Optimal Welding Processes for Life Cycle Performance of Marine Structures

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Introduction

With the increasing demand for energy using renewable resources, technological developments are needed in the offshore wind energy sector to ensure structures are fit to operate safely and in a cost effective manner. Wind turbine sizes are increasing which require larger support structures. These larger structures introduce new engineering challenges, from the design stage to manufacturing and installation. Support structure are susceptible to fatigue damage due to environmental and operational loads and therefore structures need to be designed and manufactured to high engineering standards to ensure optimal fatigue performance.

Steel Plate rolling [1]

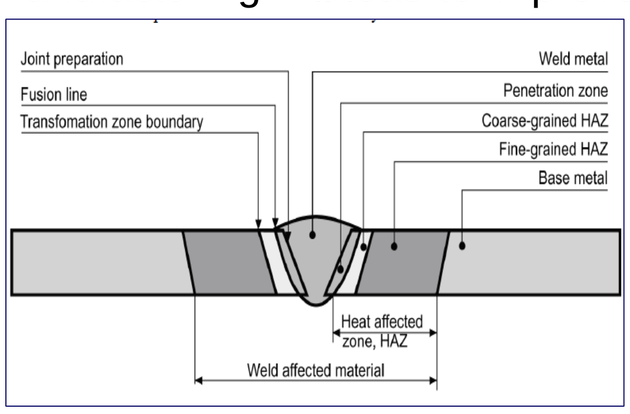
Longitudinal welding [2]

Circumferential welding [3]

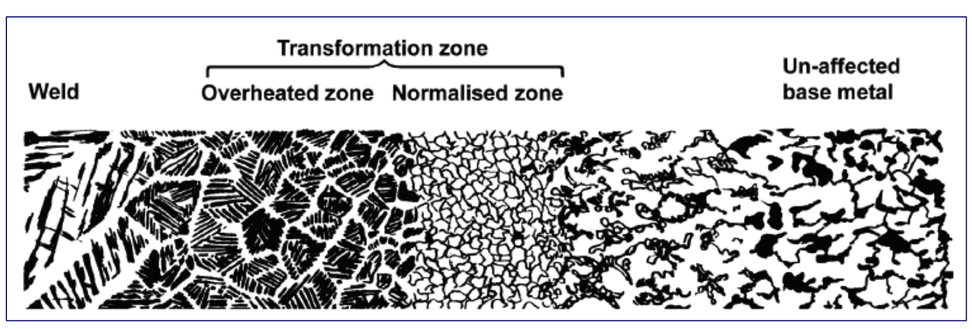
Current welding problems

Support structures are generally manufactured from steel plates using rolling and welding processes. Welding is a widely used joining process however, this degrades structural properties and can reduce fatigue resistance. Welding processes are known to introduce residual stresses, defects and changes the material microstructure.

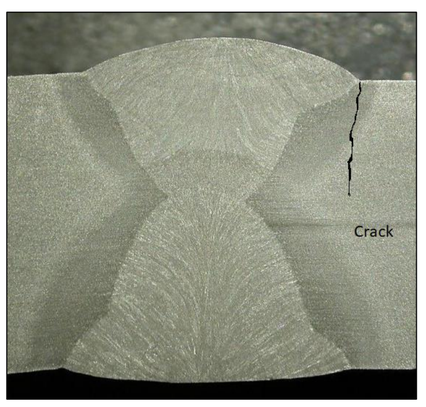
Tensile residual stresses can accelerate the propagation of any cracks present within the structure and defects can become stress concentration points from which cracks can initiate. The transformation of the material microstructure structure near the welded joint in the heat effected zone (HAZ) changes the mechanical properties and the behaviour of the structure under applied loading. Therefore, improving and optimising the welding processes during manufacturing will lead to improved fatigue life.



Welded joint and HAZ [4]



Microstructure transformation [4]



Fatigue Crack in Butt weld (adapted[5])

Aim and Objectives

The aim of this project is to expand the knowledge of the welding impact on the reliability of offshore structures and optimise welding processes to extend fatigue life. Several objectives are set to achieve this aim as listed below:

- Conduct in-depth literature review to asses current knowledge and practices in industry and academia.
- Investigate the effects of welding techniques on thick plates using numerical and experimental methods to understand the development of the residual stresses, crack behaviour and fatigue performance.
- Study the fatigue performance response to the change of welding parameters and techniques.
- Research the effects of repair welding on the residual stresses and loads distribution.

Relevant References

[1] New plate roll in operation, “BLADT INDUSTRIES”, bladt.dk https://www.bladt.dk/news/new-plate-roll-in-operation.aspx (accessed 03/05/2019)

[2] “EEW Group”, eew-group.com https://eew-group.com/locations/eew-spc/. (accessed 03/05/2019)

[3] “PEMA WELDING AUTOMATION”, pemamek.com https://pemamek.com/wind-e/pemamek-to-deliver-high-level-automation-lines-to-asm-industries/ (accessed 03/05/2019)

[4] Weman, K. (2012) ‘19 - The weldability of steel’, in Weman, K. B. T.-W. P. H. (Second E. (ed.) Woodhead Publishing Series in Welding and Other Joining Technologies. Woodhead Publishing, pp. 191–206. doi: https://doi.org/10.1533/9780857095183.191.

[5] “Steel Constrcution”, steelconstruction.info https://www.steelconstruction.info/File:Macro_of_a_Vee_Butt_Weld.jpg accessed 03/05/2019