

IMPACT OF SERVO PRESS MOTION ON HOLE FLANGING OF HIGH STRENGTH STEELS

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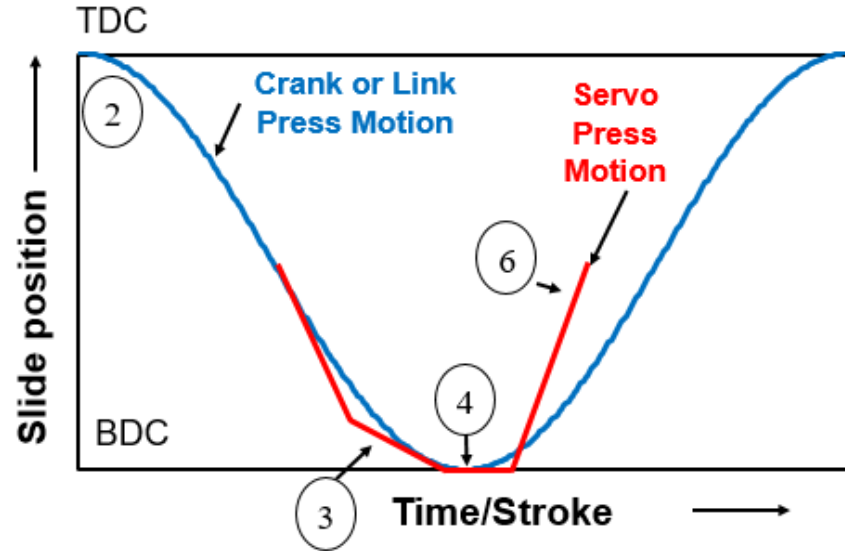
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Introduction- Servo Drive Characteristics

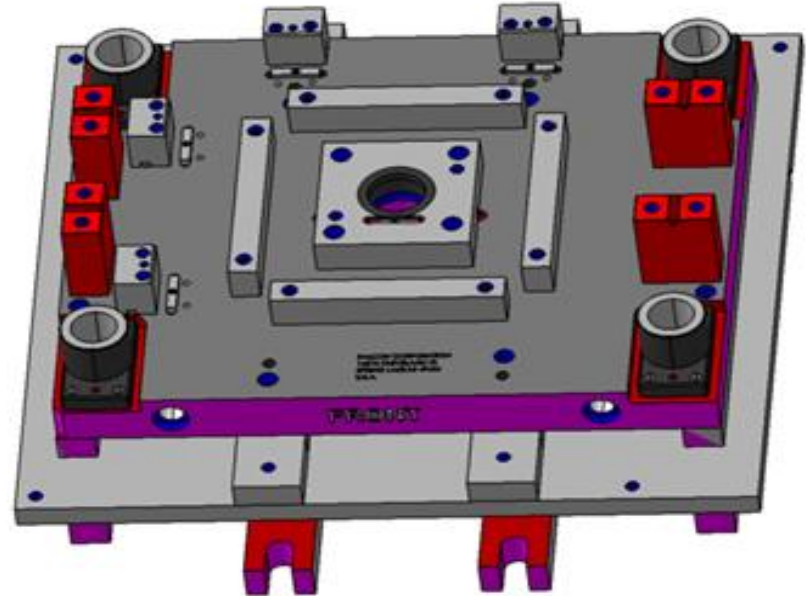
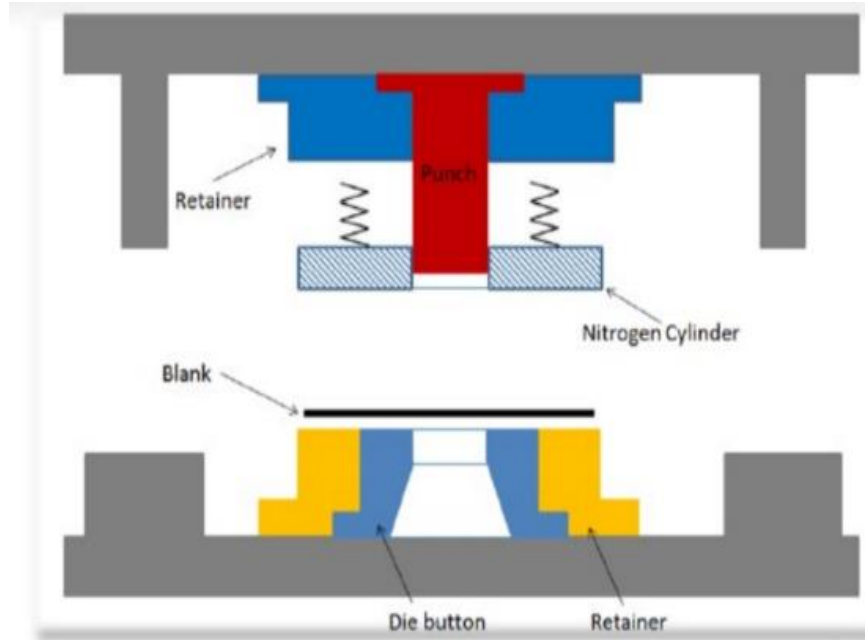
Cycle times in a mechanical and servo press



1. Shorter Cycle Time
2. Variable Stroke (TDC/BDC)/ Pendulum motion
3. “Best” Forming Speed
4. Dwell/Slow Down in Stroke at BDC
5. Attach/Detach Mode
6. Synchronization with automatic transfer
7. Energy Savings

Blanking Experiments - Schematic of Tooling

Provided by KTH, used for the blanking (Hole diameter = 75mm and Average Punch/Die clearance 15% of the sheet thickness)

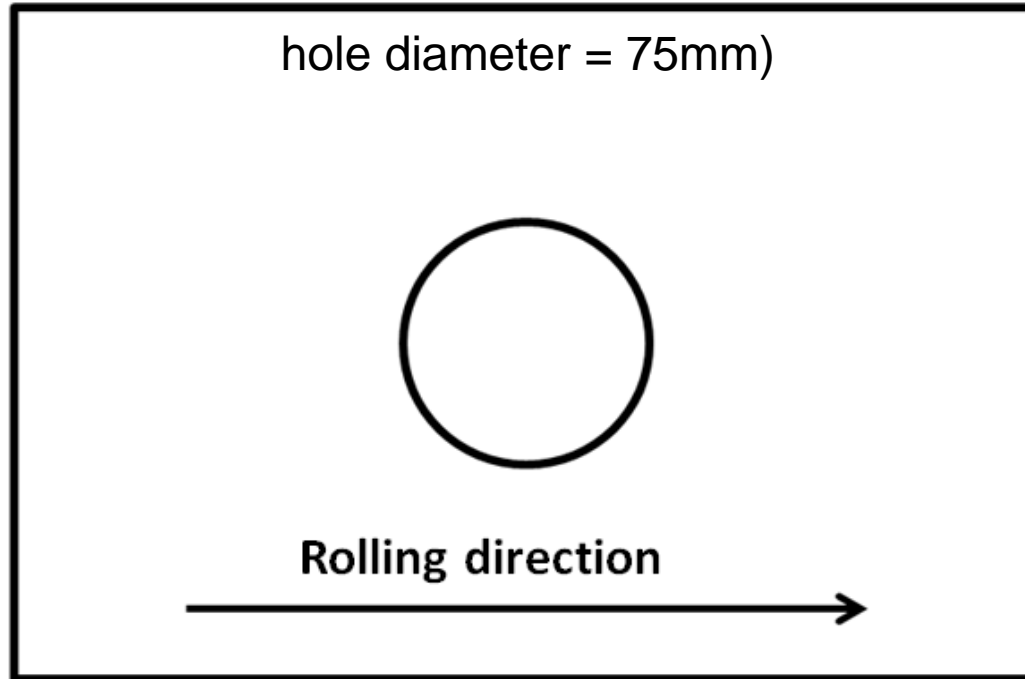


Blanking Experiments - Blanking tool in the 300 ton Aida Servo Press used in the experiments



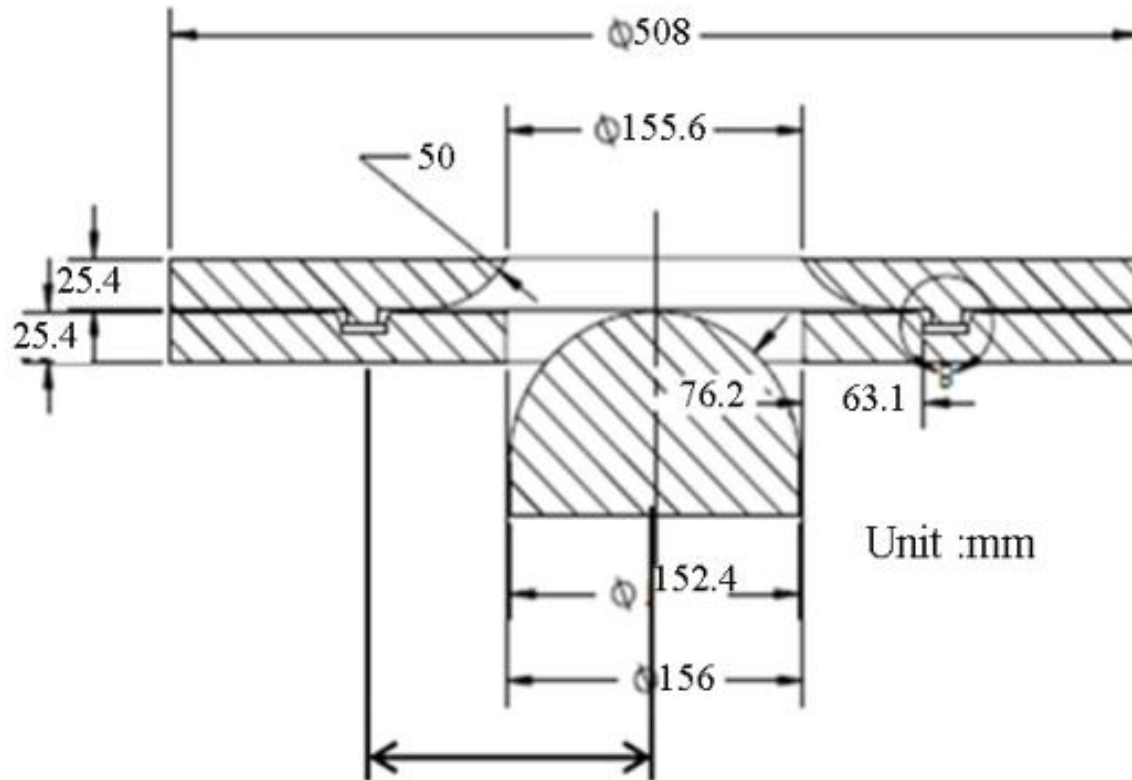
Blanking Experiments - Samples used in Blanking

(blank thickness = 1.4mm, material 780 MPa TRIP steel,
Sample size (680 x 610 mm)



Hole Flanging Experiments – Schematic of Tooling

(courtesy EWI)



Hole Flanging Experiments – Tooling in the 160 ton Hydraulic Press (courtesy EWI)



Experimental Matrix – Single Step Blanking (5 Samples – 1.4 mm thick, for each condition)

Group 1 – Single Blanking (SB) at 20 SPM (70 mm/sec)

Group 2 – Double Blanking (DB) at 20 SPM (70 mm/sec)

Group 3 – Single Blanking (SB) at 2 SPM (7 mm/sec)

Group 4 – Double Blanking (DB) at 2 SPM (7 mm/sec)

SB = Conventional blanking, single stroke

DB = Conventional blanking, two strokes (retract punch, then blank again)

Experimental Matrix (cont.) – Two Step Blanking (3 Samples – 1.4 mm thick, for each condition)

**Group 5 – Two Step Blanking (TSB) – 0.1 mm penetration / 2 SPM
(7 mm/sec)**

**Group 6 – Two Step Blanking (TSB) – 0.3 mm penetration / 2 SPM
(7 mm/sec)**

**Group 7 – Two Step Blanking (TSB) – 0.8 mm penetration / 2 SPM
(7 mm/sec)**

**TSB = Two Step Blanking, i.e. partial penetration into the sample,
punch retracts and then blanks the sample fully**

Hole Flanging Experiments

- Blanked samples were flanged, with burr down, i.e. burr in contact with spherical punch
- HER = Hole Expansion Ratio at fracture
- $HER (\%) = \frac{(D_f - D_i)}{D_i} \times 100$

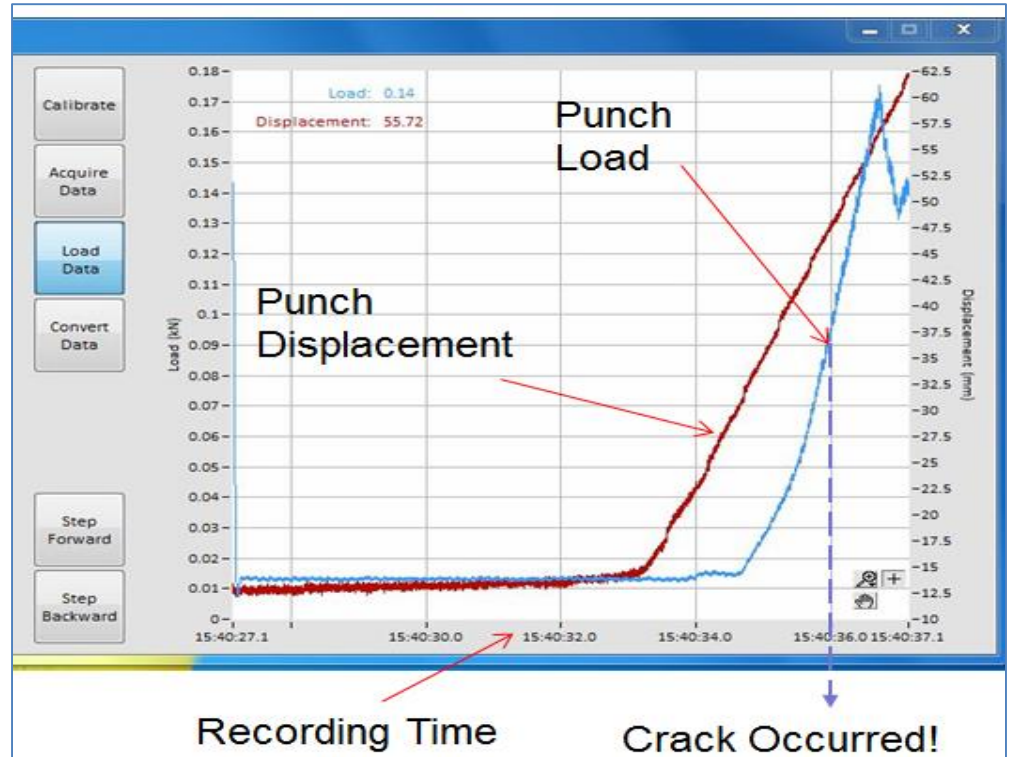
D_f = Final flange diameter, when fracture occurs

D_i = initial hole diameter (75 mm)

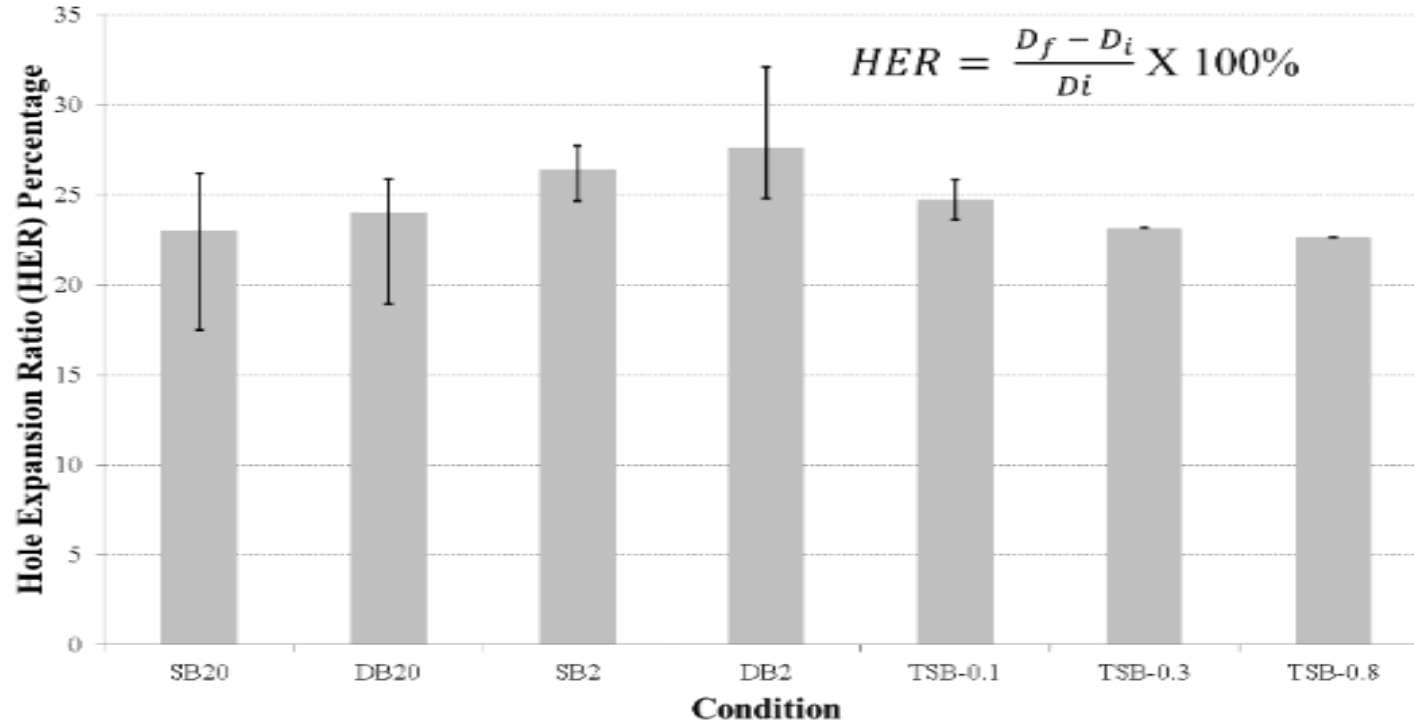
Note: Our literature review showed that ISO 16630 standard (10 mm tool) does not give reproducible results in HER

Hole Flanging Experiments

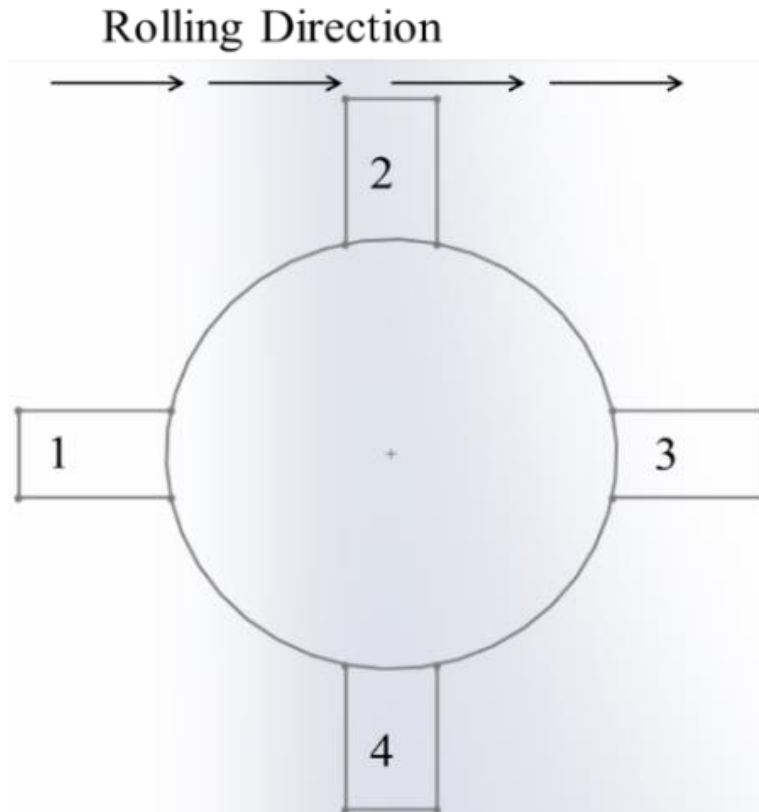
Initiation of Fracture (courtesy EWI)



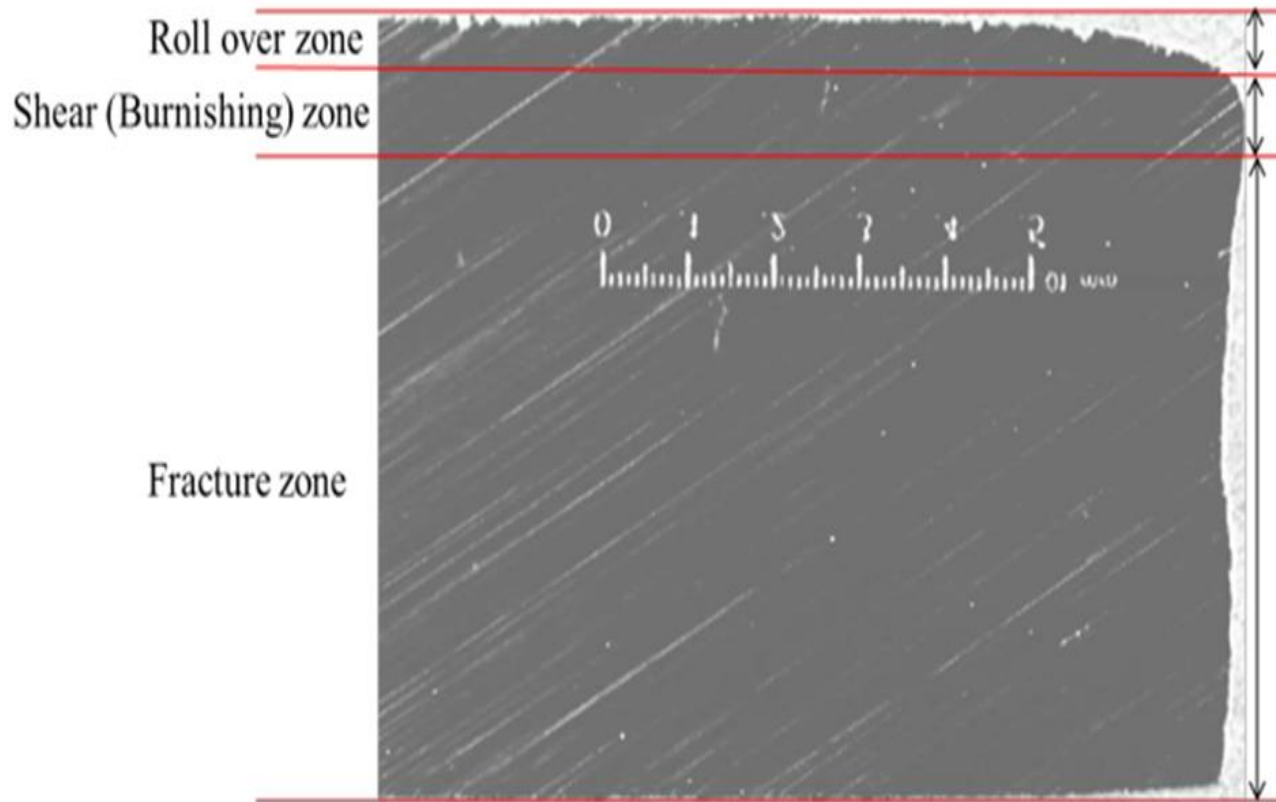
Results - HER Values for Different Blanking Conditions



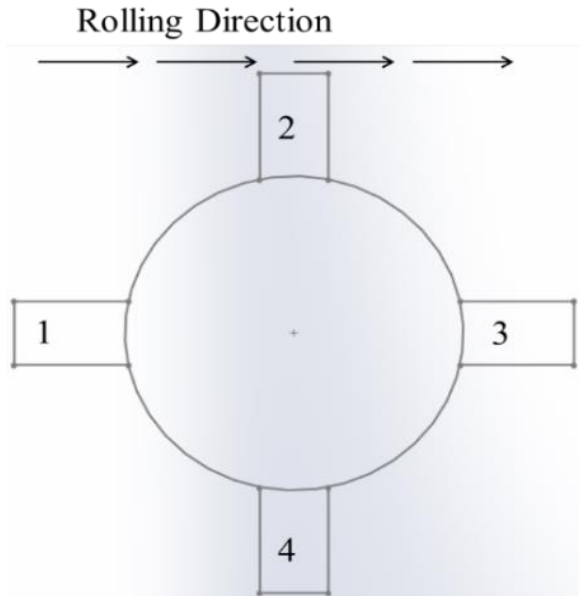
Results - Location of Edge Samples for Micrographs



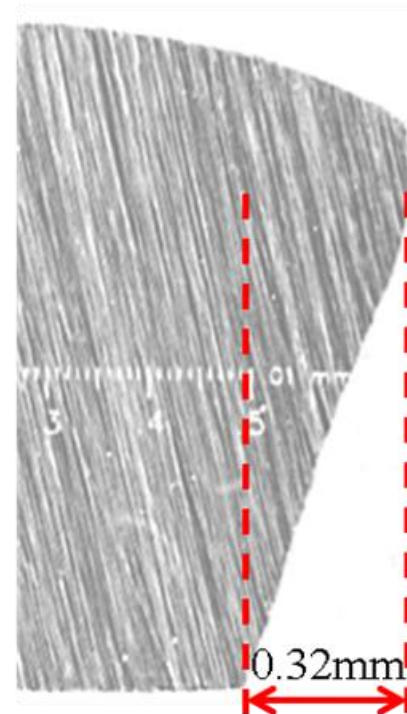
Results - Different zones in a blanked edge (micrograph)



Results – Example Micrographs of edges in different sample locations (single blanking)

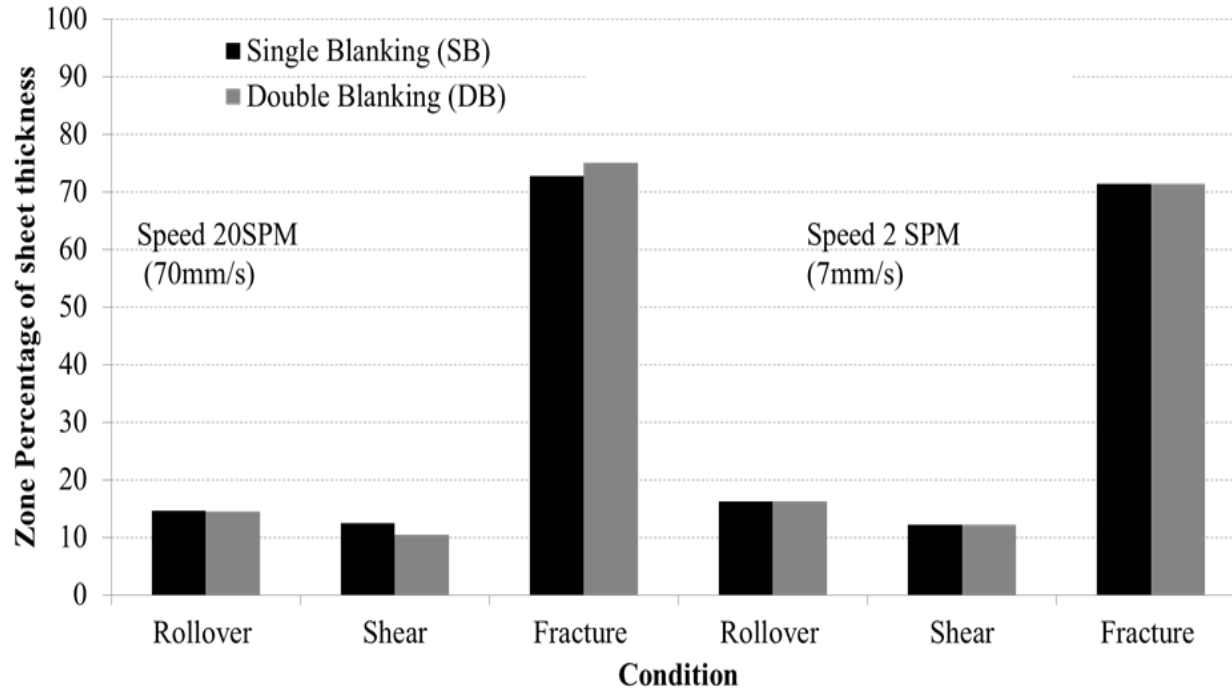


Position 1



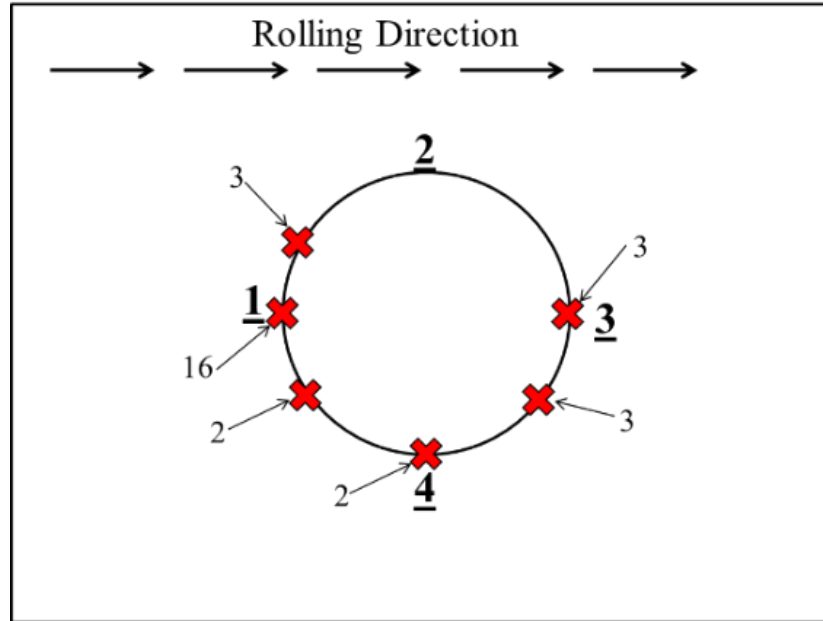
Position 3

Results - Effect of press motion on various zones in blanked edge (Example/ Position 3, Rolling Direction)



No significant effect of SB or DB on edge quality (different zones at blanked edge)

Results Location of Crack Initiation in Hole Flanging (blanked sample)



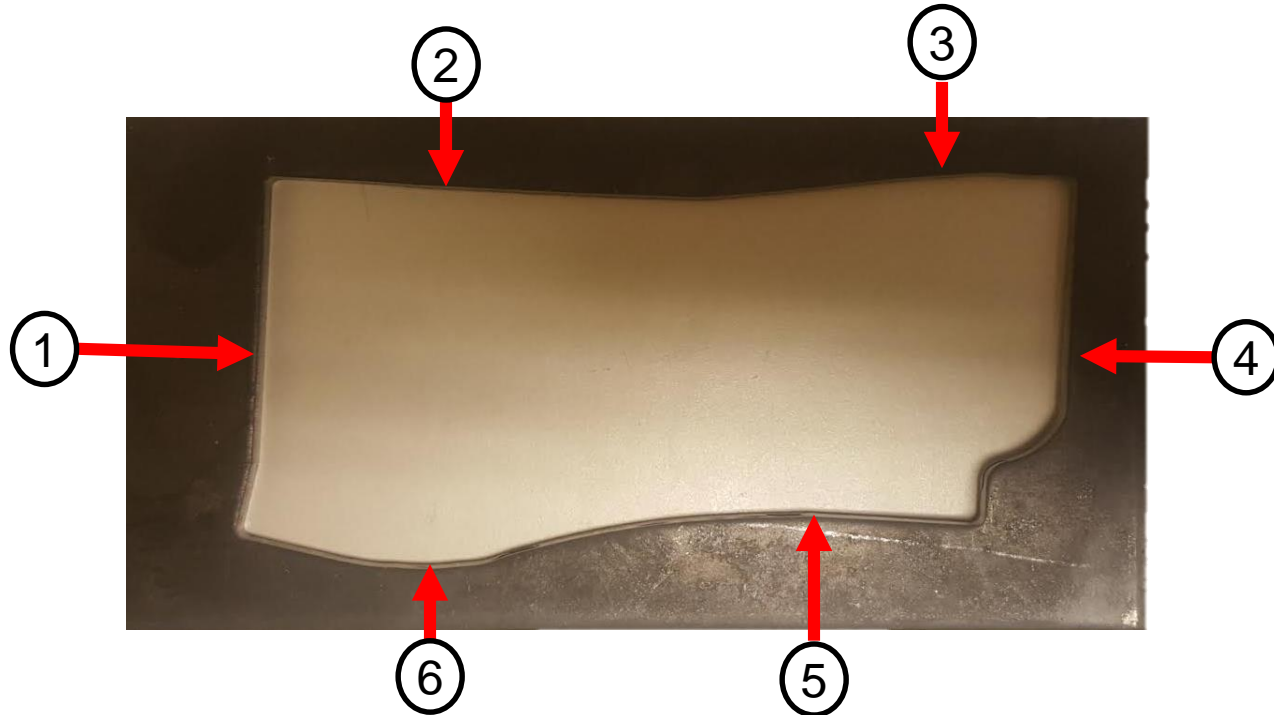
Numbers 1, 2, 3, 4 - indicate locations in the sample (slide 14)

Numbers 2 to 16 - indicate the location and the number of fractures in Hole Flanging

Conclusions

- **The 75 mm blanked hole is expected to give more reproducible results than 10 mm hole.**
- **The punch/die clearance, along the perimeter, affects HER. Thus, uniformity of this clearance and the punch/die assembly is extremely important.**
- **At slow blanking speeds (2 SPM versus 20 SPM) the HER increases slightly for both SB and DB (23 to 26 and 24 to 28%).**
- **The increase in HER with DB is negligible (about 1%).**
- **TSB gives an average value for HER (23 to 25%), i.e. no improvement.**

Future work



Blanking of a non-symmetrical shape in a servo press and evaluation of edge quality (in the marked zones)

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