

Advanced Inspection of Steel Fibre Reinforced Concrete (SFRC)

This application note describes how to inspect steel fibre reinforced concrete structures using ultrasonic pulse echo.

Steel Fibre Reinforced Concrete (SFRC) is increasingly being used for various structural applications including precast tunnel linings and warehouses. Inside SFRC there are small, discontinuous steel fibres which are randomly positioned and oriented. These fibres improve the concrete's strength, crack resistance and impact resistance.

As SFRC becomes more common, so too does the request for NDT for this material. One NDT requirement is to locate post-tensioning ducts within SFRC prior to installation work. It is essential that post-tensioning ducts are located so that they are avoided during coring and drilling. Damage to post-tensioning cables can significantly reduce the strength of a structure.

Situation

Detection of post-tensioning ducts is challenging because they tend to be quite deep below the surface, located behind at least one layer of steel reinforcement and also close to steel reinforcement. Covermeters (Eddy Current technology) are not suitable for locating tendon ducts because their penetration depth is limited and because they are designed for detecting steel rebar. [Ground Penetrating Radar](#) (GPR) offers deeper penetration and good resolution for all metallic objects, so is a good choice.

However, detecting post-tensioning ducts in SFRC poses another challenge. GPR uses radio waves which are strongly reflected from boundaries of materials with different electric properties. This means that a post-tensioning duct within 'usual' concrete will show up very clearly, due to the strong contrast between concrete and steel. The problem with SFRC is that there are randomly-distributed steel fibres within the concrete mixture making it very conductive. The contrast between the parent material (SFRC concrete) and the post-tensioning ducts (steel) is therefore greatly reduced. GPR images from SFRC are blurry and fuzzy, with strong reflections at shallow depths from the steel fibres. Covermeters also do not work well because they are designed for detecting steel rebar in non-conductive surroundings.

Solution

Screening Eagle Technologies offer an advanced ultrasonic pulse echo array instrument, [Pundit PD8050](#). This uses ultrasonic waves which are strongly reflected from boundaries of materials with different mechanical properties. Therefore they are well-suited for detecting defects ('air') inside concrete and less good at detecting metal inside concrete. Nevertheless they are able to detect the large post-tensioning metal ducts in SFRC, with little interference from the steel fibres.

The transmitting voltage and frequency of [Pundit PD8050](#) can be set exactly by the user, allowing settings to be optimized for the difficult SFRC material. Furthermore, an advanced SAFT (Synthetic Aperture Focusing Technique) algorithm is used together with a high-definition focusing technique, allowing objects at shallow depth to be resolved better than before. It is even possible to resolve overlapping rebars close to the surface.

The results here are from a 500mm thick SFRC slab with rebar meshes and multiple post-tensioning cables. The slab was part of a building that is used for chemical production and storage. Using the Screening Eagle [Workspace](#) platform, results can easily and securely be shared with other stakeholders, including those off-site. Furthermore, reporting can be done anywhere, anytime.

To complete the end-to-end inspection process, the [Screening Eagle INSPECT software](#) captures and geolocates all your inspection data - from visual inspection to sensor measurements - into a centralized cloud platform for collaboration, analysis, and customized reporting. This powerful solution eliminates the painful consolidation of disparate inspection inputs such as notetaking, photographs and sketches, and sensor data - your all-in-one platform for inspection data.

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