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# Characterisation of High-Risk Zone Failure Modes in Self-Healing Composites using Physics-Informed Neural Networks

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Self-healing materials are a class of advanced engineering material that can autonomously repair itself by mimicking the healing system of organic tissues. The emergence of self-healing composites has been recognised as a substantial advancement in enhancing the reusability and in extending the service life of composite structures. This emergence necessitates a comprehensive characterisation of their failure behaviour under various load conditions. The present study investigates the failure behaviour of high-performance self-healing composites under static tensile load. A particular emphasis is given to the failure behaviour at the high-risk zones, which contributes to the catastrophic failure of the composite. In order to achieve this research objective, an acoustic emission (AE) and artificial intelligence (AI) based technique has been integrated into the analysis. The AE signals registered from the high-risk zones during the tensile tests are acquired. Representative physical features of the AE signal sharing weak correlation are selected using correlation analysis. A deep learning neural network (NN) is built to classify the AE signals generated from different failure modes. The network is modelled to be trained using the physical features and the time domain AE signal, thereby developing a physics-informed neural network (PI-NN) framework. The PI-NN framework classifies the AE signals generated from tensile and shear failures in the self-healing composites under high-risk tensile load conditions. The results are validated using fractographic analysis using scanning electron microscopy (SEM). The research outcomes of this study aid in characterising the failure behaviour of the self-healing composites in the virgin, damaged, and healed states.

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