Mechanical Properties and Failure Analysis of Ceramics and Glass Materials

Kristin Breder, Senior Principal Scientist,
Saint-Gobain Research North America

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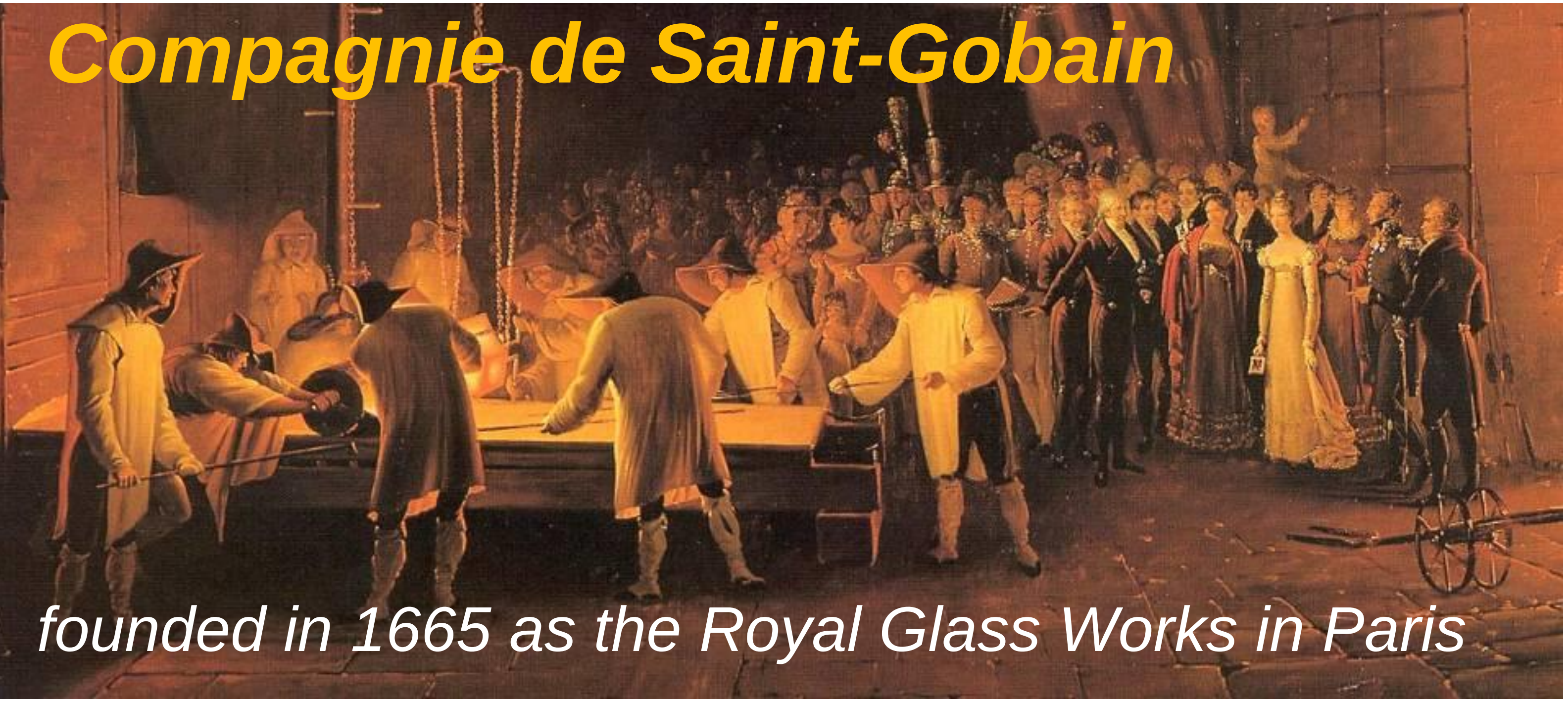
Compagnie de Saint-Gobain



founded in 1665 as the Royal Glass Works in Paris

Saint-Gobain Tower – Courbevoie, France

Kistefoss museum – Jevnaker, Norway

Academy Museum of Motion Pictures – Los Angeles, USA

Saint-Gobain Ceramics
INNOVATIVE SOLUTIONS FOR TODAY'S AND TOMORROW'S MARKETS

TRANSVERSAL R&D CENTERS BY SAINT-GOBAIN

SEFPRO
Refractory solutions for glass furnaces.

PERFORMANCE CERAMICS AND REFRACTORIES
Engineered ceramics and refractory products for extreme operating conditions and high-temperature applications: metallurgy, automotive, energy, etc.

SPECIALTY GRAINS AND POWDERS (SGP)
Engineered ceramic grains, powders, suspensions and chemicals for a wide range of industries: abrasives, semiconductors, aerospace, automotive, energy, etc.

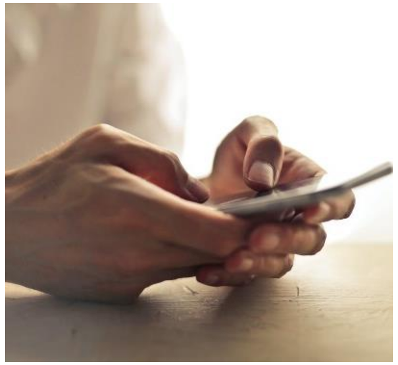
QUARTZ
Quartz fibers and fabrics for aerospace, 5G, railway solutions.

ZIRPRO
Ceramic beads for milling, ceramic beads and grains for blasting, zirconium oxide powders and chemicals for a wide range of industries: EV, 5G, new energies, automotive and aerospace, surface treatments etc.

NORPRO
Ceramic catalyst carriers and process ceramics for refining, petrochemical, chemical, environmental, gas and biofuel processing industries.

VALOREF
Refractories and technical ceramics waste management for a circular economy.

NEW HORIZONS TEAM
An agile and empowered team focused on partnering with key innovators to create breakthrough solutions for new markets.





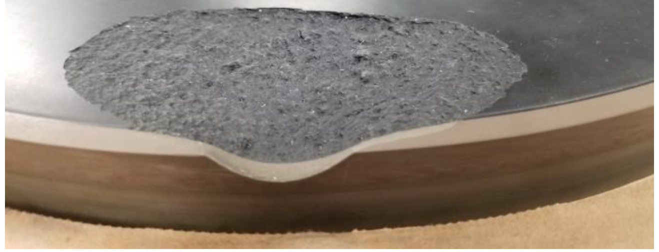

How do we predict the fracture of real components?

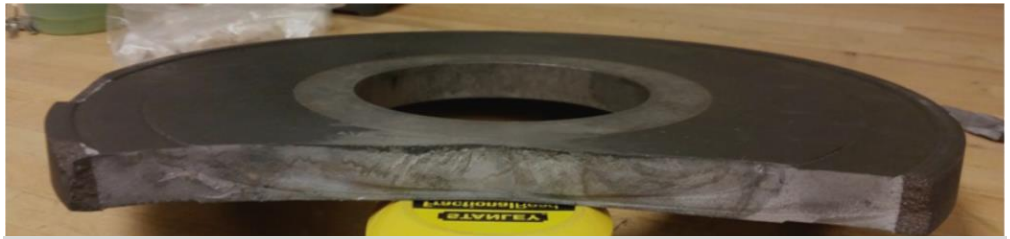
A “choke” for mining applications

SiC plate for kiln

Fractured abrasive grits

Precision grinding wheel returned by a customer





Grinding wheel fractured on a machine

Pieces of rollers used in a large kiln - new rollers are 3 m long

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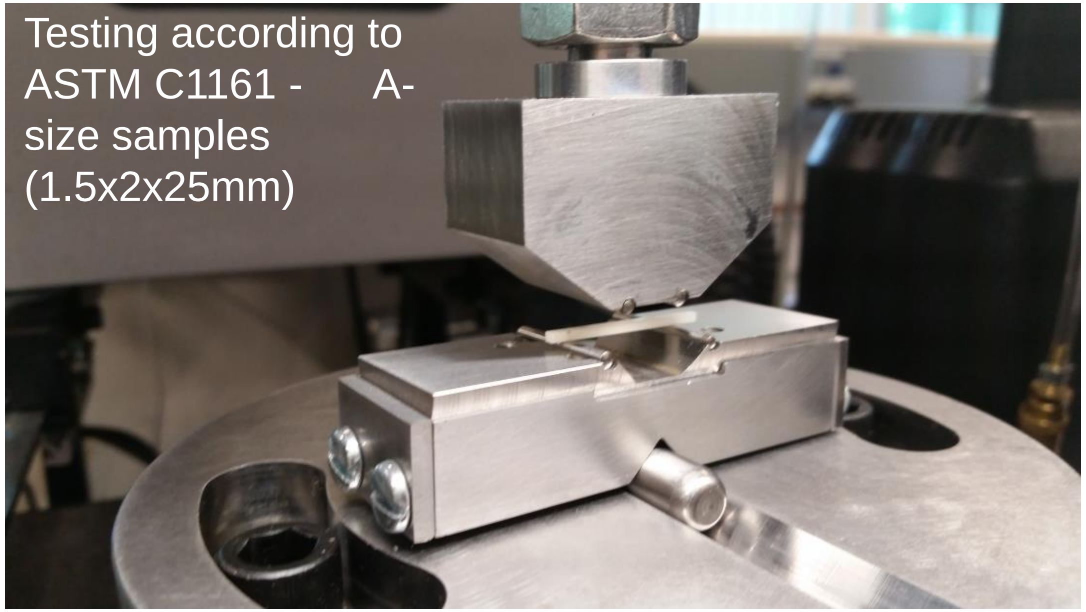
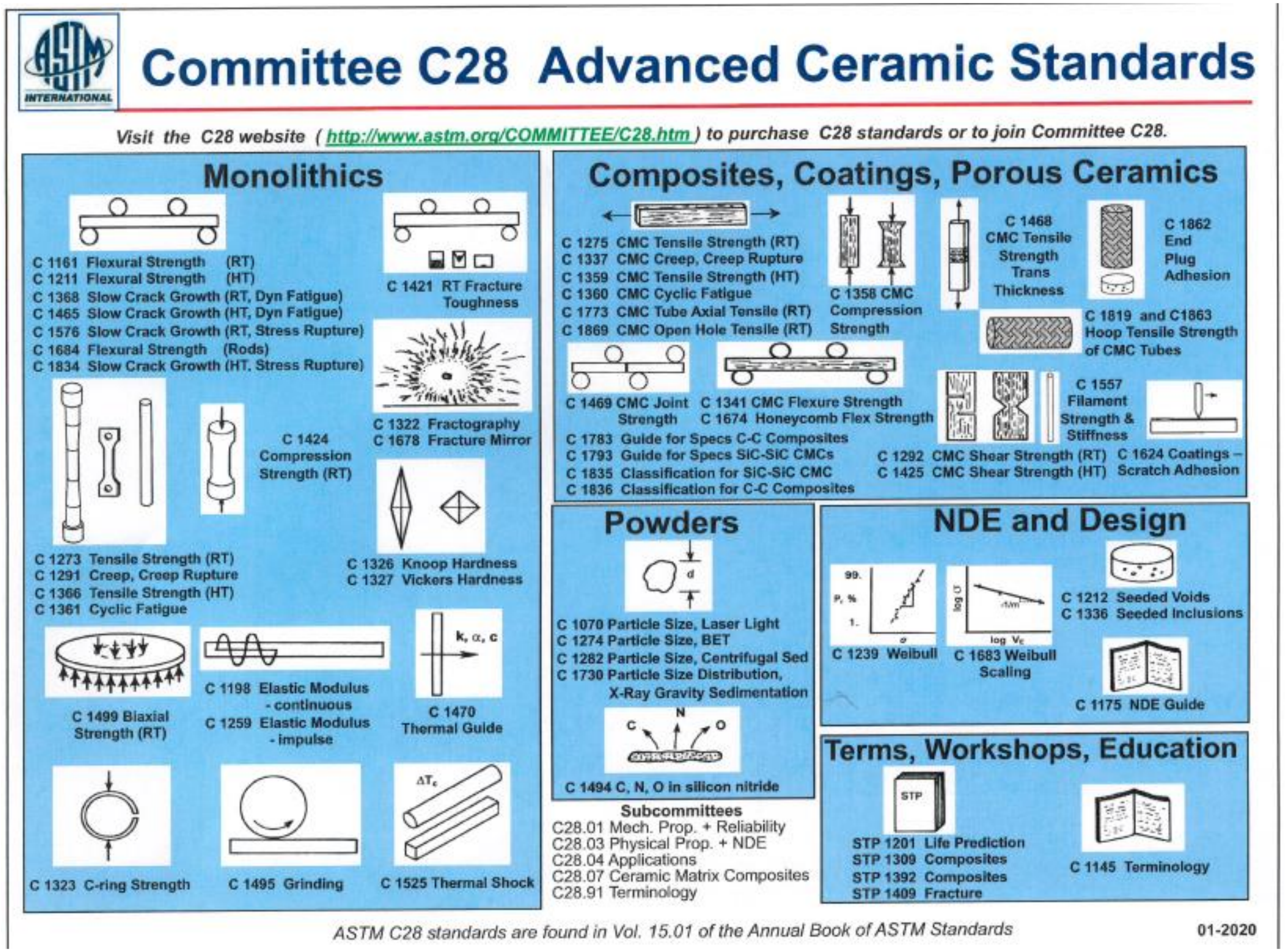
Standard methods for measuring strength of brittle materials

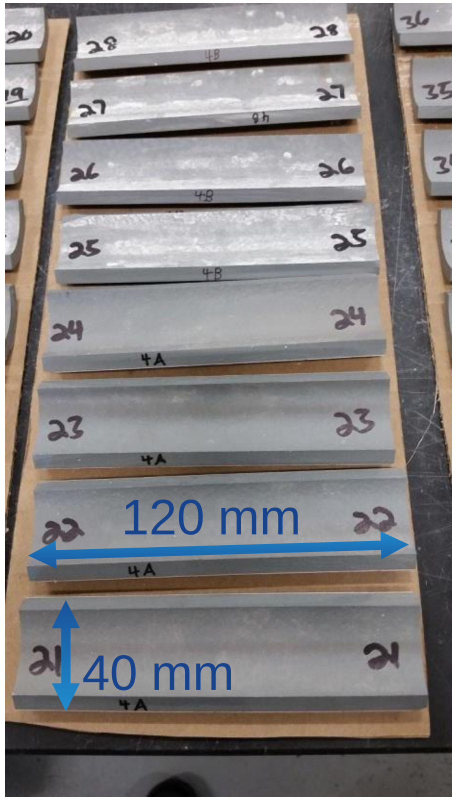
- Testing of well defined samples in carefully designed fixtures
- Stress & strength are readily calculated from fracture load
- Statistical analysis of data

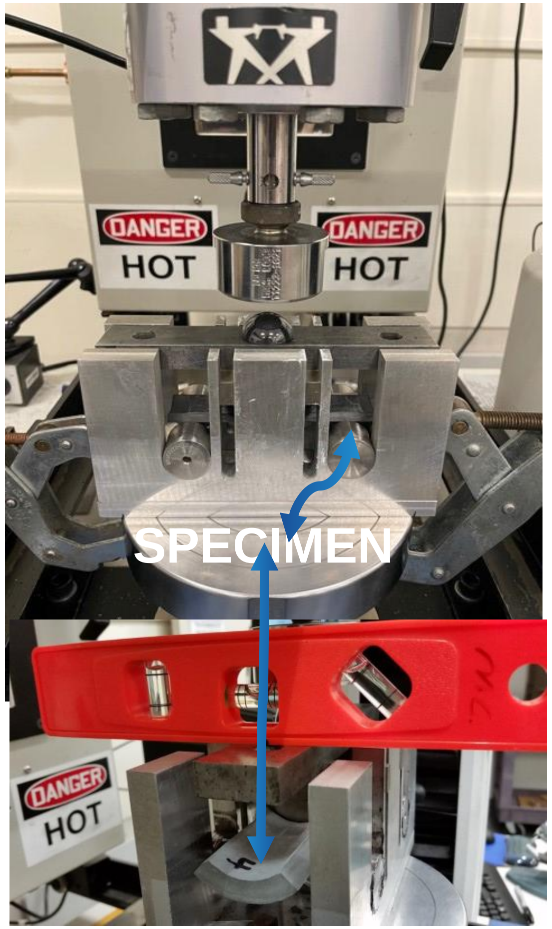


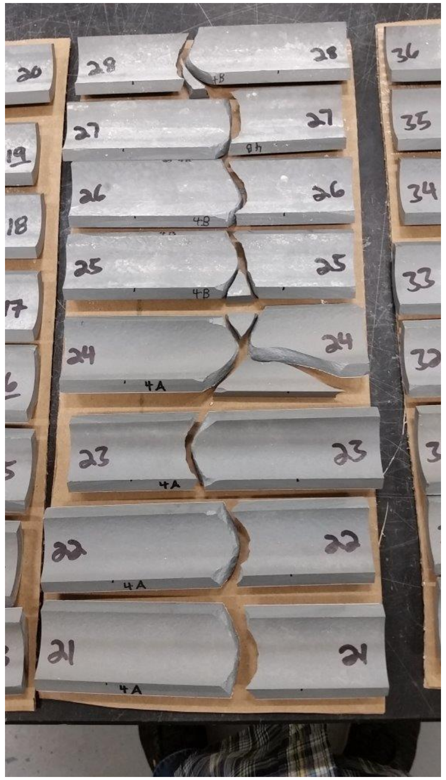


Testing of materials from an application

- Strength of actual material with as-manufactured or corroded surfaces
- Strength calculation and statistical analysis are more complex

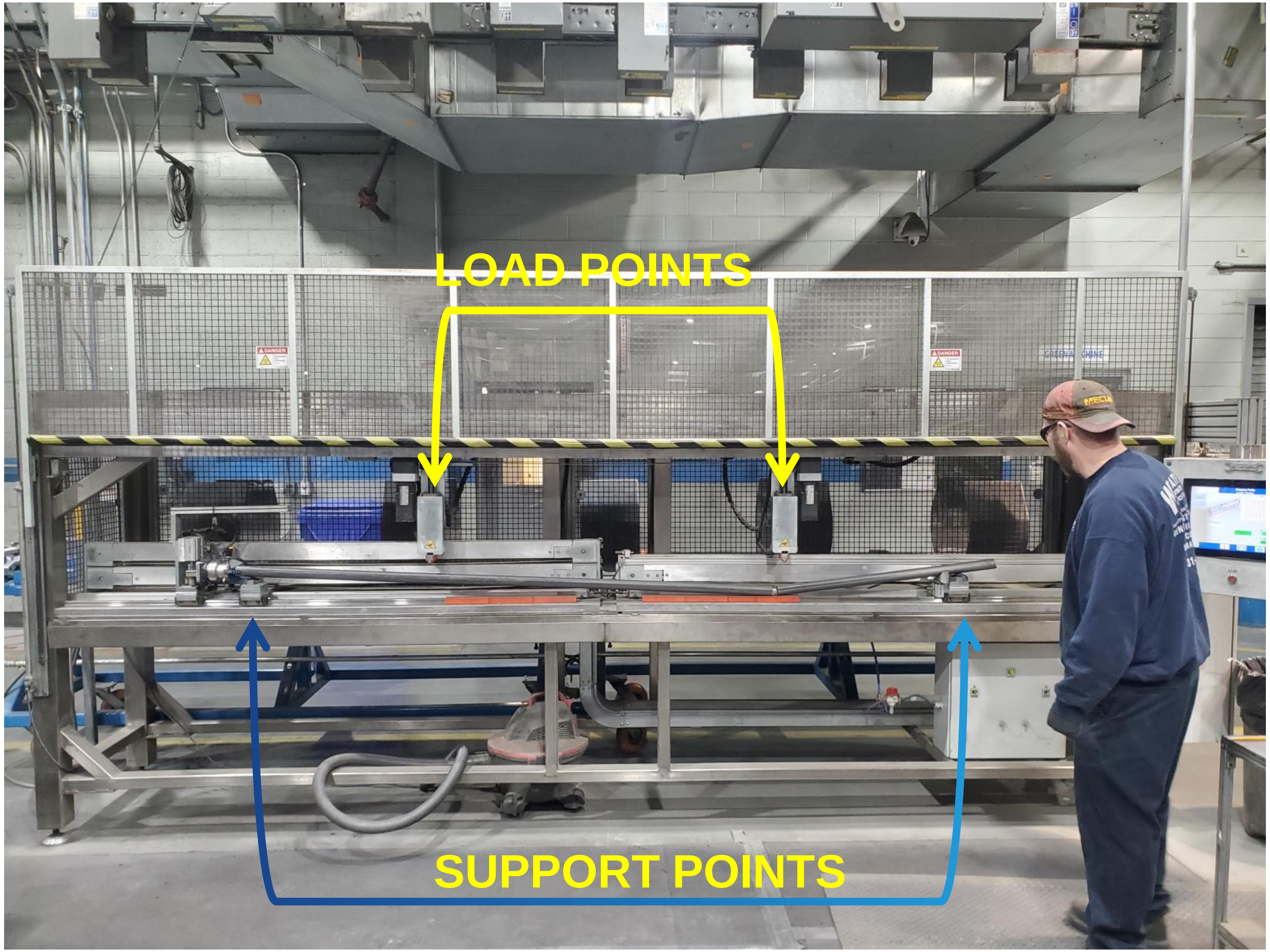






Our understanding of the fundamental principals behind Weibull analysis allows us to analyze any test we can perform and use those results to predict probability of failure in real applications.

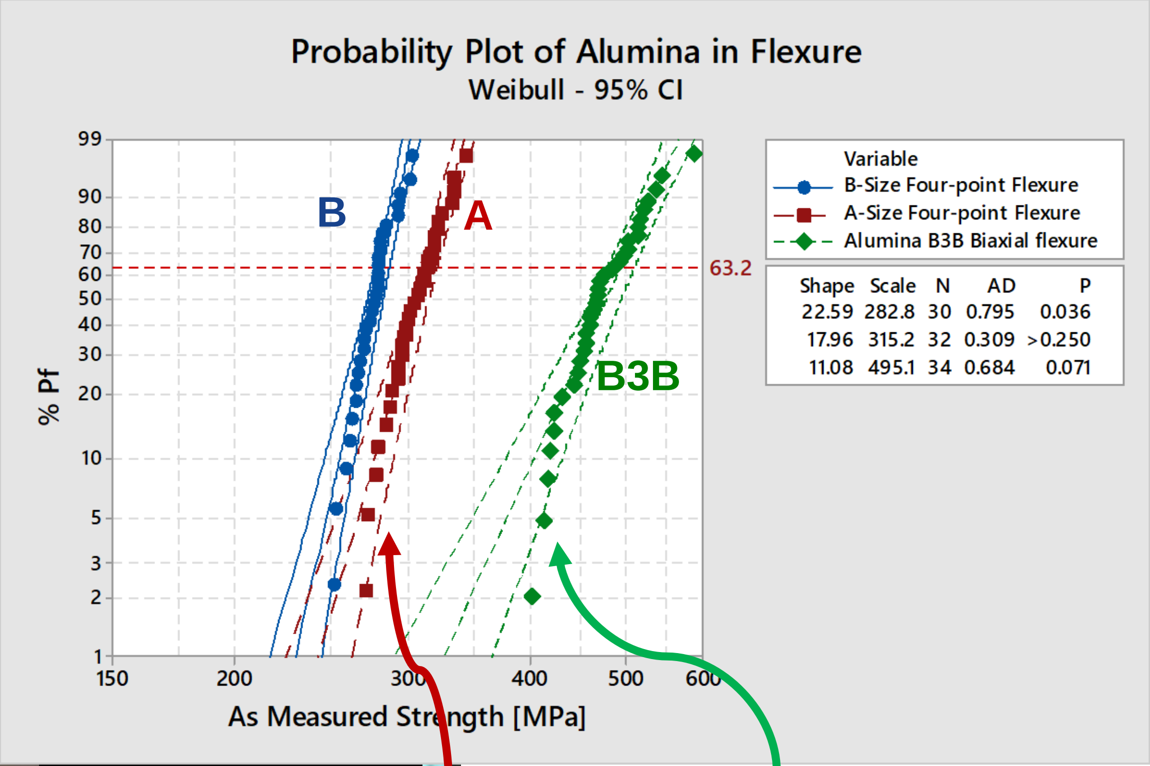
Testing of the full-size component (a 3 meter long Hexoloy tube)

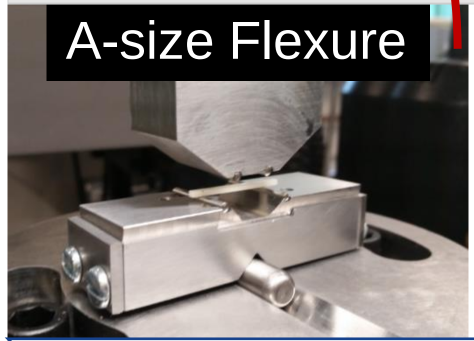


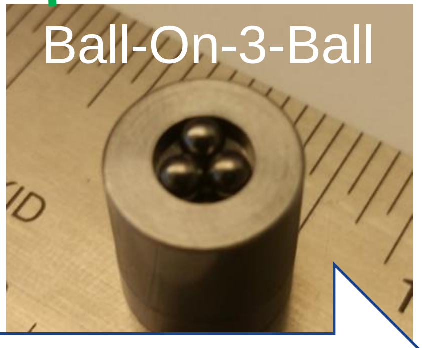
- A true test of the as-made strength of the real part!
- Valuable for proof testing
- Too expensive for practical use as a strength test

We use results of more practical tests (e.g. sector test) in combination with FEA and Weibull analysis to predict the strength of real parts in application conditions.

Combine standard and non-standard tests and perform Weibull scaling

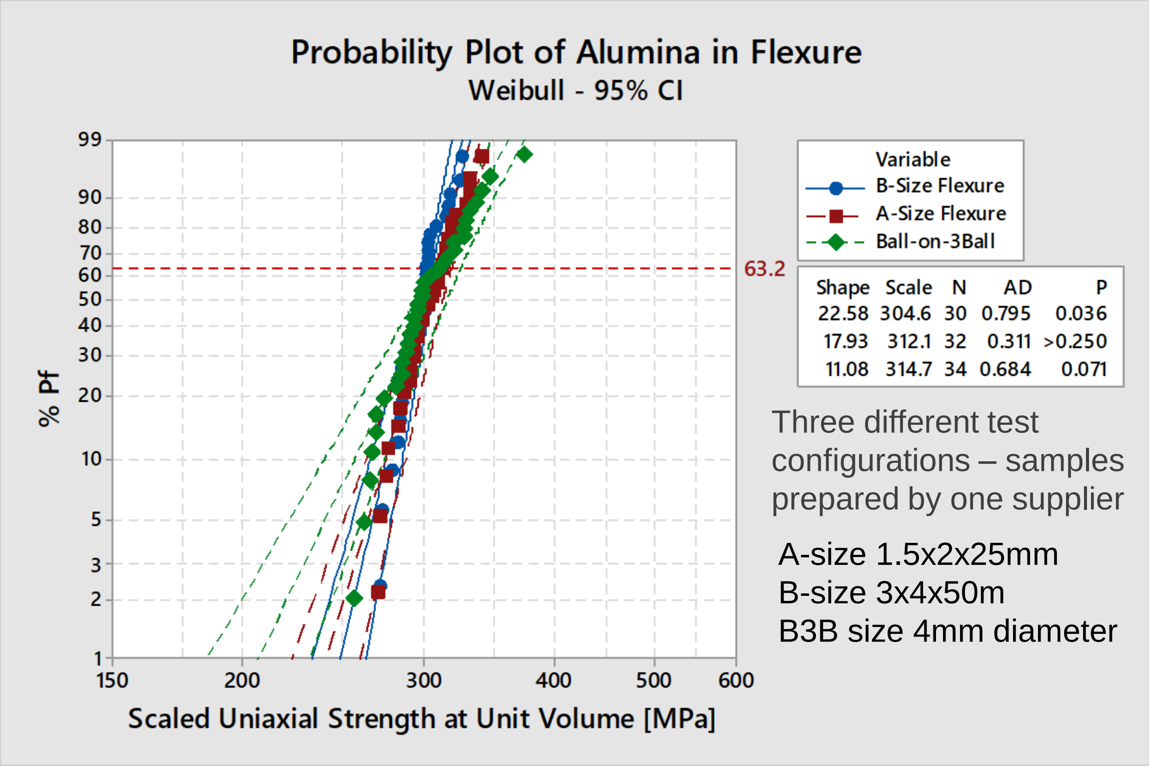






Samples with smaller stressed volume appear to be stronger

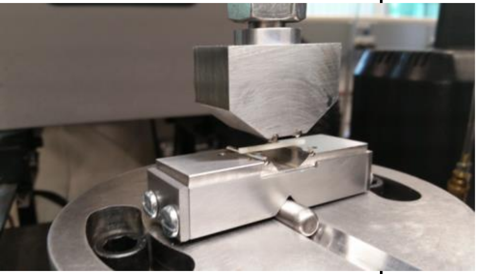
- ❑ Data scaled to unit volume using Weibull scaling analysis
- ❑ The scaling works well for similar stressed volumes with similar strength limiting flaws



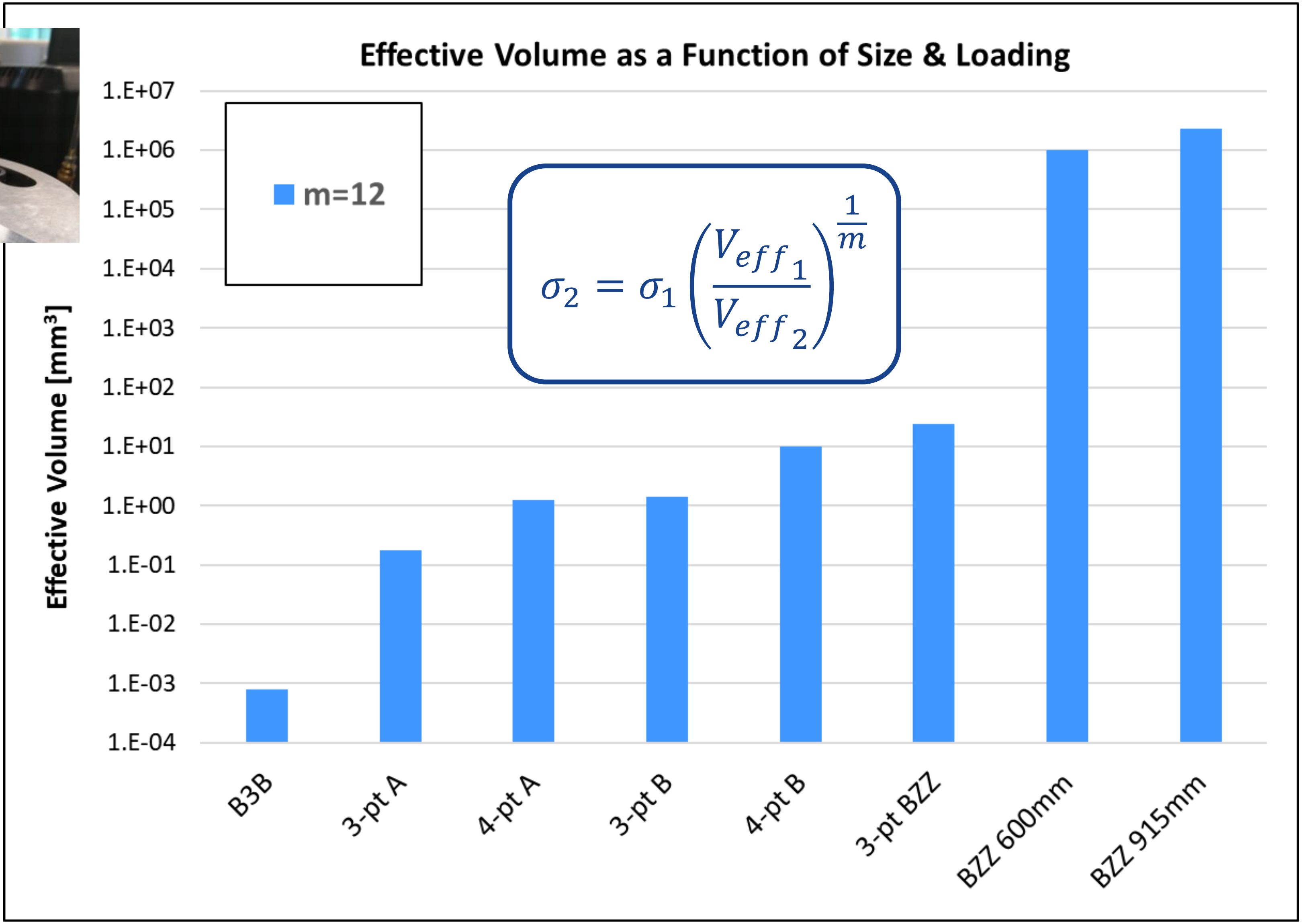
Three different test configurations – samples prepared by one supplier

A-size 1.5x2x25mm
B-size 3x4x50m
B3B size 4mm diameter

Extrapolation from tests to real applications



~ 4 mm



~ 1 m

10^4 to 10^5 times difference in V_{eff} from tests to application – a bridge too far!

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