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Research Article

Use Different Frequencies of 500 MHz Antenna and Geographic Information System Technique to assessment Road Structure

Haidar A. N. Al-dami†*

†University of Al-Qadisiya/ Al-Diwaniya, Iraq

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Abstract

The task of assessment road structure utilities using ground penetrating radar (GPR) with 500 MHz antenna by different frequencies (2061.69 , 5340.86 and 64885.66 MHz) for providing a penetrating of layers composing of road structure in different depths and connect this depth together through geographic information system (GIS) (Georeferencing technique) was more clearly in interpretation more than use the center frequencies of antenna.

Keywords: *Road structure utilities, Geographic Information System Technique etc.*

Introduction

Nnondestructive test (NDT) and geophysics methods , it's important tools for solving specific engineering problems through geotechnical investigation in site and maintenance of road ground penetrating radar its device for (NDT) by geophysical investigations method measuring, imaging , mapping and analyzing pavement system, GPR is currently used to measuring thickness of pavement, assessment structure and condition of pavement, or categorize existing pavement types on roadways for both flexible (or asphalt) pavement and Rigid pavements.

Pavement Materials and Design

A pavement is composed of a system of overlaid strata of chosen processed materials that is positioned on the in-situ soil, termed the subgrade. Its basic requirement is the provision of a uniform skid-resistant running surface with adequate life and requiring minimum maintenance. In pavement design must develop economical combination of layers that will adequate dispersion of the incident wheel stresses so that each layer in the pavement does not become overstressed during the design life of the highway. There are three basic components of the highway pavement, general definitions of which are given here.

1. Foundation

The foundation consists of the native subgrade soil and the layer of graded stone (subbase and possibly capping) immediately overlaying it.

2. Road base

The road base is the main structural layer whose main function is to withstand the applied wheel stresses and strains incident on it and distribute them in such a manner that the materials beneath it do not become overloaded.

3. Surfacing

The surfacing combines good riding quality with adequate skidding resistance, while also minimizing the probability of water infiltrating the pavement with consequent surface cracks. (M. Rogers, 2003.)

Pavement Layers

A flexible (or asphalt) pavement consists of surface, base course, and subbase built over compacted subgrade (natural soil) as shown in Figure1. In some cases, the subbase layer is not used, whereas in a small number of cases both base and subbase are omitted.

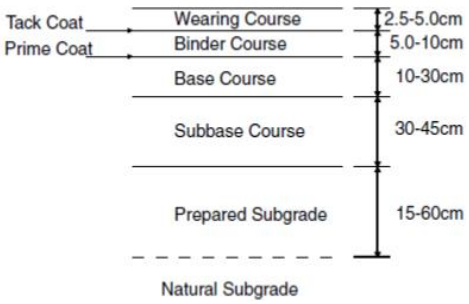

Fig. 1 Typical cross section of flexible road pavement (T.F. Fwa.2006)

*Corresponding author **MSc Haidar A. N. Al-dami**

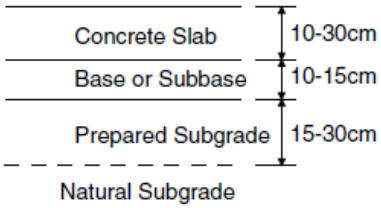

Fig. 2 Typical cross section of rigid road pavement (T.F. Fwa.2006)

Rigid pavements are mostly found in major highways and airports. They also serve as heavy-duty industrial floor slabs, port and harbor yard pavements, and heavy-vehicle park or terminal pavements. Rigid highway pavements, like flexible pavements, they offer high quality riding surfaces for safe vehicular travel, and structural layers of (Prepared Subgrade) subgrade soil, Base or Subbase and Concrete Slab as shown in Figure 2. (T.F. Fwa.2006)

Ground Penetrating Radar (GPR)

(GPR) is an electromagnetic method commonly applied to a number of engineering problems associated with both new and aging concrete structures. In the transportation sector, GPR surveys are routinely and successfully used for quality assurance verification of new construction. This includes periodic condition evaluations, beginning with a baseline survey. GPR is currently used to measure pavement thickness, determine pavement structure and condition, or categorize existing pavement types on roadways for both flexible (or asphalt) pavement and Rigid pavements.(W. Wightman & other, 2003).

GPR systems are designed to generate ultra wideband radar signals, where the bandwidth b is approximately equal to the central frequency, and the pulse duration is given by $\tau = 1/b$.(W. Freeden & other, 2010).

Bandwidth Is the ratio of the difference of the upper and lower frequencies of acceptable operation to the center frequency of that band multiplied by 100. (Geoscanners AB, 2006).

Georeference

To georeference means to associate something with locations in physical space. The term is commonly used in the geographic information systems field to describe the process of associating a physical map or raster image of a map with spatial locations. Georeferencing may be applied to any kind of object or structure that can be related to a geographical location, such as points of interest, roads, places, bridges, or buildings. (Hackeloeer, 2014).

Data Acquisition

The surveys are conducted using (GPR type (RAMAC) MALA / Sweden) by pulling the antenna along the road in the study region and data was storage in device at the field immediately, In the field survey and after a calibration process for the device has been used at different frequencies antenna 500 MHz using deferent max time window (long, medium and short) and sampling frequencies (2061.69, 5340.86 and 64885.66 MHz) respectively.

Data Processing

The data are processed by using (Ground Vision and GIS) programs. Processes such as distance normalization, horizontal scaling (stacking), vertical and horizontal filtering, and migration can all be done.

Data interpretation

Use the GPR to locate buried bodies, fracture, anomalies and In homogeneities layers for the road in the study region.

The raw radargrams shown in figures bellow illustrates many of frequencies for the 500 MHz antenna.

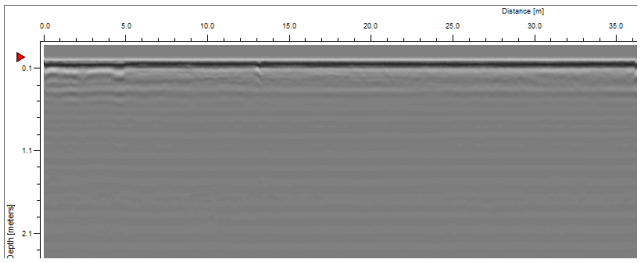

Fig. 3 500 MHz antenna with medium frequencies

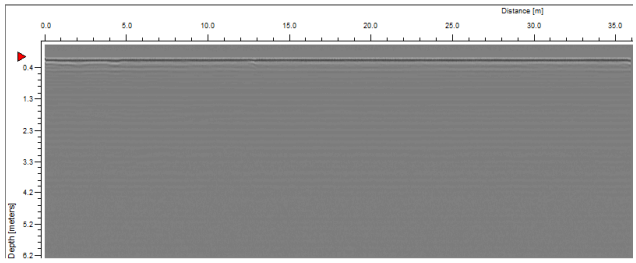

Fig. 4 500 MHz antenna with long frequencies

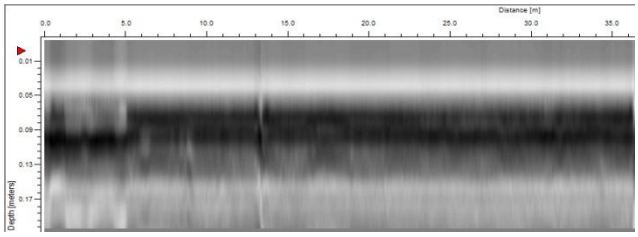

Fig. 5 500 MHz antenna with short frequencies

After processing radargrams produced from frequencies indicated above from 500 MHz antenna, by using some filters own Ground Vision program such as (DC adjustment, AGC, FIR and …etc.) notice the clear

appearance of upper layers of the pavement as well as some buried bodies clearly by using the short frequencies and clear appearance of anomalies at different depths in the radargrams by using medium frequencies and the clearly different between radargrams in depth (4.2 m) by using long frequencies as shown in figures bellow.

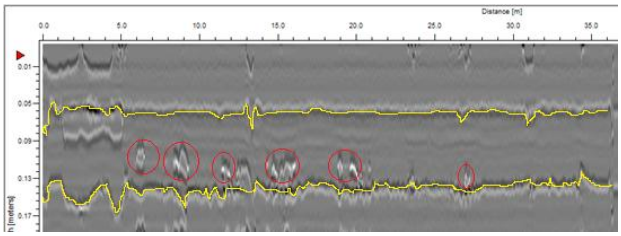

Fig. 6 Radargrams with short frequencies after processing by some filters in Ground Vision program

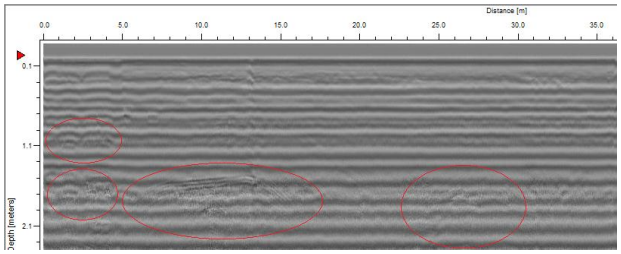

Fig. 7 Radargrams with medium frequencies after processing by some filters in Ground Vision program

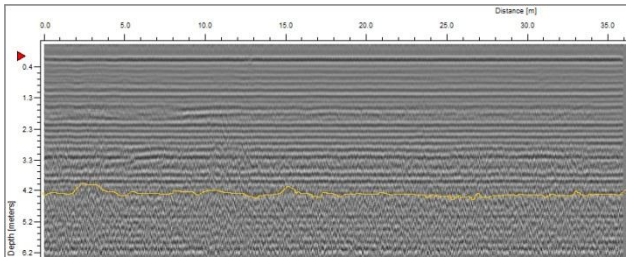

Fig. 8 Radargrams with long frequencies after processing by some filters in Ground Vision program

When used the GIS program (georeference technique) to marge radargrams with different frequencies in one radargram, details seemed clearer than before to the observed depths, as shown in figures bellow.

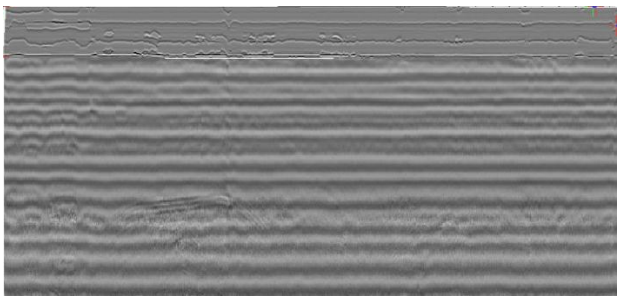

Fig. 9 Radargrams for short and medium frequencies after marge be GIS program

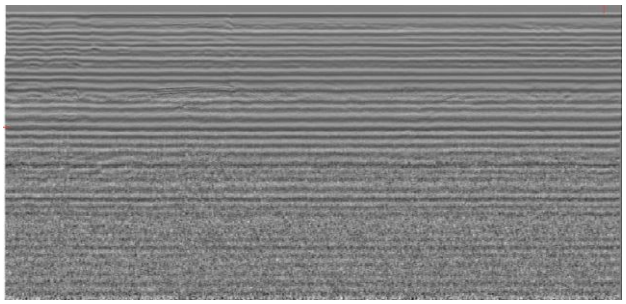

Fig. 10 Radargrams for medium and long frequencies after marge be GIS program

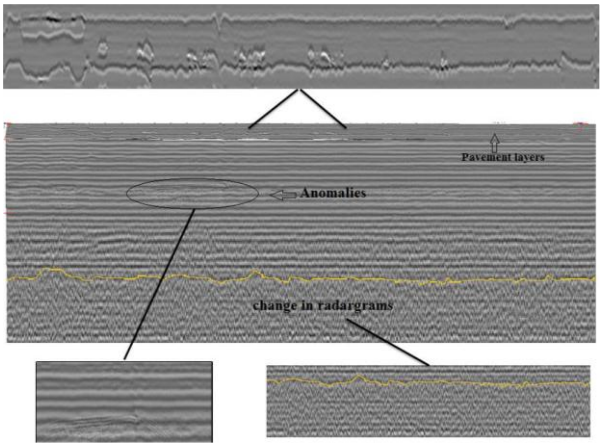

Fig.11 Radargrams for short, medium and long frequencies after marge be GIS program.

Conclusion

1- GPR is geophysical methods must be commonly used to find buried bodies, fracture, anomalies and inhomogeneities layers in road structure.
2- GPR investigation for road structure by using different frequencies , it will be more clearly in interpretation as explained in figures (6, 7 and 8).
3- Can used different frequencies for same antenna to investigate the road structure.
4- Using GIS program (georeference technique) contribute effectively in the interpretation process for different radargrams taken by different frequencies for same area as explained in figures (9, 10 and 11).

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