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Evolution of Ground using Penetration Radar

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Abstract

Geophysical tool that operates on the Theory of electromagnetic radiation is ground penetrating radar. To picture the subsurface of the Earth. This approach utilizes a radar pulse. Basically, GPR consists of three components of which the antenna has both the transmitter and the receiver. The information on the utilities present under the ground is provided when the signal from the radar transmits into the ground and returns revert signal after reaching an object. The two antenna parameters which can be considered for deep penetration in the application. GPR are high gain and wide bandwidth devices. Geographical survey of the gorund where we find the pipeline of unilities such as energy is used in this work.

Keywords: *GPR (Ground Penetrating Radar), GSSI (Geophysical Survey System, Inc.), SIR (System Incorporated TeraSIRch).*

I. INTRODUCTION

Advanced research technology has almost entered the celestial world in this 12st century and deep ocean exploration is also feasible for human underwater technology such as sonar, scuba diving etc. But people still do not know what is under the earth below us. One has to dig the soil to understand certain details or the soil information can be identified through the mining process. But we can penetrate the data up to 15 mm using electromagnetic radiation (49 ft). One of the methods that use electromagnetic radiation to explore the earth's knowledge is ground penetration radar [1]. These GPR methods were historically designed for oil and gas exploration, but now they are inter twined in a range of applications, including archaeology, environmental science, geotechnical and hydrological studies etc. Geotechnical is one the apps that can be easily identified by underground utility. As it uses an electromagnetic radiation strategy. The antenna receives an electromagnetic pulse from the radar transmitting under the ground and the return signal. Thus able to record the signal's two way travel time and amplitude.

The amplitude actually is the signal intensity coming back. Dependent on the application, the antenna comes with different frequencies. We can get a proper philosophy of this before building homes, malls, buildings etc. where we conduct a GPR survey of the land [2]. This method gives us the information about the utility present under the ground such as water pipeline utility, electric line utility, sewer line utility, metal pipe utility, gas line utility etc. With this surveying method an overall idea of any particular land can be obtained.

II. GROUND PENETRATING RADAR (GPR)

Ground penetrating radar (GPR) operates by transmitting electromagnetic waves (in the range of 10 ~ 10 00 Hz) into the probed material and receiving the reflected pulses as they encounter discontinuities. The discontinuity could be a boundary or interface between materials with different dielectrics or it could be a subsurface object such as a deboned or delamination [3]. The amplitudes of the received echoes and the corresponding arrival times can then be used to determine the nature and location of the discontinuity.

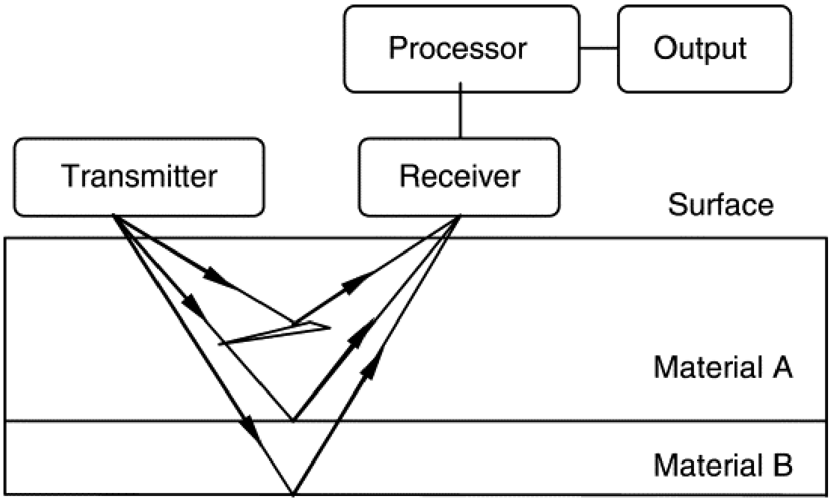

Fig. 1: Principle of Testing With GPR System

With the advancement in GPR technology, especially the increase in frequency of commercially available GPR antennae and better data processing software, GPR can now be used for subsurface condition assessment in materials consisting of thin layers, such as FRP composites [4]. Careful analysis of GPR waveforms can potentially help detect subsurface debones between the wearing surface and the underlying FRP bridge deck, and delamination within the flanges of the FRP deck.

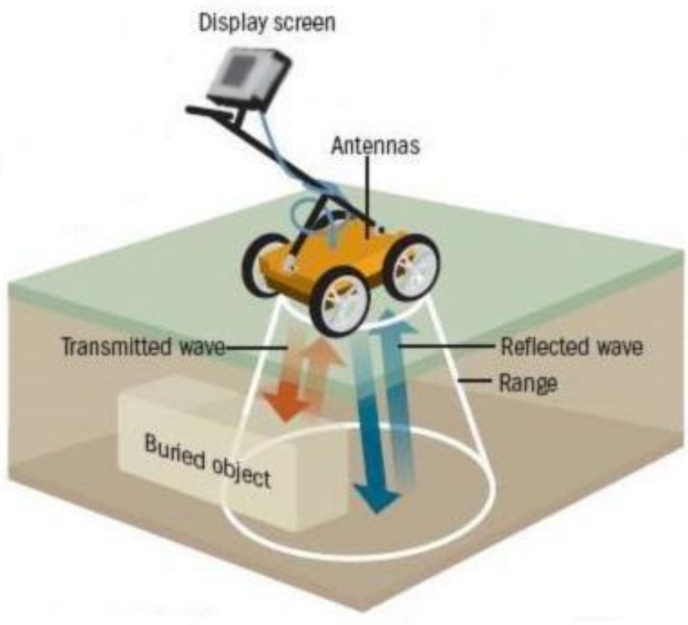

Fig 2: Penetration Radar

Compared to other non-destructive techniques such as infrared thermography, ultrasonic or microwave, GPR offers more penetrating power and so can detect concrete defects or deteriorations at greater depths. Results from the literature review show that the lower frequency GPR antenna (1 GHz) cannot detect shallow defects such as deboning in FRP wrapped members, but a higher frequency antenna (2 GHz) can detect those defects (Jackson *et al.*, 2000). On the other hand, a ground coupled 1.5 GHz antenna was found to offer higher penetration capability, which is crucial for testing FRP bridge decks (Halabe *et al.,* 2006). GPR is an excellent tool for detecting water-filled deboning's but its performance is not satisfactory for detecting air-filled deboning's in FRP wrapped concrete cylinders (Dutta, 2006) and FRP bridge decks (Hing, 2006).

Ground Penetrating Radar (GPR) is a real-time NDT technique that uses high frequency radio waves, yielding data with very high resolution in a short amount of time. This technique uses electromagnetic waves that travel at a specific velocity determined by the permittivity of the material [5]. Velocities will differ based on the kind of material, due to difference in electrical properties and will thus provide responses at different times. As antennae move along the survey line, a series of traces are collected at specific points along the line. The scans are then positioned side by side to form a profile of the area (Ekes, 2007). The main components that make up the GPR include a waveform generator, a single transducer comprised of an emitting and receiving antenna, a signal processor, and a data storage/display unit. Various approaches have been used for structural applications, such as frequency modulation, synthetic pulse-radar, and pulse systems [6]. Although all are accepted methods, the pulsed system method has been found to be the most accepted and used in most available equipment (Bungey and Millard, 1993).

GPR is most-commonly used for locating spacing and depth for reinforcing steel, posttensioning cables or anchors, measuring rebar cover, and mapping voids. With the growing availability and improvement of GPR processing software, research has found that it can be used as a subsurface condition assessment for FRP composites. GPR waveforms can now help detect voids inside the concrete. Compared to other nondestructive techniques, such as infrared thermography, ultrasonic or microwave, GPR offers more penetrating power and so can detect concrete defects or deteriorations at greater depths. Velocity (v) in the medium is given by the following equation: v=cεr Where c is the velocity of electromagnetic waves in vacuum (=3 × 108 m/s) and εr is the relative dielectric constant of the propagation medium[6]. The depth of a subsurface interface or inclusion (d) can be obtained using the following equation: d=vt2 where t is the total round-trip time taken by the electromagnetic pulse to travel from the antenna to the subsurface feature and back to the antenna. Equations assumes that the radar antenna is placed on the surface of the test specimen and the same antenna transmits and receives the echo signal (pulse-echo mode). Since the waves attenuate as they propagate through a medium, it is customary to use linear or exponential gain (increasing with travel distance) during radar data acquisition [7]. The wave attenuation coefficient increases with antenna frequency and moisture content of the propagation medium (Halabe et al., 1993). While low-frequency antennas (15–900 MHz) are typically used for subsurface investigation in pavements and soils, higher-frequency antennas (1–2.5 GHz) are typically used in cases of concrete and composite structural components where the required penetration depth is much lower (few cm to 1 m). The higher frequencies offer shorter wavelengths and better resolution, so smaller defects can be detected [8].

III. CONCLUSION

This project has proposed the entire process of identifying various utilities. This process helps the customer to identify various information under the ground. When a customer plans to construct buildings, malls, towers etc… without knowing the underground infrastructure then these utilities can be cut and the whole area people have to face immense problems. These GPR surveys let the customer get information about the ground and also help them to construct their buildings in a well facilitated place where the utilities pipeline is present. The major problem we are facing nowadays is loss of water because many times water pipelines get cut by the constructor without knowing what is underground, everybody has to face the problem of water loss. Also the constructor has to pay a huge amount of money to the government for this loss. With this project this problem can be resolved for today and further.

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