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Precast concrete unit assessment through GPR survey and FDTD modelling

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Precast concrete elements are widely used within United Kingdom house building offering ease in assembly and added values as structural integrity, sound and thermal insulation; most common concrete components include walls, beams, floors, panels, lintels, stairs, etc. The lack of respect of the manufacturer instruction during assembling, however, may induce cracking and short/long term loss of bearing capacity.

GPR is a well-established not destructive technique employed in the assessment of structural elements because of real-time imaging, quickness of data collecting and ability to discriminate finest structural details.

In this work, GPR has been used to investigate two different precast elements: precast reinforced concrete planks constituting the roof slab of a school and precast wood-cement blocks with insulation material pre-fitted used to build a perimeter wall of a private building. Visible cracks affected both constructions.

For the assessment surveys, a GSSI 2.0 GHz GPR antenna has been used because of the high resolution required and the small size of the antenna case (155 by 90 by 105mm) enabling scanning up to 45mm from any obstruction.

Finite Difference Time Domain (FDTD) numerical modelling was also performed to build a scenario of the expected GPR signal response for a preliminary real-time interpretation and to help solve uncertainties due to complex reflection patterns: simulated radargrams were built using Reflex Software v. 8.2, reproducing the same GPR pulse used for the surveys in terms of wavelet, nominal frequency, sample frequency and time window. Model geometries were derived from the design projects available both for the planks and the blocks; the electromagnetic properties of the materials (concrete, reinforcing bars, air-filled void, insulation and wooden concrete) were inferred from both values reported in literature and a preliminary interpretation of radargrams where internal layer interfaces were clearly recognizable and univocally interpretable.

Simulated and real radargrams comparison demonstrated that, in both cases, manufacturer instructions were not fully respected and confirmed GPR as a fast and effective structural assessment technique with the support of FDTD modelling as data interpretation validating method when complex reflection patterns are observed.

GPR findings will be then used to address the intrusive coring necessary to evaluate the compressive strength of the concrete and, in synergy with the intrusive survey results, to plan properly corrective actions to ensure the stability of the structures and guarantee the usability.