OPTIMAL PRODUCTION TRIMMING PROCESS FOR AHSS EDGE STRETCHABILITY IMPROVEMENT

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Outline

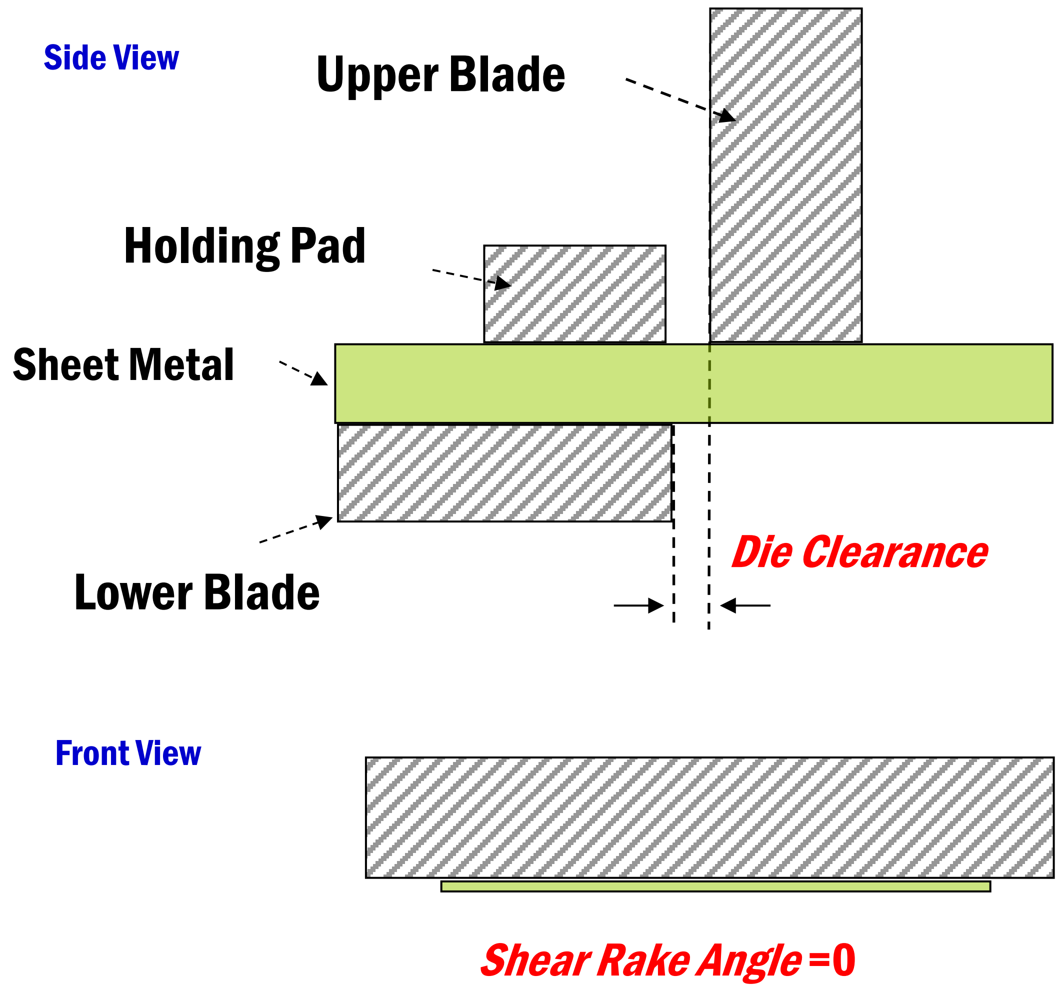
- *Introduction*
  - *Edge Fracture*
  - *Flat Trim vs. Shear Trim*
- *Cutting Test*
- *Edge Stretchability*
  - *Trimmed Edge Tension Test*
  - *Half Specimen Dome Test*
- *Trimmed Edge Characterization*
- *Summary*

Introduction – Edge Fracture

Edge Fracture

- FLD failed to predict
- May be due to poor trimmed edge condition

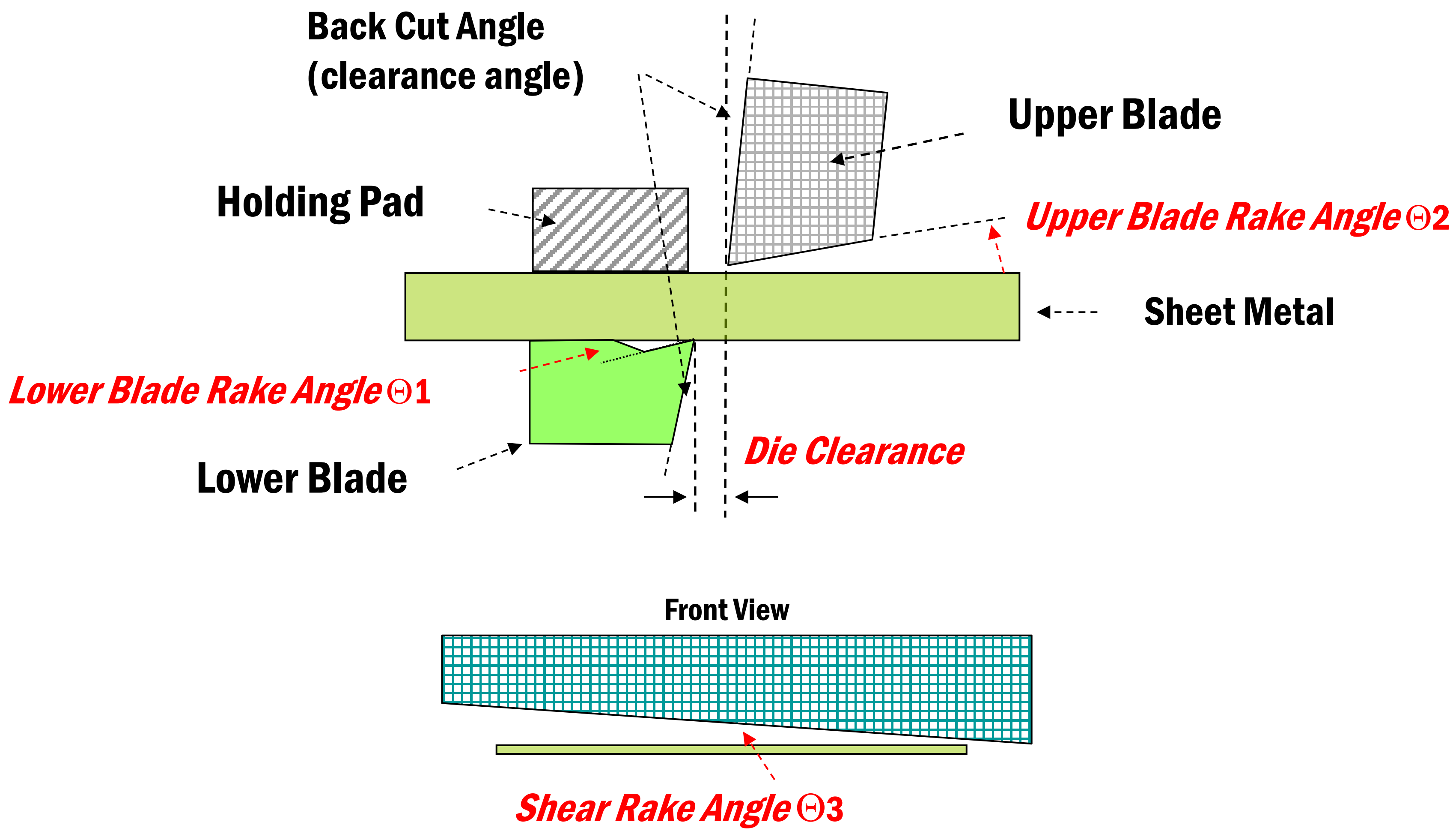
Introduction – Flat Trim



Introduction – Flat Trim

- *Quality*
  - *Poor Trimmed Edge Stretchability*
- *Cost*
  - *Split Parts*
  - *Tool Wear/Damage*
  - *Energy Consumption*
  - *Down Time*

Introduction – Shear Trim



Shearing Parameters (Θ1,Θ2,Θ3)

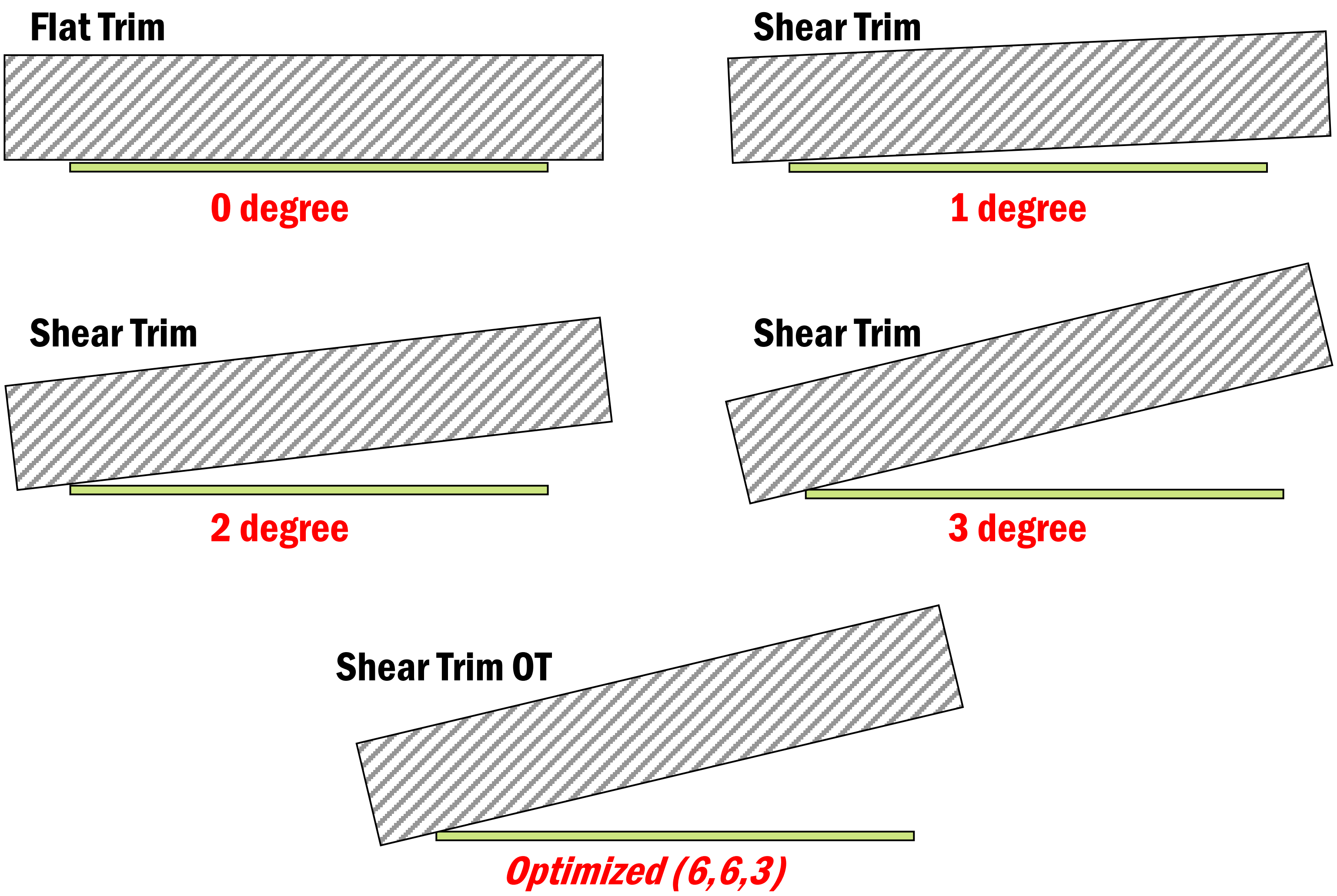
Introduction – Shear Trim

- *Quality*
  - *Better Trimmed Edge Stretchability*
- *Cost*
  - *Less Split Parts*
  - *Less Tool Wear/Damage*
  - *Reduce Energy Consumption*
  - *Reduce Down Time*

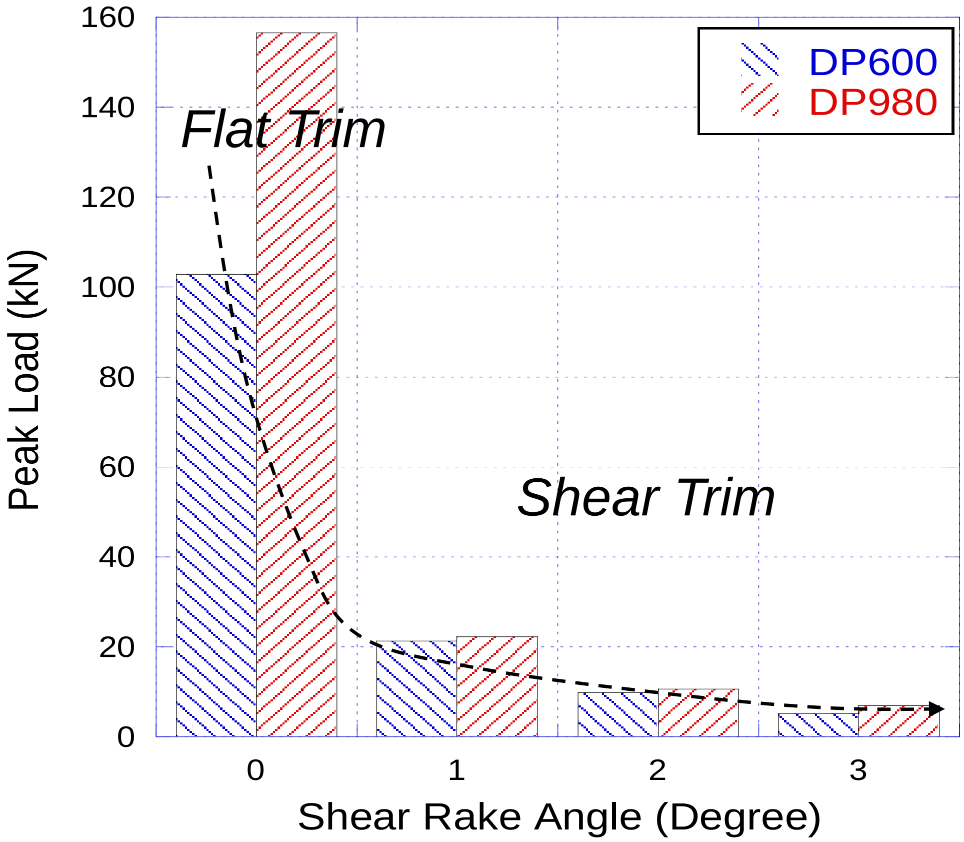
Test Materials

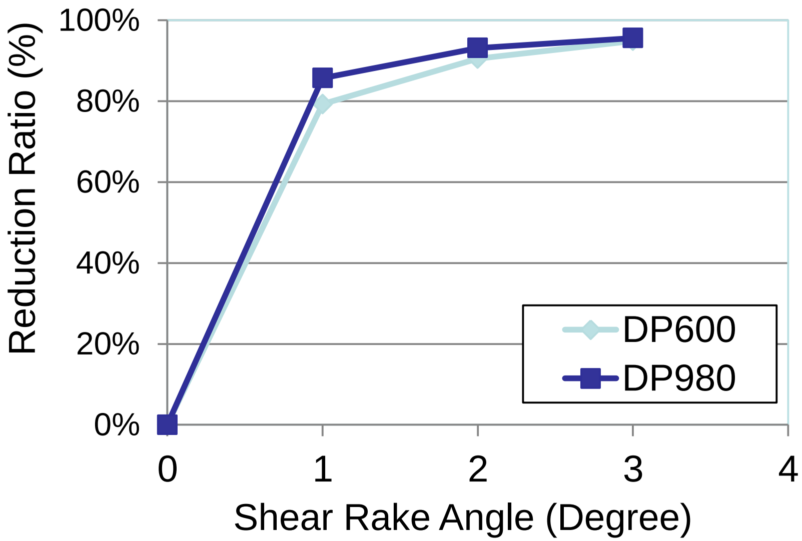
Material	Thickness (mm)	Yield Strength (MPa)	Tensile Strength (MPa)	Total Elong. (%)	n Value	R value
DP600 - L	1.0	391	645	26.4	0.16	0.86
DP600 - T	1.0	411	659	26.7	0.15	1.03
DP980 - L	1.2	677	994	14.0	0.14	0.73
DP980 - T	1.2	660	992	14.1	0.14	1.05

Cutting Conditions



Cutting Force





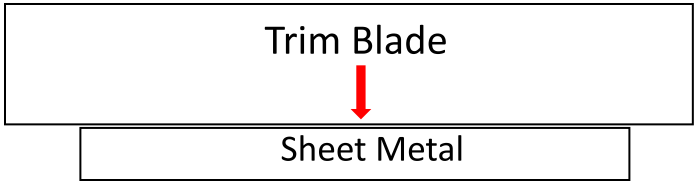
Cutting Force Estimation

Flat Trim

$$F = C_1 * T * L * UTS$$

Material Constant

C_1=0.77, DP600
C_1=0.68, DP980

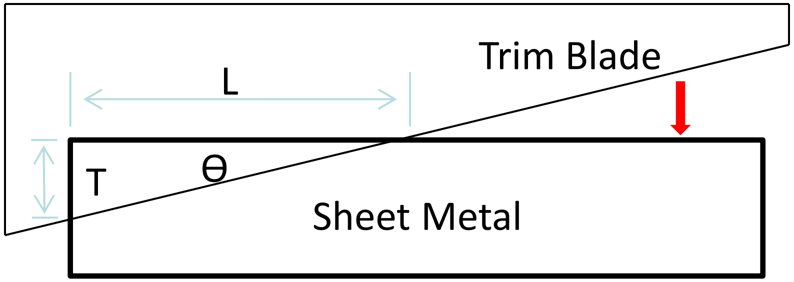


Shear Trim

$$F = C_{shear} * T^2 * UTS / 2 * \tan\theta$$

Material Constant

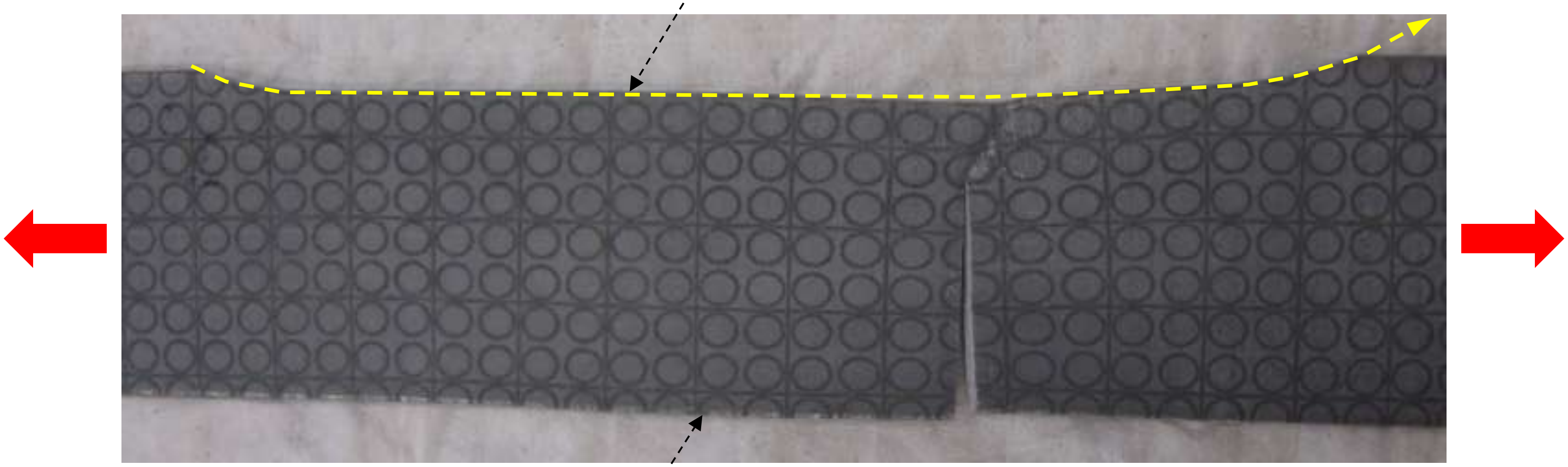
C_{Shear} =1.00, DP600
C_{Shear} = 0.86, DP980



Edge Stretchability

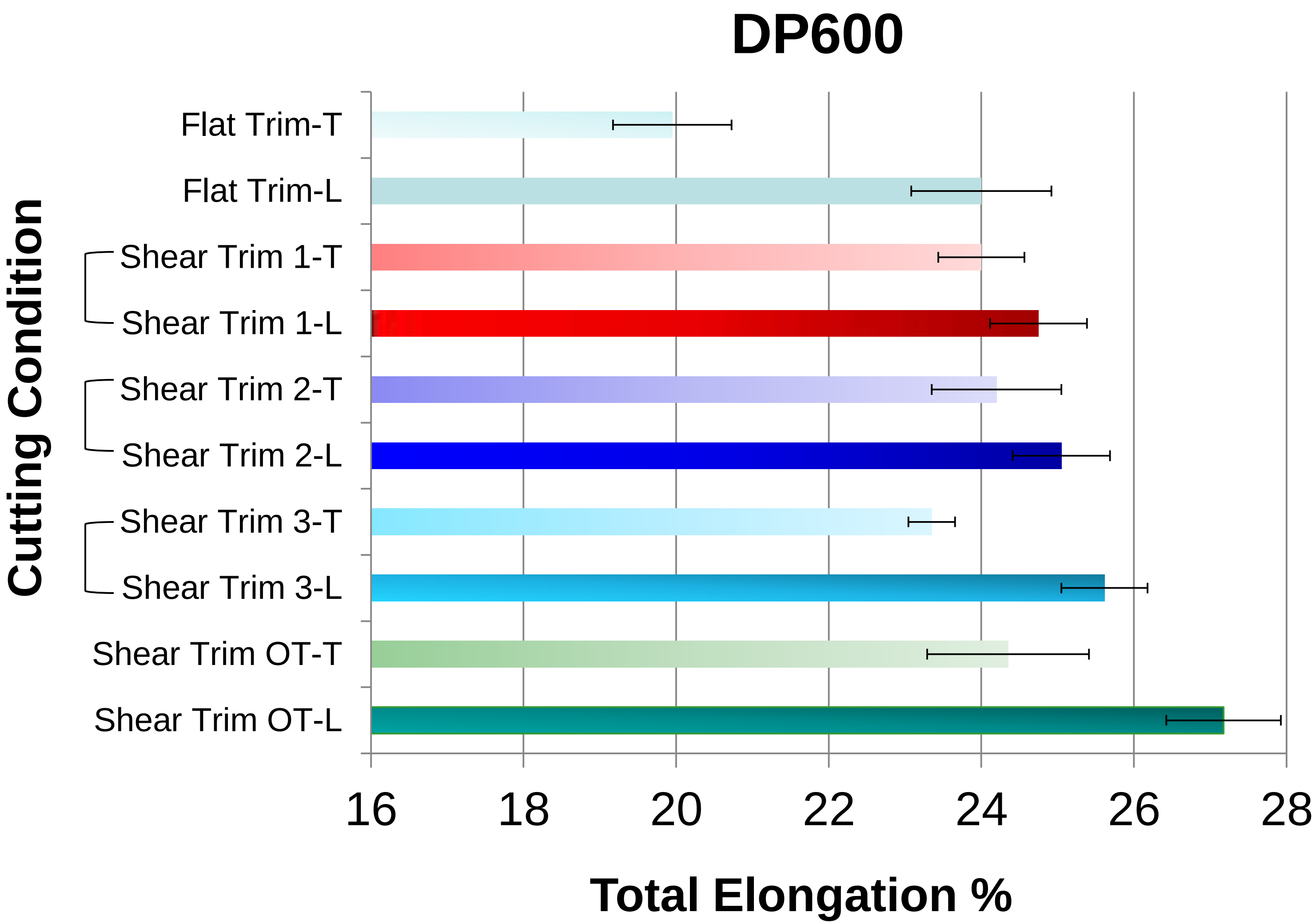
Trimmed Edge Tension Test

Milled Edge

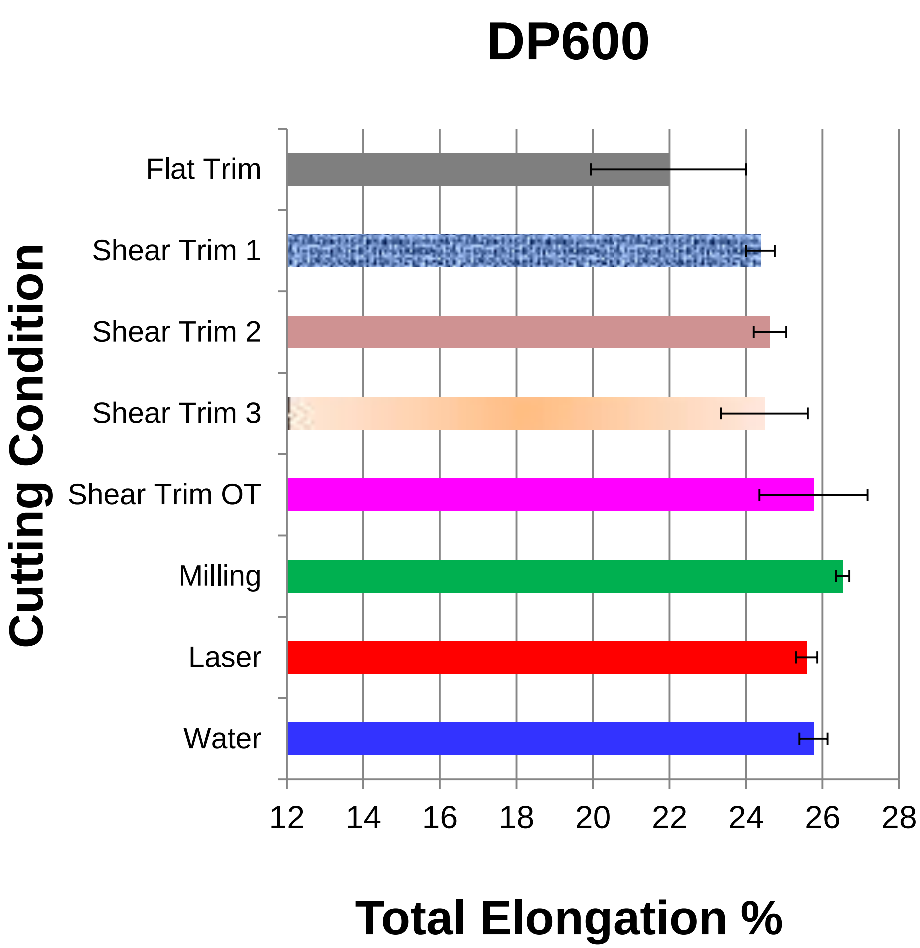


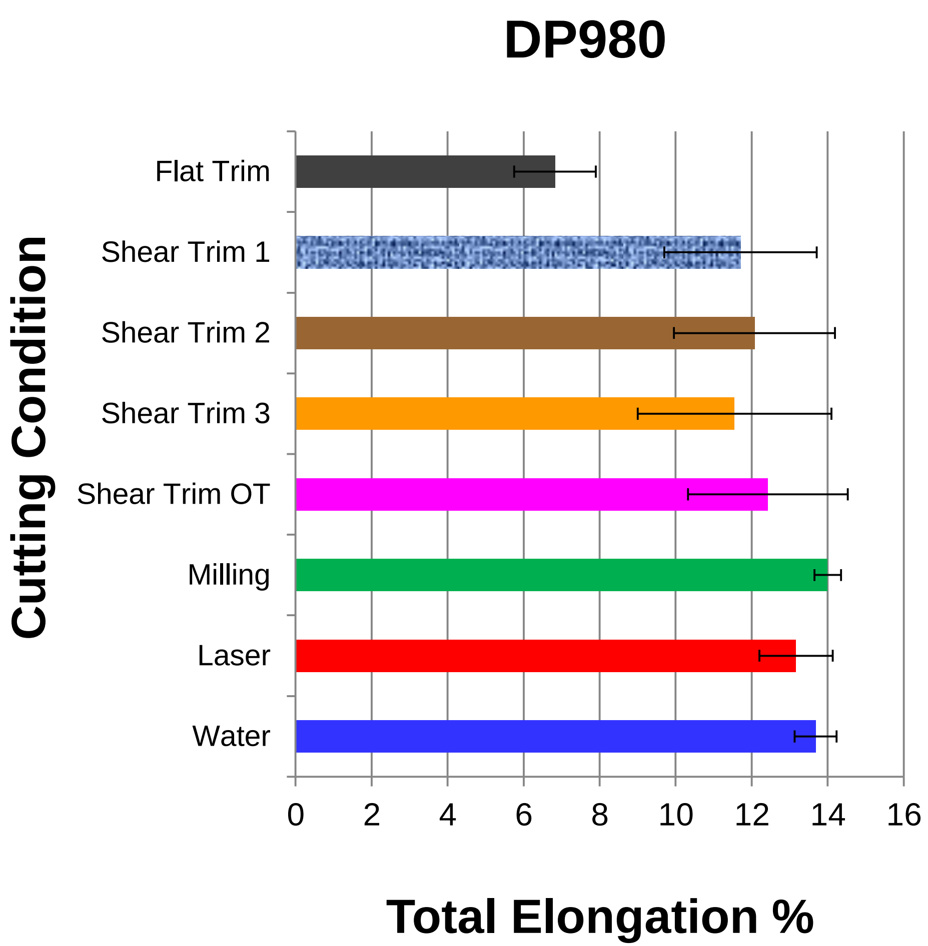
As-Trimmed Edge

Edge Stretchability – Tension Test



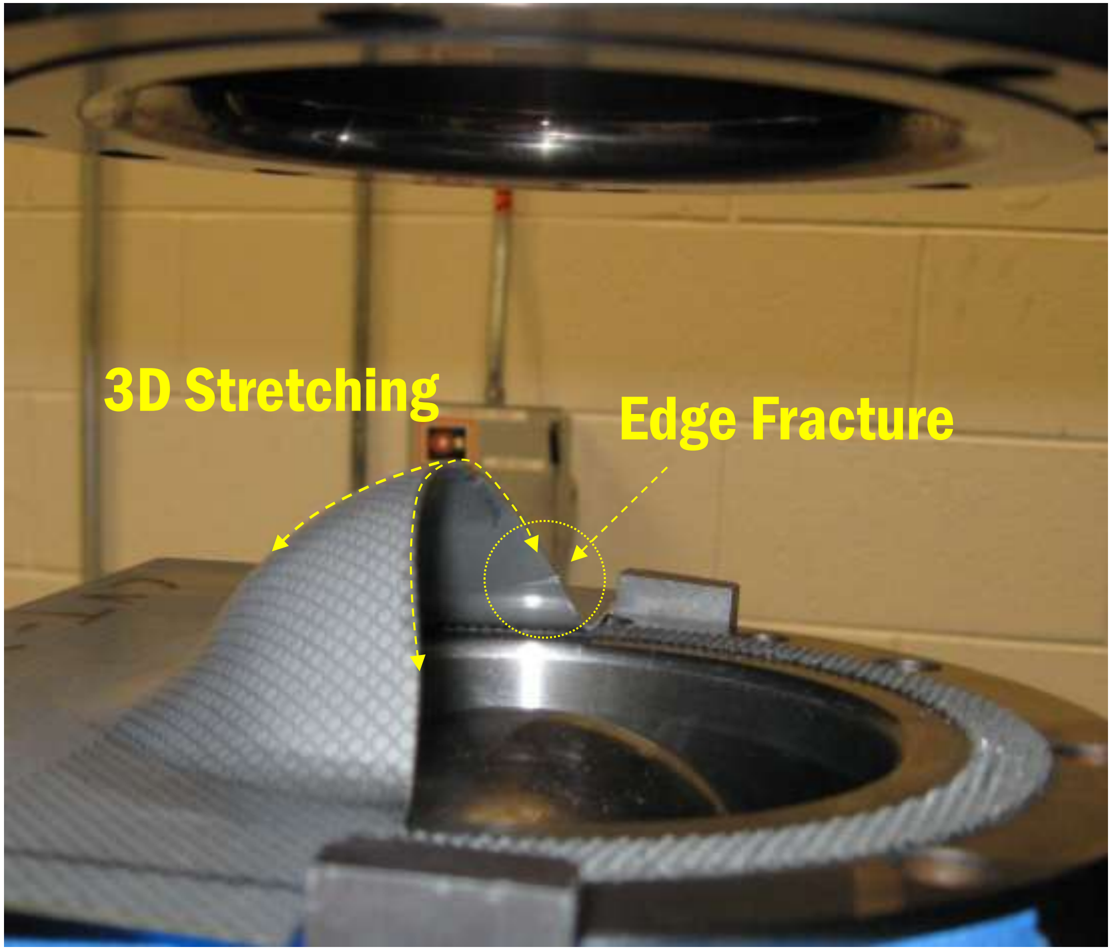
Edge Stretchability – Tension Test



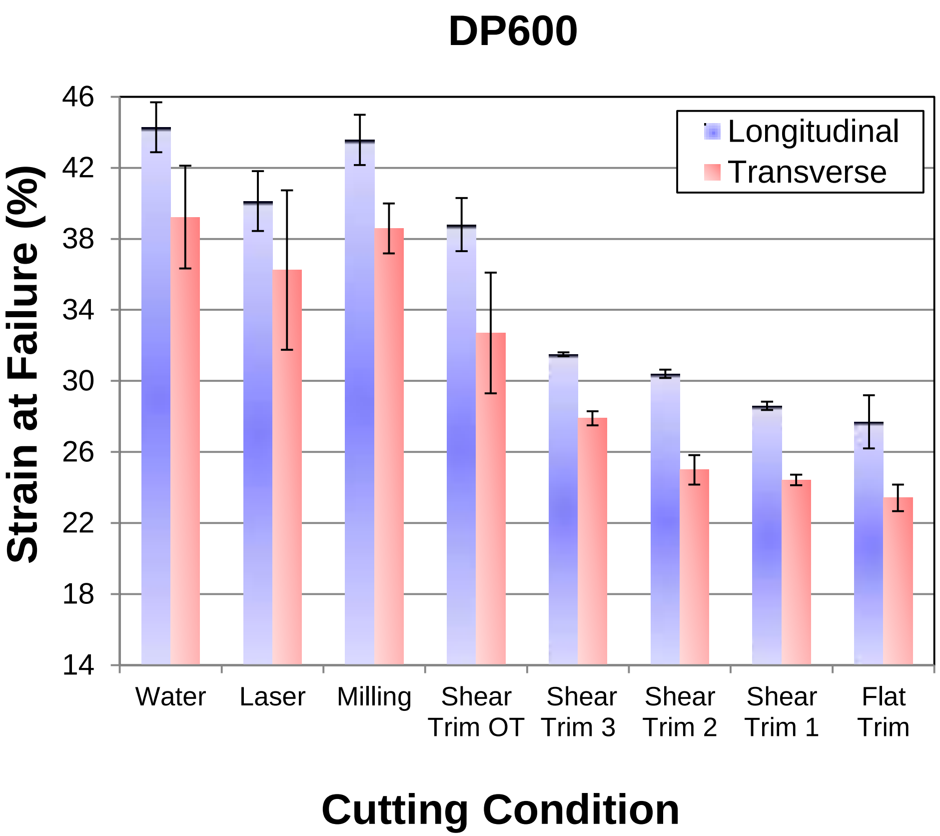


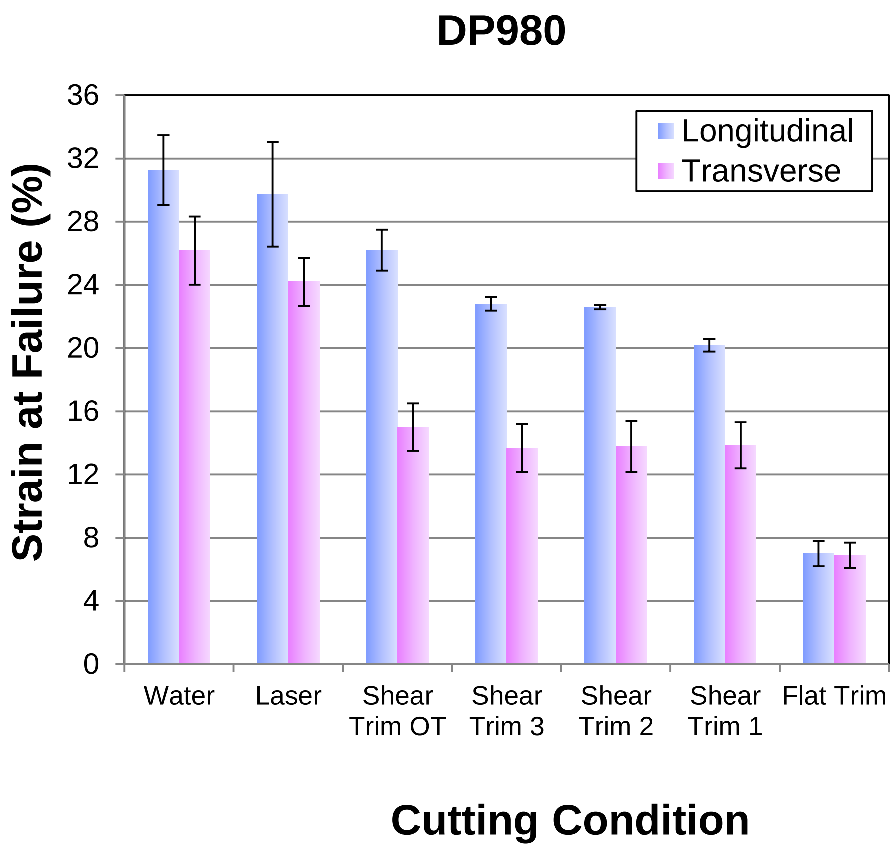
Edge Stretchability

Half Specimen Dome Test



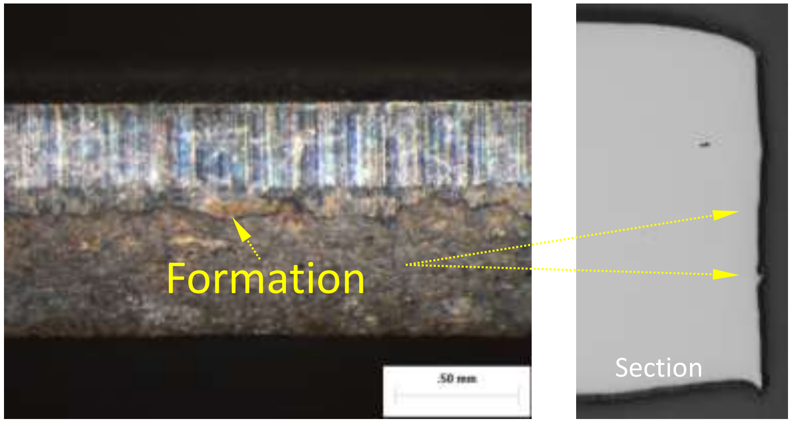
Edge Stretchability – Dome Test



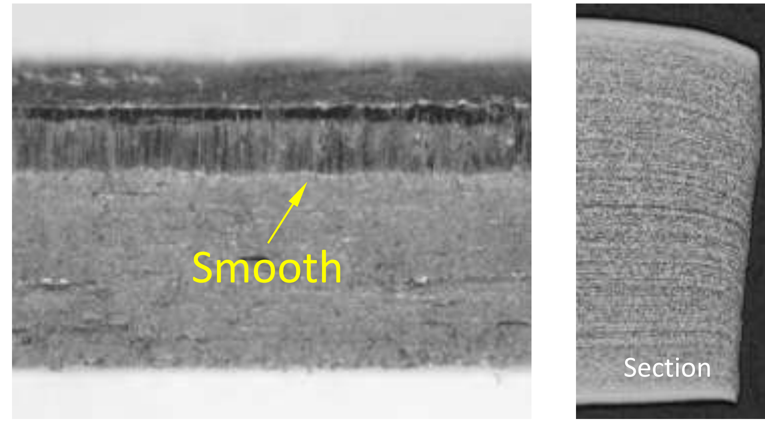


Trimmed Edge Characterization

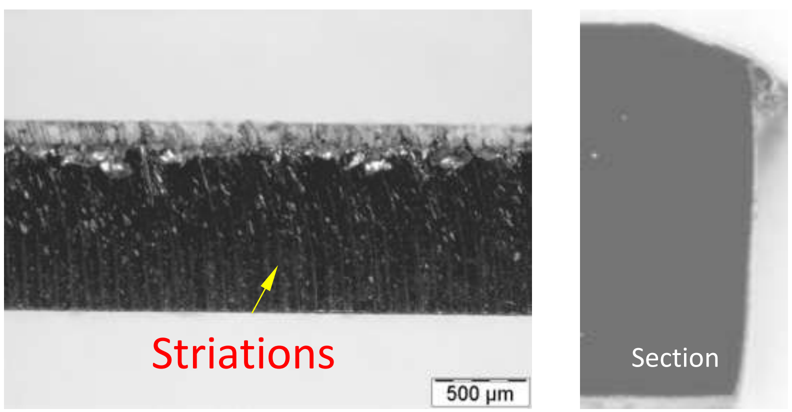
Macrographs of Cutting Edge



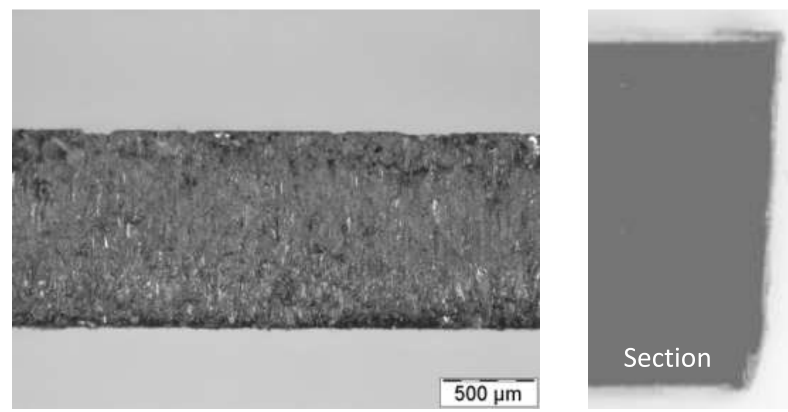
Flat Trim



Shear Trim OT

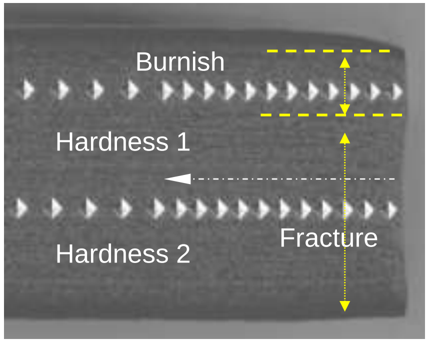


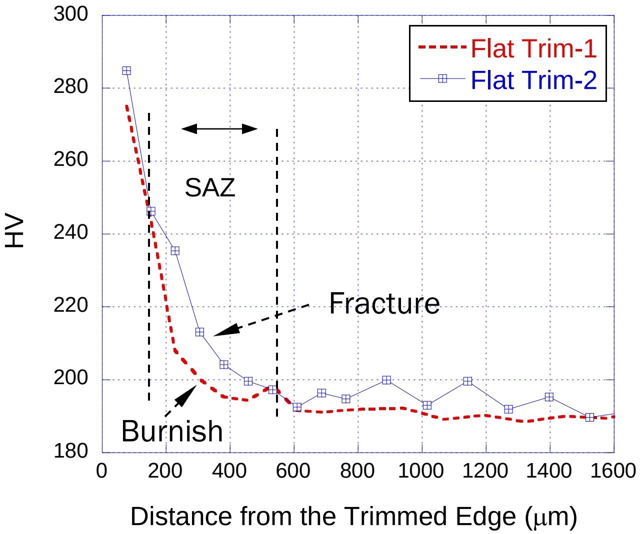
Laser

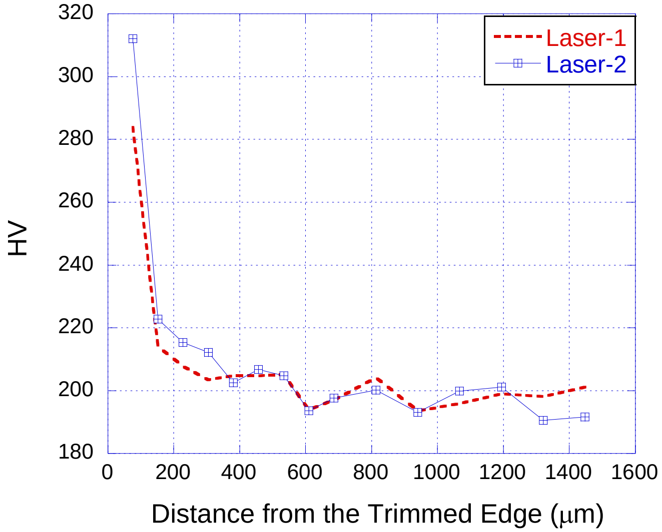


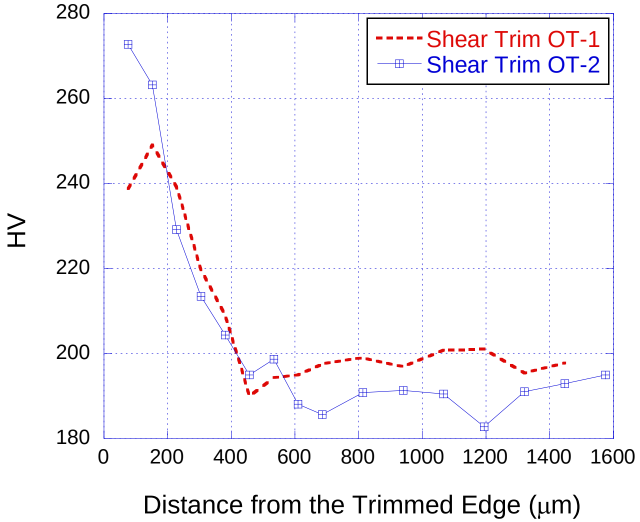
Water Jet

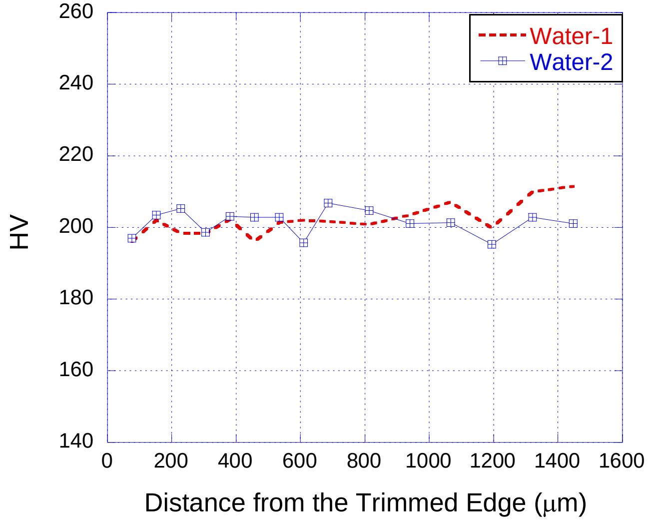
Trimmed Edge Characterization - Microhardness



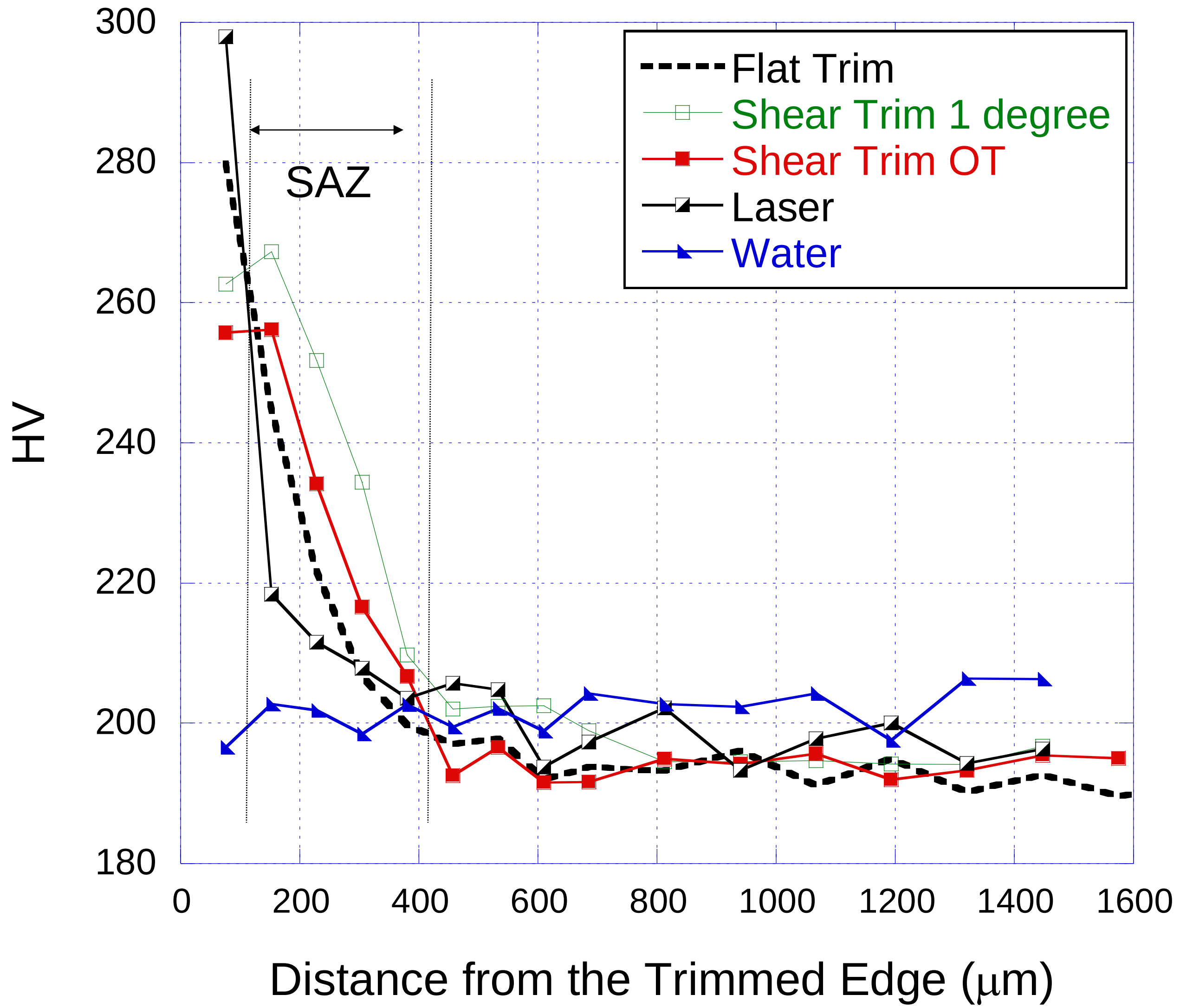




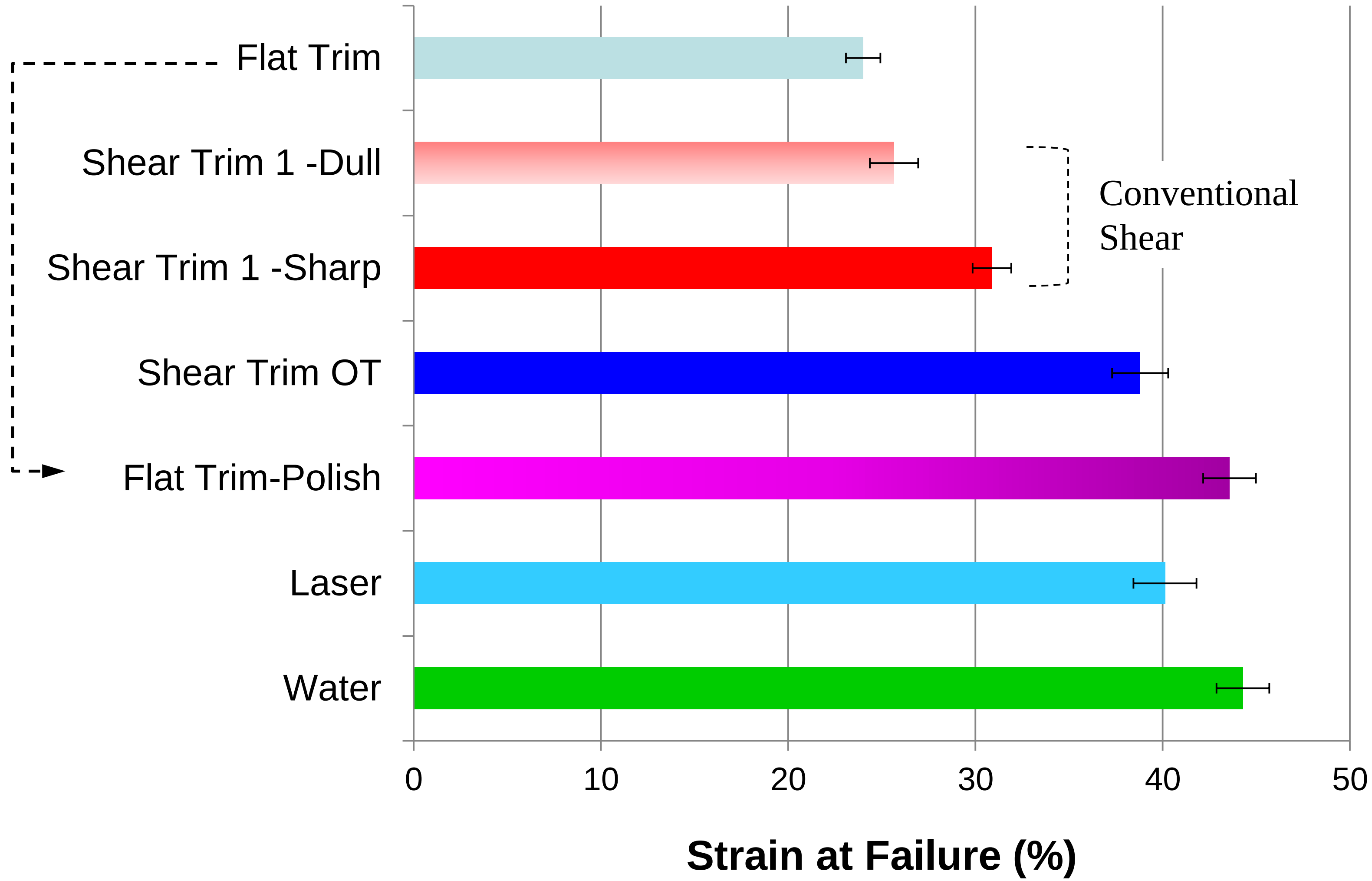




Trimmed Edge Characterization - Microhardness



The Improvement of the Mechanical Trimming Process



Summary

- The traditional trim condition with zero-degree angles has the lowest trimmed edge stretchability, while water jet cutting has the highest.
- The developed optimal mechanical trimming process (OT) can improve the cutting condition more than 60% total elongation when compared to the traditional trimming process.
- The laser cutting and water jet cutting has better trimmed edge stretchability than mechanical cutting. However, the water jet cutting edge rusted more easily and should be avoided in production.
- The post polishing process can be used as an alternative way to improve the mechanical trimmed edge stretchability.
- A shear trim with 15% die clearance is recommended in the production trimming set up for AHSS.