

Integrity issues in high productive hybrid welding processes for renewable energy marine structures

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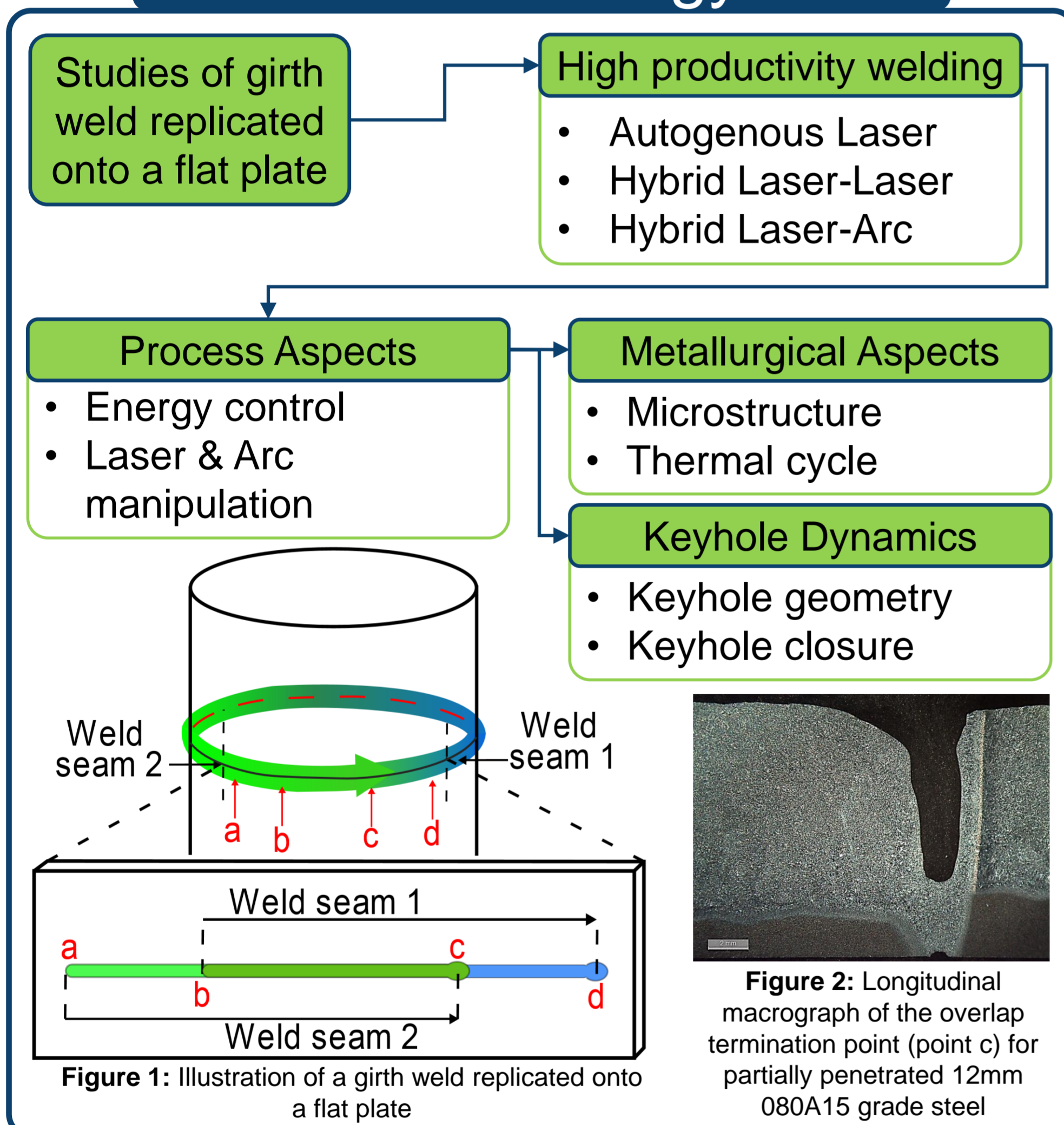
Introduction

High productivity welding is needed for the offshore wind industry to improve on the current manufacturing capabilities. Laser or hybrid laser-arc welding is an attractive option for welding thick section structural steels and when used in girth welding applications such as for the wind turbine tower and monopile and space-frame foundation structures; fewer passes and filler materials are required when compared to conventional multipass submerged arc welding. The main issues of laser welding however are the keyhole related defects at the termination point hence the lack of applications of this technology when it comes to girth welding due to the keyhole void at the start/stop intersection.

Aim

Formation of defect free girth welds in structural tubular steels focusing on the laser keyhole termination, solidification of high aspect ratio melt pools and factors responsible for the generation of cracks and other defects.

Methodology



Preliminary Results

Effect of interpass temperature on girth weld start/stop intersection and weld overlap was studied by varying the wait time in between each weld pass.

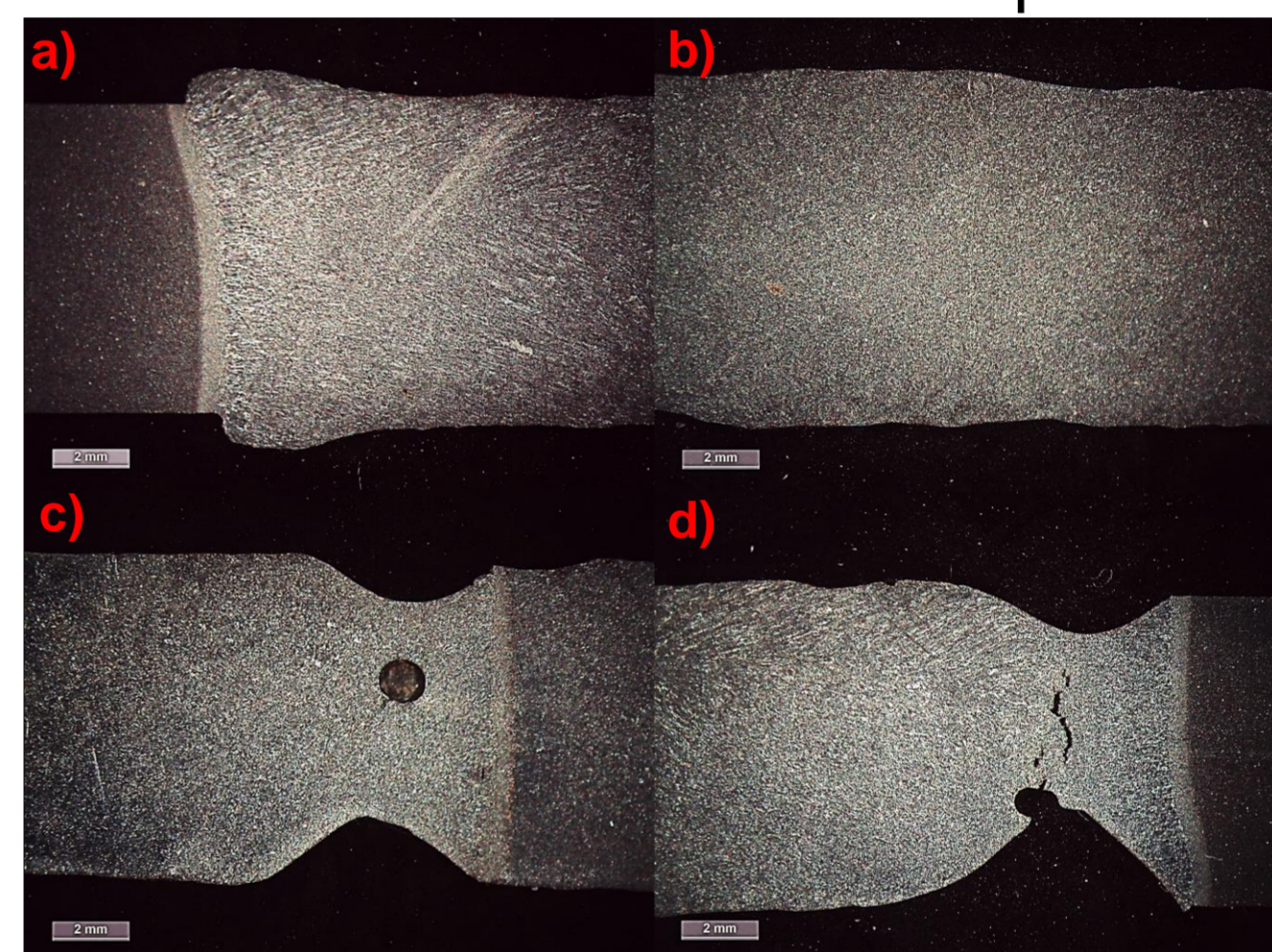


Figure 3: Longitudinal macrographs of the points corresponding with the illustration shown in Figure 1

Laser keyhole termination defects such as craters, voids, porosity and cracking were visible.

Different interpass temperatures affects the microstructure, keyhole defects and geometry.

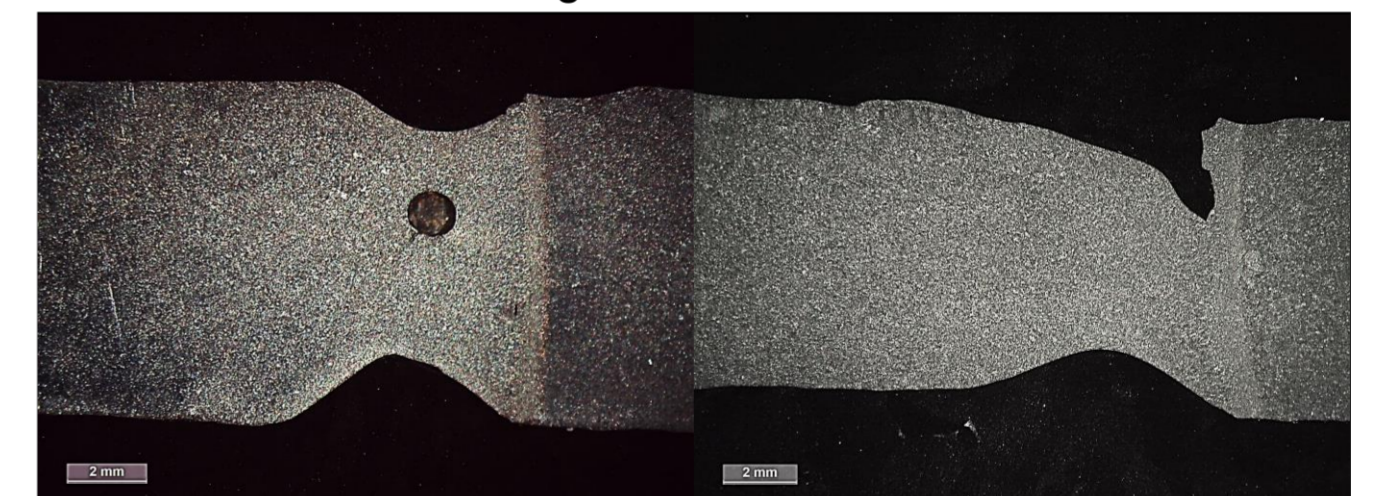


Figure 4: Longitudinal macrographs of the overlap-termination point (point c) at low (left) and high (right) interpass temperatures

Ongoing Work

Visualisation of keyhole closure and solidification

- Image processing of the weld, keyhole closure and geometry of both top and root face

Suppressing issues of laser keyhole termination

- Dynamic control of laser power source
- Transitioning from keyhole to conduction mode welding through defocusing

Application of hybrid welding and filler material

- Hybrid Laser-Laser or Laser-Arc Welding methods
- Filler material composition for refinement

Assessing the integrity of the start/stop intersection

- Residual Stress measurements
- Digital Image Correlation (DIC) along Tensile Testing