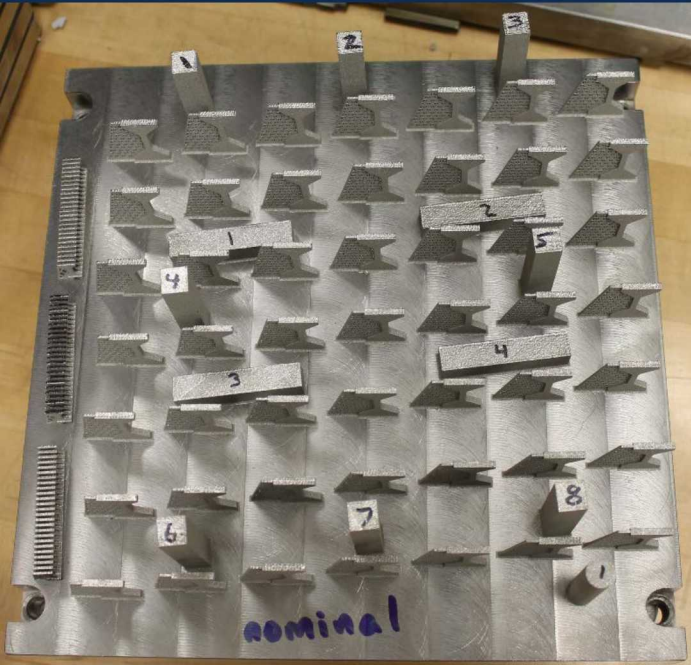




Sigma Labs Tensile Charpy, Density, Thermal Energy Density Results NMSBA Project

Jay Carroll, Isaac Valdez, Todd Huber, Aron Robbins, Brad Boyce



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service
in the
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interest*

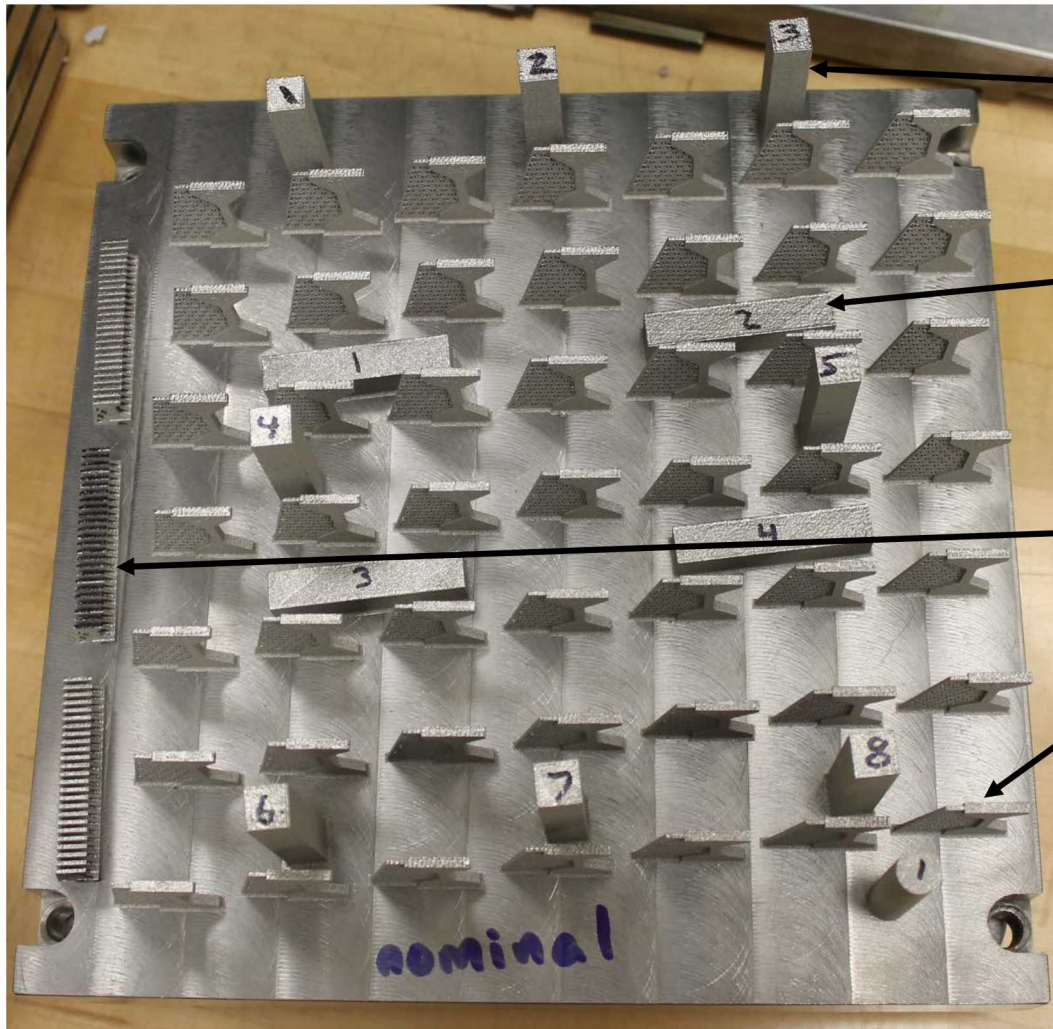


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Build Plates and specimen types. Material: 316L Stainless Steel

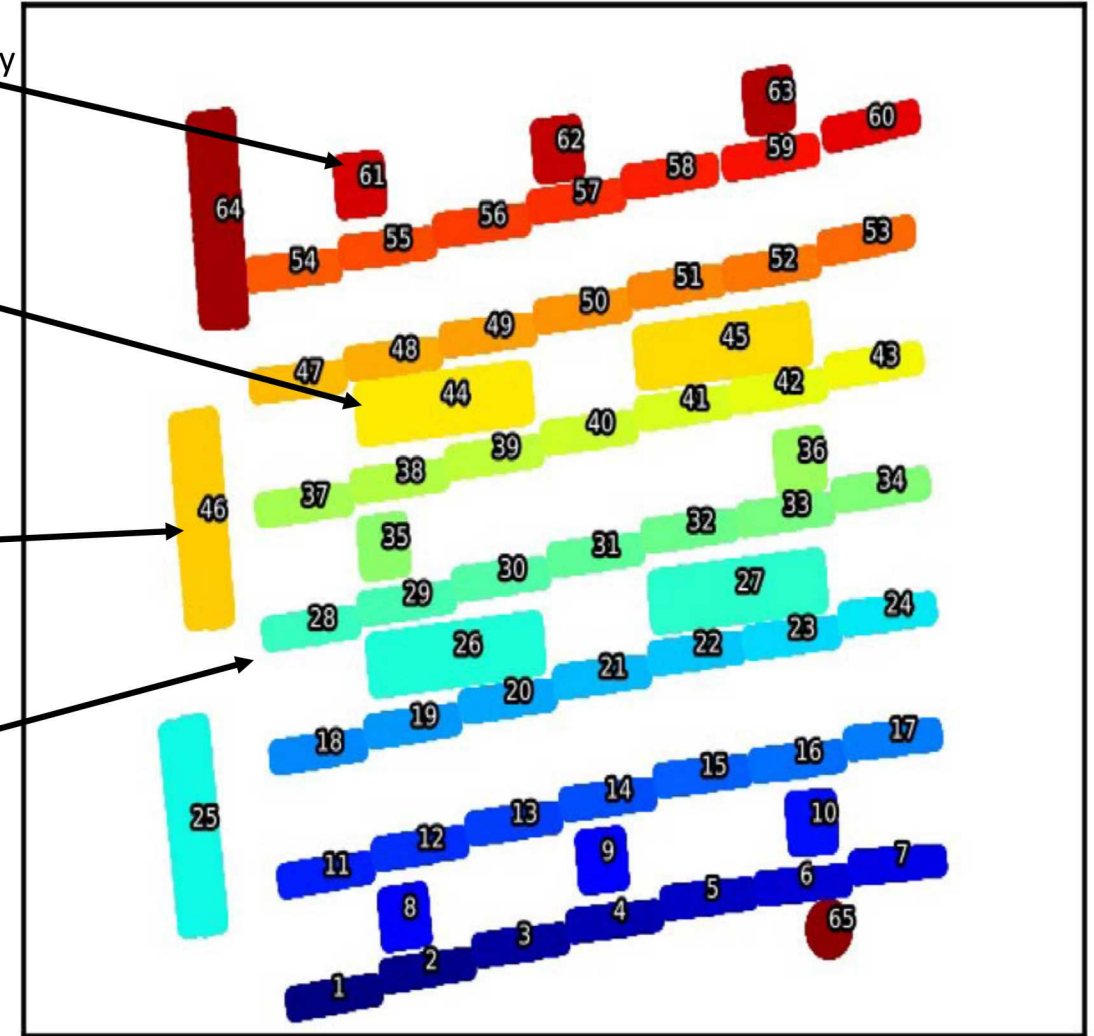


Vertical Charpy
Specimens (8)

Horizontal
Charpy
Specimens (4)

A-size tensile
bars (75)

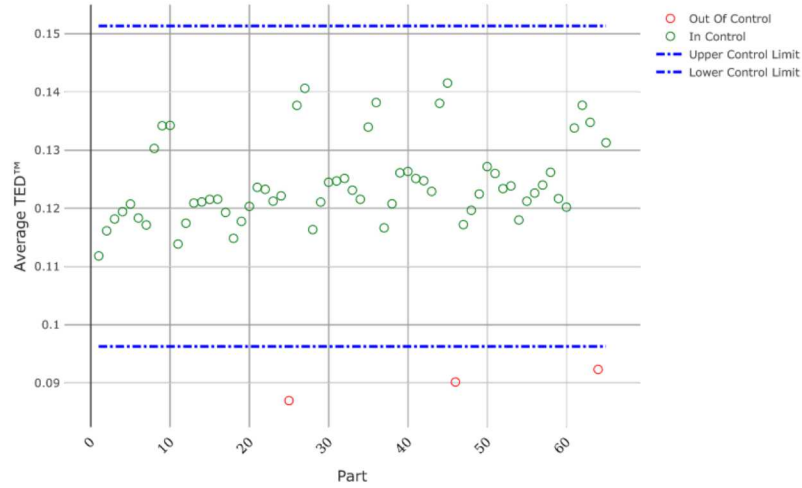
B-size tensile
bars (42)



Specimen map and TED values

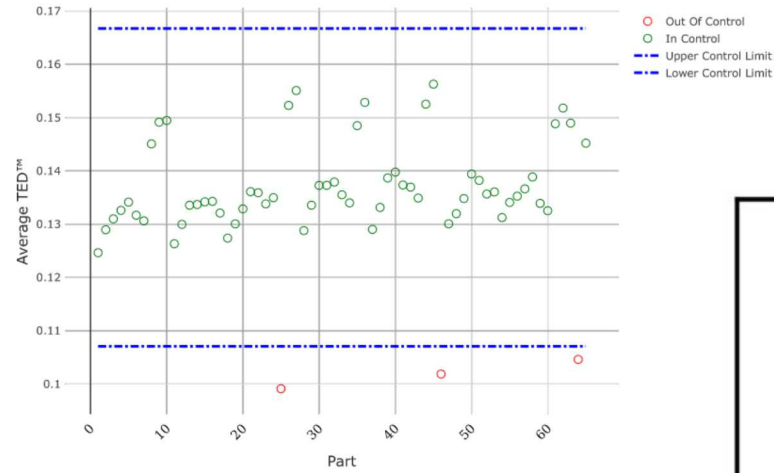
Low

Parts SPC



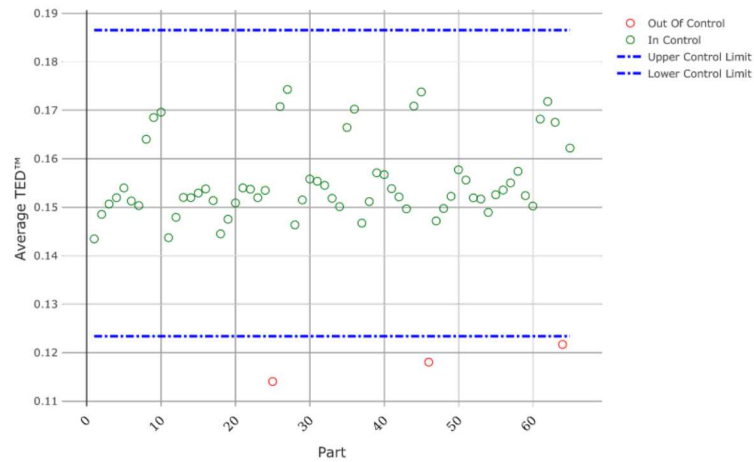
Nominal

Parts SPC

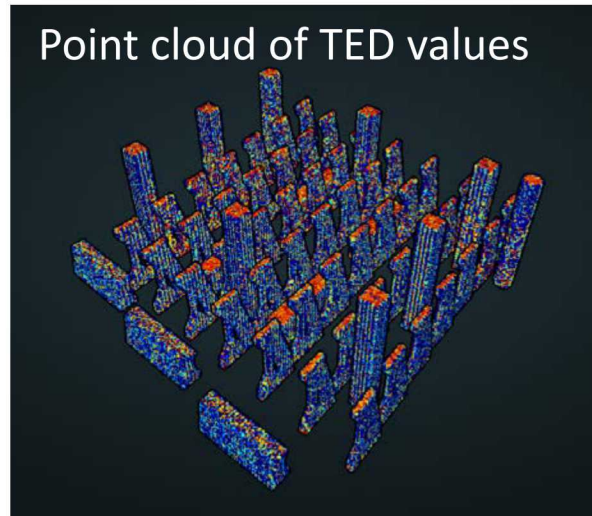


High

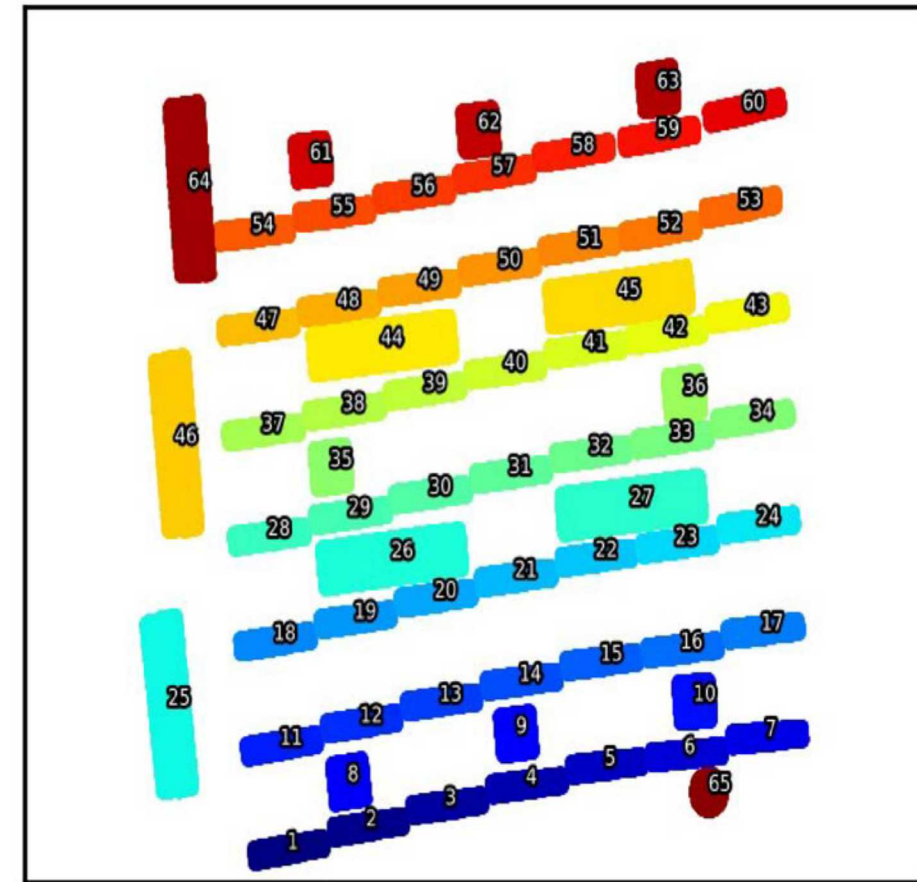
Parts SPC



Point cloud of TED values



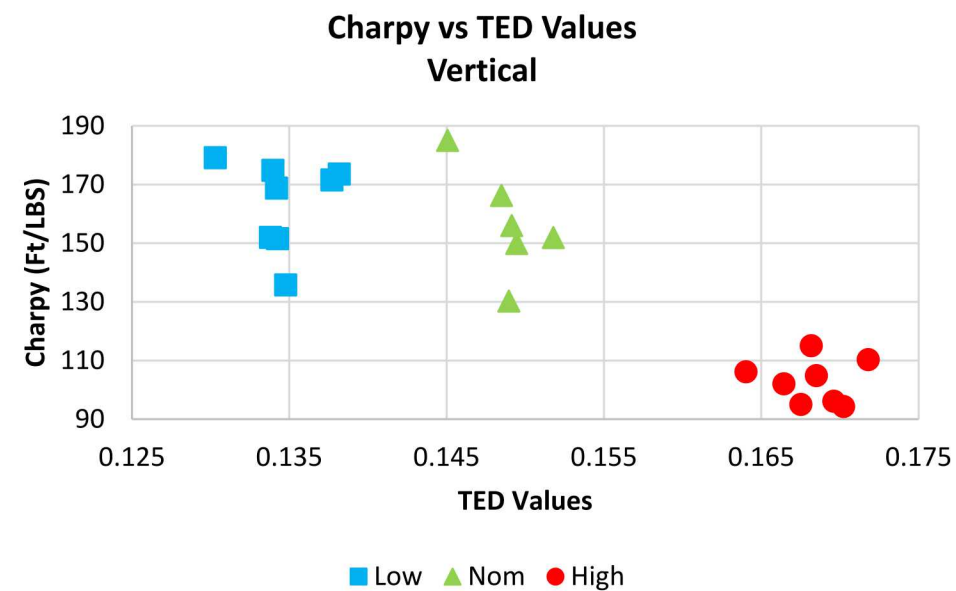
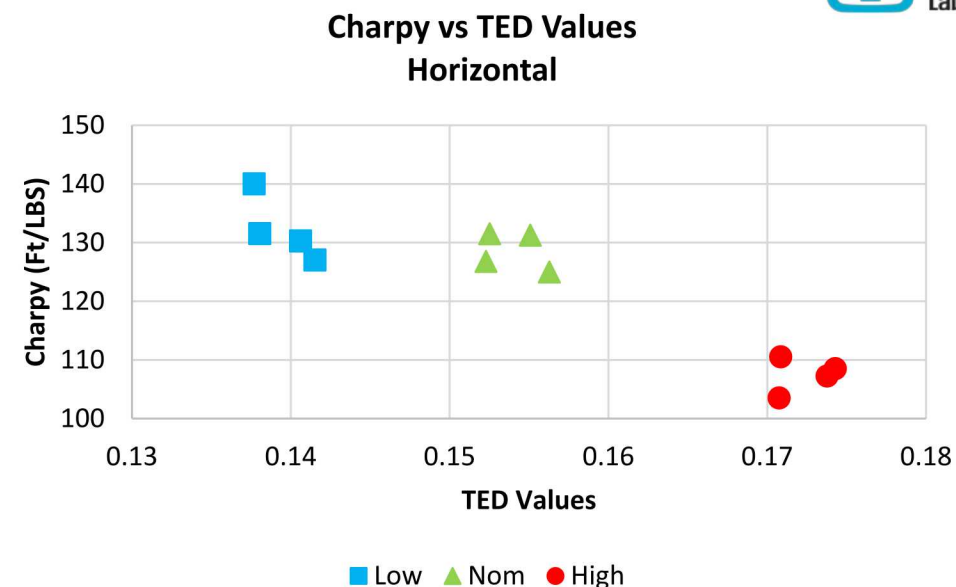
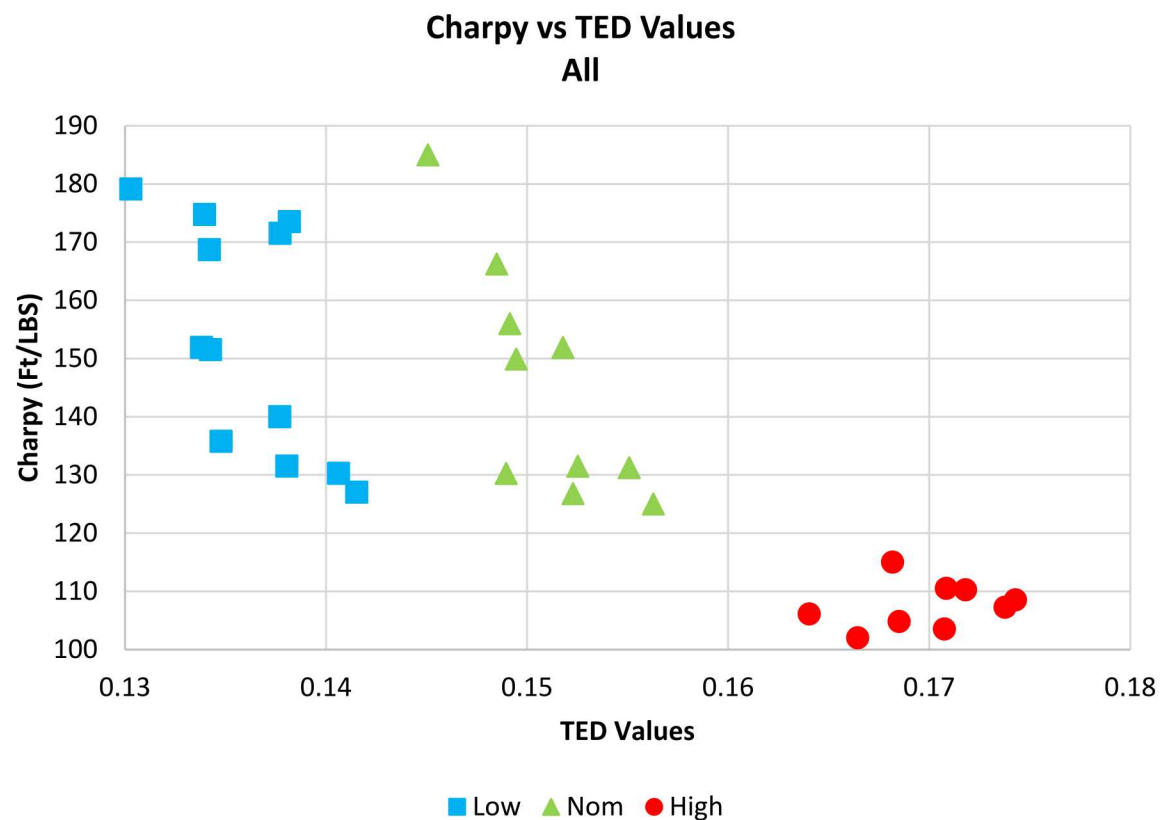
Specimen Layout Map



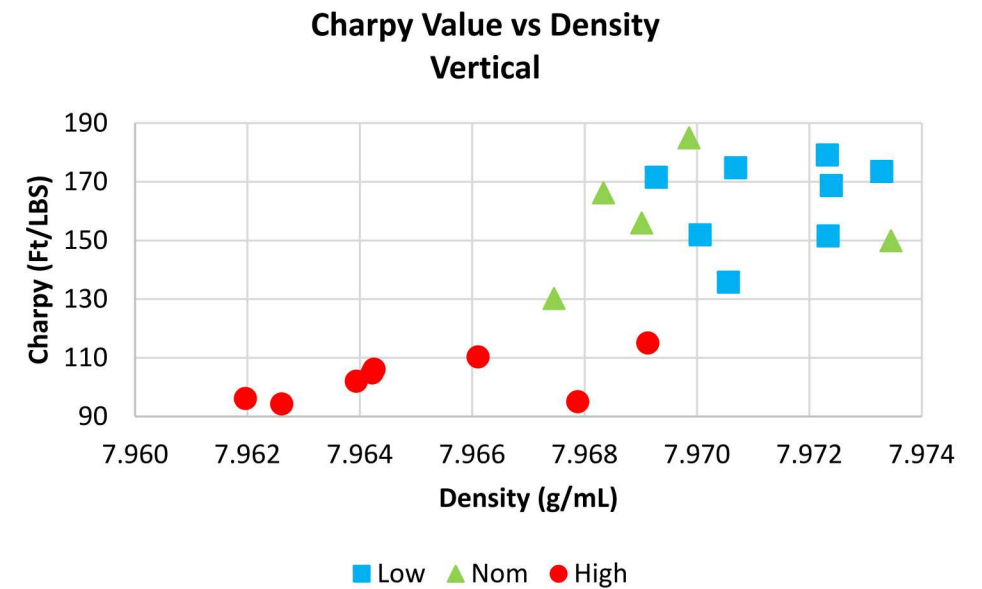
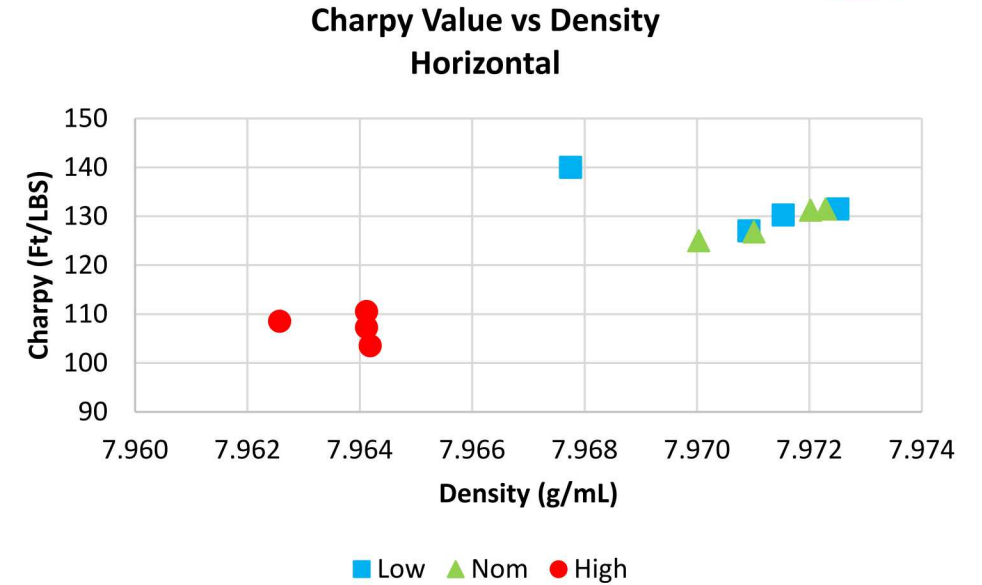
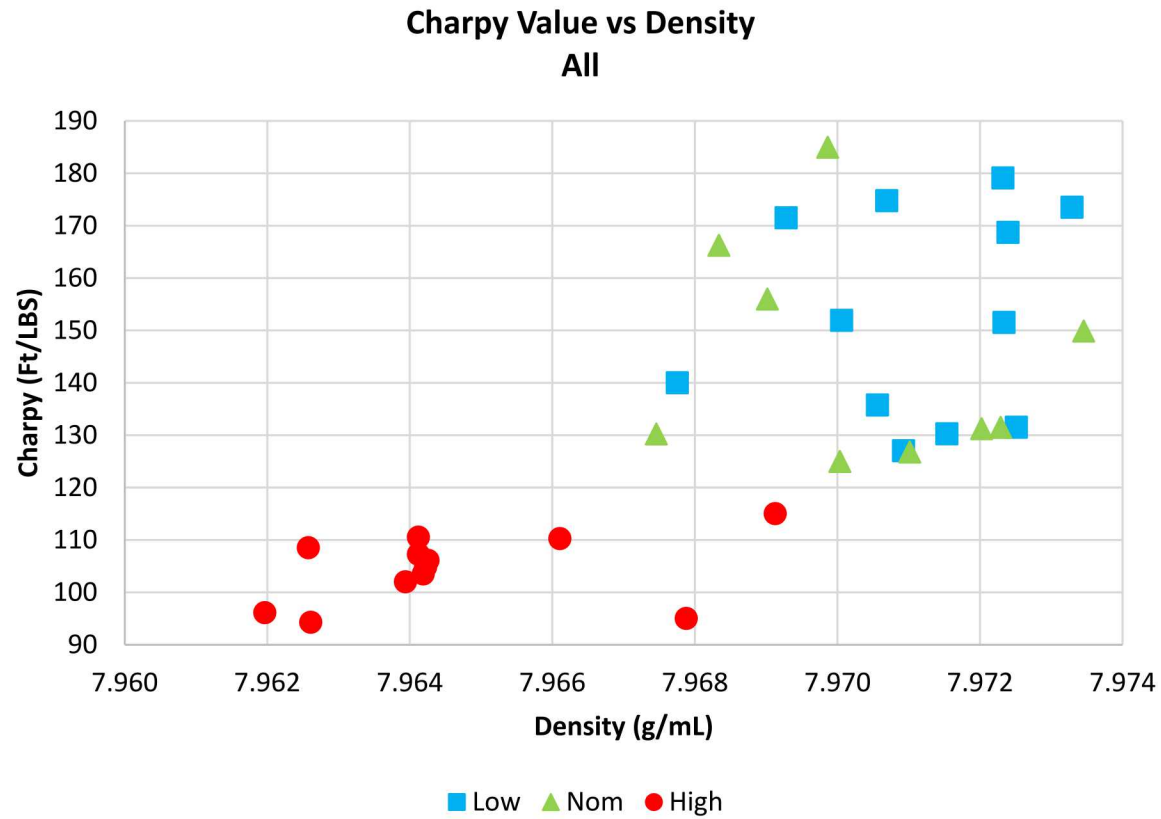
Charpy Specimen Test Results



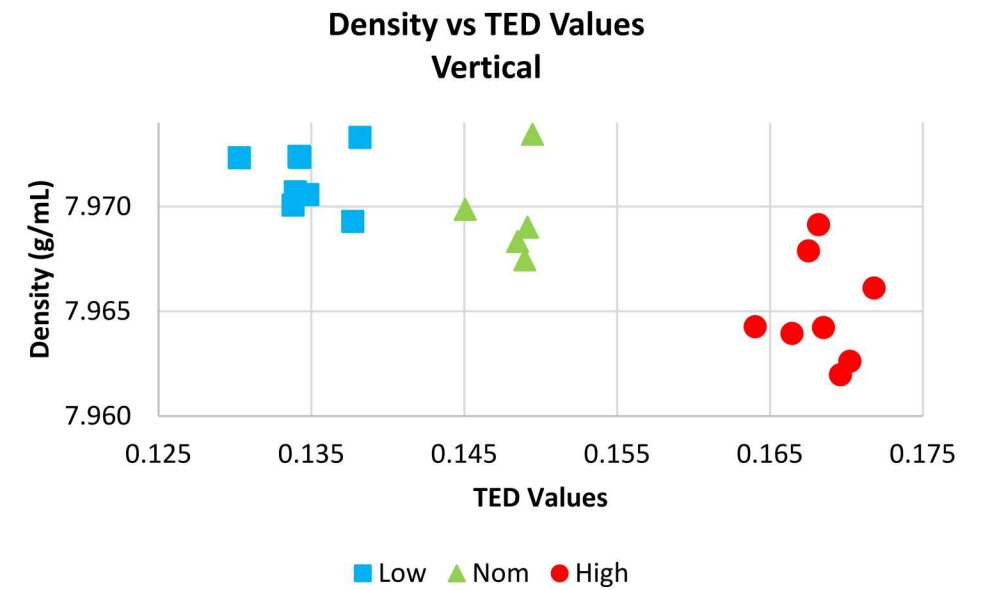
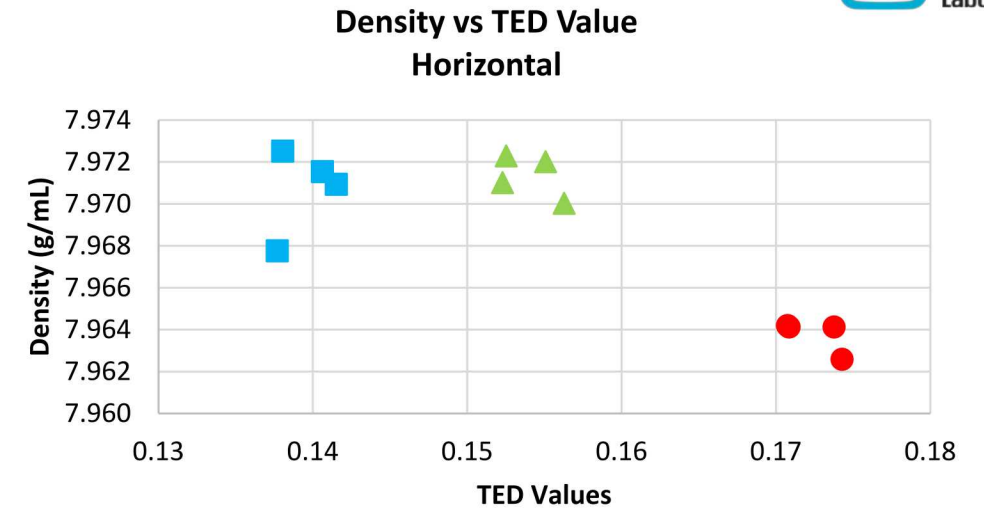
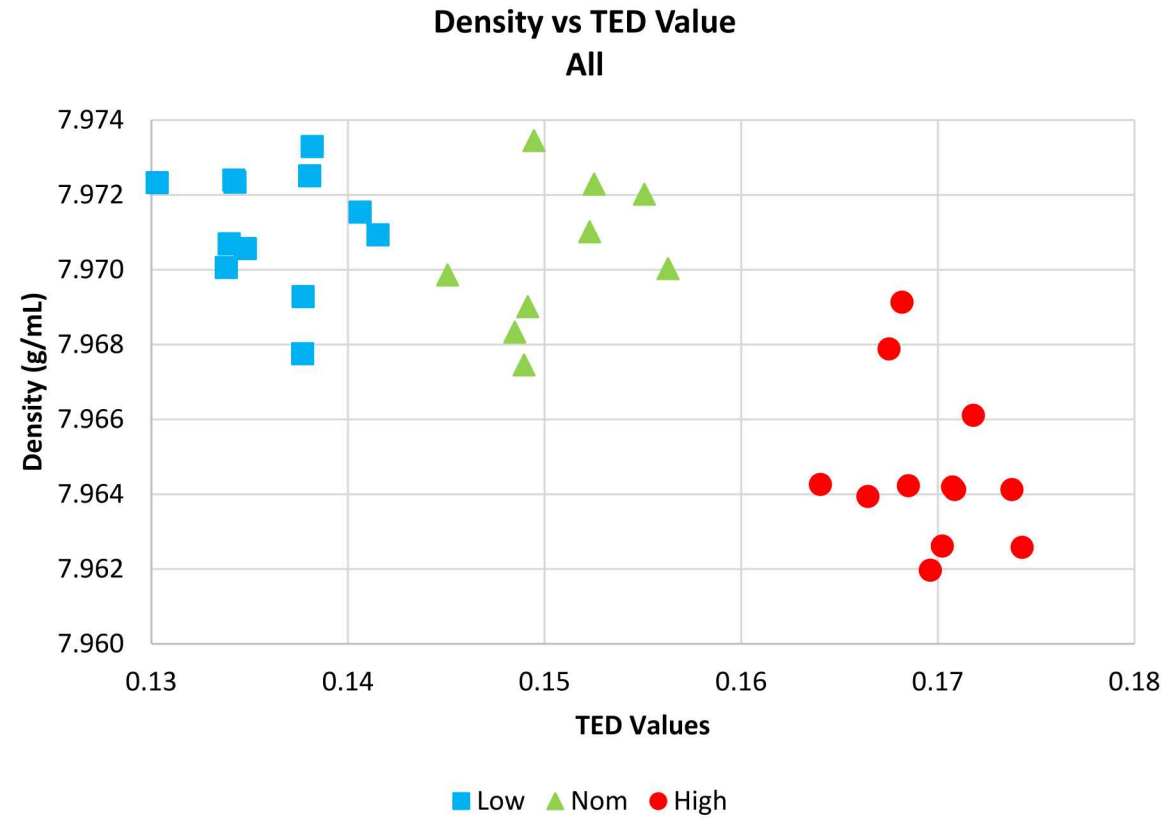
Charpy vs TED



Charpy vs Density

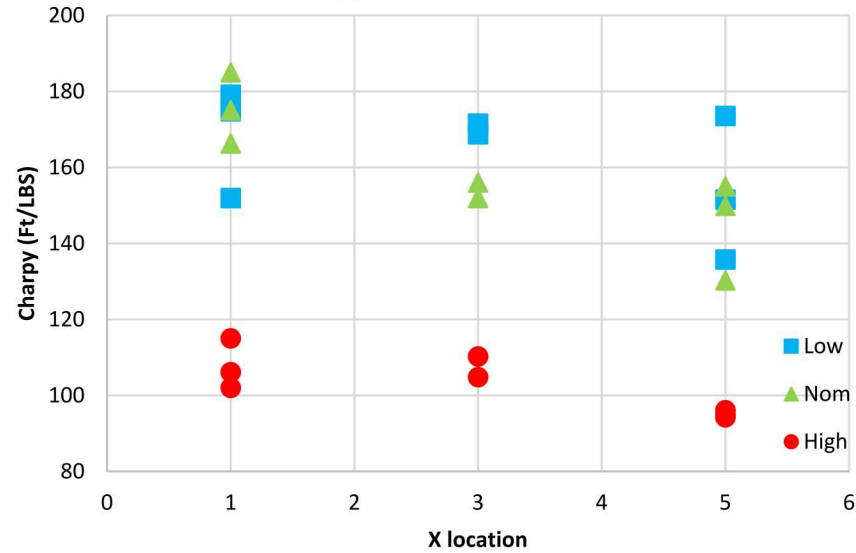


Density vs TED

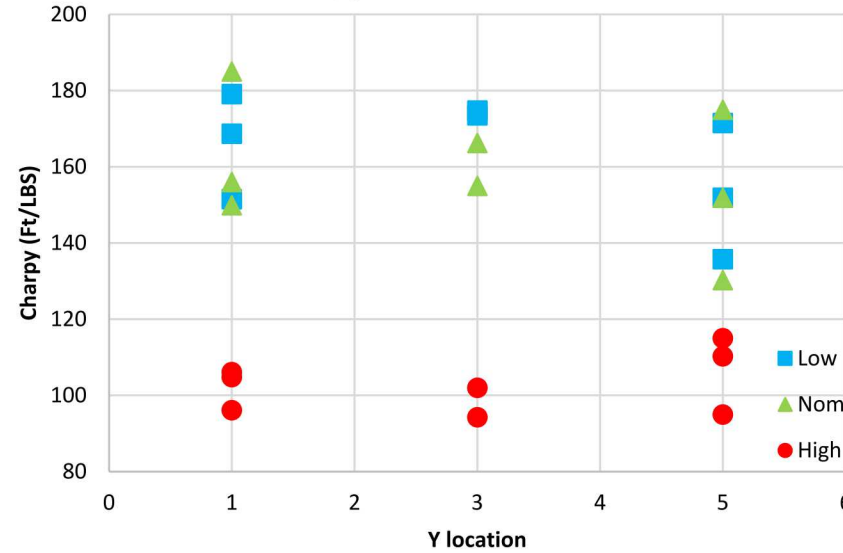


Charpy toughness within a build plate appears to be location dependent

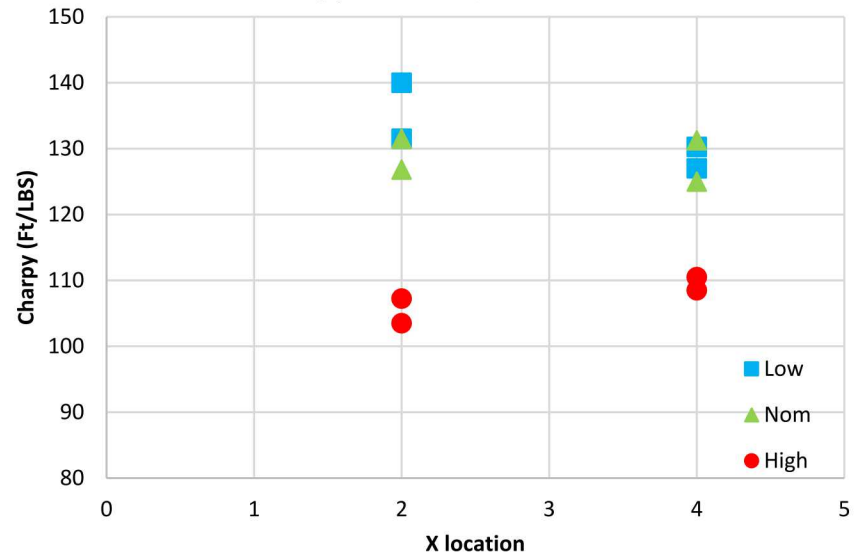
Charpy Value vs X, Vertical



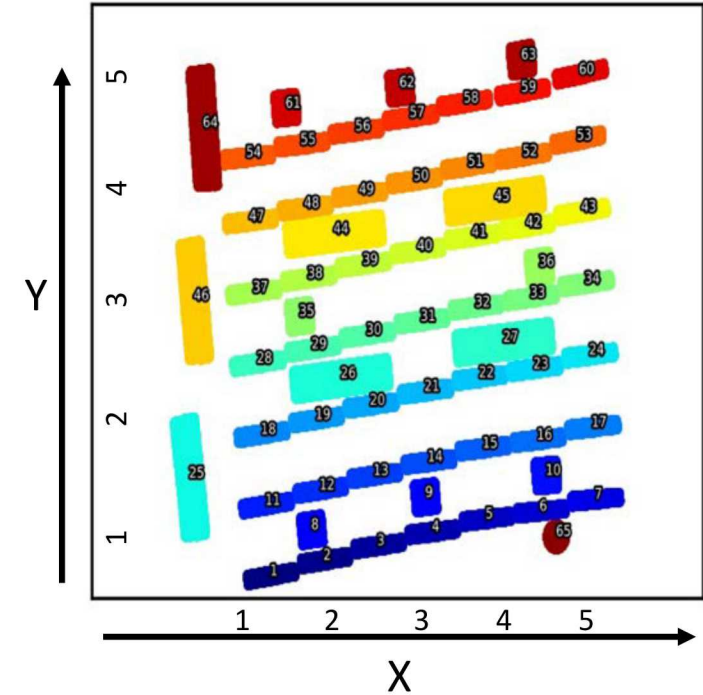
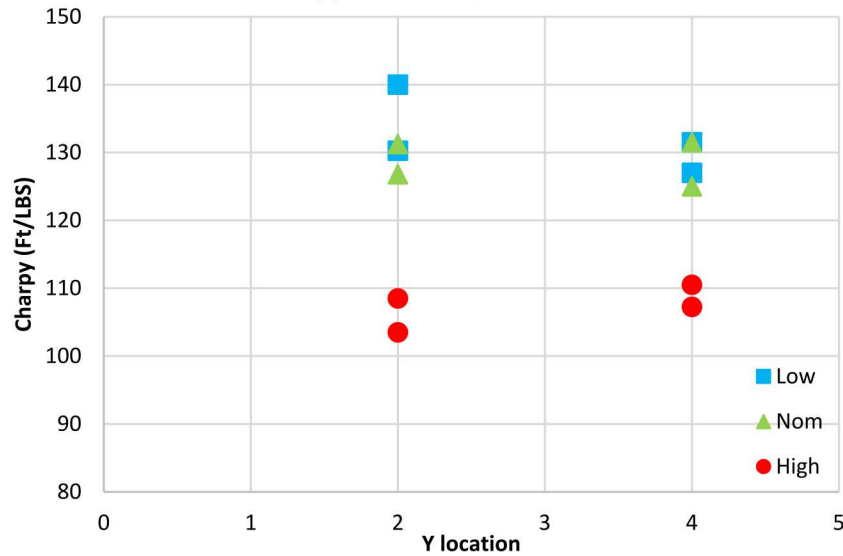
Charpy Value vs Y, Vertical



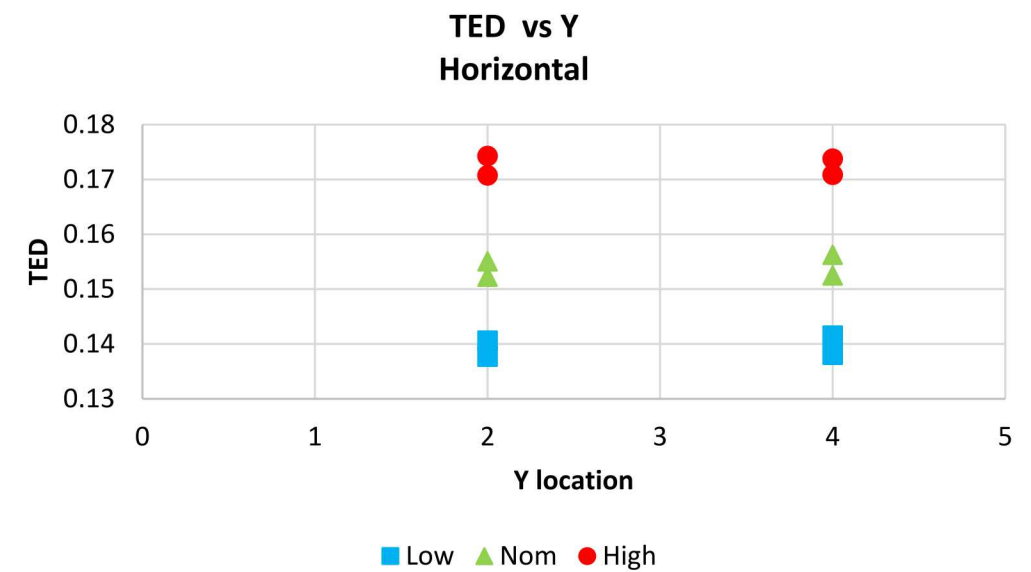
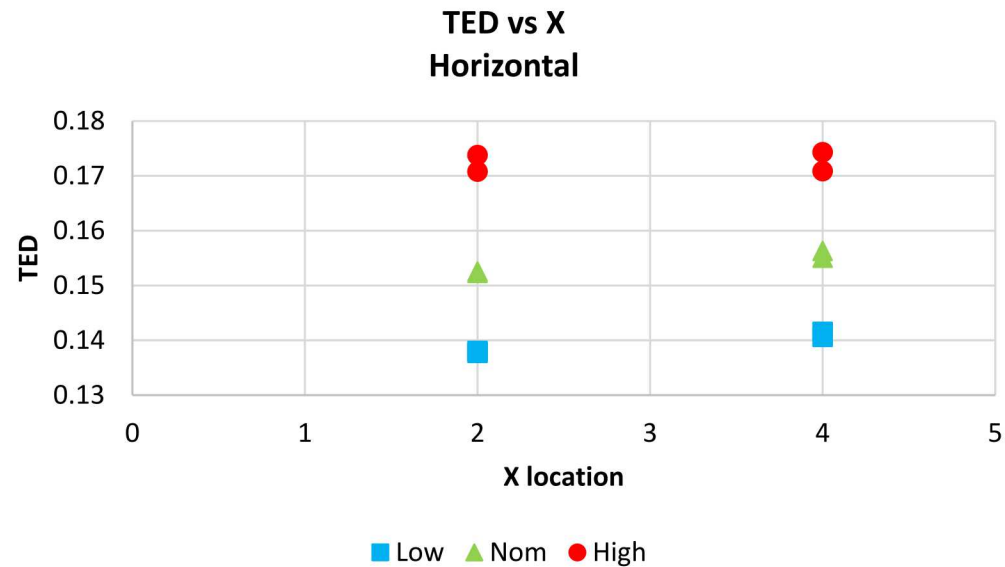
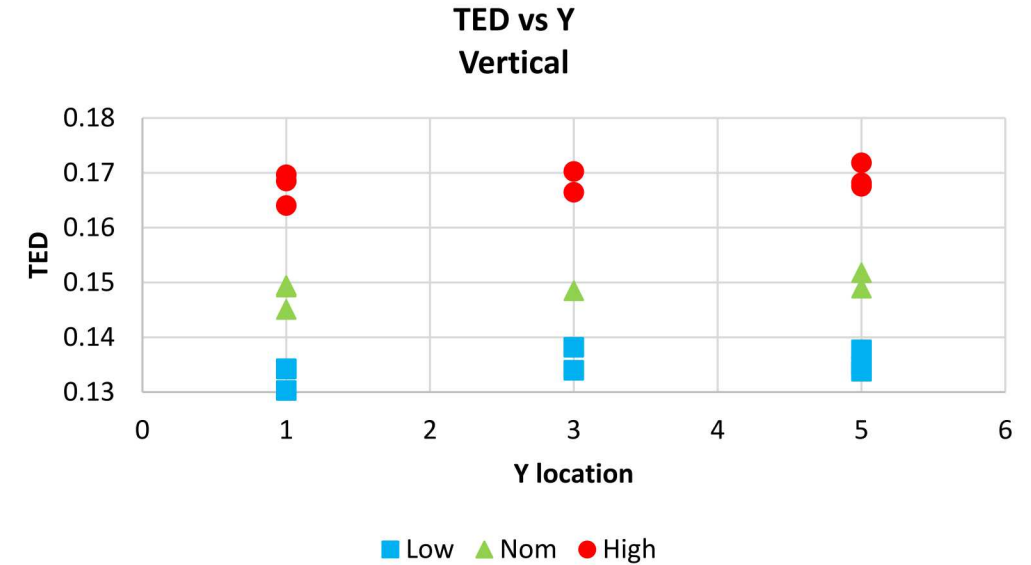
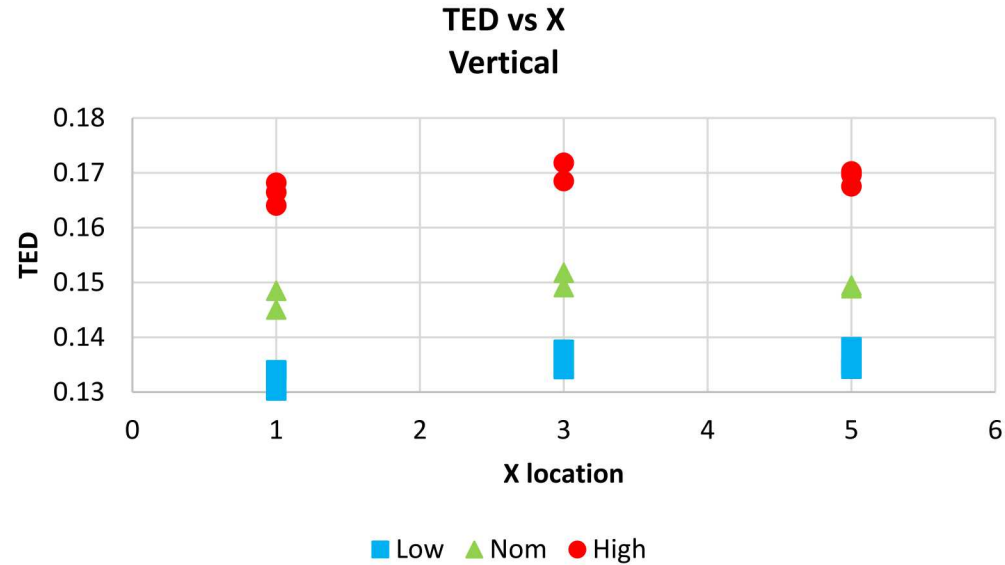
Charpy Value vs X, Horizontal



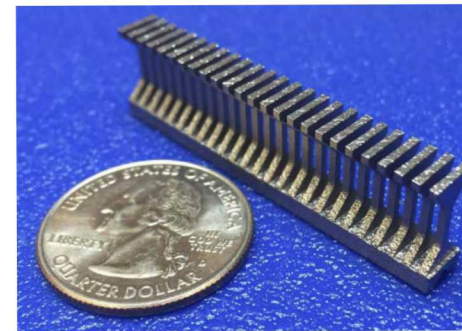
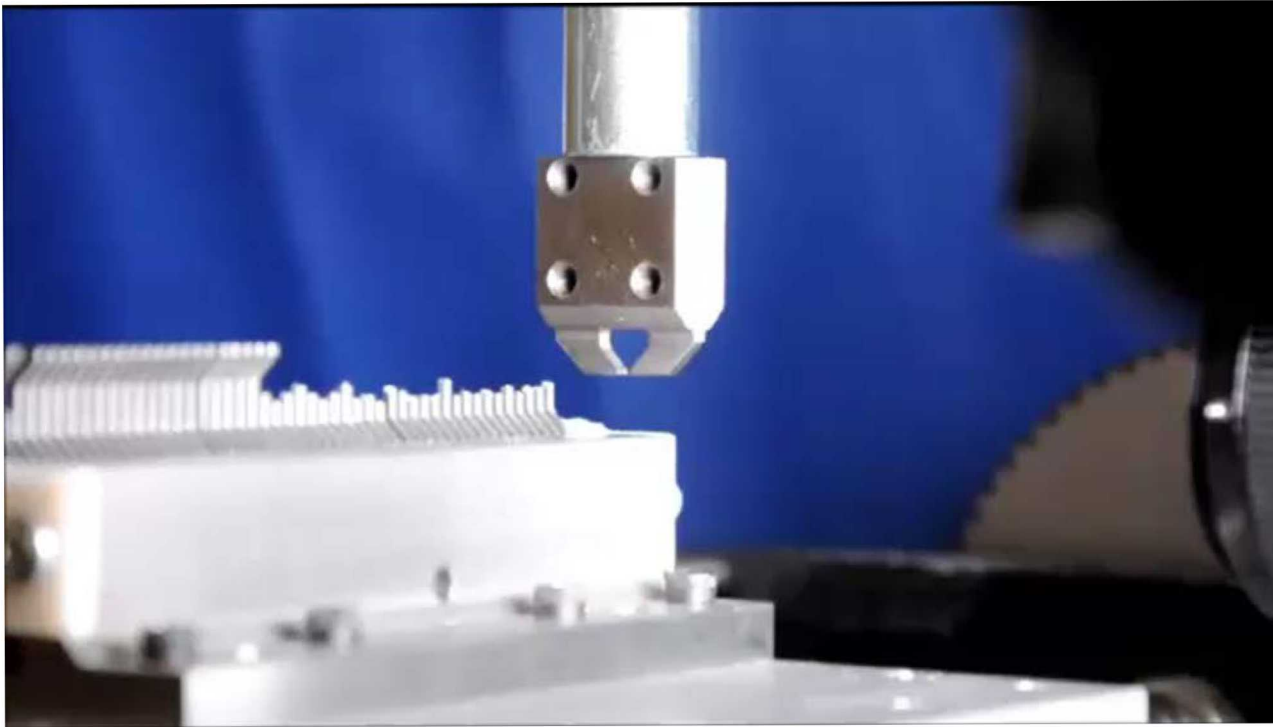
Charpy Value vs Y, Horizontal



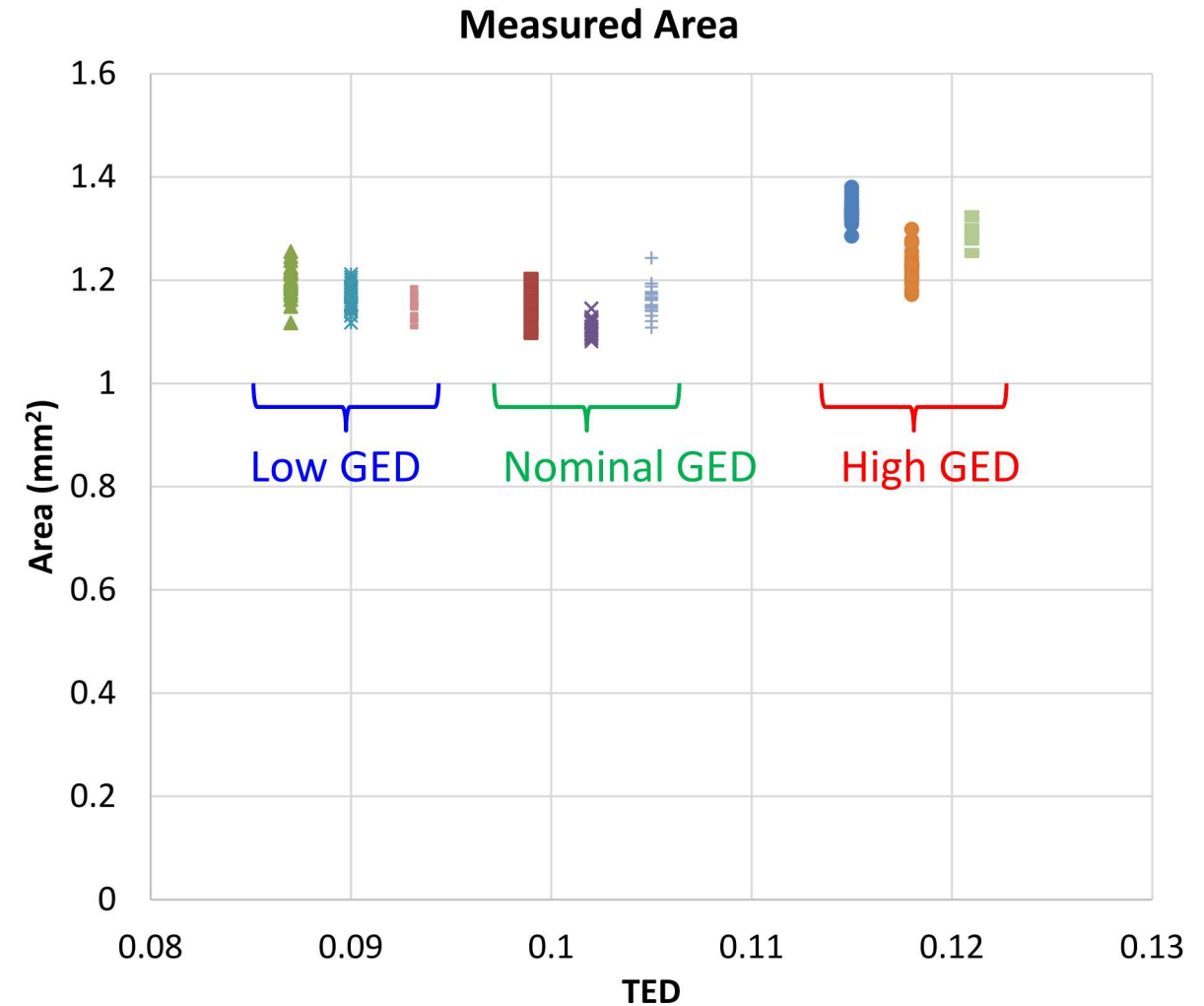
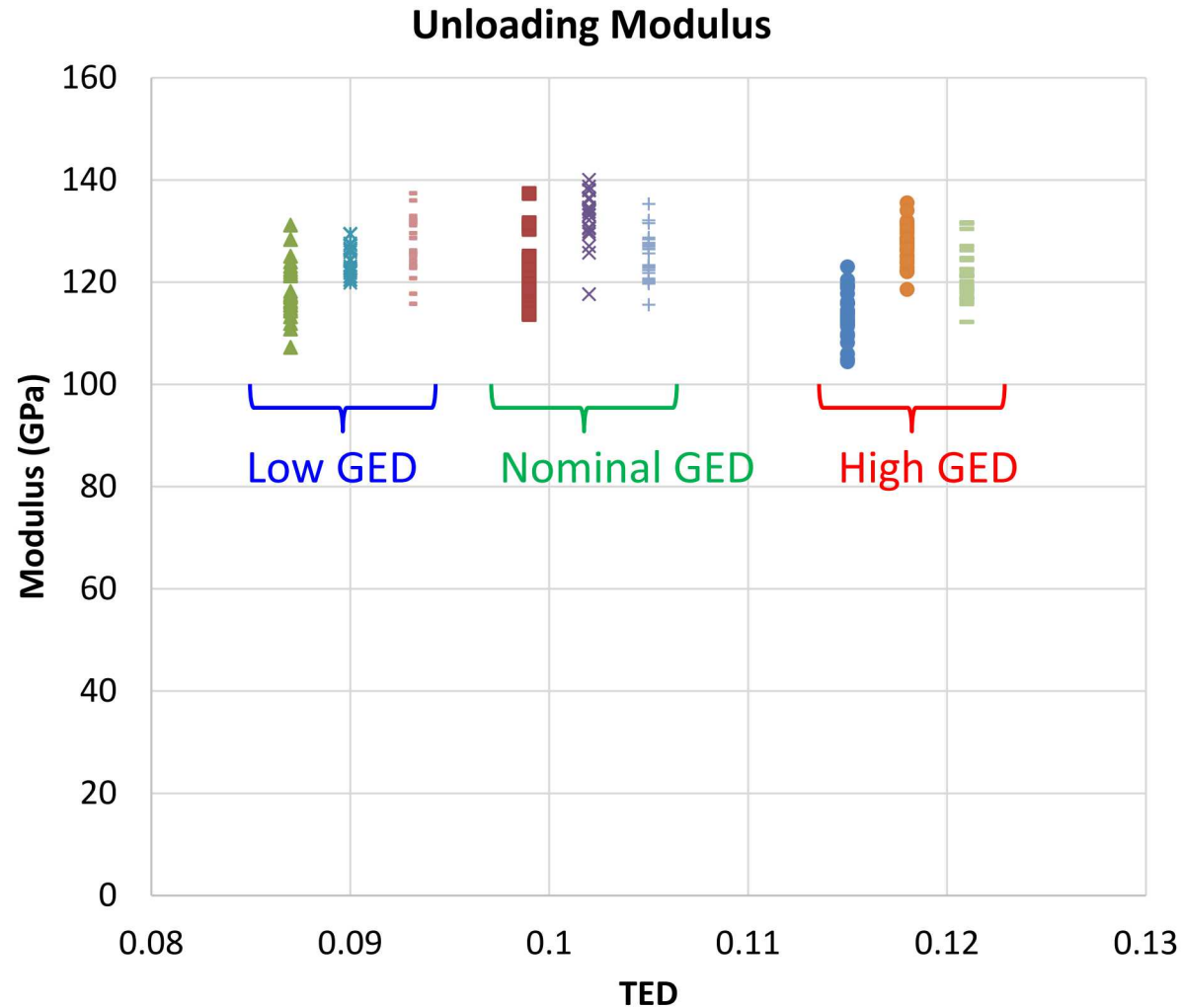
TED Values appear relatively independent of sample location



High Throughput Tensile Specimen Results

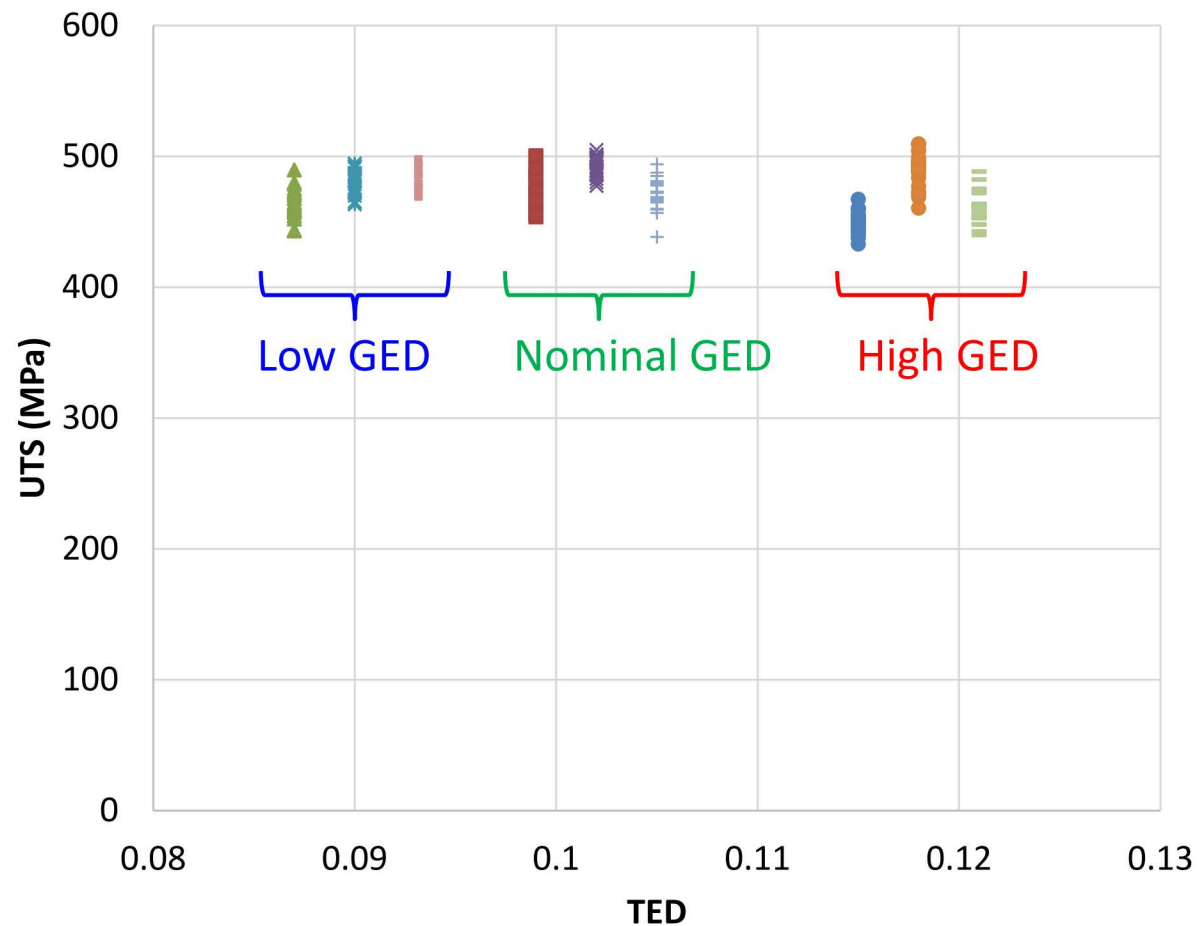


Unloading modulus is an underestimate due to the effective cross sectional area effects such as surface roughness, porosity, and other factors (typical of high throughput AM specimens)

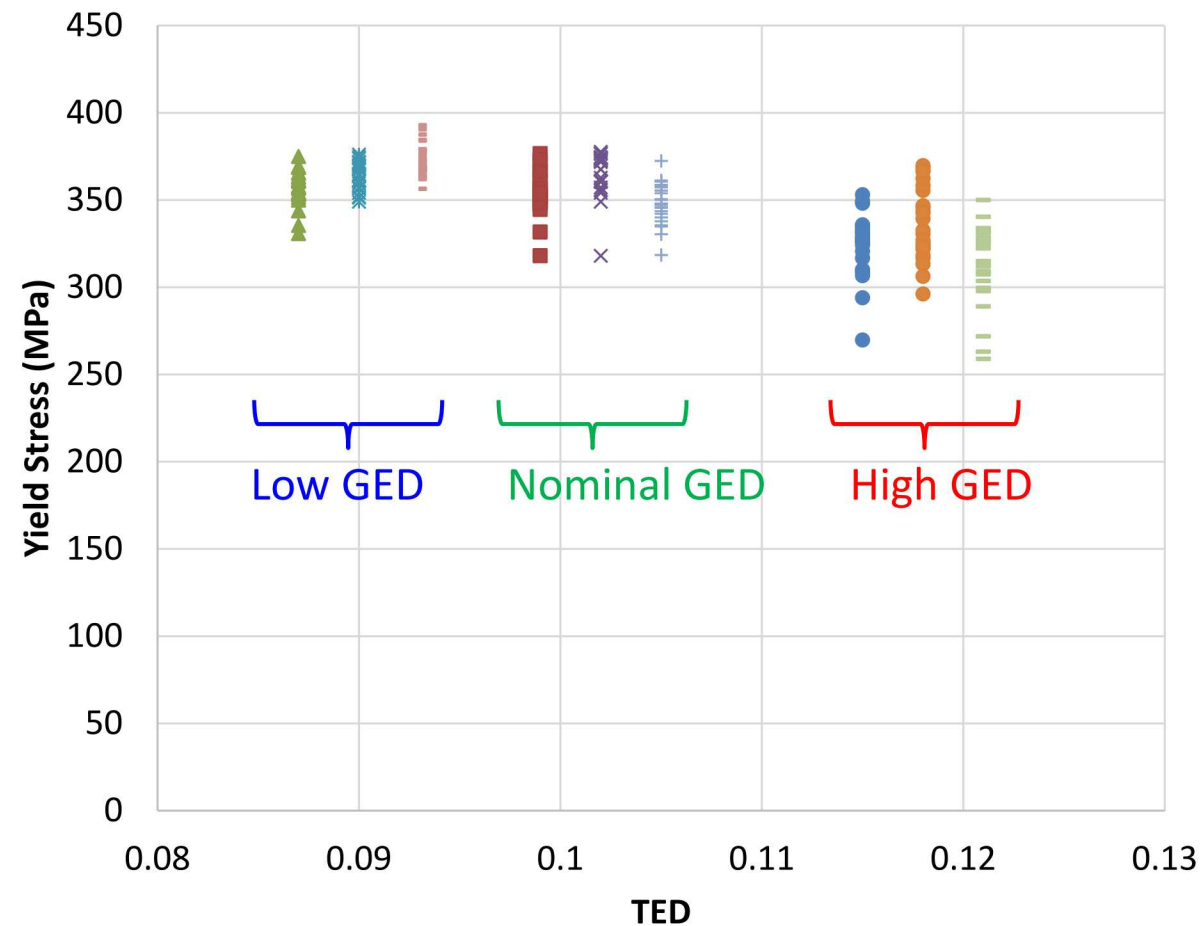


Strength changes little with TED value or even with GED value

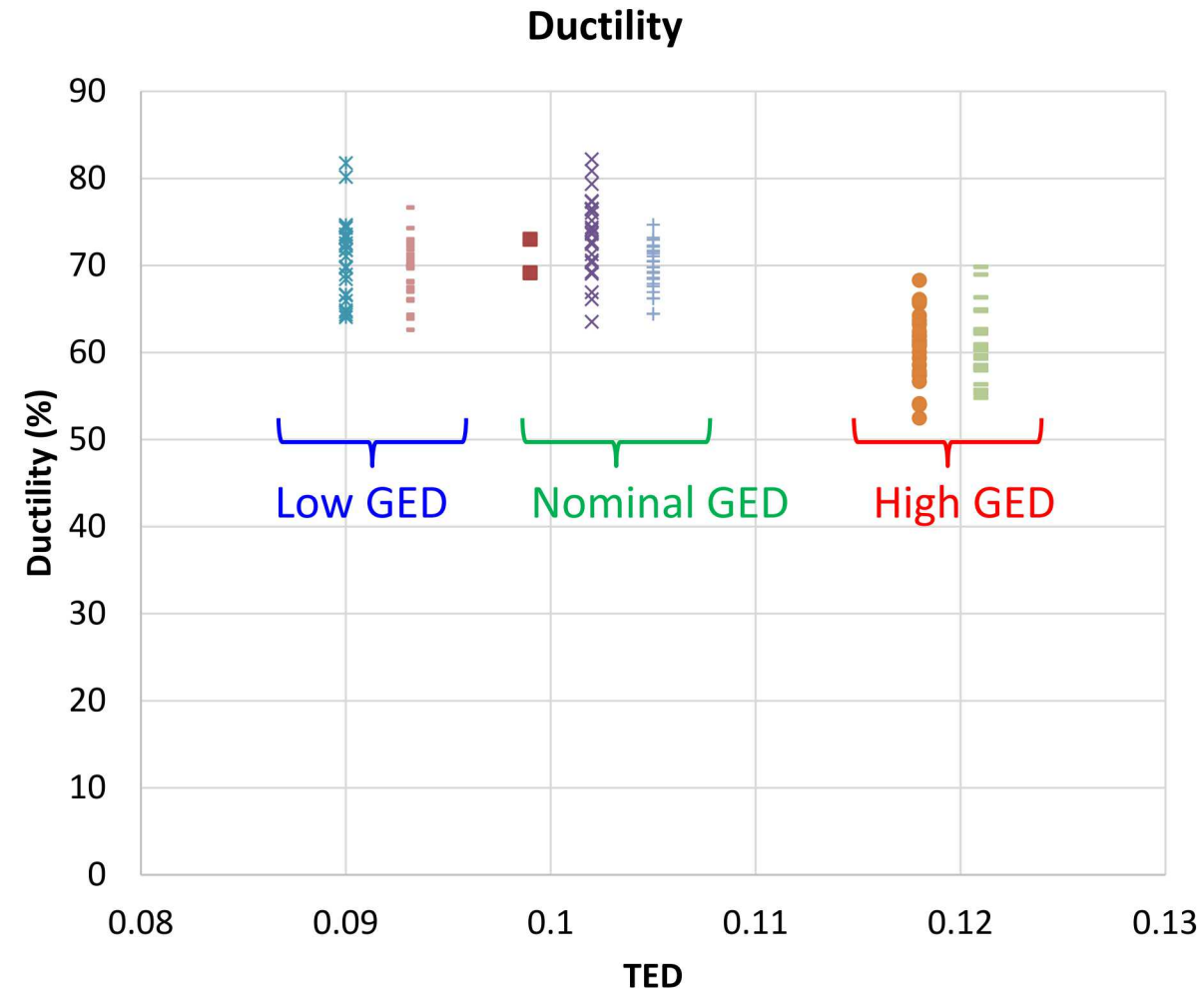
UTS



Yield Stress



Ductility of high GED specimens appears slightly lower than other build plates.



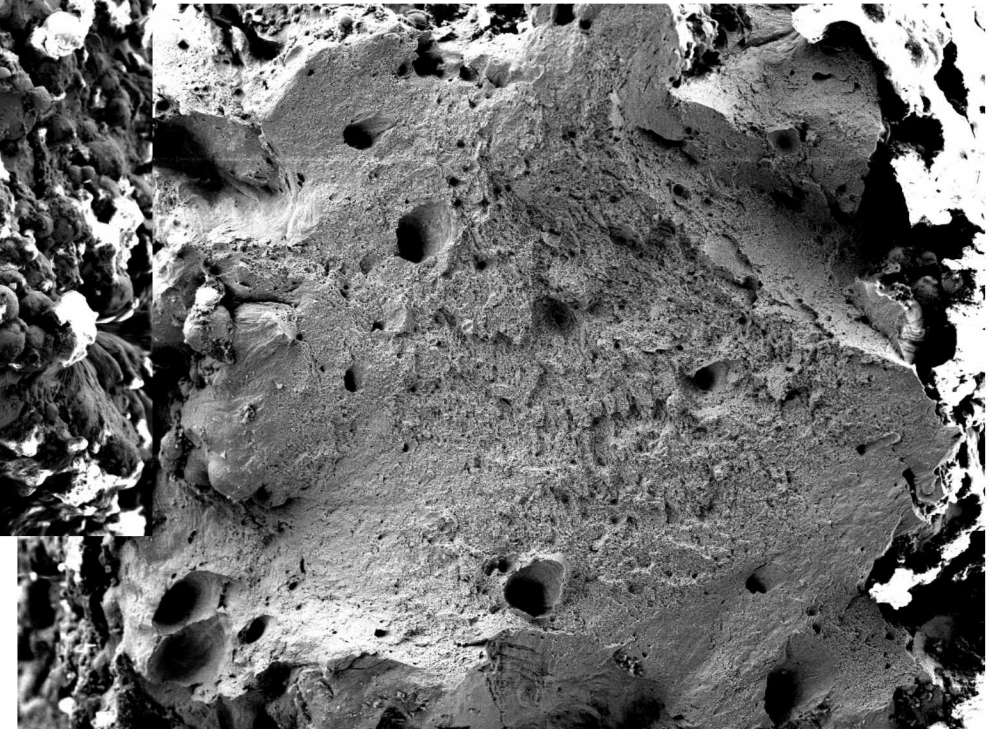
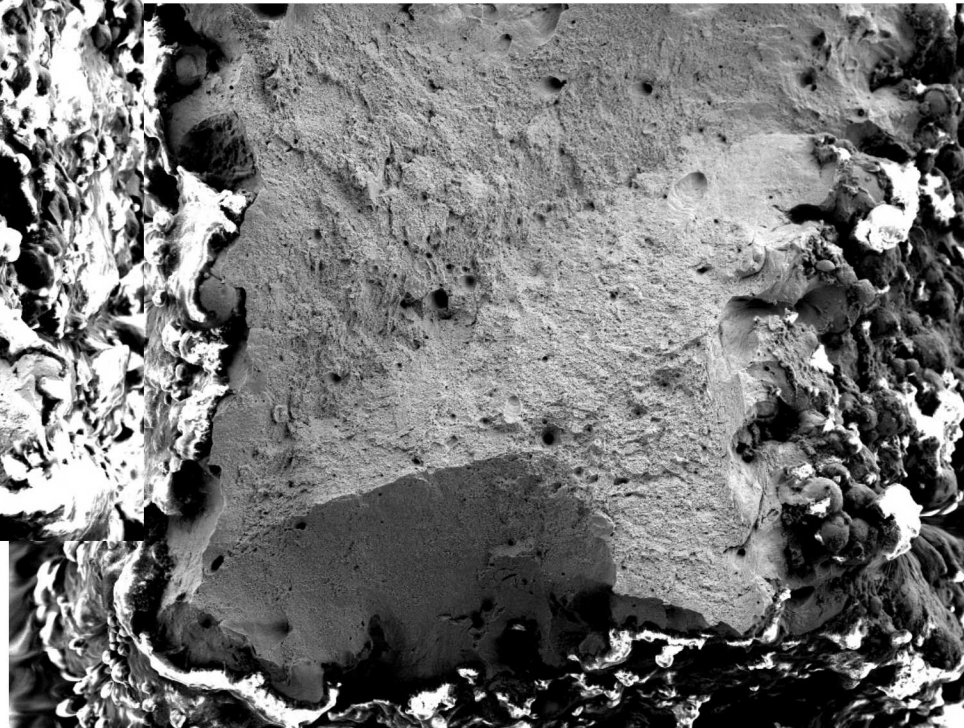
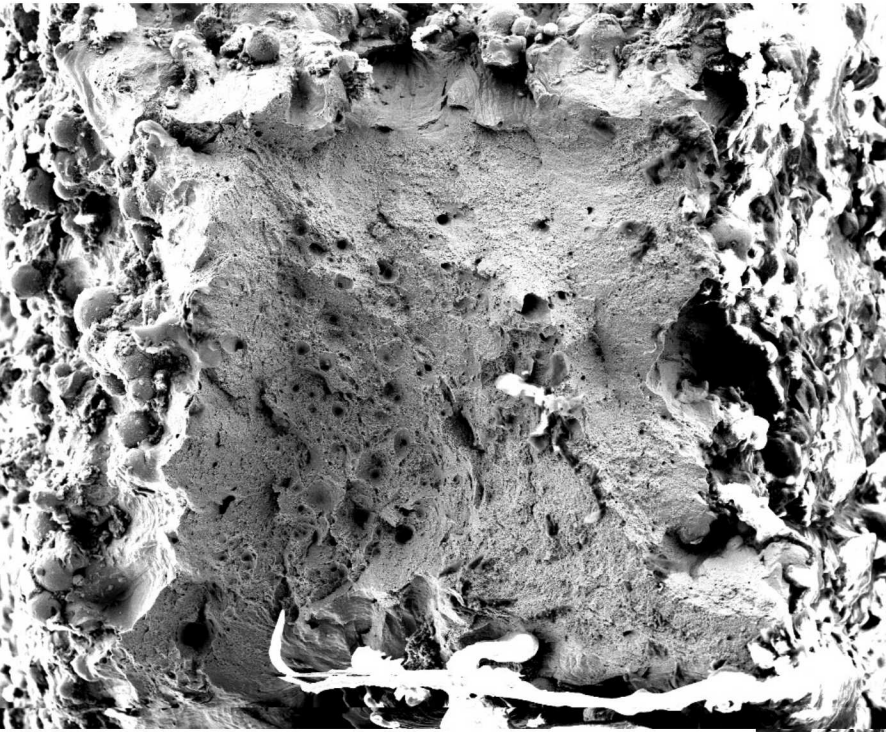
Only one TED value was available per rack of A-size tensile bars.

Fractography on Tensile Samples

Low

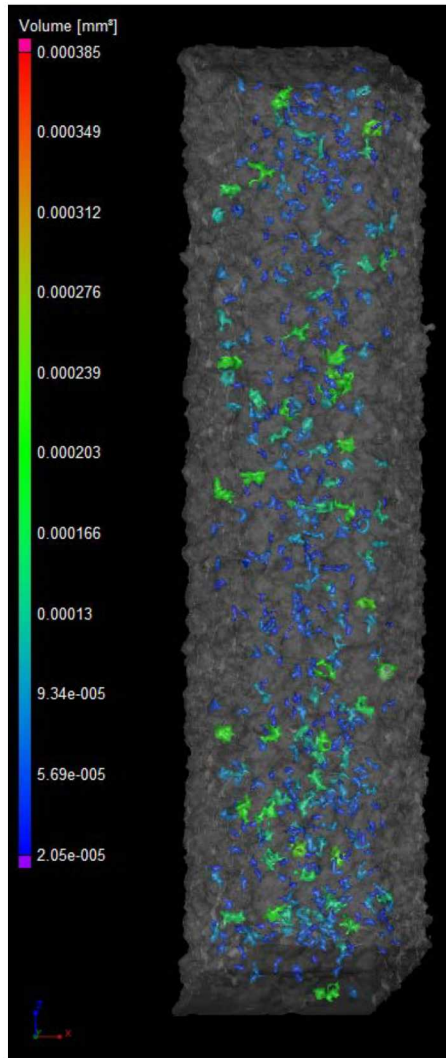
Nominal

High

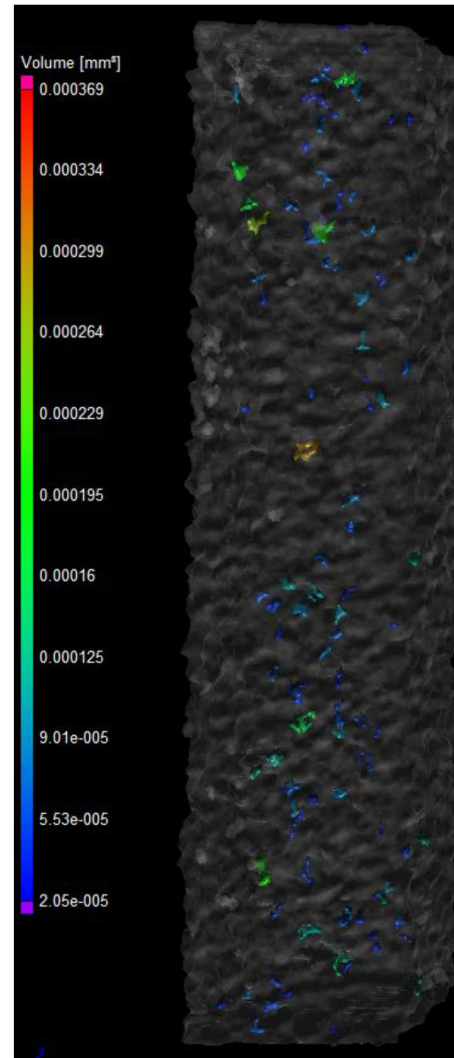


Porosity from CT measurements, specimen 25 from each build plate

Low



Nominal



High

