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Nonlinear and dynamic modeling of stainless steel strands using artificial neural networks

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In this study, artificial neural networks (ANNs) are used to model a collection of acoustic signals that propagate down a stainless steel strand embedded in concrete. The study of acoustic signals in stainless steel strands is important because steel strands are used to strengthen concrete structures such as bridges, walkways, overpasses, buildings, etc. Unfortunately, stainless steel strands are susceptible to corrosion, which can be the source of various catastrophic failures. The acoustic signals are launched, using Electromagnetic Acoustic Transducers (EMATs), in a stainless steel strand that has been mechanically altered to simulate the corrosion process and to monitor the corrosion that has taken place. The information in the acoustic signals has proven to be extremely difficult to evaluate. Therefore, using principal component analysis (a data compression technique) the large dataset, consisting of over 10,000 points, is compressed down to three principle components (PCs). After the appropriate file conversions have taken place, the PCs are fed into an ANN in order to predict the amount of corrosion within the stainless steel strand. The acoustic signals are compressed, modeled, and predicted with up to 91% accuracy. The neural network structure was optimized to allow 10000:3 data compression ration of acoustic signal intensity values to PCs.