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Machine Learning-Based Anomaly Detection in Concrete Structures: Influence of Training Data Set and On-Site Validation

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要 旨

A machine learning-based anomaly detection method for concrete structures, using localized vibration measurements and transfer learning, has been previously proposed by the authors. The method detects anomalies based on changes in the frequency response function obtained from localized vibrations measurements. An autoencoder model is first trained using sound-state data from an arbitrary-structure to create a general-purpose model, which is then customized for a target structure using transfer learning with a small amount of sound-state data from that target. This paper investigates the influence of the arbitrary structure's structural type on the model's performance and provides an on-site validation. To this end, three general-purpose autoencoder models were developed using data from full-scale beam and slab specimens: a "beam-trained model", a "slab-trained model", and a "mixed-data model". The validity of these models was confirmed by using them to identify load-induced damage in the specimens. The models were then evaluated through an on-site inspection of a concrete pier's main beam and deck slab. Results indicate that while transfer learning provides a robust baseline for anomaly detection even with mismatched structural types, accuracy is significantly improved when the training data's source structural type matches the target structure. Furthermore, a model trained on a mixed-data set exhibits superior generalization and robustness, suggesting that for practical field applications, the development of a versatile model would be beneficial.

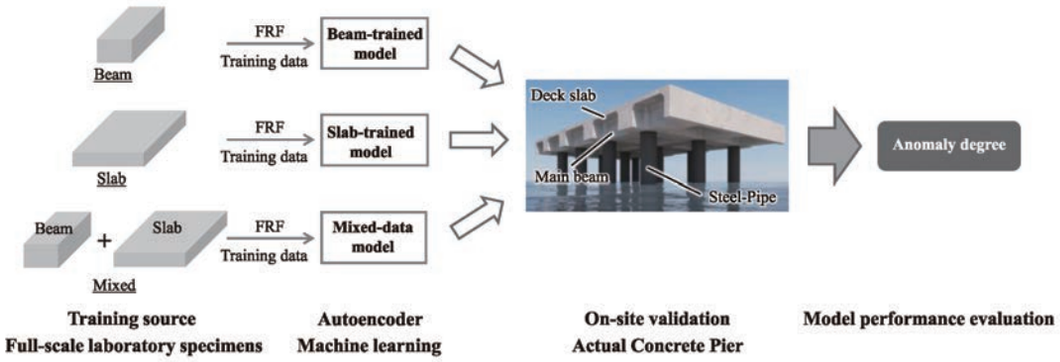


Fig.3 Research flow outline

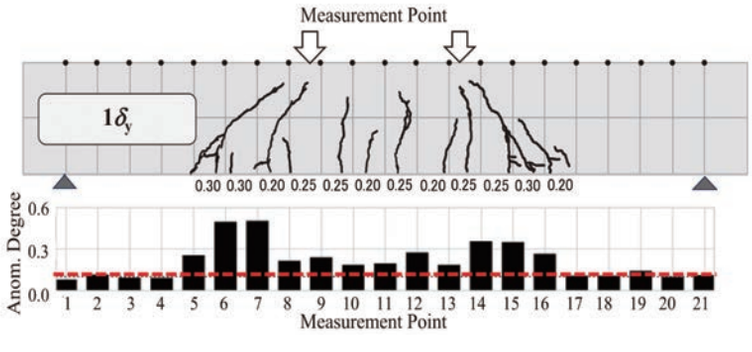


Fig.8 Beam specimen's crack sketch and anomaly degree distribution using the "Beam-trained model" (after unloading)（抜粋）

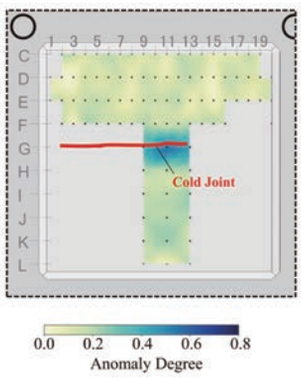


Fig.16 Target Pier Slab – Anomaly degree distribution (Customized “Mixed-data model”)

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