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Cracking and delamination in roads and concrete structures cause severe problems if not detected and corrected early enough. Not only are there are financial and economic disruption implications, depending on the structure, there may also be risks to life. Problems arise both from poor initial construction and from everyday wear and tear. Examples of the former include the misplacement of rebars on installation, asphalt delamination on roads and airport runways and inadequately deep asphalt layers. Daily wear and tear can cause vertical cracking, water ingress on top of internal membranes, delamination and rebar corrosion.

Ground Penetrating Radar (GPR) is an efficient method of detecting and quantifying the extent of all these problems. Factors which have to be taken into consideration are the antenna frequency to be used, the speed of investigation (often critical on roads), the size and likely distribution of targets and a realistic sampling strategy. Simulations can be used to verify GPR results and to investigate the optimal detection methods.

This paper presents results from practical GPR surveys using a multi-channel radar, Groundvue 3, and a range of high frequency antennas, including very high frequency (4GHz) and adapted antennas. The differing requirements of layer detection and the detection of small fractures are illustrated. The former can be carried out at high speed in multi-channel mode (e.g. c. 100km/hour on 4 channel operation). The latter requires slower survey speeds and a more careful consideration of the GPR results.

The high target definition of a 4GHz antenna allows the detection of very thin layers of delamination whether filled with water or air. The practical results are compared with simulations in order to illustrate the advantages of using a higher frequency than is normally deployed.

The paper also explores useful frequencies for rebar detection and position checking using GPR. Corrosion is also considered. An indication of the degree of corrosion can be correlated with the amplitude of the rebar signal. The micro-cracking as a result of the corrosion increases the scattering of the GPR signal, giving a lower amplitude and less focussed signal. Survey data and simulations are used to illustrate these effects.

Vertical cracking is commonly measured using high frequency antennas to identify an area rather than focussing on the depth of cracking. However, the vertical depth is often more critical than the areal extent. A

specialist adapted antenna, known as the Crack Detection Head (CDH has been developed in order to measure the vertical extent of cracks. The cracks do not need to be visible on the surface as they can be detected either from the bottom up or the top down. Both types of cracks are typically found in buildings, on airport runways and on the roads. The critical constraints are, however, different. For example, airport runways rely on refurbishment before cracks developing at the concrete joints below the asphalt break the surface. On roads, however, it is the vertical extent of visible cracking which is critical. In either case or in the case of buildings, especially in earthquake zones, the development of cracking may result in whole or partial collapse, causing major operational risks and potentially life-threatening hazards.