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Radar database over narrow debonded areas into pavement structure

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1. GENERAL INFORMATION

This database was collected by several ground-penetrating radar (GPR) systems over artificial debonded areas during an accelerated pavement testing at the carrousel of Gustave Eiffel university. GPR data have been collected over ten artificial defects (tack-free, geotextile and sand-based), which were embedded between the top and the base layers.

This data collection is complement to the data paper from Dérobot et al. (2020a), which was focused on the largest defects. The GPR experimental campaign was organized in a two-stage experiments and covers the full life-cycle of the pavement structure. During the first stage that took place in 2012-13, data were collected at each of 10k, 50k, 100k, 200k, 250k and 300k loading cycles. The second measurement campaign, performed in 2019-2020, lasted up to 800k loading cycles.

1.1. UNIVERSITY GUSTAVE EIFFEL CARROUSEL

The pavement fatigue facility of Gustave Eiffel university is a road traffic simulator composed of a carrousel and a test track, using a 65 kN twin-wheel. It has been described in several papers (Simonin et al., 2012 ; Simonin et al., 2014 ; Todkar et al., 2019), and in particular in detail for this experiment in Derobert et al. (2020a).

The pavement structure consists of two bituminous layers (a 8-cm base layer, and a 6-cm wearing course), over a granular sub-base. Rectangular patches of defects were incorporated at the interface between the two asphalt layers to create embedded debonding areas. Patches described by materials are composed of sand (5-10 mm expected), textile and tack-coat free interface. Their size are listed in table 1 and their locations presented in Figure 1. The database of this paper is focused on the narrow defects from I1 to I10 and complements the one dedicated to the largest ones (from I11 to I13) in Dérobot et al. (2020a).

Table 1 Characteristic of the debonded zones along the test site; in bold, the narrowest artificial embedded defects are concerned by this database.

Name (notation 2012)	Type	Length (m)	Width (m)
I1	Sand	0.5	2
I2	Geotextile	0.5	2
I3	Tack-coat free	0.5	2
I4 – I9	Geotextile	0.5	0.5
I10	Geotextile	3	0.5
I11	Sand	1.5	2
I12	Geotextile	1.5	2
I13	Tack-coat free	1.5	2

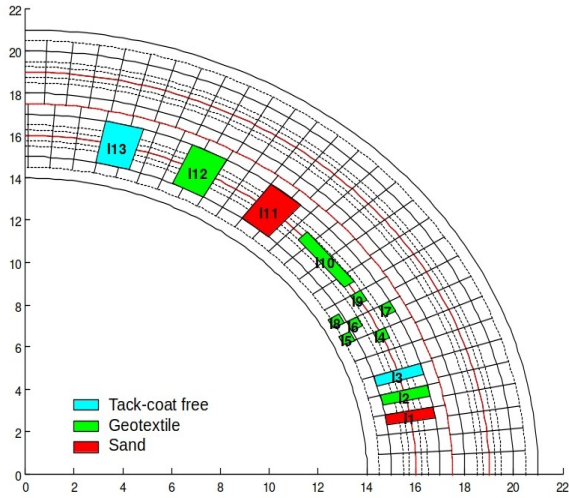


Fig. 1 Location of defect zones in the intern radius of Gustave Eiffel university carrousel (Dérobert et al., 2020b)

1.2. GPR TECHNIQUES

Three GPR systems, manufactured by GSSI, were used during two series of experiments in 2012 and 2019 (see further section).

In 2012, the GPR systems used are as follows (most data were focused on I11 to I13 at that period):

- A SIR3000 GPR system associated with an impulse ground-coupled 2.6 GHz antenna,

In 2019, GPR systems were:

- A SIR4000 GPR system associated with an impulse ground-coupled 1.5 GHz antenna,
- A 2.6 GHz StructureScan (an impulse ground-coupled system).

1.3. EXPERIMENTATIONS

The experiment started in the spring 2012. 300 000 loads of 65 kN were applied on the debonded area. Survey of the debonded zone was possible at different loading times:

- After the construction and before loading (initial state),
- At 10 000 loadings, corresponding to the consolidation of the structure,
- At around 50 000, 100 000, 200 00, 250 000 and 300 000 loadings.

A second series was programmed in 2019, supported by the French Research Agency (ANR), the FEREC foundation, and the French Ministry of Ecological and Solidarity Transition (MTES), as the global loading did not reveal clear evolution for road specialists.

Survey of the debonded zone were performed at the following loading times:

- At 310 000 loadings, corresponding to a new consolidation of the structure,
- At 396 000, 420 000, 500 000, 550 000, 600 000, 720 000 and 800 000 loadings.

For the last loading stages, the pavement layer was considered as severely damaged by road engineers, leading to the end of the experiment.

Data were collected longitudinally and transversely through the centre of defects. Location of the beginning of the profiles in relation with the traffic path, described in Dérobert et al (2020a) is summarized in Table 2. One has to take into account the width (center to front) of the antenna systems and add 9 cm for the StructureScan and 15 cm for the 1.5 and 2.6 GHz antennas.

Table 2 Location of the beginning of the GPR profiles to the internal traffic limit

Name	Profile orientation	Distance antenna front to the internal traffic limit (cm)	Observation
I1	T	50	
I2	T	59.5	
I3	T	61	
I4	L	~85	Lateral distance
I5	L	~50	Lateral distance
I6	T	55	
I7	L	~169	4 cm outside the external traffic limit
I8	T-	24	Start inside the trafic path
I8	L	50	Lateral distance
I9	T	3	Start inside the trafic path
I10	T	22	

The reader can find the dates of experiments and a synthesis of the data in the folder /TOTAL/, file Table_Synthesis_Profiles. Moreover, weather information, such as sunshine, precipitation, temperature and daily weather, are gathered in a specific folder /Weather_Conditions/ or can be found at the Internet site www.infoclimat.fr/stations-meteo/analyses-mensuelles.php.

2. DATA PRESENTATION

2.1. DATA FILES AND STRUCTURE OF DATA

Database is organized in folder trees; folders à the first level being dedicated to each defect. They are named I1 to I10 respectively.

In each of them, folders are organized in type of measurements and named by their central frequency and type of impulsion, as presented below:

/Defect_Central frequency_Type of impulsion/,

where:

- Defect: namely I1, I2 to I10,
- Central frequency: 1.5 or 2.6 GHz,
- Type of impulsion: impulse (namely Imp)

For each Bscan, file nomenclature has been defined similarly to Dérobert et al. (2020a) as:

Freq_Emission_Defect_Orientation>Loading,

where:

- Freq corresponds to the nominal central frequency (* 100 MHz),
- Emission, to the impulse radar type (Imp),
- Defect, to the name of the defect,
- Orientation, specifying if transversal or longitudinal B-scan (T or L). Directions of the transversal B-scans towards outdoors are noted T (and T- for the ones towards indoors) and for the longitudinal ones noted L, from I13 to I1.
- Loading, the loading stage (in kloading) at which the GPR data were collected.

Data are raw data but the SIR3000 ones, which get the following setting parameter: a [0.5 GHz–5 GHz] bandwidth and a constant time gain.

At last, data are in a binary format for GSSI ones (extension .dzt, and coupled with a parametric file of the same name and extension .dxt for the SIR4000 system).

2.2. DATA PARAMETERS

List of data, with their setting parameters, are gathered in the table 3.

CONCLUSION

This data base is available to the GPR community and may serve as a reference benchmark, as complement to the first one (Dérobert et al., 2020a), for both developing and testing the performance of various processing techniques for either interface detection, characterization, or monitoring purposes of debonded areas of pavement structures under scale-1 controlled traffic.

Table 3 Information about data collected on the fatigue carousel defects I1 to I10.

GPR system	Central Freq (GHz)	Type impulse	Coupling (AC / GC)	Orien-tation	File Name	Scan/m	Sampl.	Range (ns)	LP / HP (MHz)	Loading (k)	Nb Files
SIR4000	1.5	Imp	GC	L / T	1.5_Imp_I11_L/T_kload	100	1024	7	3000/250	300 / 310 / 396 / 420 / 500 / 550 / 600 / 720 / 800	105
SIR3000	2.6	Imp	GC	L	2.6_Imp_I11_L_kload	100	1024	8	5000/500	0 / 200 / 300	8
StructScan	2.6	Imp	GC	L / T	2.6_Imp_I11_L/T_kload	400	256	6	5000/500	310 / 396 / 420 / 500 / 550 / 600 / 720 / 800	107

Imp: impulse

GC: ground-coupled

L/T: longitudinal (direction I13 to I1) / transversal towards outdoors

Sampl.: sampling of A-scans

LP/HP: low pass/ high pass

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