GROUND PENETRATING RADAR (GPR) FOR DETECTION OF INTERNAL DEFECTS

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Ground Penetrating Radar was recently developed for the study of soil conditions and subsurface geological formations. Adapatations and improvements to the technology have resulted in a versatile tool for inspecting other structures. For example, it has been used successfully to locate reinforcing steel in concrete structures, inspect dams and other large structures, determine asphalt thickness, locate artifacts and buried structures in archeological digs, identify and map chemical distribution from spills or dump-sites, locate and check buried pipelines, tanks, conduits and sewers, and to locate and measure voids under pavement or behind walls. We believe that it has application in diagnosing the internal condition of such wood products as beams, columns and poles.

Principles of Operation

GPR is an "echo location system" analogous to sonar but uses pulsed radio waves rather than sound waves. These radio waves can penetrate virtually all materials except metals, which absorb or reflect them totally. The depth of penetration varies with the radio frequency; 1GHz waves will penetrate soil only a few inches while 10 MHz waves may penetrate hundreds of feet. However, the long wavelengths associated with lower frequencies result in reduced resolution.

As the radio waves interact with the substrate, they change velocity and are partially reflected depending on the nature of the material. Discontinuities or abrupt changes in material properties result in reflecting boundaries. The reflected radio signals are received and recorded on a tape recorder and converted to a print-out of the radar profile for the material.

The thickness of a layer of uniform material is defined by the distance between the reflecting faces of the material. However, this apparent thickness varies with the speed of sound through the material and is highly dependent on the dielectric constant of the material. High density or high moisture content materials have high dielectric constants, resulting in slower transmittance of sound waves and higher apparent thickness of the material.

Suitability for Use on Wood Structures

In theory, GPR should be applicable to detection of internal decay and structural damage in large wood members. Discontinuities such as checks, splits, and cavities should show reflecting boundaries. Reduced density resulting from decay should be indicated by an apparent reduction in the thickness of the member. Higher moisture content, associated with decaying wood should have the reverse effect of showing an apparently thicker member.

Preliminary field evaluation on southern pine beams in a warehouse structure in Pawtucket, R.I., showed that discontinuities such as checks and decay cavities were readily identifiable.

Advantages and Limitations

- GPR provides a visual readout plot as the antenna is moved over the surface.

- Since the readout is based on reflected signals, access to the back of the structure is not needed, nor do films on other receiving devices have to be placed behind the structure.

- The unit used for the above tests is general purpose and flexible to many uses, but as a consequence is unwieldy. It may be powered by 120 volt AC, 12 volt DC using a vehicle electrical system or a portable generator. Improved portability should be possible for dedicated uses, such as pole or timber inspection.

- GPR does not provide an x-ray type print-out and for correct interpretation, the operator must be familiar with the properties of the structure tested and may have to take test borings for calibration.