

NYLON FASTENERS & RIVETS:

How Environmental Factors
Impact Extraction Force



Darren Zellak

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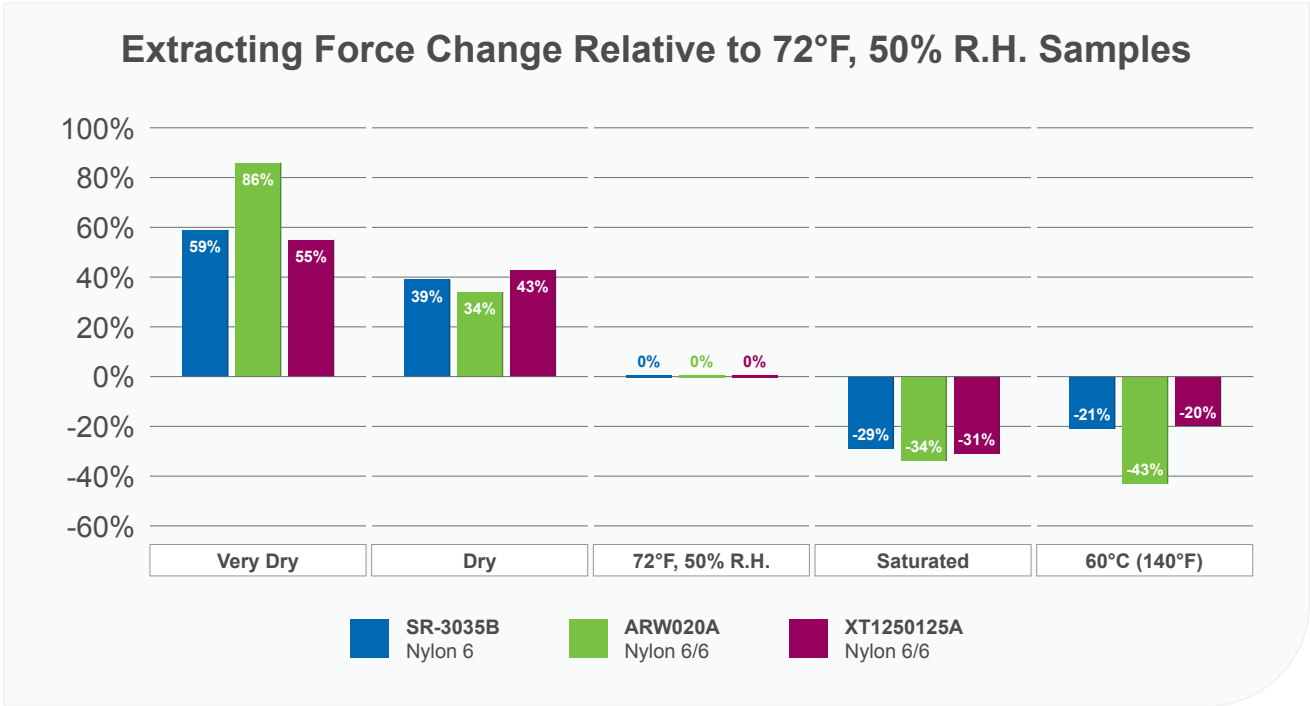
How Environmental Factors Impact Extraction Force

When selecting nylon rivets, snap rivets, or other fasteners, design engineers should be mindful of the proportionate relationship between the material's (Nylon 6, Nylon 6/6) moisture content, its tensile strength and ductility. This inherent tradeoff can result in unanticipated material challenges, as storage and environmental conditions vary regionally and between production facilities. This challenge is evident in the divergent extraction force values produced when testing nylon fasteners with different moisture contents and changes in temperature.

Can Moisture Content impact extraction forces in nylon fasteners?

The mean extraction force test results outlined on *graph 1* and *chart 1*, illustrates how Nylon 6 and Nylon 6/6 fasteners performed with changes in both moisture content and temperature relative to a baseline of 72° Fahrenheit and a 50% relative humidity. Interestingly, the same fastener tested in the same hole, varying only the material's moisture content, can produce broadly different pull force values.

In the most extreme example, a very dry fastener with moisture content of 0.67% produced a relative extraction force 224% higher than that of the same fastener with a moisture content of 6.74%. Differences in humidity between a product's point of production and its point of final use, could lead to premature failure if variance in moisture content isn't considered during the application design process.



Extraction Force Change Relative to 72°F, 50% R.H. / Avg. Moisture Content

	Very Dry	Dry	72°F, 50% R.H.	Saturated	60°C (140°F)
SR-3035B Nylon 6	59% Δ 0.85% ●	39% Δ 1.60% ●	0% Δ 3.29% ●	-29% Δ 7.29% ●	-21% Δ 3.26% ●
ARW020A Nylon 6/6	86% Δ 0.53% ●	34% Δ 1.34% ●	0% Δ 2.80% ●	-34% Δ 6.75% ●	-43% Δ 2.56% ●
XT1250125A Nylon 6/6	55% Δ 0.67% ●	43% Δ 1.40% ●	0% Δ 2.72% ●	-31% Δ 6.74% ●	-20% Δ 2.37% ●

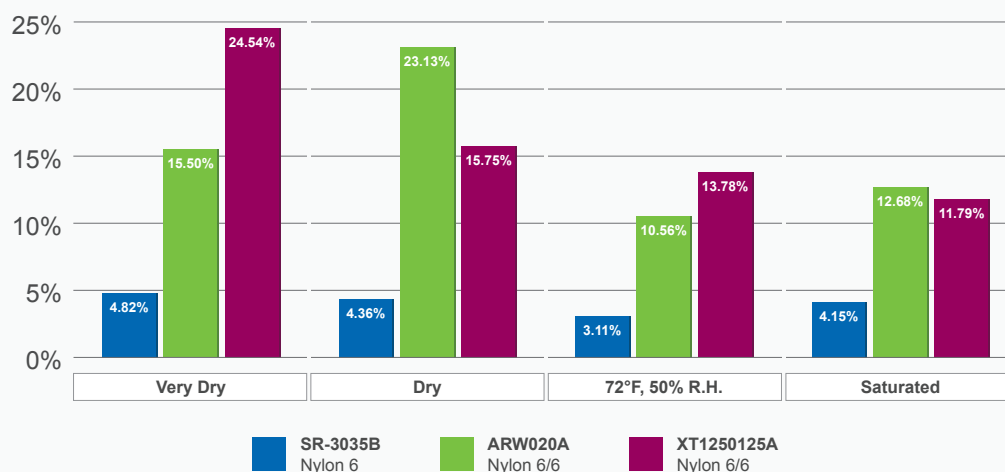
chart 1

What's the impact in tensile strengths for nylon rivets?

While lower levels of moisture content result in increased tensile strength (facilitating higher extraction forces), it also results in lower levels of ductility and impact strength. Since nylon fasteners depend upon the material's flexibility to perform (e.g. the limbs of a firtree fastener must flex to pass through a mounting hole during insertion, before springing back into position on the opposing side of the panel to facilitate retention. See *illustration 1* on page 4.) minimal moisture content is rarely an ideal condition during the application of the product. It is also easy to envision how a fastener's reduced impact strength could result in premature or unanticipated failure, if not anticipated during design.

Intuitively, one might expect that a substantial increase in the ambient temperature of the test would adversely affect extraction force. At nearly all moisture levels, a higher coefficient of variation (CV) was observed than that of the 72° F control group. The tradeoff is the predictability of the unit's extraction force, as illustrated by the extraction force CV values illustrated in *graph 2*:

Coefficient of Variation Sample



graph 2



SR Rivet



ARW Rivet



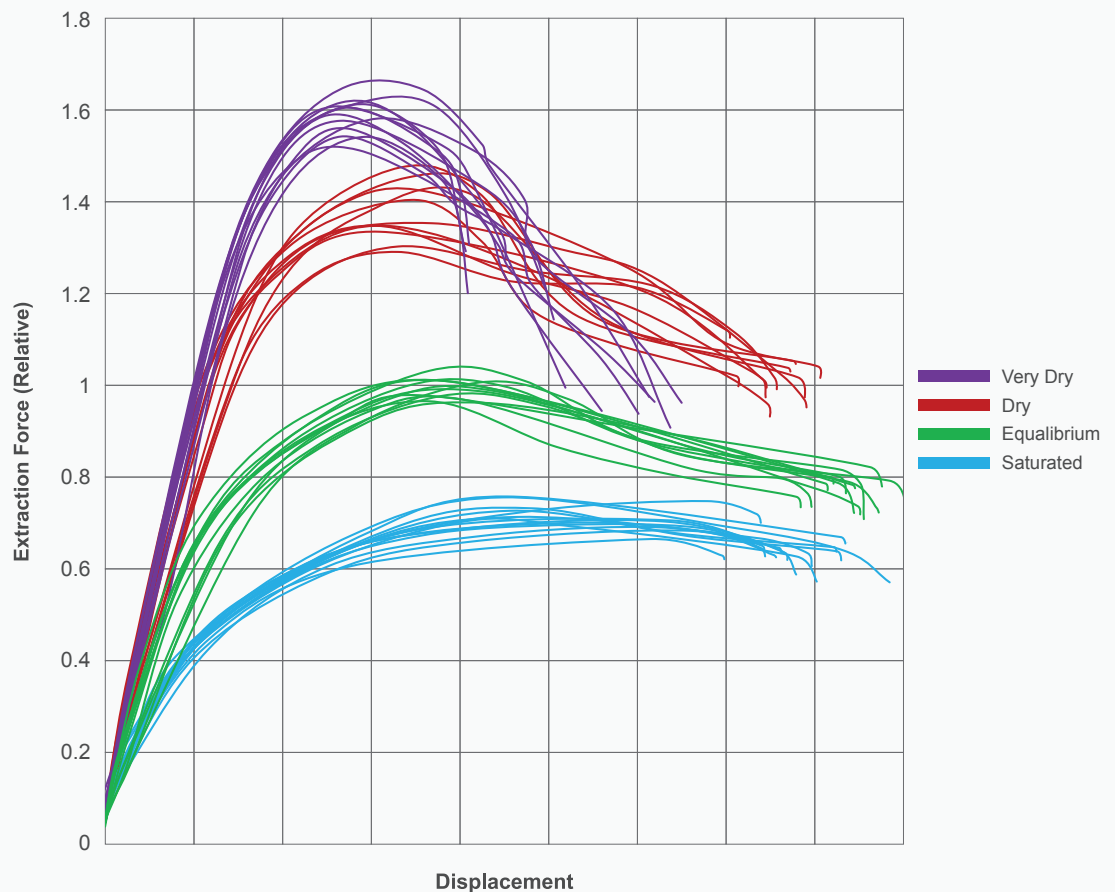
XT Rivet

What practical insight can be extrapolated from this data?

Fir tree fasteners present attractive options for many applications given the range of panel thickness accommodation, and cost-effective, single-piece construction. If the point of installation or use is in a dry, hot environment, there may be other options better aligned with the environment. Without accommodating environmental and temperature factors, precautions should be taken within the application to limit stresses which could result in premature failure (e.g. shock loading).

In examining the load-deflection curves of the SR-3035B, in *graph 3*, at the various moisture levels, the tradeoff between predictability and strength is most apparent in the variation of the points ultimate force of rivets with different moisture contents.

Extraction Force vs Displacement | SR-3035B



How to select the best nylon rivets for extreme environments?

The primary take away is to carefully consider technical attributes, tradeoffs and the relative cost of options. The careful review of application requirements and environmental factors at both the point of installation and end use can minimize the possibility of unforeseen post-production issues.

Ultimately, if a design employs nylon fasteners it's likely to experience variability in either temperature or humidity over the course of its expected lifespan, there is no substitute for a robust testing regime. The regime may include a variety of other application-based factors, but the fastener's moisture content should be one of the baseline requirements in understanding how it will perform over the product's expected lifetime.

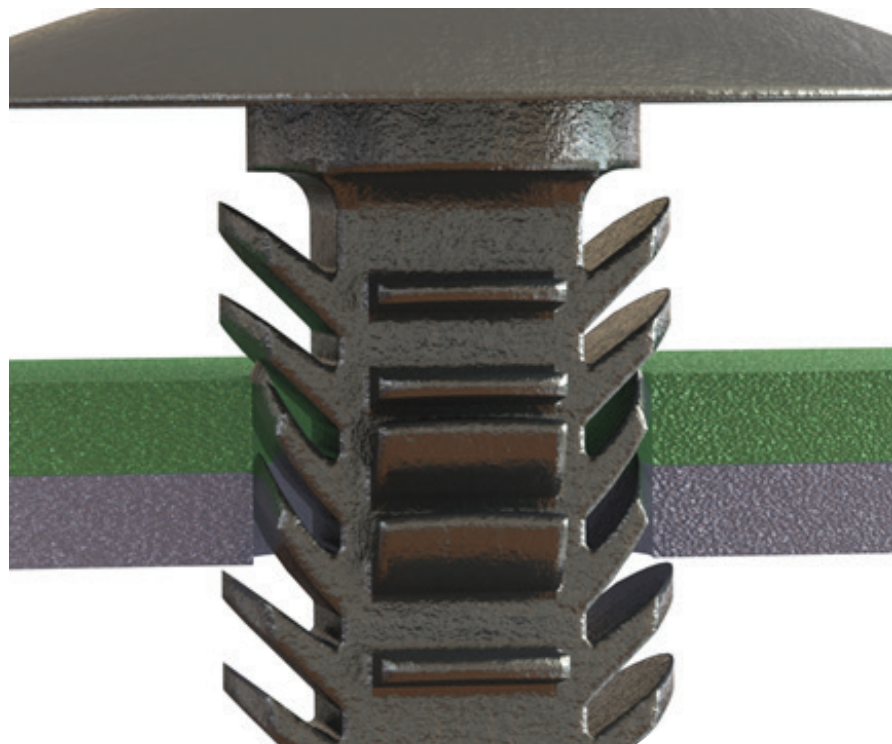


illustration 1



About the Author

Darren Zellak

Darren is a Senior Engineer with Essentra and holds a B.S. in Aerospace Engineering and a M.S. in Mechanical Engineering. He has 25 years of relevant engineering experience and is a principal designer on 3 patents: Fiber optic cable guide, connector coupling/decoupling, internal shutter for optical adapter.