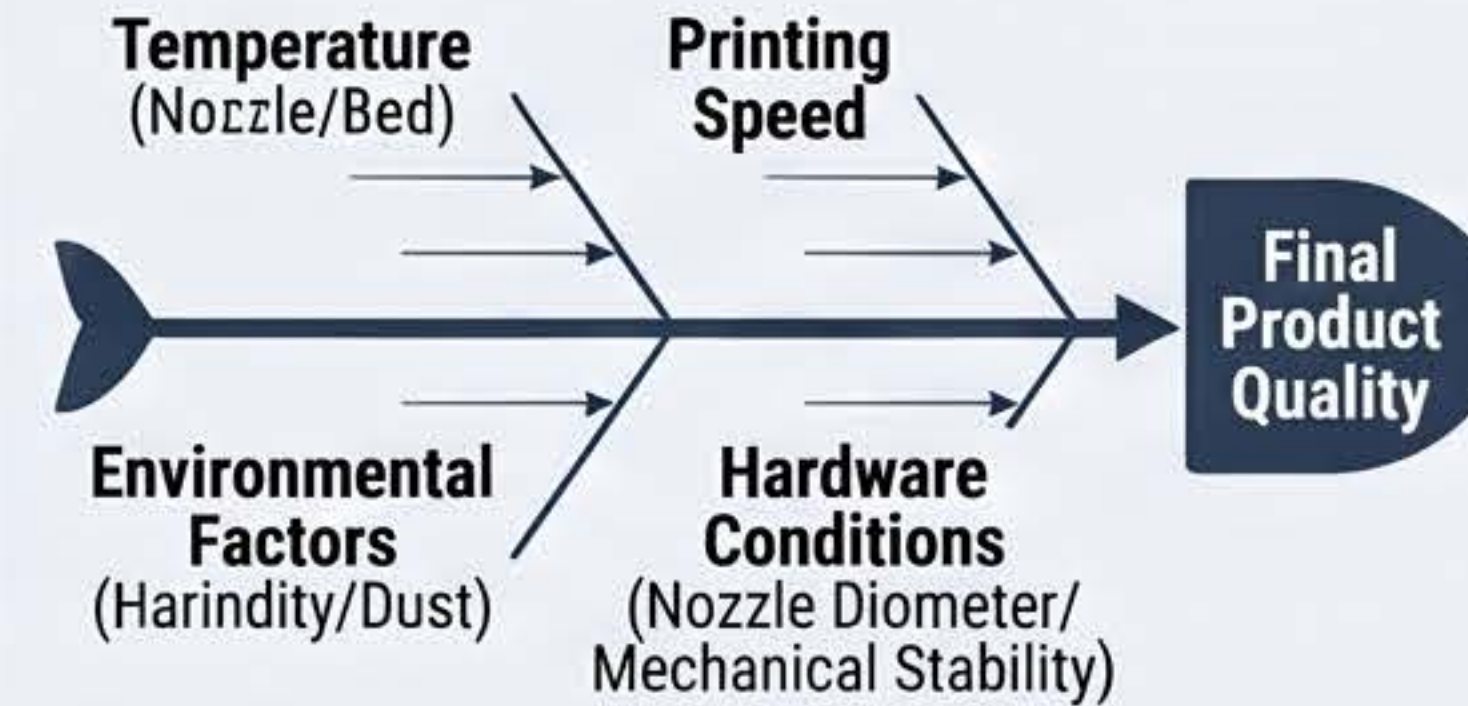


Optimizing Durability: The Impact of Printing Parameters on 3D-Printed Conductive Composites

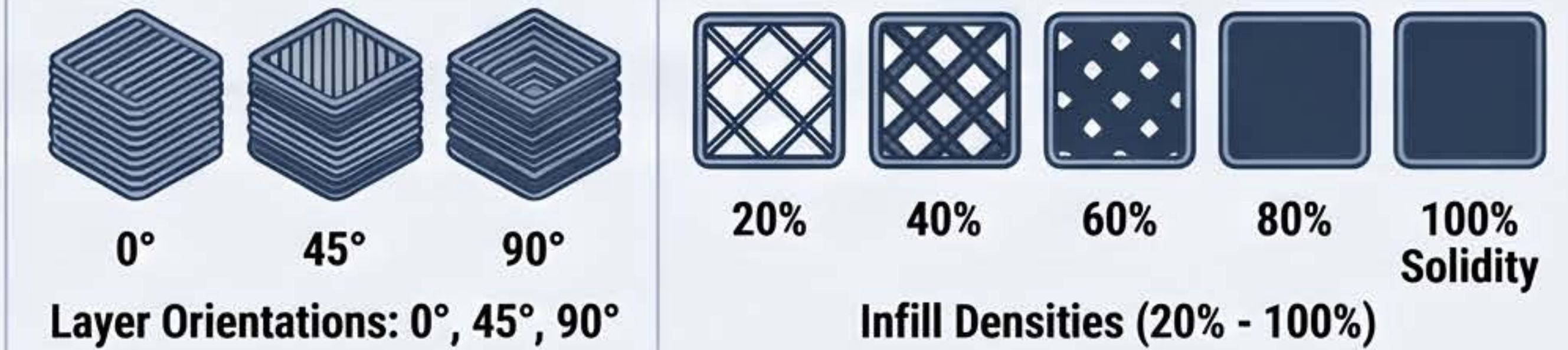
THE FDM VARIABLE MIX



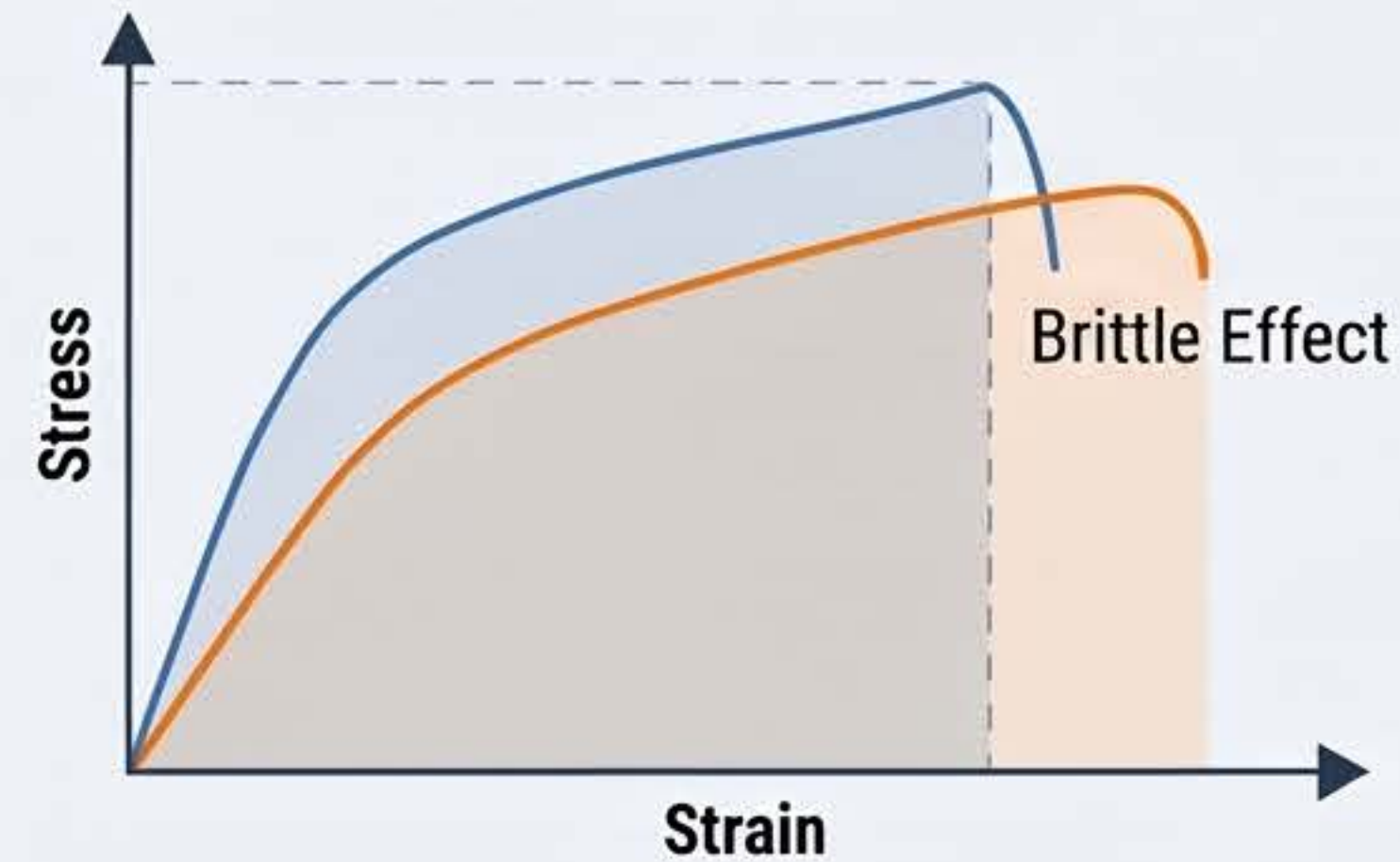
CRITICAL QUALITY FACTORS



PRIMARY VARIABLES: ORIENTATION & DENSITY



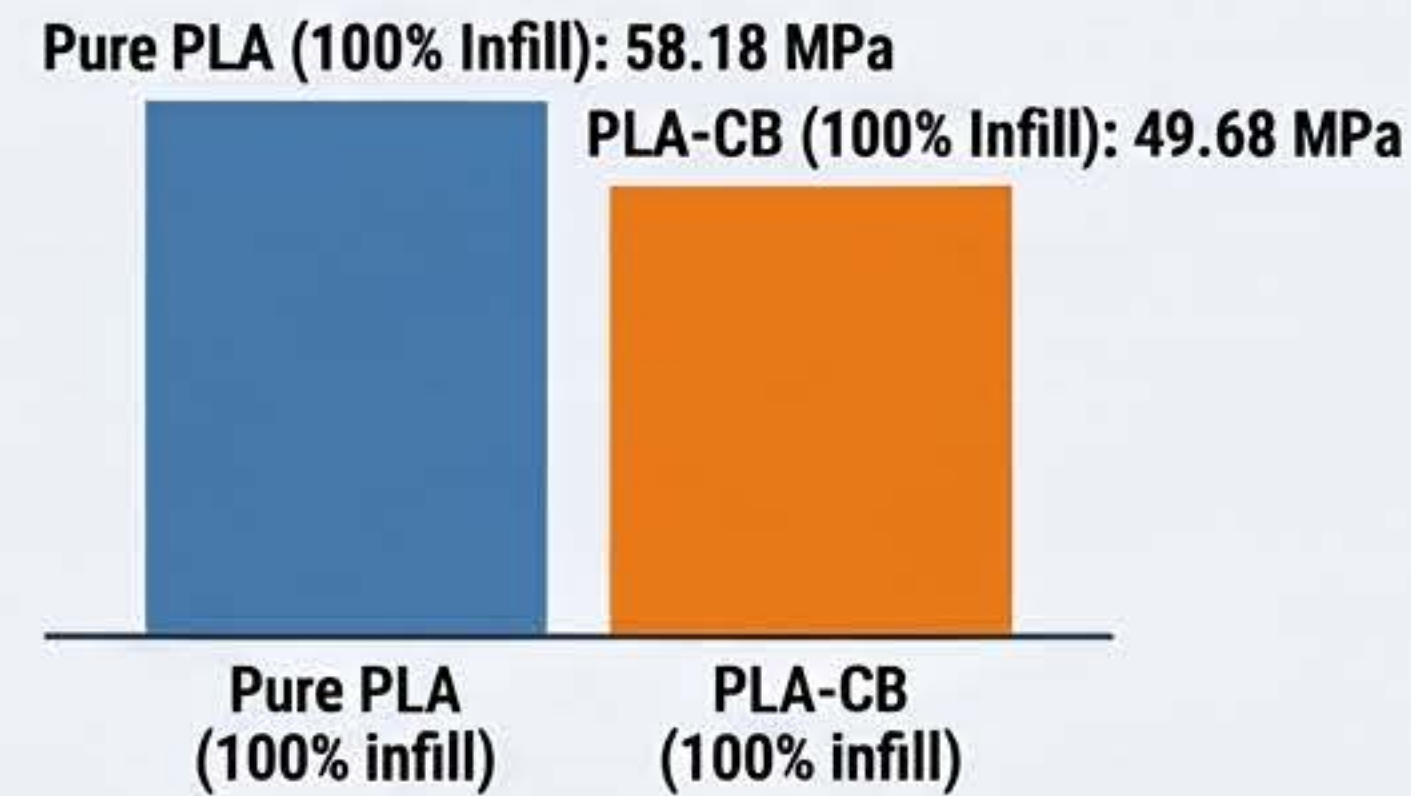
MATERIAL COMPARISON: PLA-CB vs. PURE PLA



Strength Penalty of Conductivity

Adding 40% Carbon Black, Strionoot Black creates a "brittle effect", reducing tensile stress and elongation.

MAXIMUM STRESS GAP (0° ORIENTATION)

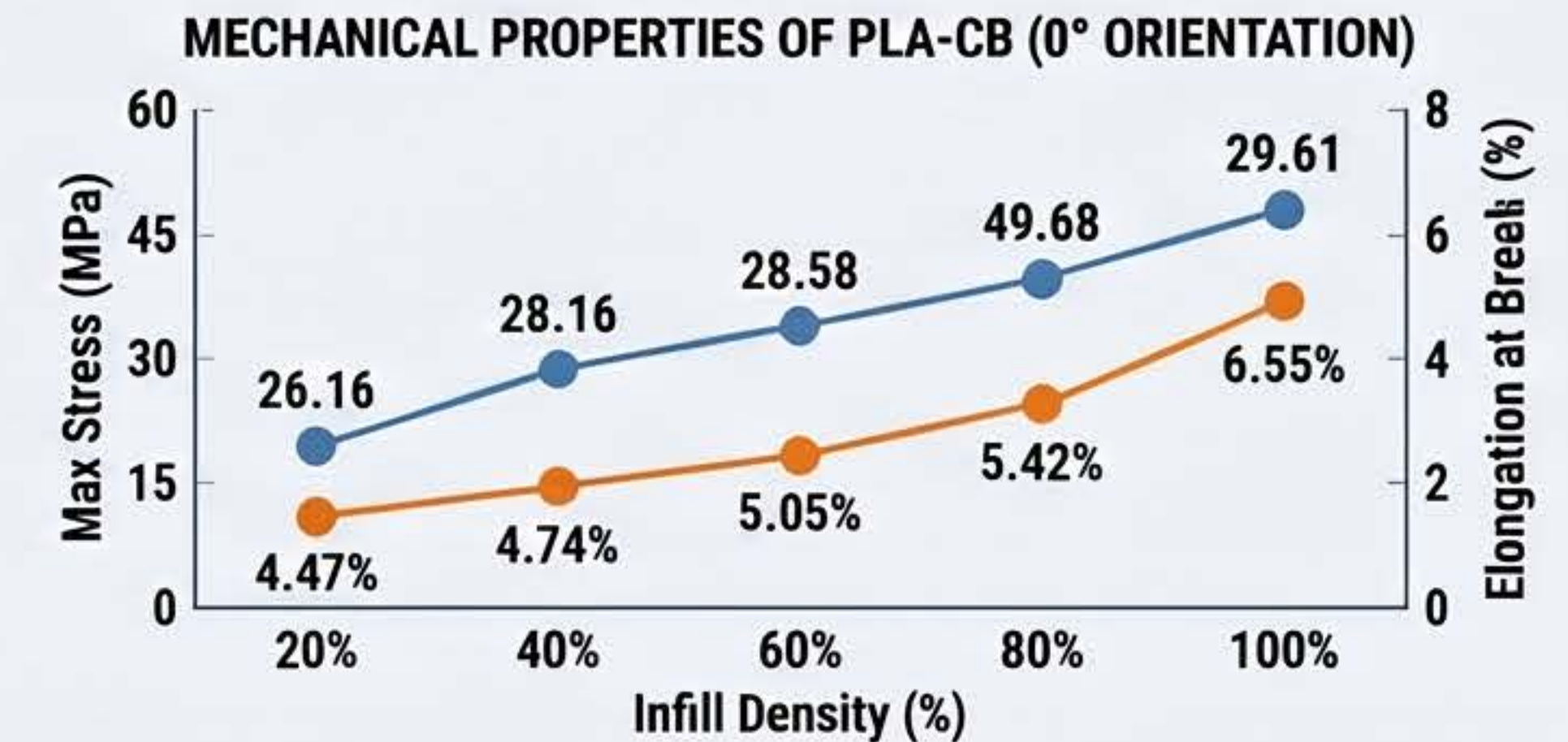


IMPACT OF INFILL DENSITY

Density Drives Continuity

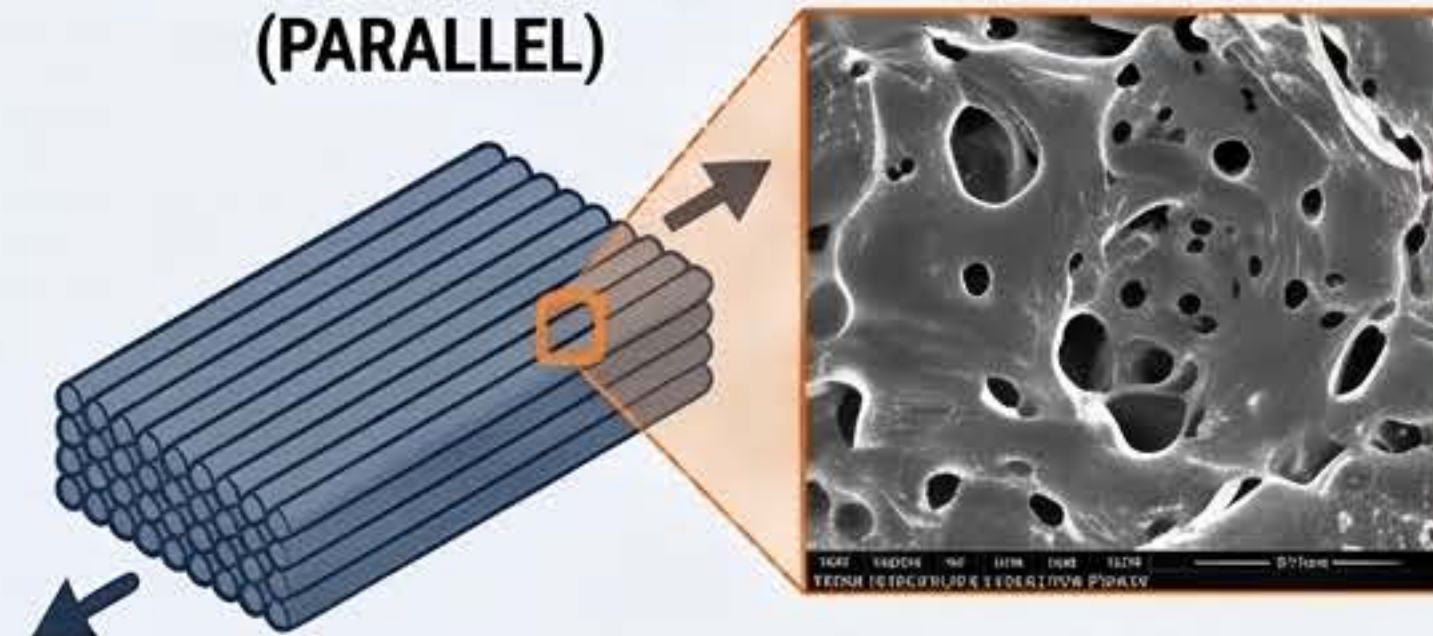
Higher density creates continuous load-bearing paths, while lower density of monodiity discontinuous paths.

Lower density leads to unbalanced stress to on higher density and in premature failure.



THE ROLE OF LAYER ORIENTATION & STATISTICAL RELIABILITY

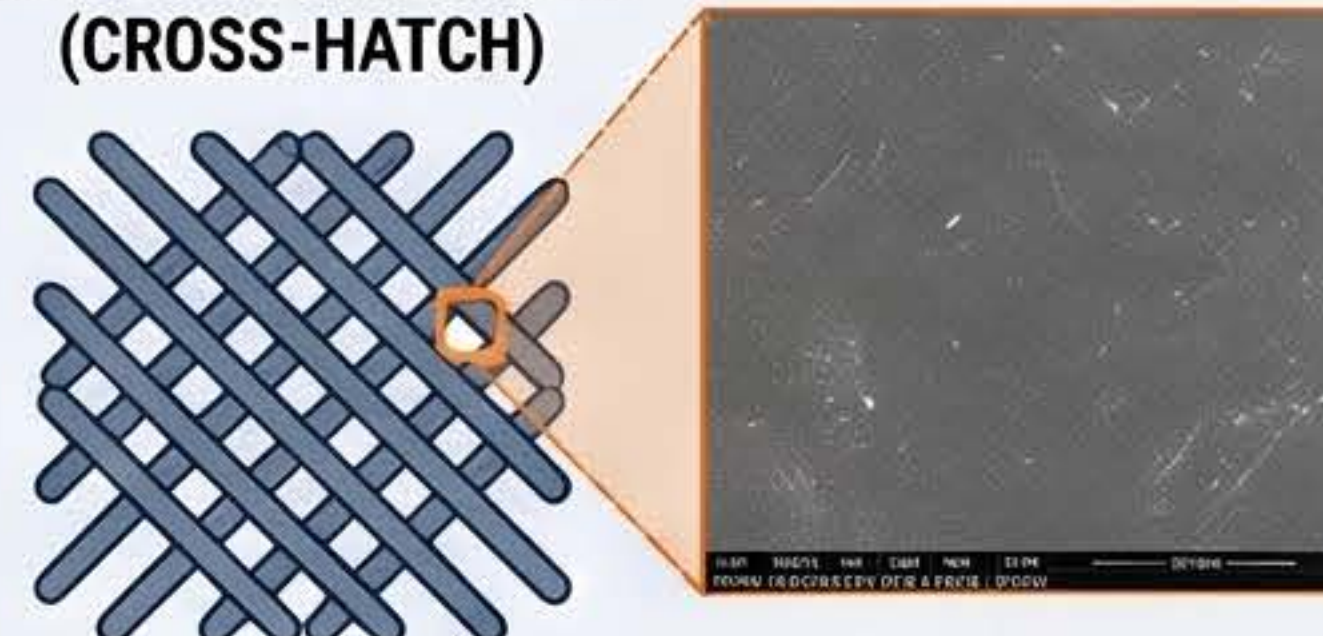
0° ORIENTATION (PARALLEL)



Best Mechanical Performance

Sensitive to Bonding Imperfections

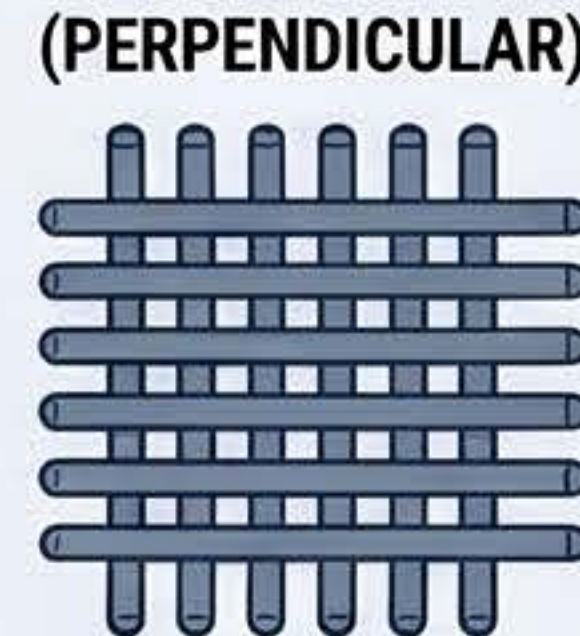
45° ORIENTATION (CROSS-HATCH)



Intermediate Behavior (Stiffness/Flexibility)

Failure: Crack Opening & Shear Sliding

90° ORIENTATION (PERPENDICULAR)



Weakest Configuration

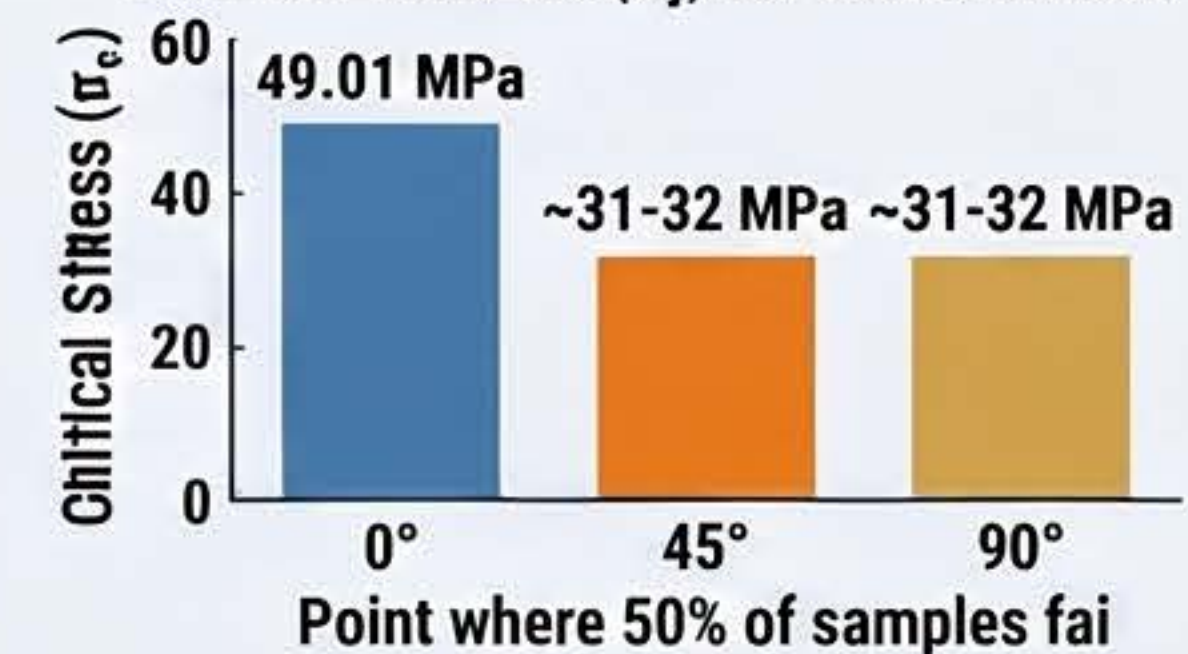
Dominated by Delamination (Peeling)

STATISTICAL RELIABILITY

PREDICTABILITY vs. STRENGTH

While 0° is strongest, 45° has the highest **Weibull Modulus ($m = 44.13$)**, indicating most predictable failure.

CRITICAL STRESS (σ_c) vs. ORIENTATION



THE CRITICAL FAILURE POINT

A summary chart is [SOURCE_IMAGE_ (o.) [SOURCE_IMAGE_16], this is the point - where 50% of samples fail.

SERVICE LIFE HIERARCHY

