

Analyzing Electromagnetic and Geometric Characterization of Building Insulation Materials Using the Transient Radar Method (TRM)

Authors : Ali Pourkazemi

Abstract : The transient radar method (TRM) is one of the non-destructive methods that was introduced by authors a few years ago. The transient radar method can be classified as a wave-based non destructive testing (NDT) method that can be used in a wide frequency range. Nevertheless, it requires a narrow band, ranging from a few GHz to a few THz, depending on the application. As a time-of-flight and real-time method, TRM can measure the electromagnetic properties of the sample under test not only quickly and accurately, but also blindly. This means that it requires no prior knowledge of the sample under test. For multi-layer structures, TRM is not only able to detect changes related to any parameter within the multi-layer structure but can also measure the electromagnetic properties of each layer and its thickness individually. Although the temperature, humidity, and general environmental conditions may affect the sample under test, they do not affect the accuracy of the Blind TRM algorithm. In this paper, the electromagnetic properties as well as the thickness of the individual building insulation materials - as a single-layer structure - are measured experimentally. Finally, the correlation between the reflection coefficients and some other technical parameters such as sound insulation, thermal resistance, thermal conductivity, compressive strength, and density is investigated. The sample to be studied is 30 cm x 50 cm and the thickness of the samples varies from a few millimeters to 6 centimeters. This experiment is performed with both biostatic and differential hardware at 10 GHz. Since it is a narrow-band system, high-speed computation for analysis, free-space application, and real-time sensor, it has a wide range of potential applications, e.g., in the construction industry, rubber industry, piping industry, wind energy industry, automotive industry, biotechnology, food industry, pharmaceuticals, etc. Detection of metallic, plastic pipes wires, etc. through or behind the walls are specific applications for the construction industry.

Keywords : transient radar method, blind electromagnetic geometrical parameter extraction technique, ultrafast nondestructive multilayer dielectric structure characterization, electronic measurement systems, illumination, data acquisition performance, submillimeter depth resolution, time-dependent reflected electromagnetic signal blind analysis method, EM signal blind analysis method, time domain reflectometer, microwave, millimeter wave frequencies

Conference Title : ICGPRDMT 2023 : International Conference on Ground Penetrating Radar Design and Modulation Techniques

Conference Location : London, United Kingdom

Conference Dates : December 11-12, 2023