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Effectiveness of ANN and optimization techniques coupled with approximators in delamination prediction

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Reliable delamination prediction scheme is indispensable in order to prevent failure in composite structures. This paper focuses on the viability of coupling K-means clustering, artificial neural network (ANN) and optimization techniques to effectively detect delamination parameters (interlaminar position, location and size) for efficient structural health monitoring (SHM). Finite element analysis is harnessed to perform expensive computer simulations and validated with analytical model. These numerical simulations are computationally expensive; computation time for a single design usually takes hours, days or even weeks. Therefore, direct use of high-fidelity simulations in the optimization loop is very inhibitive. This necessitated the need to develop computationally efficient and cheaper design via surrogate-based modeling otherwise known as function approximations for enhancement of the optimization process. The optimization techniques using global search by NSGA-II and gradient local search based on SQP are employed on the surrogate models instead of direct optimization via the finite element (FE) model. The merits of this approach are to lower the number of expensive function evaluations, drastically reduce the overall optimization cost, and, consequently, increase the accuracy of the optimum results. ANN is also introduced to replace the optimization problem. ANN is employed to detect accurately delamination parameters by solving an inverse problem which involves using Bayesian regularization, a robust iterative training algorithm that learns the delamination pattern based on input natural frequency data. Performance assessment of the proposed methodology is studied in the presence of uncertainty and physical experimental results. The objective of uncertainty quantification is to ascertain the effects of variability of numerical simulations on the robustness of the technique. Delamination prediction results are shown to be very efficient and robust in terms of accuracy.

Biography

The main author for all correspondence, Obinna K. Ihesiulor is a postgraduate student in the department of Aerospace, Civil and Mechanical Engineering (ACME), University of New South Wales (UNSW) at the Australian Defence Force Academy (ADFA), Canberra, Australia.

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Study of the surface conditions effect on the corrosion behaviour of reinforcement steel in simulated concrete pore

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The most of studies on corrosion of steel reinforcement in concrete are often conducted on steel samples with polished surface (free of all oxides) in order to reproduce the same experimental conditions.However, before embedding in concrete, the steel bars are often covered with natural oxides (rust) which are formed during exposure to the atmosphere. The presence of the rust may affect the electrochemical behavior of steel rebar in concrete.

In order to understanding the effect of rust on the corrosion behavior of reinforcement steel, potentiodynamique and EIS tests were carried out in a simulated concrete pore solution using steel samples with two different surface conditions: polished and rusted samples.

The obtained results have shown that the presence of rust on the steel bar has a negative effect on its corrosion behaviour, with or without presence of chlorides, but its effect is less than the one of chlorides ions.

This detrimental effect can be explained by the fact that the rust provokes a decrease of the electrolyte resistance at the metal/concrete interface and reduces the repassivating ability. On the other hand, they act as a barrier facing the ions hydroxyl diffusion, which prevents the re-alkalinization phenomenon.

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