

MICROWAVE NON-DESTRUCTIVE TESTING OF CEMENT CONCRETE USING FREE - SPACE TECHNIQUE

**This is presented in partial fulfilment for the award of
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ABSTRACT

Since the existence of moisture in concrete is a major cause of damage to pavements and other concrete structures, there is an increasing need for non-destructive detection and monitoring of moisture content before failure occurs. Thus, we have developed a free-space measurement system at microwave frequencies in the frequency range of 8.0 - 12.5 GHz. for the measurement of reflection and transmission coefficients, S_{11} and S_{21} of concrete samples. The dielectric constant and loss tangent values are calculated from the measured data via a C++ language program.

Dielectric properties are correlated to water content by dielectric mixture theory. Water content will be measured for different wet specimens of cement concrete, with varying values of air void content. The key components of the measurement system are a pair of horn lens antennas, Wiltron Vector Network Analyzer, mode transitions and a printer. Errors due to multiple reflections between antennas via the surface of the sample are corrected by using a free-space LRL (Line, Reflect, Line) calibration technique.

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CHAPTER 1

1.0 INTRODUCTION TO MICROWAVES

Microwaves are small waves, specifically, waves having short wavelengths. Since frequency is inversely proportional to wavelength, microwave frequencies are relatively high. The term is used to describe electromagnetic waves with wavelengths ranging from 1 cm. to 1 m.. The corresponding frequency range is 300 MHz up to 30 GHz for 1-cm-wavelength waves. Electromagnetic waves with wavelengths ranging from 1 to 10 mm. are called millimeter waves. The infrared radiation spectrum comprises electromagnetic waves with wavelengths in the range of 1 micrometer up to 1 mm. Beyond the infrared range is the visible optical spectrum, the ultraviolet spectrum and finally x-rays. Several different classification schemes are in use to designate frequency bands in the electromagnetic spectrum. These classification schemes are summarized in Tables 1.1 and 1.2. [7]

In the UHF band up to around a frequency of 1 GHz, most communication circuits are constructed using lumped-parameter circuit components. In the frequency range from 1 up to 100 GHz, lumped circuit elements are usually replaced by transmission line and waveguide components.