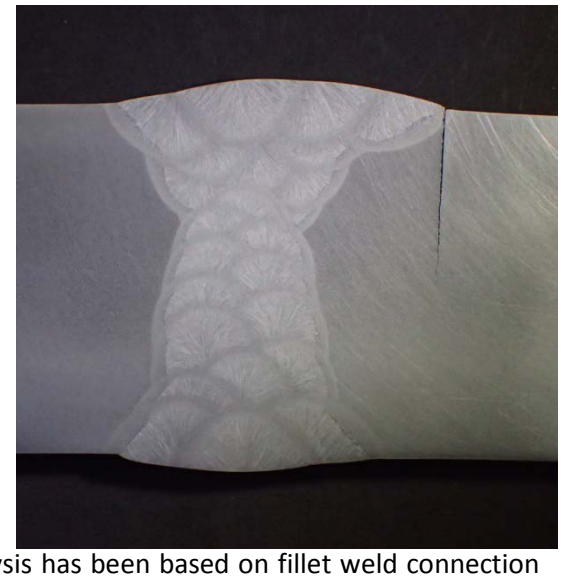
Surface crack growth magnification factor for assessment of thick plate butt weld joints by Linear Elastic Fracture Mechanics

Objectives

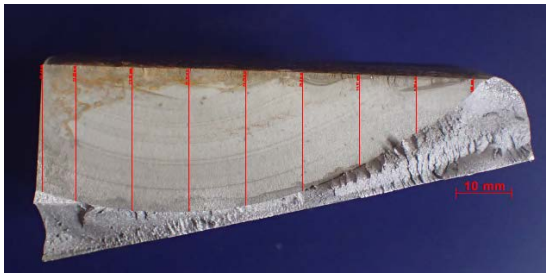
Results of the project shall be a set of formulas for evaluation of M_k factors specific for assessment of crack growth in a butt weld joint. Formulas shall be applicable for assessment of butt joints of topology and geometry common in wind industry, e.g. towers and monopile foundations.

Background



Surface crack parameters for fracture mechanics assessment as well as methodology for cracks in a flat plate are well described in literature and appropriate standards. Challenges arise when an analysis has to be done for a flaw in a structure detail that features stress concentrations. It is acknowledged that stress distribution around a crack in a flat plate and in a detail with stress concentrations will be different. In order to be able to use the known methodology also to the latter group of details it is necessary to evaluate that difference and establish a set of dimensionless magnification parameters, known in literature as M_k factors. Such a work with application of Finite Element Analysis (FEA) has been done in the past for a general type of a welded joint detail. The analysis has been based on fillet weld connection for a variety of different geometries of attachment element and variety of weld toe angles. A set of formulations approximating results of FEA have been proposed. According to recommendation in industry standards it is possible to use the proposed methodology also for butt weld joints by choosing specific geometry input to the formulations. It is however uncertain whether the proposed methodology is sufficiently accurate and allows to represents real physics of crack propagation in a butt weld joint. As fracture mechanics analysis of butt welds is rather common in wind industry, it would be desired to have a methodology dedicated specifically to this type of joints.

Suggested scope of work



Project shall focus on topologies and geometries of butt welds used in supporting structures of wind industry. A FEA based parametric study of crack growth is to be performed for an applicable range of geometrical weld joint parameters and crack sizes. The results of FEA in form of respective magnification factors shall be approximated to formulas with dimensionless parameters representing weld joint geometry as an input.

Benefit of application of butt weld joint specific M_k factors as compared to factors based on filled weld detail shall be demonstrated in analytical fracture mechanics crack growth assessment.

Options

Demonstrate anticipated differences in fatigue lifetime for various geometries of butt welds and compare to S-N based method.