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**Civil structural health monitoring and machine learning: a comprehensive review**

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**Abstract**
In the past five years, the implementation of machine learning (ML) techniques has surged in civil engineering applications, particularly for optimizing and predicting solutions to various challenges. More robust prediction models may be produced by combining test data collected in the laboratory or field with ML. These models may be used to estimate the compressive strength of masonry or repair mortars, probable damage scenarios in buildings, concrete models, beams, and columns for determining the mechanical characteristics of materials, damage detection in civil structures, and so on. This comprehensive review aims to clarify the array of ML-based methods employed in civil engineering, specifically focusing on their efficacy in strengthening energy efficiency and cost-effectiveness. In combination with ML, the review explores corresponding soft computing methodologies such as fuzzy logic (FL) and design of experiments (DOE). A variety of case examples that highlight the versatility of these approaches, particularly in applications linked to structural reinforcement, enhance the story. The review navigates difficulties associated with the integration of soft computing in civil engineering and expands its scope to include emerging research directions. This synthesis of advanced artificial intelligence (AI) serves as a guide, providing new researchers with knowledge about a developing field. These methods could revolutionize the current situation by providing creative answers to complex problems that arise in civil structural applications. 

**Author Keywords**
Concrete structures; Damage detection; Damage repair; Electromechanical impedance; Machine learning

**Index Keywords**
Compressive strength, Concrete construction, Cost effectiveness, Cost engineering, Damage detection, Design of experiments, Energy efficiency, Fuzzy logic, Repair, Soft computing, Structural health monitoring; Civil engineering applications, Civil structural health monitoring, Damage repair, Electromechanical impedance, Machine learning techniques, Machine-learning, Masonry mortars, Prediction modelling, Robust predictions, Test data; Machine learning

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