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Time varying deconvolution of GPR data in civil engineering

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Civil engineering problems have in many cases been approached by using geophysical methods, like GPR, electrical tomography, seismic refraction, multichannel surface waves analysis etc. GPR is at the top of the list of high resolution geophysical methods. Since there is a trade off between penetration depth and dominant frequency of the EM signal, GPR surveys are usually conducted utilizing at least two antennas. Thus, one obtains high resolution for shallow targets and strong reflections from deeper targets.

Many authors tried to solve this problem, by using deconvolution commonly used in seismic industry. GPR data deconvolution has been notoriously not efficient, especially for medium to high loss media. This is due mainly to fact that the phase of the EM wavelet is mixed to maximum and the non-stationarity of GPR trace. These properties make statistical and wavelet deconvolution inefficient. In particular, wavelet deconvolution of GPR data suffers mainly by the non-stationarity. Spectral balancing restores the signal's initial dominant frequency and is set as a precondition for efficient GPR data wavelet deconvolution. Thus, wavelet deconvolution efficiently increases the temporal resolution and also obtains the correct polarity of the reflectivity series. This method utilizes a known wavelet, either measured or extracted from the data. Alternately, if the wavelet is not known, zero-phase deconvolution is applied.

In this work, time varying deconvolution is applied on four civil engineering projects. The scope of the geophysical survey in the first project is to characterize the karstic formation, where a public building will be situated. This survey integrates GPR, electrical tomography, multi channel surface wave analysis (MASW) methods and boreholes to map in detail weak zones in the carbonate formations. The second case involved mapping of karstic cavities in carbonates. GPR data deconvolution demonstrates how karstic cavities can be detected and mapped in detail, when GPR sections are superimposed on electrical tomography sections. The other two projects are for road monitoring. They demonstrate the use of time varying deconvolution in increasing the temporal resolution of GPR data, with the scope to map the bottom of the pavement, the sub-grade and the base formations. Thus, one can reduce the number of antennas for scanning shallow and deeper reflections in road monitoring.