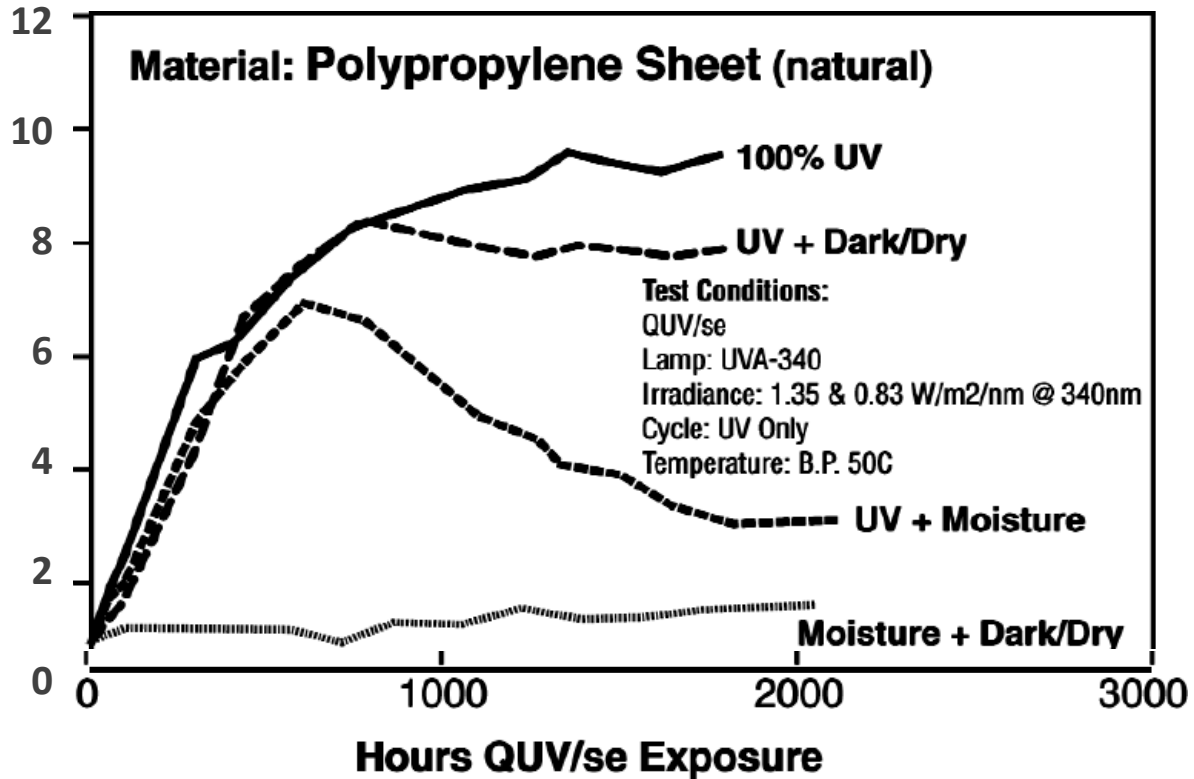


# Moisture Effects

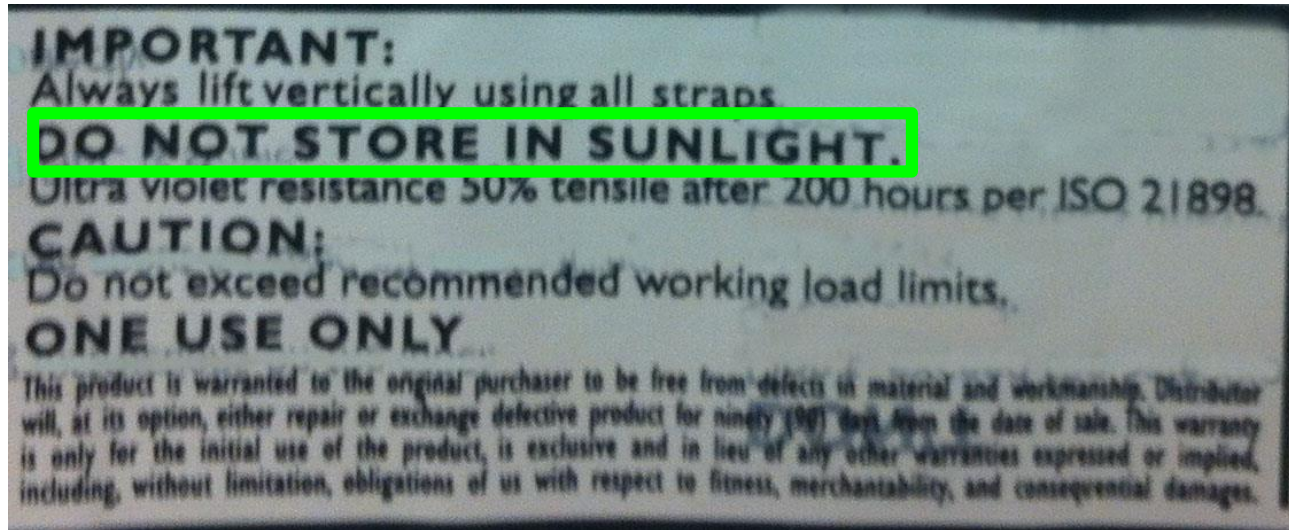
Delta b  
(yellowing)



Degradation



# FIBC UV Resistance Label



**Not everyone follows this recommendation!**

This is why weathering testing is required



# Weathering Technologies

- Natural outdoor
- *Accelerated outdoor (Q-TRAC<sup>®</sup>)*
  - *Produced too much heat for materials in this study*
- Fluorescent UV (QUV<sup>®</sup>)
- Xenon arc (Q-SUN<sup>®</sup>)

# FIBC Natural Outdoor Exposures



# Accelerated Testing: Xenon Arc

- Simulates full- spectrum sunlight
- Optical filters for various simulations
- RH Control
- Water Spray
- Test standards:  
ISO 4892-2, ASTM G155

## Q-SUN Xe-3



## Xenon arc lamp



## Optical filter



# Accelerated Testing: Fluorescent UV

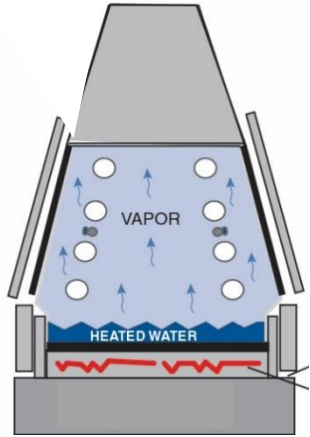
- Simulates UV portion of spectrum
- Two common lamp types
- Condensing humidity
- Optional water spray
- Test standards: ISO 4892-3  
ASTM G154, **ISO 21898**



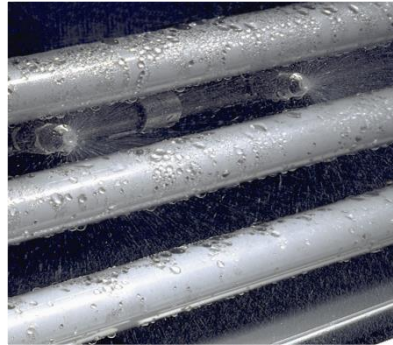
# Accelerated Test Comparison: Water

## UV Fluorescent

Condensation



Water Spray



## Xenon arc

Relative Humidity

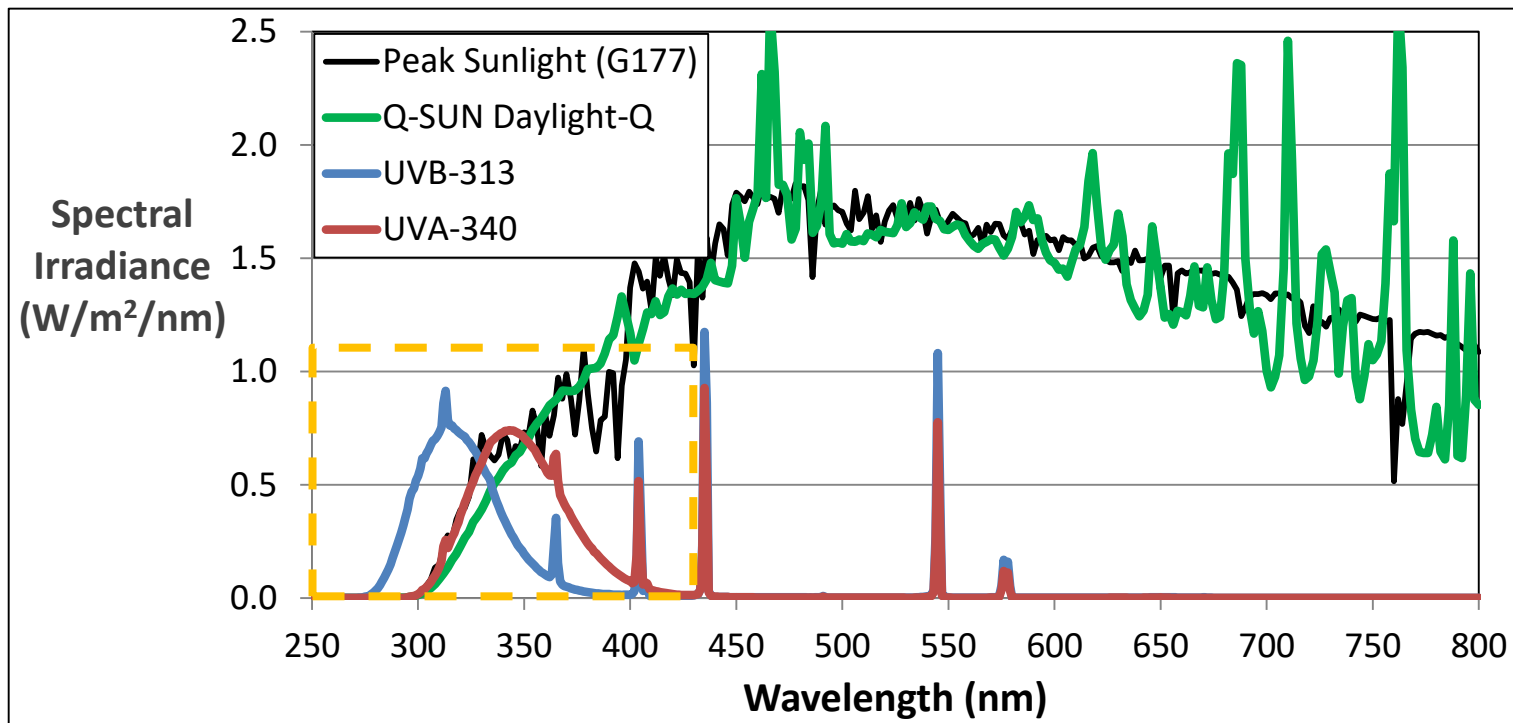


Water Spray



*Water delivery plays a critical role in accelerated tests*

# Accelerated Test Comparison: Light

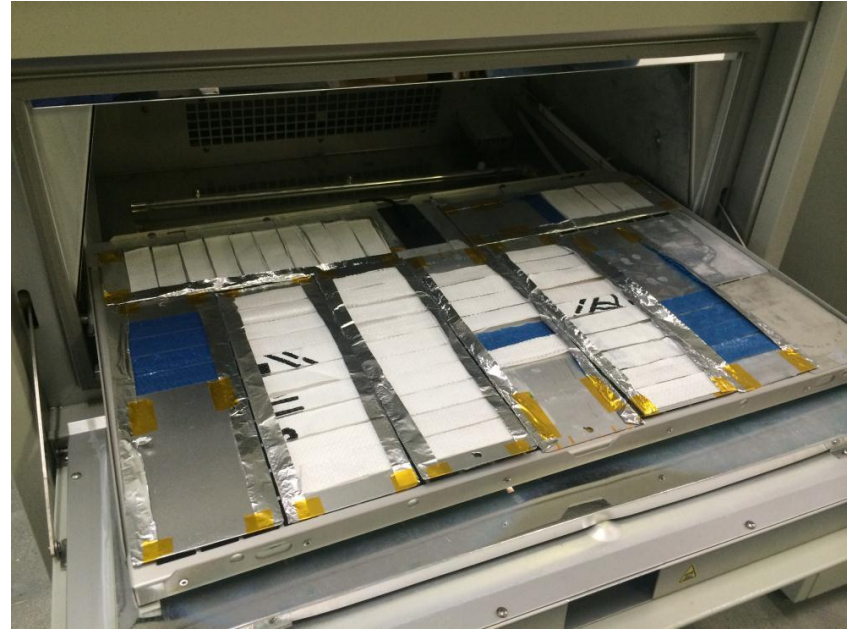


*Accelerated testing often involves tradeoffs between speed and realism*

# QUV test setup



# Q-SUN test setup



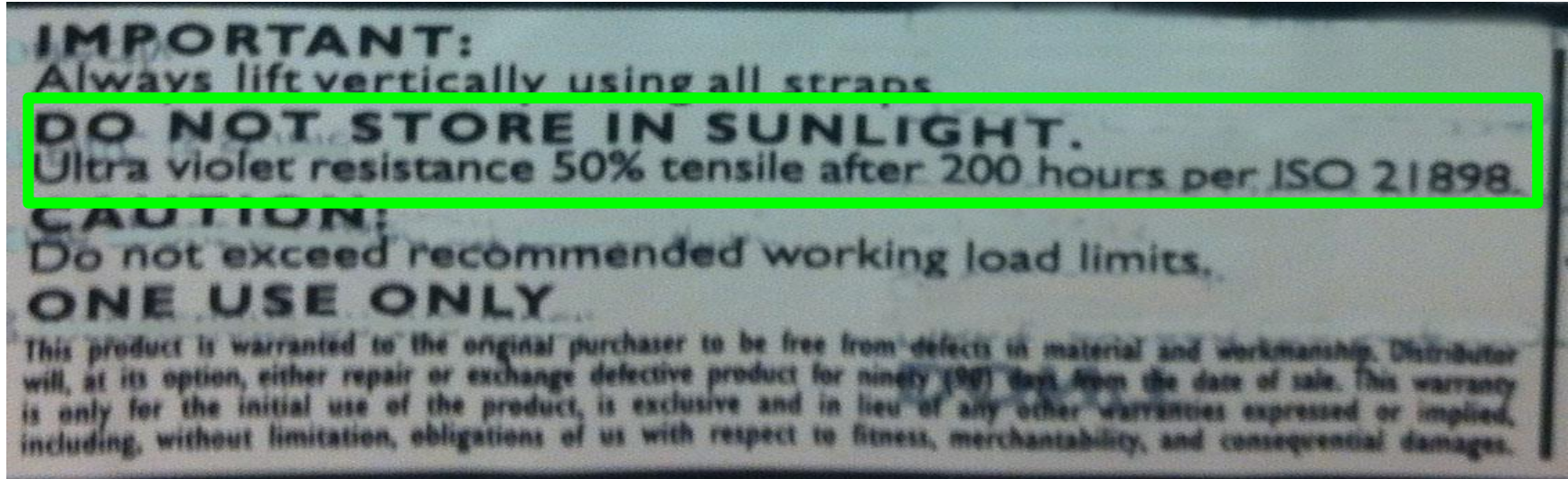


# FIBC Weathering Test Study

# FIBC Weathering Test Overview

- Weathering test study was conducted to develop correlation between tensile strength loss observed in **Accelerated Laboratory** testing and **Natural Outdoor** testing
- **Six** different fabric suppliers evaluated, effects of weight and  $\text{CaCO}_3$  additive considered.
- **Warp** (machine) and **weft** (cross) both tested separately
- Accelerated laboratory testing conducted with **fluorescent UV** (ultraviolet) apparatus (QUV)
- Outdoor exposures conducted in **Florida** and **Arizona**
- **50% tensile strength retention** used as performance threshold

# FIBC UV Resistance Label



# ISO 21898

## Packaging — Flexible intermediate bulk containers (FIBCs) for non-dangerous goods Annex A: UV Resistance test

- **A.2 Principle:** “Test specimens are alternately exposed to UV light alone and to condensation alone in a repetitive cycle.”
- **A.4 Procedure:** “Expose a test specimen to a fluorescent UV lamp **for at least 200 h**, using a test cycle of 8 h at 60 °C with UV radiation, alternating with 4 h at 50 °C with condensation.”



# ISO 21898: Questions

- **Question 1: What does “200 hours” mean**
  - 200 hours total test time? *or...*
  - 300 hours total test time including : 200 hours of UV exposure and 100 hours of dark condensation
- **Question2: What is the irradiance setpoint?**
  - It is not specified in the standard
  - ASTM G154 allows many irradiance levels
  - 0.71 W/m<sup>2</sup>/nm at 310 nm is commonly used and referenced as ASTM G154 Cycle 2 for UVB lamps

# Outdoor Test Protocol

- **Test Locations:** Florida, Arizona
- **Exposure Type:** Direct Weathering
- **Exposure Angle:** 45° South - Standard for General Weathering Test
- **Exposure Backing:** Plywood - Standard for Flexible Materials
- **Test duration:** 12 Months
- **Strength Evaluations:** After 3, 6, and 9 months

***Outdoor exposure is the true benchmark!***

# Accelerated Test Protocol

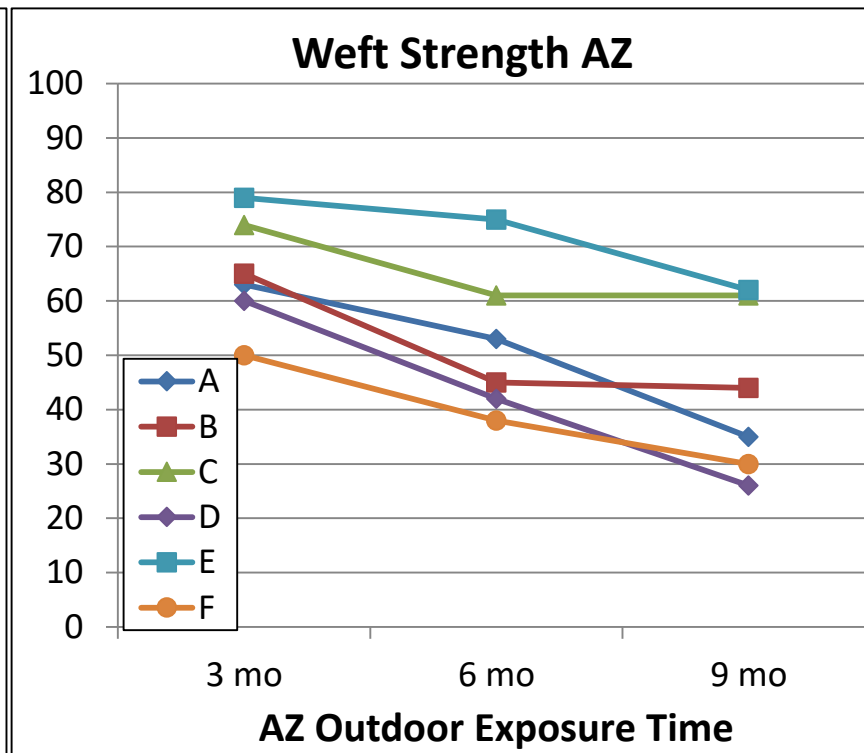
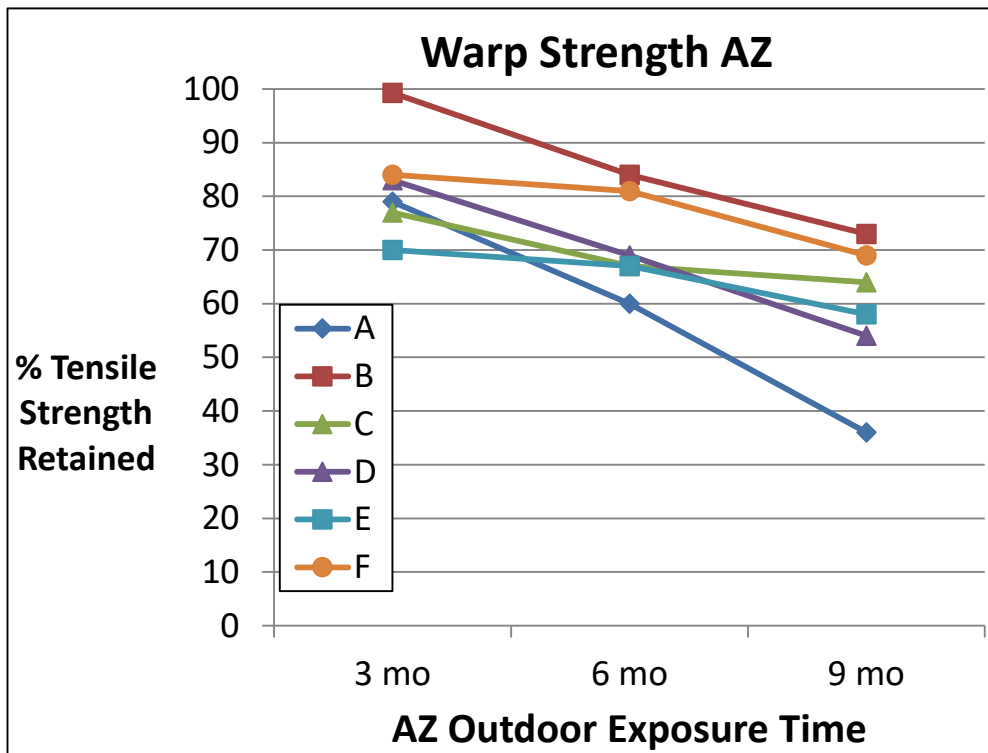
- **Test Standard:** ISO 21898 2004 Annex A
- **Light source:** UVB-313 lamps
- **Test Cycle:** UV exposure for 8 hours at 60 °C, alternating with condensation exposure for 4 hours at 50 °C
- **Irradiance** 0.71 W/m<sup>2</sup>/nm @ 310 nm.
- **Specimen repositioning:** Three times per week
- **Strength Evaluation:** every 100 hours

*Goal is to use accelerated testing to validate FIBC materials more quickly*

# FIBC Weathering Test Results

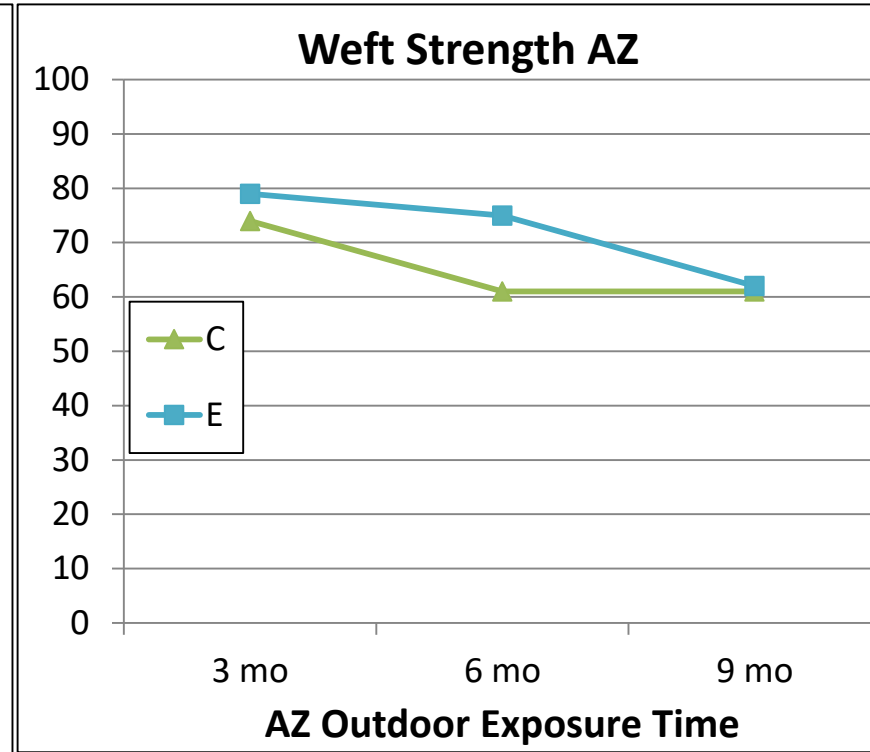
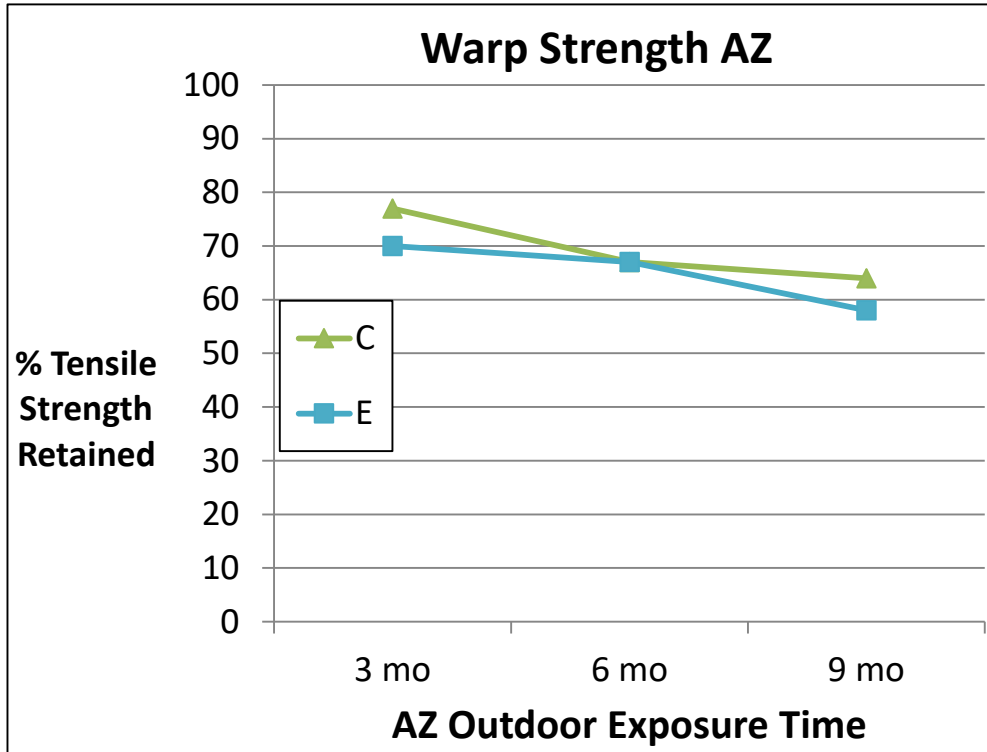


# Outdoor Test results: Warp vs Weft



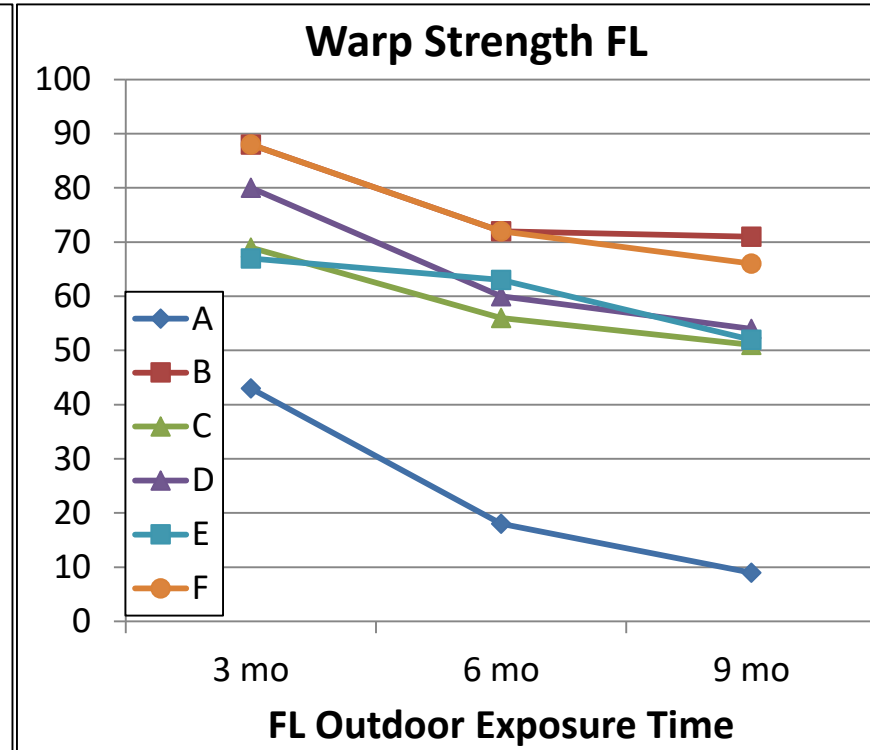
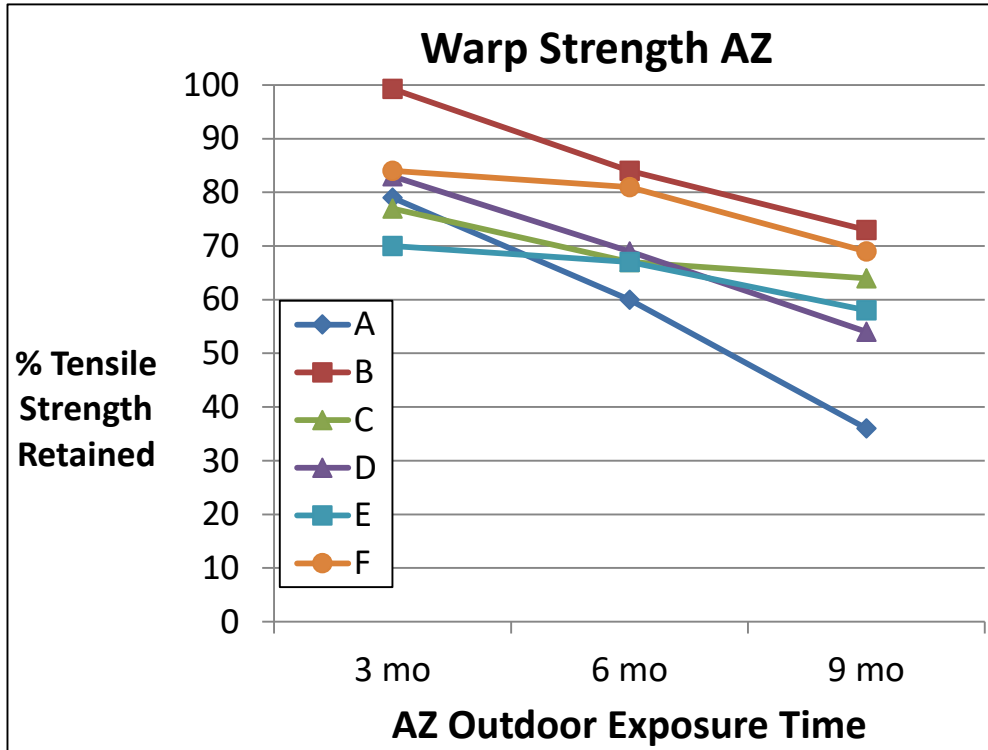
Warp direction held tensile strength generally better than weft

# Outdoor Test results: Warp vs Weft



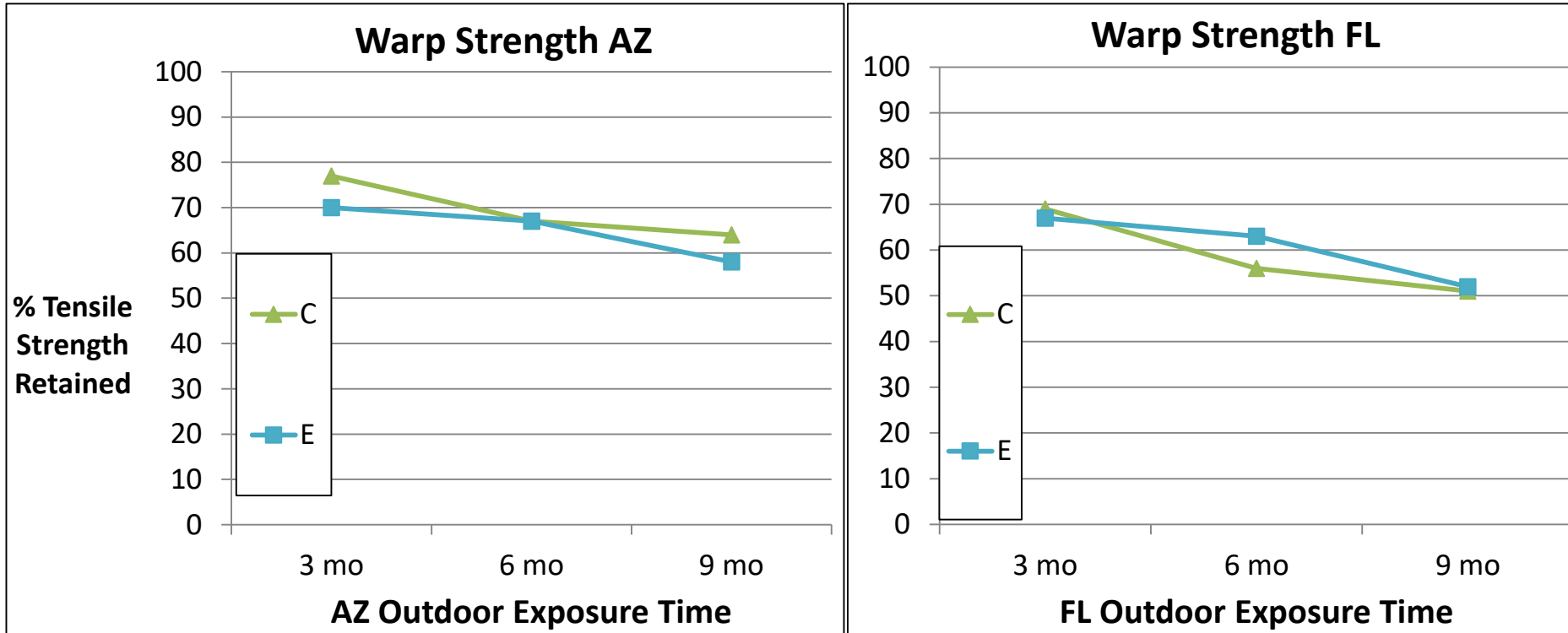
Warp direction held tensile strength generally better than weft

# Outdoor Test results: AZ vs FL



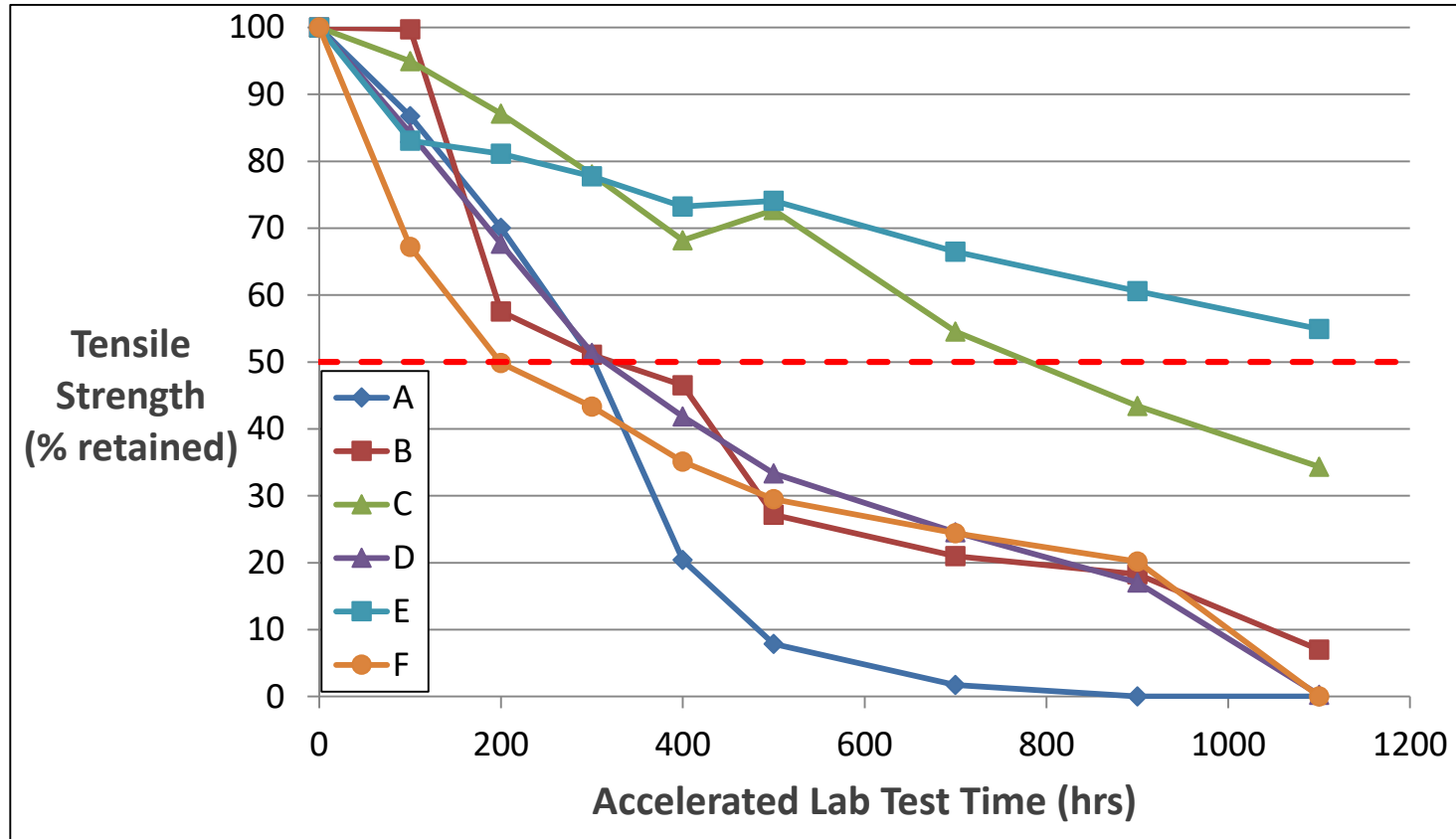
AZ testing generally less severe than FL testing

# Outdoor Test results: AZ vs FL

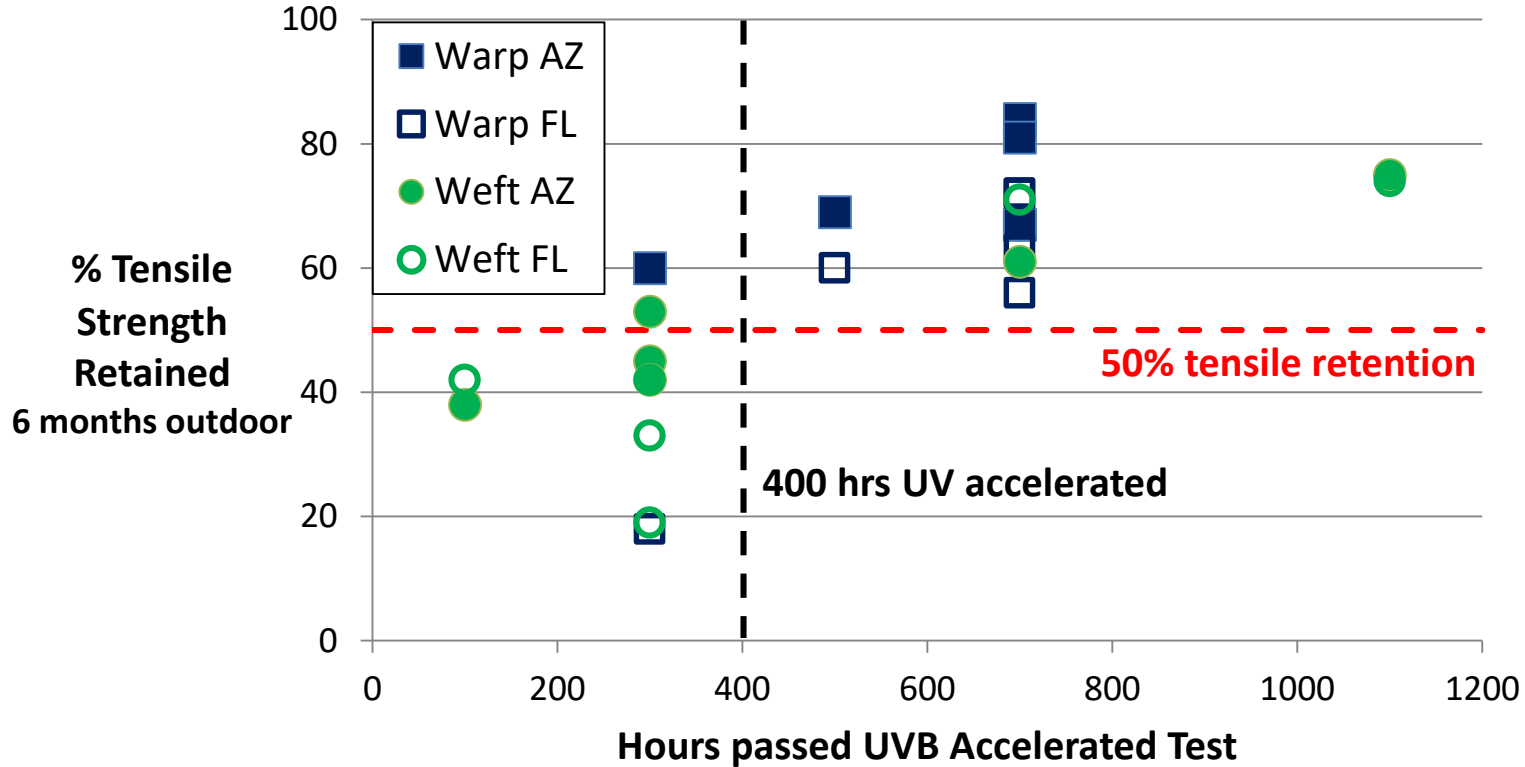


AZ testing generally less severe than FL testing

# Accelerated Test Results

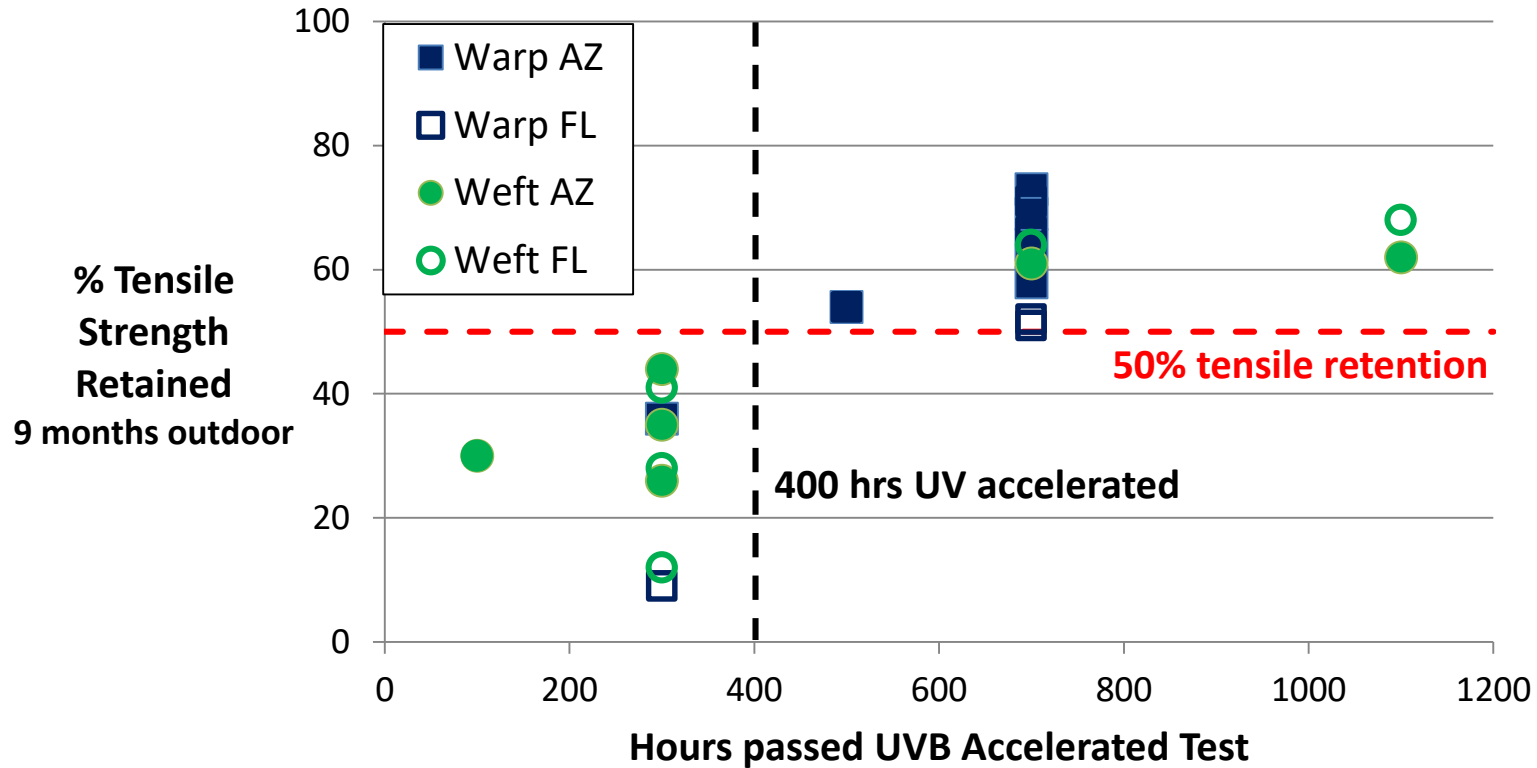


# Test results: Outdoor/Accelerated Correlation (6 months)



Very good correlation between accelerated and outdoor weathering

# Test results: Outdoor/Accelerated Correlation (9 months)



Very good correlation between accelerated and outdoor weathering

# Evaluating the Effect of CaCO<sub>3</sub> Additive

- The addition of Calcium Carbonate (CaCO<sub>3</sub>) in the FIBC extrusion formulation provides benefits in quality and efficiency in the production of tape yarn. Used properly, calcium carbonate will:
  - Prevent fibrillation or splitting of the tapes,
  - Allow for higher draw ratio and hence yield higher strengths
  - Improve overall extrusion process efficiency.
  - **Virtually all FIBC fabric is made with some Calcium Carbonate content**
- However, there is uncertainty about the effect of CaCO<sub>3</sub> on FIBC properties
  - The general concern is that any presence of this mineral in extrusion formulas will compromise the mechanical properties of polypropylene tape yarn.
  - This can be affected by processing parameters like the quality of the CaCO<sub>3</sub> material and how it is introduced into the mix



# Test results: Effect of CaCO<sub>3</sub>

		Warp			Weft		
Supplier	CaCO <sub>3</sub> %	AZ 9 mo	FL 9 mo	Accel hrs	AZ 9 mo	FL 9 mo	Accel hrs
C	2.46	64%	51%	700	61%	64%	700
E	2.68	58%	52%	700	62%	68%	1100
A	4.61	36%	9%	300	35%	12%	300
F	4.63	69%	66%	700	30%	30%	100
D	6.02	54%	54%	500	26%	28%	300
B	7.90	73%	71%	700	44%	41%	300

Lower CaCO<sub>3</sub> % correlated to better accelerated and outdoor performance

# Summary and Conclusions

- Warp retained tensile strength better than weft in general
- FL exposures were generally more severe than AZ exposures
- The two suppliers (C&E) with the **lowest CaCO<sub>3</sub> %** passed all tests
  - Difference more significant for Weft
  - Effect of fabric weight is less clear
- Very good correlation between accelerated testing and outdoor testing
  - **Warp:** 50% tensile strength failures after **9 months** outdoors passed 300 hours but failed to reach 400 hours in UV fluorescent testing
  - **Weft:** same observation - but **6 months** outdoors
- **UVB fluorescent testing is a good test to correlate to 6-9 month outdoor failure**

# Recommendations

- The guidance for ISO 21898 accelerated test should be for **minimum 300 hours *total* time**
  - Industry needs to decide benchmarks for guaranteeing outdoor performance – 6 months, 9 months
  - Recommendation may even be 400 hours
- Potential to save testing time by requiring accelerated test only for **weft**
- Specify irradiance of **0.71 W/m<sup>2</sup>/nm @310 nm** in ISO 21898

# Thanks for Listening!



**Questions?**

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