Can material thickness of pressed sheet metal be used to determine surface defects ?

3D laser scanning is used to measure the thickness of pressed test plates. This work investigates the relationship between surface defects produced during the pressing operation; caused by poor material formability and the material thickness.

These test plates are created to evaluate material formability for plate heat exchangers production and have similar geometrical features.

Formability is the ability of a material to plastically deform without damage. The current method for testing formability of stainless steel and titanium sheet metal supply at a large heat exchanger production facility involves visual inspection of a test pressing. Once these test pressings are made, which have similar geometrical features to production plates, a technician identifies surface defects on the pressings at specific locations by eye. Surface defects at the individual points are scored and summed to generate a single formability score. The drawback of this method is that it is possible that some defects are not identified due to there size or that defects are mischaracterised as this is a subjective evaluation. Surface defects are initiated by a processes known as necking, which is where deformation is concentrated in a small region. This deformation concentration results in a local reduction in the thickness of the sheet metal which eventually results in material fracture.

This work aims to determine if material thickness, measured using 3D laser scanning, can be used to detect material fracture and localised material thinning caused by material necking. The ultimate goal of this project is to determine the feasibility of replacing the current subjective visual evaluation with an objective measure of material formability.

Results from 3D laser scanning are used to extract the material thickness variation around the specific evaluation points (used in the visual inspection) for direct comparison. Minimum material thickness and maximum material thickness gradient are identified as important metrics for identifying surface defects, and for titanium pressings a linear relationship is identified between the visual sore and these metrics. For stainless steel, however, the formability of all tested suppliers and heats are so high, that major surface defects are not detected dur-

ing the visual evaluation. Variations in the identified metrics for stainless steel were also very low when compared to titanium, therefore it is not possible to draw conclusions about the relationship between the measured material thickness and formability for stainless steel pressings. This work also takes into consideration the stain conditions at the different evaluation points by analysing the results of forming simulations (using finite element analysis) to explore the effects that pressing geometry have on material thinning and surface defects.

This work concludes by summarising the potential of using material thickness in combination with strain state as an objective measure of material formability and suggests future works that can further develop the understanding which is needed in order to confidently replace the current evaluation method.