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ADVANCE GEOSPATIAL TECHNOLOGY – GROUND PENETRATING RADAR

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ABSTRACT

The objective of this paper is to analyze the various application of Ground Penetrating Radar (GPR) in different field, mainly focused on the civil engineering related application (i.e., Application in Concrete structure, Bridge and Tunnel evaluation & Underground utility survey) and analyzes the field report of a survey conducted by Total tech surveyor. Ground penetrating radar (GPR) is one of the Nondestructive testing (NDT) techniques which is based on the principle of transmitting the electromagnetic waves in to the surface of materials to find the buried objects in material. This paper will give an overview and of GPR equipment in civil engineering, use and applications. It will help to understand the advantages and disadvantages of GPR and its limitations. In this paper we collected a project from a surveyor company name Total tech surveyor and analyze the maps of the project regarding the underground utilities and safe path for pipeline work in U.P.

Keywords: Ground Penetrating Radar (GPR), Survey, NDT.

I. INTRODUCTION

Ground Penetrating Radar (GPR) technology is increasingly used on civil engineering site by the aim of detecting buried (Unknown Material) and measuring the depth or thickness of material. GPR can helpful to predict pathological risks related to civil structures. Ground penetrating radar (GPR) is a technique that use radar waves to exploration of underground surface. It can be helpful to many mapping applications (like In civil Structures for NDT (Non Destructive Testing), and in tunnel and bridge evaluation, underground utility survey etc. This Paper will give an overview of GPR equipment, use and applications. It will help to understand the usage GPR applications in various field, assist in determining what situations or site conditions GPR is appropriate, and where not. This report will give a brief overview and of GPR equipment, use and applications. It will help to understand the potential GPR applications for use, assist in determining what situations or site conditions that GPR is appropriate, and where it is not.

II. LITERATURE REVIEW

Use of Ground Penetrating Radar (GPR) for civil engineering purpose. Open issues in this field of civil engineering are identified and desirable advances in GPR technology & latest development of the GPR's primary infrastructure applications, namely buildings, pavements, bridges, tunnel liners, geotechnical and buried utilities. Applicability of the developed ground-penetrating radar (GPR) model of kinematic GPR and self-tracking (robotic) terrestrial positioning system (TPS), Information of the visualization of processed data, as well as the advantages and disadvantages of GPR, is provided. The article presents the results of investigations to determine the identification features of cracks in loose sediments filled with rocks, based on GPR survey data.

III. METHODOLOGY

The methodology of proposed research work will be as follows:

PHASE 1 – Study of research paper regarding the Ground Penetrating Radar and its applications.

PHASE 2 – Searching and contacting the surveyors for site visit and demonstration.

PHASE 3 – Case study of GPR (i.e. Application of GPR, Principle and field reports)

PHASE 4 – Study of the field Report performed by Total tech surveyor about ground utility.

STUDY AND DISCUSSION

PRINCIPLE OF GPR

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The principle of GPR is to transmitting the electromagnetic waves in to the material and when the waves are reflected by any buried object or material GPR receives this pulse. The buried object could be any material. Receiving antenna can record the variations in the returning of signal. The GPR methods implement electromagnetic energy rather than acoustic energy, and energy can be reflected at boundaries at subsurface electrical properties changes with subsurface mechanical properties as is the case with seismic energy.

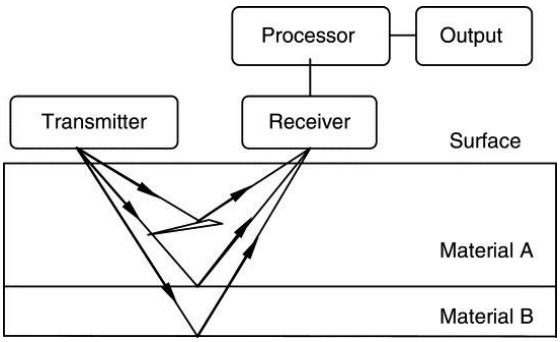

Figure 1: Principle of GPR

COMPONENTS OF GPR

There are three component of GPR :-

1. Control unit –

The control unit contains the electronic system which triggers the pulse of radar energy that the antenna sends into the ground. It also has a built-in computer and hard disk/solid based memory to store data for examination after fieldwork application.

2. GPR antenna –

The antenna emits and receives the electrical pulse wave from the control unit and transmits it into the ground or other medium at a frequency. Antenna frequency is main factor in the depth penetration. Following are the frequencies for potential use –

Table no. 1

Sr. no	Antenna Frequency	Max penetration depth	Potential use
1	1500 MHz	0.5 m	Rebar mapping & concrete.
2	900 MHz	1 m	Pipe and void detection.
3	400 MHz	4 m	Utility surveys,
4	270 MHz	6m	Geology and archaeology.

3. Power supply unit –

GPR equipment can be run with a variety of power supplies ranging small rechargeable batteries to vehicle batteries and normal 110/220-volt. The unit in the given in above figure can run from a small internal rechargeable battery or external power.

OPERATING PROCEDURE OF GPR

1. First of all set up the instrument according the manufacturer's instruction.
2. Lay out straight transects using tape measures. Use a GPS and locate start and end point of all the measurement lines.
3. Station in travels along the transects should be determined by using the manufacturer's instruction on how to avoid "aliasing".
4. After completing the transect measurement in "common offset" mode (i.e., the distance between both antennas remains the same), perform "common midpoint" (CMP) measurements to estimate the electromagnetic wave velocity. During CMP measurements the antennas are moved away from each other, while keeping the midpoint the same.

5. During the surveys repeat each transect with different frequencies to find out which frequencies perform best. We begin with the 100 MHz antennae. The 100 MHz usually gives a better overall picture of the subsurface structures.
6. At this point field work are done and next part are the Data processing.
7. For Data processing following software can be use-

- RADAN Software.
- Condor Software.
- GPR max
- GPR slice
- Reflex

IV. APPLICATIONS

1. Agriculture & Forestry:

In this GPR are can be used for Locating buried drainage pipes and buried objects is a difficult task confronting farmers and land improvement contractors, especially in the Midwest , where the removal of excess soil water using subsurface drainage systems is mostly common included in farm practice.

2. Archaeology:

Ground Penetrating Radar (GPR) cemetery surveys are non- intrusive for locating cemeteries and for unmarked grave detection. Geo Model uses GPR to detect a number of features that help identify a grave, including: The coffin or casket or vault.

3. Concrete Structures:

This includes gauging the concrete thickness, what the rebar content is, its spacing and its elevation within the slab GPR can locate voids - air gaps between the sub-grade, dirt and the concrete slab-grade - hidden below concrete and asphalt surfaces.

4. Environmental surveys:

Almost any new development will require an environmental survey to study the impact of the development on local wildlife and habitats, such as badgers and other protected species and the roots of protected trees.

5. Geological survey:

Ground Penetrating Radar (GPR) can be used for geological surveys to detect buried features such as the bedrock, water table layers. In these cases, the GPR frequencies in typical use (200MHz and higher) are not suitable and a lower frequency system should be used.

V. LIMITATIONS OF GPR

- GPR is unable to list the services: GPR is cannot identify services which will be marked on the drawing as unidentified linear feature.
- GPR penetration varies from: GPR is limited to a given penetration which is dependent on the frequency of the GPR used and the ground conditions; it can vary from less than 1m to several meters but cannot be guaranteed in advanced.
- Clutter in GPR data: - Another consideration for GPR is the level of clutter in the ground, much cluttered ground conditions with many rocks and tree roots, will make it more difficult for the correct readings to be individually distinguished and mapped.

VI. FIELD REPORT STUDY

We studied the GPR and locator survey in WFGD NTPC Civil work performed in Unchahar, Raibareli, and U.P by total tech surveyors.

1. In the bellows image they surveys the area for underground utilities, following are the details.Grid size – 40.10 * 5 = 4100 sq.m

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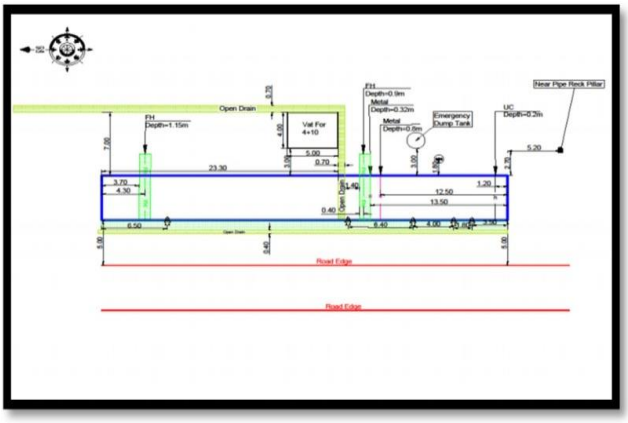

Figure no. 2

Table no. 2. Legend

	Street Light pole
	Telephone / Eclectic pole
	Traffic signal
	Fire hydrant
MH CH W.V	Manhole/Chamber/Valve
	Gate/Tree
W	Fresh Water pipe line
S	Sewer line
GAS	Gas pipe line
FH	Fire hydrant utility

2. In the bellows image he surveys for the safe path for an underground pipe line work, following are the details.

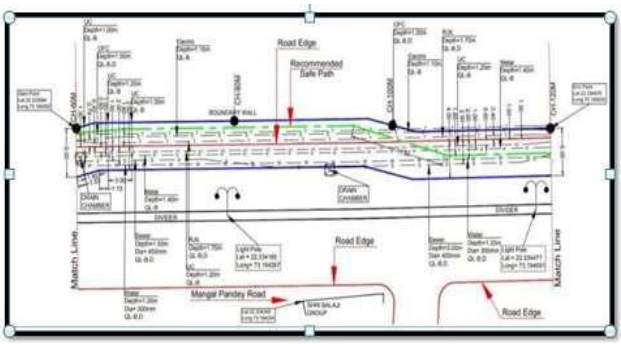

Figure no. 3

Table no. 3. Legend

	Street Light pole
	Telephone / Eclectic pole
	Traffic signal
	Fire hydrant
MH CH W.V	Manhole/Chamber/Valve
T	Gate/Tree
---------- W----------	Fresh Water pipe line
----------S----------	Sewer line
---------- uc----------	Other Utility
	Recommended Safe path
	Survey Corridor

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3. In the bellows image he surveys the area for underground utilities, following are the details:-

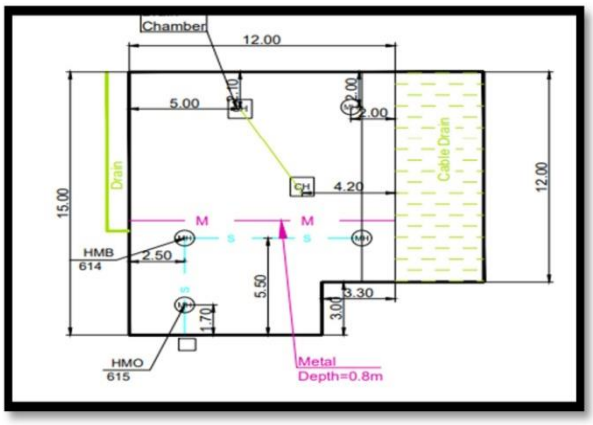

Figure no. 4

Table no. 4. Legend

	Fire hydrant
MH CH W.V	Manhole/Chamber/Valve
W	Fresh Water pipe line
S	Sewer line
GAS	Gas pipe line
M	Metallic
Drain	Drain

VII. CONCLUSION

Now a day the ground penetrating radar in increasingly used in civil engineering fields Because of its Non Destructive testing for the testing of various structure like old houses, and bridges, tunnels, flooring surfaces, and dock and airport runway. The GPR can also use in Agriculture and forestry, Archaeology, environment survey and in police and security. In the above studied survey in first plan they have done the underground utilization of an area of 4100 sq.m in this they located fresh water pipe line, sewer pipe line and gas pipe line etc. In the second plan they have find safe path for a pipeline work and underground utilities and in third plan they have done the survey for underground utility and detected a metal at0.8 m. As a civil engineer we have to know the advance technologies in the industry and we studied on of them technology i.e. Ground penetrating radar.

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Internet videos

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