MEASUREMENTS OF ELECTOMAGNETIC PROPERTIES OF CEMENT CONCRETE FOR NONDESTRUCTIVE EVALUATION AT MICROWAVE FREQUENCIES

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ABSTRACT

Electromagnetic properties such as complex permitivities of concrete are a functions of moisture content, fequency, temperature and concrete mix constituents. By using an appropriate model (e.g. effective medium theory), it is possible to determine the moisture content from dielectric measurements of dry and wet specimens of concrete. A fre-space microwave measurement system will be used for reflection coefficient measurements of metal-backed specimens in the frequency range of 7.5 - 14.5 GHz. Complex permitivities of concrete specimens will be determined from reflection coefficient values using two minima method and infinite sample method. The key components of the measurements system are a pair of spot-focusing horn lens antennas, mode transition, coaxial cables and microwave network analyzer. The inaccuracies in dielectric measurements using this set up is due to diffraction effects at the edges of the specimens and the multiple reflection between two horns.

The spot-focusing horn lens antenna are used for minimizing diffraction effects and free-space LRL (line, reflect and line) calibration method eliminates errors due to multiple refelctions. Complex permitivities and moisture contents is reported for cement concrete specimens of grades 25, 30, 40 and 50. These grades have different values of water to cement ratio and concrete mix constituents. We have calculated moisture content of cement concretesamples using dielectric mixture theory.

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CHAPTER 1

1.0 INTRODUCTION

The term microwaves is used to define all electromagnetic radiation waves whose frequencies lie between 0.3 and 300 GHz. These frequencies correspond to a range of free-space wavelengths in vacuum from one meter to one millimeter. Microwaves travel at the velocity of light, c in vacuum or air[1].

$$c = 2.997 \times 10^{8} \text{ m/s} \qquad (1)$$

Microwaves are commonly used in our daily lives. In recent years, microwaves are being used in communication links generally referred to as a microwave links. Telephone and communication circuits use microwaves relay stations to transmit signals over distances of many miles. Microwave is also used in space communication and radio astronomy. To a much lesser degree, microwaves are used for non-destructive testing. Electromagnetic waves are used to nondestructively evaluate properties of materials. Nondestructive evaluation of material has shown to be a valuable science which has produces probes and methods by which flaws, cracks, defects and voids[3].