

THE USE OF GROUND PENETRATING RADAR WITH A FREQUENCY 1GHZ TO DETECT WATER LEAKS FROM PIPELINES

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ABSTRACTS

In this research we study the possibility of using ground penetrating radar with frequency 1GHz to detect leaks from pipelines transporting water safe for human use and that you get because of this broken and cracked pipe. Usually the pipes buried under the ground or walls, making it difficult to detect leakage in the case where defective. This research examines economic way to use ground-penetrating radar to reduce the leakage of water.

1. INTRODUCTION

networks of safe water for human consumption, drainage pipes are damage as a result of the continued use of it and expand it under the ground adjacent to the times of the cables the transfer of energy and telecommunications, which lead to environmental damage and economic losses increases directly proportional with time due to the detection time of an early and that the damage out in the case of a leak in pipeline transport of water and sanitation starts from observations of the Earth's surface where they appear in depressions that appear on the sidewalks or public streets and subsidiary, which had extended beneath the water and sanitation. best general index of the leak of the pipeline using a variety of techniques such as dyeing, smoke, surveys, and test air pressure, and water tests. However, all the reported techniques are, unfortunately, are expensive and need quite.

2. THE TEORRETICAL OF GROUND PENETRATING RADAR:

Ground penetrating radar device supports sending of electromagnetic waves or also referred to as microwave radar , which used to feel the underlying layers, which depend on the theoretical interpretation of Maxwell's equations .

$$\nabla \times E = -\frac{\partial B}{\partial t} \dots\dots\dots 1$$

$$\nabla \times H = J + \frac{\partial D}{\partial t} \dots\dots\dots 2$$

$$\nabla \cdot D = q \dots\dots\dots 3$$

$$\nabla \cdot B = 0 \dots\dots\dots 4$$

Where E the electric field, B magnetic flux, t time, H the magnetic field, J the electric current density, D electric displacement, q the electric charge.

The waves transmitted by transmitting antenna, which will be reflected from layers of the earth. The receiving antenna will record the electric field as a function of reflux time (trace), pointing to the initial survey (a-scan) and the compilation of these recordings in survey (profile) called surveys per aggregate (b-scan). There are different ways to convert the track (the distance change of time) to the section of the true depth (distance change depth), but the basic principles are the same if we know the speed of the wave radar and time sent and received along the path it is possible to calculate the depth of the point where there is a reversal under the ground[1].

$$\delta t = \frac{d}{v} \dots\dots\dots 5$$

Where d the depth of penetration v, speed pulse.

Ground penetrating radar consists of main part (antenna) which divided to transmitter (Tx) and receiver (Rx) separate by fixing distance (d) show in figure (1).

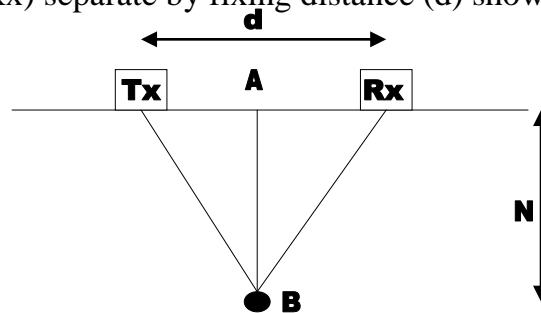


Fig. 1 work of ground radar , Tx: transmitter antenna , Rx: receiver antenna , d : distance between the transmitter and receiver (fixed) , A: mid-point between the transmitter and receiver, B: position of the body is buried, N: depth of the body

Reversal process occurs when the increase in the dielectric material in the ground , will reflect radar waves , in the case of contact with the layers . The dielectric materials will record the time it takes for the delivery of these waves. That the reference electromagnetic suffer from attenuation when passing classes waterlogged and supports this disparity on the frequency as well as on the water content in these layers, as shown in the relationship of frequency with attenuation shows in Figure (2) of amount of water logging.

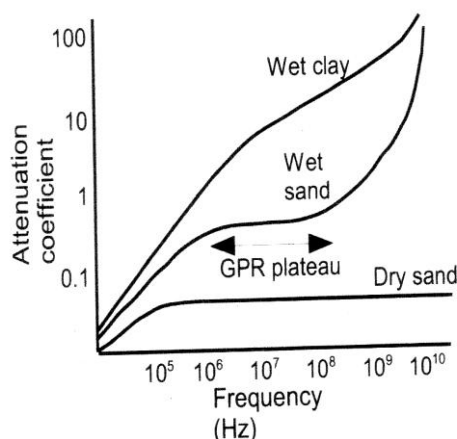


Fig. 2 Frequency curve with the attenuation coefficient

3. ANALYSIS THE SPEED OF WAVE

Knowing the value of speed in the middle is a priority in determining the rest of the measurements. Since all these measurements entirely dependent on the value of the speed of the wave. For example, the accuracy of account depth proportionate to the accuracy of calculation of wave propagation in the middle. The higher the measurement accuracy required increased effort required to find the value of speed. It is important to remember that the value of speed is not constant during the movement of the wave in the middle, but they change the front in both directions(toward the center of the antenna) and the radial direction(depth) as in Figure (3). Therefore, the calculated value of the speed is in fact the average of the changes in speed through the middle[2].

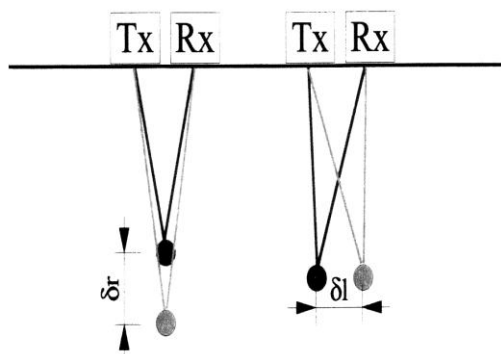


Fig. 3 Geometry for calculation of depth

And know the value of speed in different media, we can distinguish the depth of buried objects, based on standard velocities, shown in table (1)The response from both of these targets will appear in two differences of interference, and reflection of waves. that both of the wave with the presentation of the real wave W is equal to half the wave power. Shown equation No. (6)

$$\Delta t = \frac{2\delta r}{v} = \frac{W}{2} \dots\dots\dots 6$$

Where Δt the time taken to move the wave , δr different displacement direction of the vertical and diagonal v half the speed of the wave W bandwidth limit[3].

Table 1 Magnetic wave speed in different media

Media	Speed m/m.sec.
Air	300
Distilled water	33
Fresh water	33
Dry sand	150
Saturated sand	60
Limestone (calcareous)	120
Clay	60
Stone	160

4. EXPERIMENTAL MEASUREMENTS

the laboratory simulation model must fit with nature of conditions in the field measurement, the design mode of the model were selected from wood material to construction the form (sink tester) to avoid reflections and unwanted interference in the transmitted signal from the antenna and ground penetrating radar along. the dimensions of the basin 80 cm, width of ponds 36 cm, height of the basin (depth) 40 cm, as shown in fig (4).The shielded antenna 1GHz are use in laboratory measurement ,installed wheel determine the distance (shift encoder) and the readings are taken , the distance change as a function of depth with installation of following facts:

Sampling frequency : 1909 MHz

Number of sample : 191

Number of stacks : 1

Number of trace : 127

Time windows : 10 ns

Trace interval : 0.005 m

Antenna separation : 0.1 m

pipe made of pvc in L-shaped (total length : 60 cm, diameter : 4 cm) and closes of end pipe figure (4-a) that allow water to pass through and placed inside the tub , cover the pipe with dry sand . A sheet of aluminum foil is placed behind the sink tester to have sharply line under sink tester . ground radar passes on the surface with perpendicular direction to the cross section of tube and take readings of the depth in terms of distance figure (4-b) , this measurements will be the reference that obtained from analyzing data of radar by using filters which support with Reflex program figure (5-a), Add water to the tube and recorded radar measurement for this experiment and analyze the results in the same program filters figure (5-b) , Tube drill in diameter of 4 mm to allow leakage of water, after 15 min of starting experimental , the radar show variation in the Environment around pipe position figure(5-c) .registration data (a radar survey) each 15 minutes and continuously shown Increase the size of the wet area figure (5-d,e,f,g) .



(a)

(b)

(b) Fig. 4 laboratory simulation model

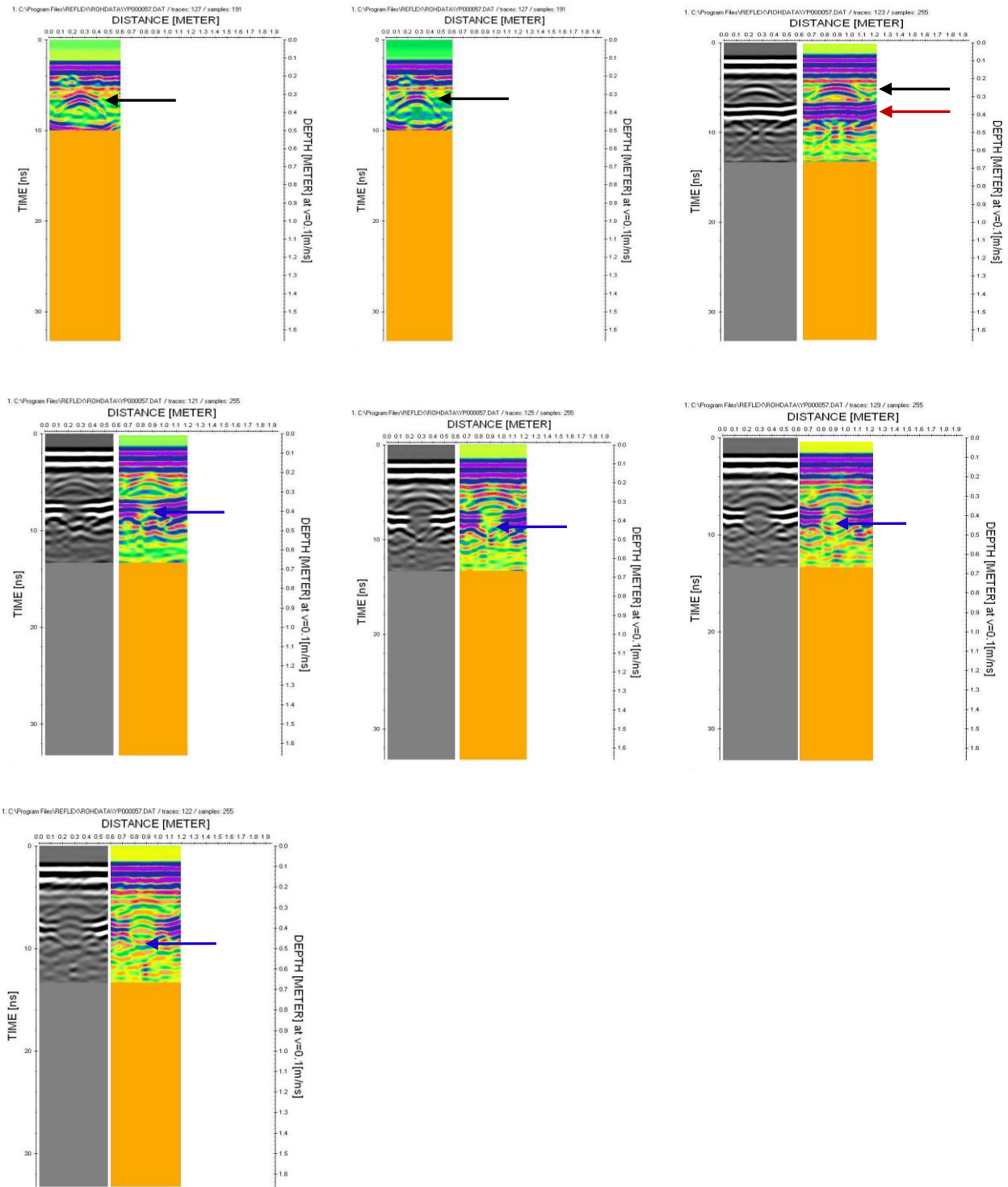


Fig. (5)

a. Pipe fill by ear

c. Pipe leakage after 15min

e. Pipe leakage after 45min

g. Pipe leakage after 75min

b. Pipe fill by water

d. Pipe leakage after 30min

f. Pipe leakage after 60min

shape of pvc pipe ←

aluminum foil ←

Impact of the leak ←

5. CONCLUSIONS

In this research we use the GPR with frequency (1GHz) as a tool to detect leakage of water from plastic pipes that used to transport fresh water in this experiments has been built form the laboratory to measure and monitor the leakage of water (before, during and after the injection of water). That a comparison between the radar imaging of the pipe non-container break and profiles the existence of breakage and leakage of water from periods of time gives the possibility to distinguish the site breakage raises of high and this means is it easily adapted GPR to detect leakage of fresh water in distribution systems, plastic pipes at the present time. Although it is possible to go forward digital signal processing the presence of advanced programs help improve the accuracy of the results, and results showed the possibility of imaging in real time, which will facilitate the work of people working in this field can also avoid the cables transfer the energy and telecommunications, which appear in the image radar is very clear (using wafers aluminum in the search

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