GPR Application	Methodology			Processing		Results		Complementary Tests (NDT, coring, etc.)	Ref.
	Antennas & Acquisition parameters	Testing Set-up	Equipment	Filters & Algorithms	Software	Achievements	Inconveniences & Limits		
[Damage in airport runway] Development of an algorithm that allows determining the existence of damage due to cracks and voids, automatically classifying them and recognizing the anomalies associated with the damage and those that are not caused by damage	900 MHz antenna	NP	NP	Pre-processing: mean method to suppress background clutter Processing: Hough transform The analysis is done using the A-scans	Pre-processing NP Processing with the developed algorithm	(i) The algorithm can classify damage due to cracks and voids; (ii) small calculation quantity; (iii) reliable recognition results	NP	Computational simulation	[76]
[Airfield pavements assessment] Examples of GPR applications in airfields pavement assessment	Pulse 2.2 GHz antenna 3D step frequency antenna	The antennas are mounted on a vehicle The step frequency antenna are 15 pairs of transceiver antennas	GSSI (2.2 GHz antenna) 3D Radar AS (step frequency antenna) Position using a GPS	NP	NP	(i) Detecting early signs of potential damage of the structure and Subgrade; (ii) measurement of a thickness of individual layers of construction and the entire pavement; (iii) the layered structure of asphalt packages is well visualized on echograms; (iv) horizons between the upper and the lower layer are distinguishable, particularly at the border between new and old layers; (v) mesh reinforcement is easily identified between the layers	NP	NP	[77]

[Grouting under pavement] Case study of the assessment of grouting under a rigid airport pavement. GPR is used to detect the possible voids under the slab before grouting	1 GHz shielded antenna (time window 12 ns)	Grid of radar lines spaced 45 cm	RAMAC (MALA Geoscience)	NP	Ground-vision	(i) To examine the grouting effectiveness, the GPR surveying results after grouting are compared with GPR images before grouting along the same line; (ii) GPR and FWD used to verify the restoration with grouting	NP	FWD	[78]
[Damage in airport pavements] novel method to inspect partially damaged pavement when the thin cracks are difficult to detect using the reflected GPR signals	8-channel transmitter and receiver antennas Frequency range: 50MHz - 1.5GHz CMP	Radar lines along the top of the wall	Multi-static GPR system "Yakumo" (developed in the Tohoku University). Stepped-frequency	Wave velocity obtained from CMP data combined with an interferometric method Evaluating deviation in the depth and velocity	NP	(i) Thin cracks filled with water and air produce inhomogeneity in the asphalt layer, and the RMS velocity of signals traveling through the layer at these inhomogeneity differs slightly from that in the undamaged asphalt; (ii) slight deviations in permittivity in the damaged zones; (iii) the special antenna arrangement of the Yakumo system makes it possible to simultaneously acquire several CMP datasets along a survey line; (iv) the proposed method is more accurate than the conventional CMP velocity estimation method	(i) error caused by the distortion of the wavelets by small sources of scatter and by the choice of reference point; (ii) in field applications of this method, the estimated deviations in the velocity and thickness should be considered as an indication of the distribution of inhomogeneity within the inspected asphalt layers and not as exact numerical results	Coring FDTD simulation using ray tracing, convoluted with a Ricker wavelet with a center frequency of 500 MHz	[81]
Case study: evaluation of the structure of the rigid pavement of	250 MHz shielded antenna	6 radar lines (total surveyed distance: 1432 m)	Detector Duo (IDS)	NP	ReflexW	(i) Thickness of the pavement layers; (ii) shallow geology under the pavement (sand and embankment)	NP	Borehole	[82]

Santos Dumont Airport in Rio de Janeiro, Brazil	700 MHz shielded antenna Time window: 64 ns	Spacing traces: 2 cm 256 samples per trace							
Two case study: a) stratigraphic information up to 2 m depth; recognize possible failures or subsidence structures; detect lateral variations of the geotechnical properties (Test 1). b) Verify the thickness of new constructed FRC (Fiber Reinforced Concrete) plates (Test 2)	500 MHz shielded antenna (Test 1) (Time window: 60 ns) 800 MHz shielded antenna (Test 2) 1600 MHz shielded antenna (Tests 1 and 2) (Time window: 12 ns)	Use and test of a tow designed by an spin-off of the University of Trieste (the device can reach velocities between 50-60 km/h during data acquisition	Malå ProEx GPR RTK mode GPS with centimetric precision	background removal; high-pass filtering; true amplitude recovery; depth conversion		(i) Test 1: the interpretation of inhomogeneity of the subgrade let to locate the critical failure points and drive for future maintenance activities; (ii) Test 2: Verification of the layers thicknesses	(i) Improvement of precision and speed in picking the horizons is required	Cores	[83]
Test in the Tokyo International airport in the taxiway. Method to analyze the trend of the maximum amplitude of the lateral wave with the offset in CMP gathers after	Stepped-frequency antennas in a range from 50 MHz to 1.5 GH (8 pairs of bowtie antennas)	Survey interval: 1 trace per cm Samples per trace: 256 Scan velocity: 7 km/h	Multi-static ground penetrating radar system developed by the authors	Variation of the maximum amplitude value is estimated as a linear function of the antenna offset by the least square method	CST Studio Suite (numerical simulation)	(i) Novel method consisting of characterizing the properties of the lateral wave in the CMP gathers acquired by a multi-static GPR system to detect interlayer debonding; (ii) the lateral wave is very sensitive to material properties; (iii) the results are consistent with the conventional acoustic finding	NP	Cores Numerical simulation	[85]

amplitude compensation for detecting interlayer debonding of the upper asphalt layer		Data acquired using common offset and CMP				method and with cores; (iv) Efficient data acquisition			
Assessing with GPR filled layers, including the runway, aprons and taxiway of the new sea-filled airport OGU (Black sea, Turkey)	100 MHz shielded antenna (time window: 400 ns)	6 radar lines Distance between traces: 0.05 m	RAMAC CUII GPR	Time-zero correction; dewow; background removal; gain (amplitude decay); band-pass Butterworth filter, deconvolution (autocorrelation; 14 ns, filter length: 150 ns), velocity analysis (matching hyperbolas), F-K filter, Kirchhoff migration, topographic corrections	ReflexW	(i) Detection of the bottom depth line of the filling; (ii) the proper selection of the filter length in deconvolution improves the signal-to-noise ratio in B-scans; (iii) determination of bathymetric depth	(i) Data had too much diffraction and multiple reflections that obscured the real depth of the filled layer along the profile	Topographic measurements Drilling	[86]
GPR survey to study the frozen surface beneath the airfield in the Kangerlussuaq Airport	(time window: 150 ns)	11 radar lines 50 traces per m Samples per trace: 512	GPR model SIR-2000 (GSSI)	Band-pass filter (175 MHz - 700 MHz); spatial filter; running average	ReflexW	(i) Clear connection between the areas with white-painted asphalt and a reduced depth to the permafrost surface; (ii) detection of the permafrost surface showing variations related to ground materials and the asphalt color	(i) Measurements during all the year are needed in order to determine whether the entire active layer freezes in winter or not	Borehole Trench	[87]

Table S2. Airports: relevant on-site GPR surveys (NP = Not Provided; Ref. = Reference).