

CHAPTER

5

DECISION TREE MODEL FOR CONCRETE EVALUATION

Mohd Amri Md Yunus, Sallehuddin Ibrahim, and Shafishuhaza Sahlan

5.1 INTRODUCTION

Concrete is the most widely used construction material in the world, playing a critical role in the development of infrastructure such as buildings, bridges, roads, dams, and tunnels. Due to its extensive use, the performance and durability of concrete structures are of significant concern to civil engineers, public authorities, and the public. Over time, concrete structures may develop defects and deteriorate because of factors such as material aging, environmental exposure, and load-induced stresses. These issues can compromise the structures' safety, serviceability, and longevity, leading to costly repairs or even catastrophic failures (Abdallah et al., 2021).

To ensure the integrity and performance of concrete structures, effective assessment and monitoring techniques are essential. Traditional destructive testing methods, such as core sampling and laboratory-based material testing, provide valuable information about the properties and condition of concrete structures. However, these techniques have several drawbacks, including the need for invasive procedures, damage to the structure, limited sampling locations, and time-consuming analysis. Consequently, there is a pressing need for Non-destructive Testing (NDT) methods that can provide accurate and comprehensive information about the internal condition of concrete structures without causing any damage or disruption to their integrity. NDT methods have been developed and

applied in the field of concrete assessment, including ground-penetrating radar, ultrasonic pulse velocity testing, impact-echo testing, and infrared thermography (Brown et al., 2018). While these techniques have proven valuable in various applications, they often suffer from limitations such as low resolution, insufficient sensitivity, complex interpretation, and a lack of quantitative information about the properties and condition of the concrete. As a result, there is a need for the development of a more advanced NDT system that can overcome these limitations and provide reliable, accurate, and detailed information about the internal condition of concrete structures (Daungwilailuk et al., 2017; Desa et al., 2018).

The Transmission Echo Method (TEM) has emerged as a promising NDT technique for concrete assessment, offering the potential for high-resolution imaging and accurate quantification of defects and material properties. However, its application in the field of concrete assessment is still in its infancy, and several challenges remain to be addressed, such as improving the signal-to-noise ratio, enhancing defect characterisation, and developing robust techniques for estimating mechanical properties. This study aims to address these challenges by developing a novel NDT system for concrete assessment based on the TEM, which combines state-of-the-art ultrasonic sensors, advanced signal processing algorithms to achieve a comprehensive and accurate evaluation of concrete.

5.2 NON-DESTRUCTIVE TESTING FOR CONCRETE ASSESSMENT

Various NDT techniques are applied to evaluate the integrity, strength, and condition of concrete in a variety of structural applications, including general settings as well as specific ones like bridge decks, as outlined in Table 5.1. Most of the approaches make use of either ultrasonic techniques such as Ultrasonic Pulse Velocity (UPV), rebound-based testing, Ground-Penetrating Radar (GPR), or radiographic scanning.

Table 5.1 Non-destructive testing for concrete assessment

Title	Performance / Achievement	Limitation
Assessment of strength development at the hardened stage of High-strength concrete using NDT (Lee et al., 2020)	To design two models based on the rebound test and the ultrasonic velocity test for estimating the compressive strength of concrete within a specific range	Evaluation focused only on cement and did not examine the effect of admixtures, aggregate types, or curing conditions
Monitoring of concrete structures using the ultrasonic pulse velocity method (Karaiskos, et al., 2015)	To evaluate the quality and integrity of concrete using ultrasonic testing as a non-destructive method	Difficult to measure pulse velocity in heterogeneous concrete; environmental factors affect results
Performance of NDT techniques in appraising condition of reinforced concrete bridge decks (Komárková, et al., 2019)	To develop a systematic methodology for ranking NDT techniques for defect detection in RC bridge decks	Only evaluates five performance measures; excludes safety, environmental impact, and durability
NDT method for the assessment of homogeneity of steel fibre reinforced concrete (Abd Elrazek & Gamal, 2021)	Evaluate homogeneity of steel fibre Reinforced Concrete (RC) using X-radiation (X-ray)	Limited width capability, radiation safety concerns, time-consuming and costly method
Method for attenuation assessment of GPR data from concrete bridge decks (Dinh et al., 2017)	Develop GPR signal attenuation method using simulated and actual waveforms	High computation effort; affected by surface irregularities
Experimental assessment of rebar corrosion in concrete slab using ground penetrating radar (Zaki et al., 2018)	Evaluate and monitor corrosion in concrete using GPR	Accelerated corrosion may not reflect real-world behaviour
Assessment of concrete compressive strength using ultrasonic pulse velocity test (Mohana, 2020)	Investigate relationship between compressive strength and UPV under different ages and densities	Tested specific mix; did not consider curing or defect presence