MEASUREMENTS OF DIELECTRIC CONSTANTS AND LOSS TANGENTS OF METAL-BACKED CONCRETE SPECIMEN USING A ZERO FINDING TECHNIQUE

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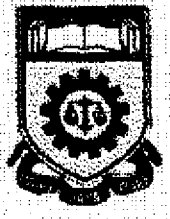

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ABSTRACT

A free space microwave measurement system is used for the high temperature measurement of dielectric constant and loss tangent of homogeneous material and is applicable to composite materials as well. 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, this measurement system operating in the 8.0 -12.5 GHz frequency range is used for reflection coefficient, (S_{11}) measurement of concrete samples at room temperature. The dielectric constant and loss tangent values are calculated from the measured data using a zero finding technique.

Dielectric properties are correlated to water content by dielectric mixture theory. Water content will be measured for different wet specimen of concrete, with varying the value of air void content. Key components of measurement system are Spot-focusing horn lens antennas, Wiltron Vector Network Analyzer, Mode transition, Computer and Printer. Errors due 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

Nowadays the microwave has played a very important part used in our daily lives. Now it is perhaps curious that a technique as developed as microwave testing has been given only scant attention as a nondestructive testing technique of materials. Non destructive testing does not usually require removal of material and it allows the user to test more extensively. The measurement of complex permittivities can be used for nondestructive evaluation of concrete structure regarding moisture content. Also knowledge of complex permittivities of construction materials such as concrete is important in radio propagation related applications such as cellular mobile system and wireless local area network. Recently, a method was developed to measure dielectric properties of a substance nondestructively at microwave frequencies. By using this method, the dielectric properties of materials are calculated from the free space reflection coefficients of a metal-backed specimen. In the method presented in this project, the free space reflection coefficients of dry and wet concrete specimens mounted on a perfectly conducting metal plate can be used to calculate the dielectric properties of the specimens. This is by using FMM (Free Space Measurement) setup after performing LRL (Line, Reflection and Line) calibration. An algorithm called zero finding technique, which finds zeros of the error function, is used for calculation of complex permittivities [1].