STRAIN EVOLUTION AROUND CORROSION PITS UNDER FATIGUE LOADING USING DIGITAL IMAGE CORRELATION

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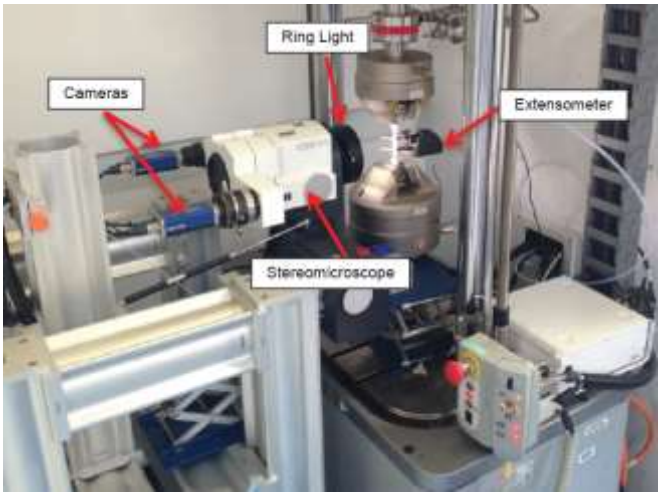
Localised corrosion plays a dominant role in the failure of components and structures exposed to the conjoint effects of corrosion and fatigue through the mechanism of corrosion fatigue. In general materials show good fatigue resistance when tested in air. However, under the synergistic effect of a corrosive environment and cyclic stress, this fatigue resistance is greatly diminished.

Localised corrosion, in the form of pitting, occurs in the early stages of corrosion fatigue. The corrosion pits that initiate and grow in the walls of components and structures can act as precursors to cracking due to a stress concentration around the pits. The pit-crack transition stage of the corrosion fatigue damage process occurs once the corrosion pit is of a size/geometry where it creates a sufficient stress concentration to allow generation of localised strain, which in turn leads to the initiation of a crack. Therefore, it is of interest to determine the effect of pit geometry on the fatigue resistance of materials.

In this study, single and multiple corrosion pits were created using a micro-electrochemical cell, which allowed pit geometry to be controlled. This method enables the effect of a single or multiple corrosion pits on fatigue lifetime to be studied.

In-situ Digital Image Correlation (DIC) was performed on pre-pitted fatigue specimens to examine the evolution of strain around corrosion pits across a range of pit aspect ratios. The aim of the study was to establish whether there is a critical strain concentration at which a crack initiates from a corrosion pit, and whether this critical strain value is dependent on pit geometry and pit-pit spatial relationship. Following single pit studies, two pits were generated on fatigue specimens using different pit aspect ratio and separation distance combinations. DIC was then used to investigate the interaction between neighbouring pits, and its effect on surface strain evolution during crack initiation and subsequent crack coalescence.



DIC Experimental set up

The localised strain data generated from this series of experiments will be used in the validation of the cellular automata finite element modelling approach being developed to develop a unified corrosion fatigue predictive model.