LAMBDA CALCULATION

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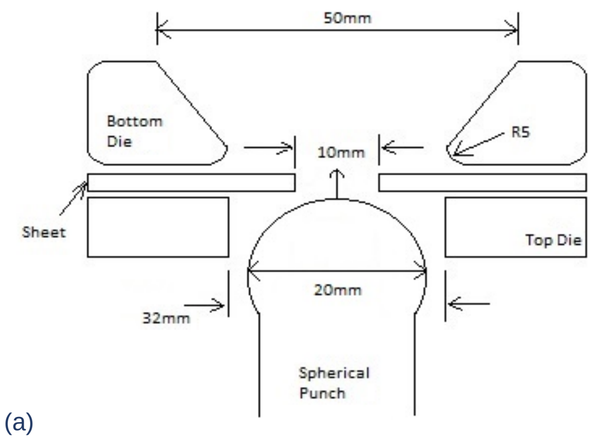
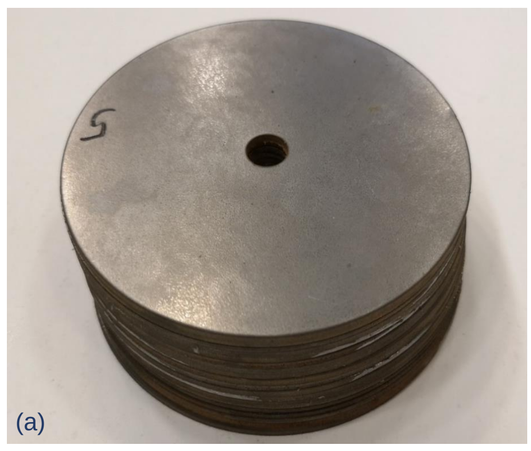
1. Overview

Advanced High Strength Steels (AHSS) were developed for use in the automotive industry due to increasing pressure to reduce vehicle emissions and improve vehicle safety. The AHSS DP600 (commercial name) was the main subject of this study. Dual Phase (DP) steel global formability is comparable to conventional HSS but local formability is poor. Automotive component manufacturing processes require excellent material formability. Uniaxial tensile tests and FLCs are insufficient in evaluating total formability. The Hole Expansion Test (HET) was developed to overcome this issue, it evaluates material stretch flangeability. A schematic of the test can be found in Figure 1a). The test measures the critical Hole Expansion Ratio (HER or λ), where:

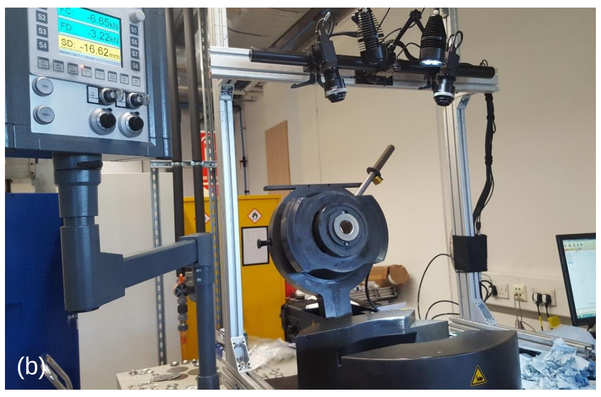
$$\lambda = \frac{(\boldsymbol{Final\ hole\ dia.} - \boldsymbol{Initial\ hole\ dia.})}{\boldsymbol{Initial\ hole\ dia.}}\ \boldsymbol{x\ 100}$$



(a)



(a)



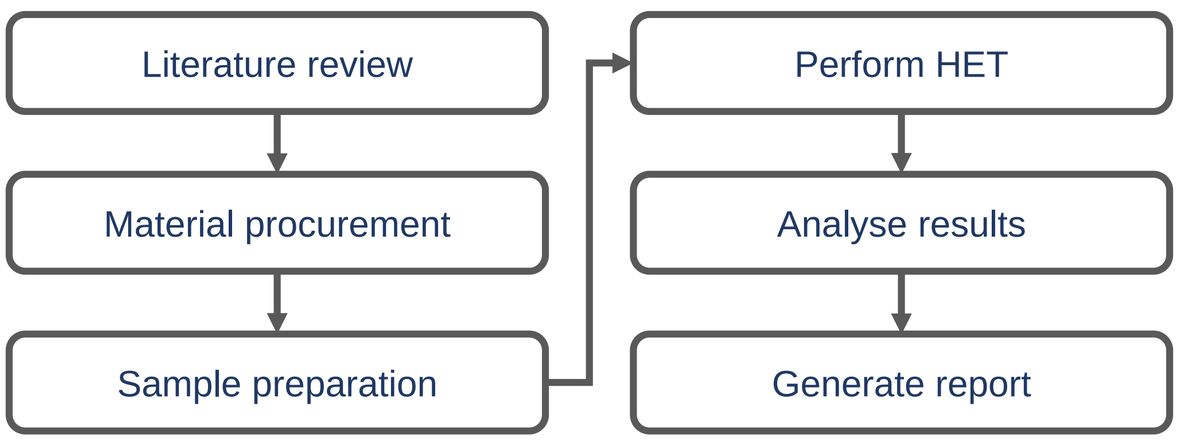
(b)

Figure 1) – HET schematic (a) and equipment (b)

(b)

Figure 2) – Specimens before (a) and after (b) testing

2. Main Objectives

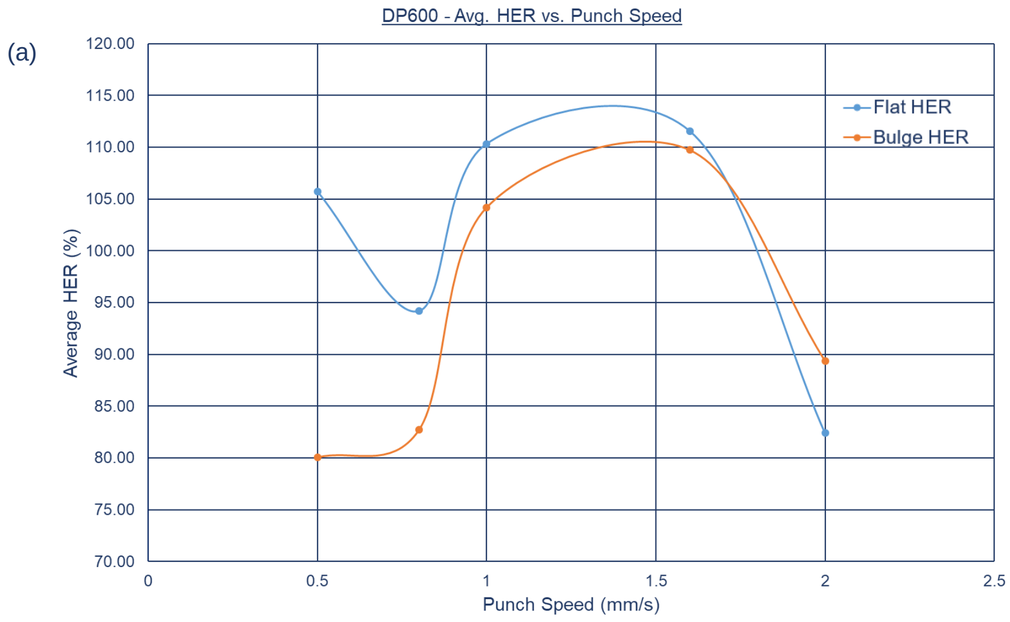


3. Project Outcomes

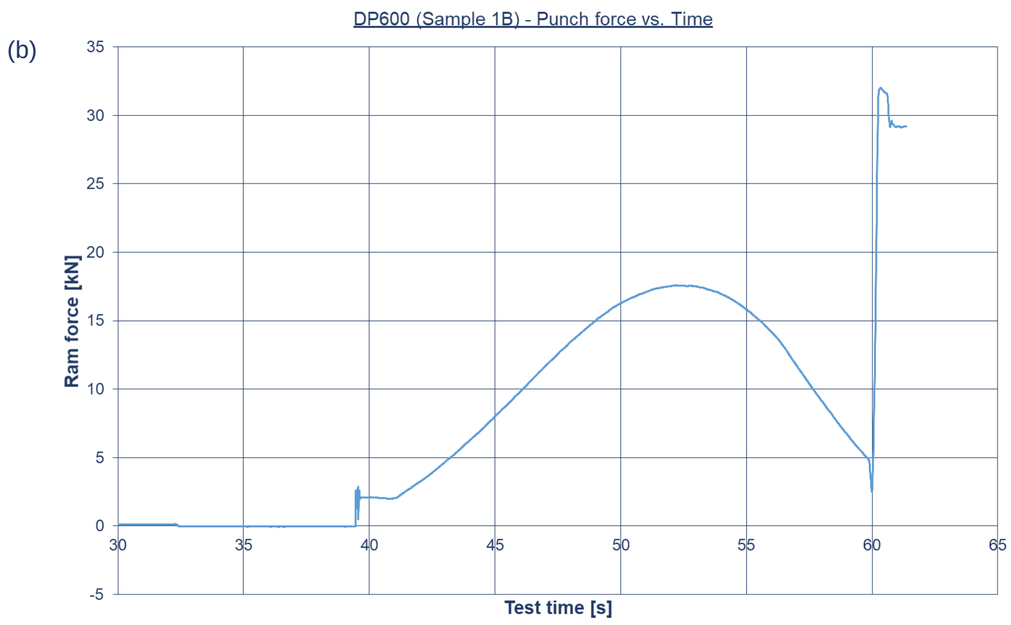
The following conclusions were obtained from the experiments performed:

- An optimum HER exists between 1 and 1.6 mm/s for DP600.
- A positive correlation exists between flange height and HER.
- Tool misalignment showed a positive correlation with flange height variation.
- At 1 mm/s DP600 and FV 607 showed similar HER values, whereas at 2 mm/s FV 607 outperformed DP600.

(a)



(b)



(c)

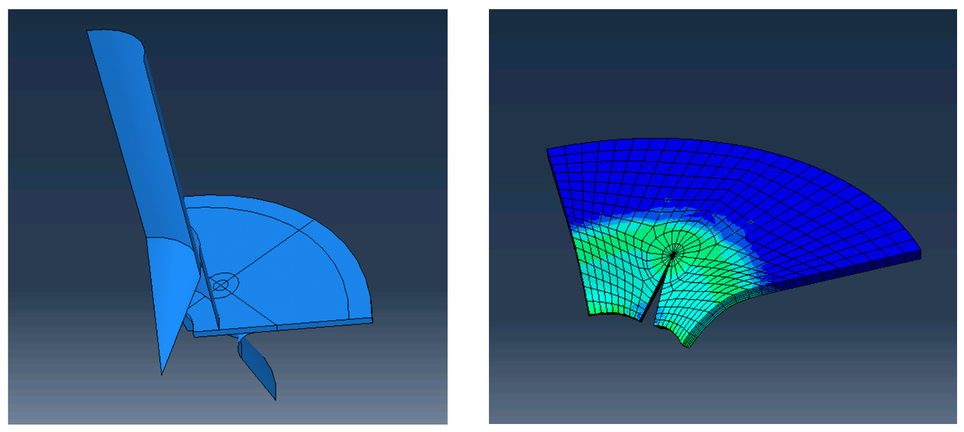


Figure 3) – A plot of Avg. HER vs. Punch Speed (a) clearly showing and optimum speed in the region of 1-1.6mm/s. The second plot, Punch force vs. Time (b), showing crack initiation at a max force of approximately 32kN. An initial FE model of the HET was created to include fracture (c) but results have not been compared.

4. Future Work and Recommendations

- Test other parameters to try and find a combination that provides optimum formability (e.g. effect of material thickness, more die geometries, different punch geometries, etc.)
- Conduct in-house uniaxial tests for material characterization
- Microstructural analysis would aid in post-experimental analysis
- Develop an FE model which can model, accurately, the HET and specimen failure

5. Benefits for the AFRC

- Demonstrates another capability of the AFRC
- ***Gain interest, and potentially investment, from companies in the automotive sector***
- Further work could identify potential, much needed, breakthroughs in the field (e.g. identification of a combination of forming processes which increases the applicability of AHSS)

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