From the Editor's Desk

In a continuation of our efforts towards creating awareness on non-destructive testing for condition assessment of buildings and infrastructures, we have brought focus to this issue with ReBuild, one the most advanced equipment of Ground Penetrating Radar (GPR), which is not yet being used largely in civil engineering applications in India. But over the last few years, GPR, a versatile and most powerful NDT instrument, has emerged from the shadows of geo-physical applications for civil engineering applications.

The application of GPR for surveying roads, highways and airports pavement generally includes measuring pavement thickness, detecting voids beneath pavements, identifying and classifying defects and damages, distinguishing the location of reinforcing bars in concrete, identifying pavement structure changes, mapping underground utilities and bridge inspection. Using the GPR, the volumetric water content in structures, sub-structures, foundations and soil can be measured.

Besides these civil engineering applications, it has varied applications which include; locating the buried services, detecting the buried voids or cavities, mapping bedrock depth or faults and finding fracture zones in rocks. Other applications include geotechnical foundation investigations, archaeological, environmental and hydrogeological surveys. The GPR methodology and technology used in civil engineering can be compared to those employed in such areas as, archaeological prospecting and cultural heritage diagnostics, detection of explosive remnants of war and humanitarian demining, localization of buried and trapped people, geology and geophysics, agriculture surveys, environment research, forensics and security.

GPR can be applied in general without surface preparation by sliding the antenna over the surface. Fast data collection allows covering a large area in reasonable time.

Due to the nature of electromagnetic waves, it can be used for concrete and masonry structures; radar waves cannot however, penetrate metals. Any metallic layer, e.g. a metal sheet or a metallic tendon duct is an impenetrable boundary. However, reinforcement which leaves gaps between the rods can be passed by radar waves within limits.

Impulse (or pulse) radar systems are the most widely used type and operate by transmitting numerous small pulses. Another less commonly used method is continuous-wave (CW-GPR) method, which uses sinusoidal radio waves of a single frequency.

The penetration depth and the resolution obtained with GPR depend primarily on (a) the transmitting frequency of the antenna, (b) the electrical properties of the medium and (c) the contrasting electrical properties of the target.

The propagation of electromagnetic waves in solids depends on the dielectric constant (relative permittivity) of the material. The permittivity of the material basically describes how the dielectric field in the material is following the applied electric field of the waves. The permittivity is a complex number and the real part determines the propagation velocity in the material. Generally, there is a direct relationship between the transmitter frequency and the resolution that can be obtained; conversely there is an inverse relationship between frequency and penetration depth. The depth of the GPR survey depends on the transmitting frequency, the transmitted power and the conductivity of the ground or medium investigated. Depth range varies from 25 mm to 40 m, but is typically 0.1–5 m for most geotechnical applications. However, the deeper penetration is possible with lower frequencies (e.g. 25–100 MHz), provided the ground is not too conductive.

By forming COST Action TU1208, Australia, USA and a few leading European nations, are making efforts to exchange and increase scientific-technical knowledge and experience of GPR techniques in civil engineering, as well as to promote the effective use of this safe and non-destructive technique in the monitoring of systems. In this interdisciplinary action, advantages and limitations of GPR will be highlighted, leading to the identification of gaps in knowledge and technology. The objective of this task force is to standardize the test parameters of GPR as follows:

- Networking for the design, realization and optimization of innovative GPR equipment;
- Design, realization and testing of innovative GPR equipment dedicated for civil engineering applications;
- Selection of the most suitable antenna frequency and bandwidth that impose the resolution and penetration range to be featured by the system.

The integration of GPR with other NDT techniques useful for civil engineering tasks has significant importance. Among such techniques there are ultrasonic testing, radiographic testing, methods employing surface waves, approaches involving the using of an open co-axial probe combined with a vector network analyzer, liquid-penetrant testing, magnetic-particle testing, acoustic-emission testing and eddy-current testing.