



Silent surfaces: an experience in Portugal

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Organization

- **Overview of past Portuguese experiments**
- **Experiment description**
 - Properties of asphalt mixes
 - Noise measurement
 - Weather, Texture, Skid resistance
- **Results**
 - Noise – far field test
 - Noise – near field test
 - Noise – far field versus near field test
 - Noise – near field test – spectra
- **Conclusions**

Overview of past Portuguese experiments

- **Studies based on environmental noise - L_{eq} (15-30 min)**
 - Gap graded asphalt rubber versus “rough” dense asphalt
noise reduction = 5 to 8 dB(A)
 - Gap graded asphalt rubber versus cement concrete
noise reduction = 8 to 10 dB(A)

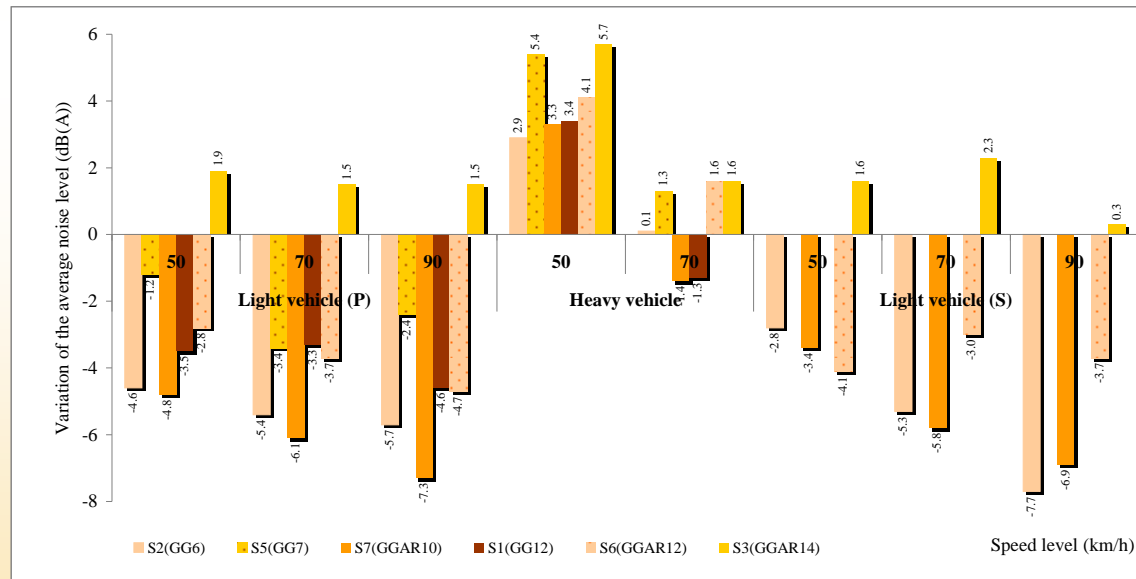
Overview of past Portuguese experiments

- Studies based on Controlled Pass-By Method (CPB)
 - Porous asphalt versus dense asphalt and dry versus wet surfaces

Vehicle	Ref. speed (km/h)	PAw - PAd (dB(A))	DAw - DAd (dB(A))	DAd - PAd (dB(A))	DAw - PAw (dB(A))
L1	80	6.1	7.6	1.4	2.9
L2a	70	0.3	0.5	3.3	2.5
L2b	70	2.0	1.0	3.8	2.8
L1	110	6.2	7.3	2.5	3.6
L2a	85	3.2	4.9	1.3	0.0
L2b	85	2.6	2.2	0.5	0.1

Overview of past Portuguese experiments

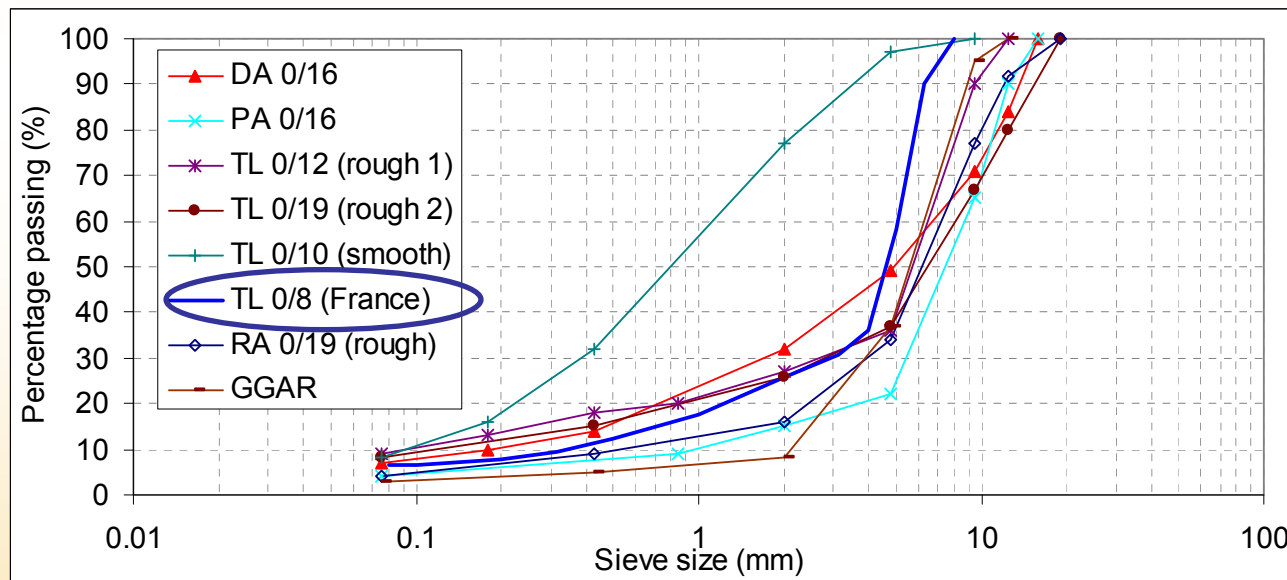
- Studies based on Controlled Pass-By Method (CPB)
 - Layers assessed: gap graded asphalt rubber, dense asphalt, unconventional gap graded asphalt mixtures with small aggregate size (< 7 mm)



Overview of past Portuguese experiments

○ Analysis

- The big maximum aggregate size of **conventional** Portuguese surface mixtures seems to control noise

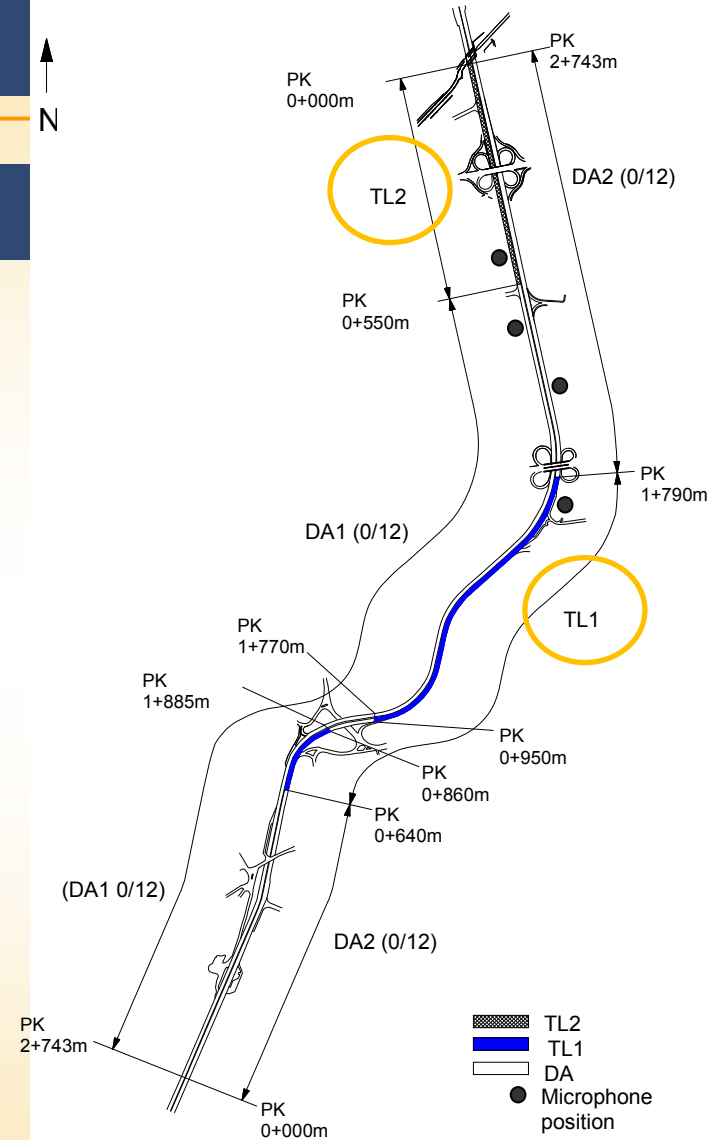
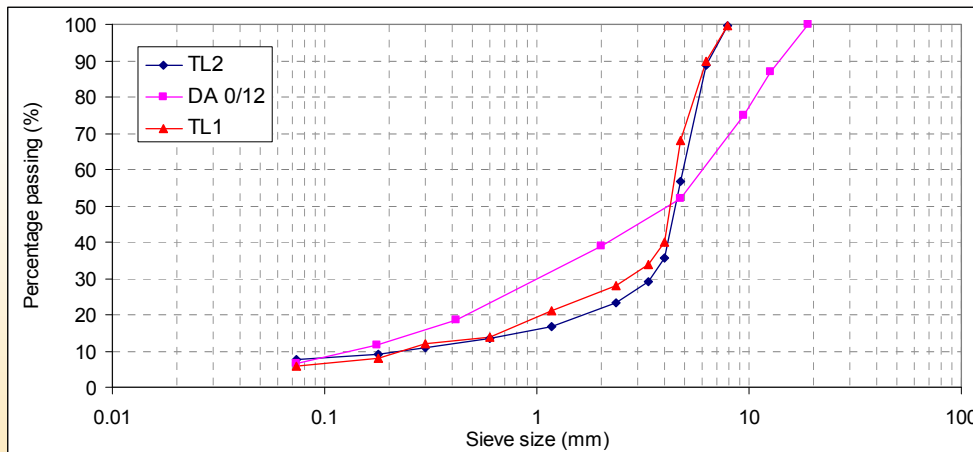


Experiment description

- Rehabilitation project: urban distribution road in the centre of the city of Braga
- Three surface layers constructed consecutively:
 - one dense asphalt layer with 12 mm of maximum aggregate size
 - two very-thin surfaces with different grading
(adaptation of the very-thin layers, widely used in France, to Portuguese conditions)
- Noise assessment methods
 - Controlled Pass-By method
 - Close Proximity Method
- Other complementary tests
 - Macrotexture and skid resistance

Properties of asphalt mixes

Type of mix	Thickness (cm)	Max. aggregate size (mm)	Void content* (%)
TL1	3	8	15.0
TL2	3	8	18.5
DA (0/12)	4	4.9	



Testing vehicles and speed

- 2 passenger cars
 - 2 pass-bys each at 50, 80, 110 km/h
- 1 tri-axle truck:
 - 2 pass-bys at 60, 80, 90 km/h

Noise measurement

- CPX method
 - Based on ISO CD 11819-2
 - Captured signals in a dedicated audio module – Matlab
 - Test sections with more than 100 m



Noise measurement

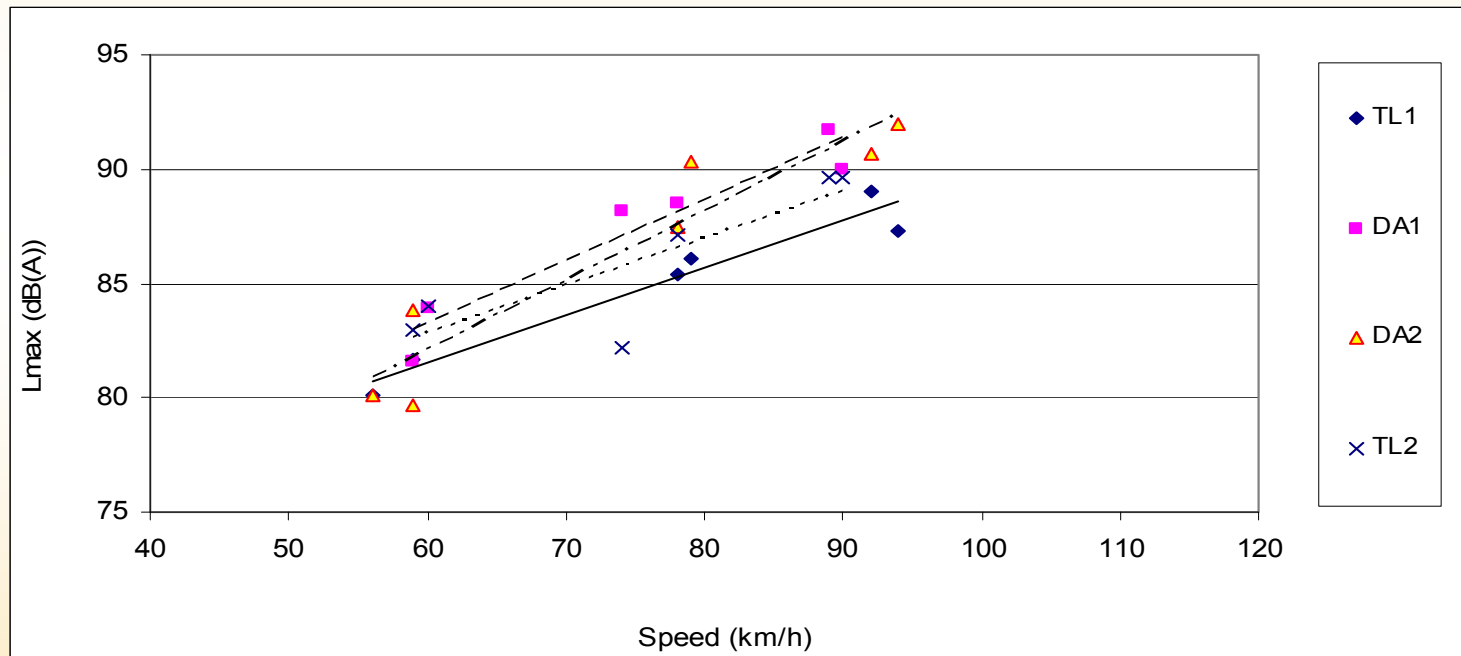
- CPB method
 - Based on ISO 11819-1 (1.2 m, 7.5 m)
 - Simultaneous measurement in each direction (2 microphones, 2 surface layers)
 - Tests carried out at night
 - Traffic closed in both directions
 - Vehicle's engine switched on

Weather / Texture / Skid resistance

- Air temperature \approx surface temperature: [5.5; 7.9]°C
- Wind speed: < 1 m/s
- Texture near microphone position:
 - TL 1 \approx 1.1 mm
 - TL 2 \approx 1.3 mm
 - DA1 \approx 0.8 mm
 - DA2 \approx 0.6 mm
- Skid resistance: 0.6 (average)

Noise – far field test

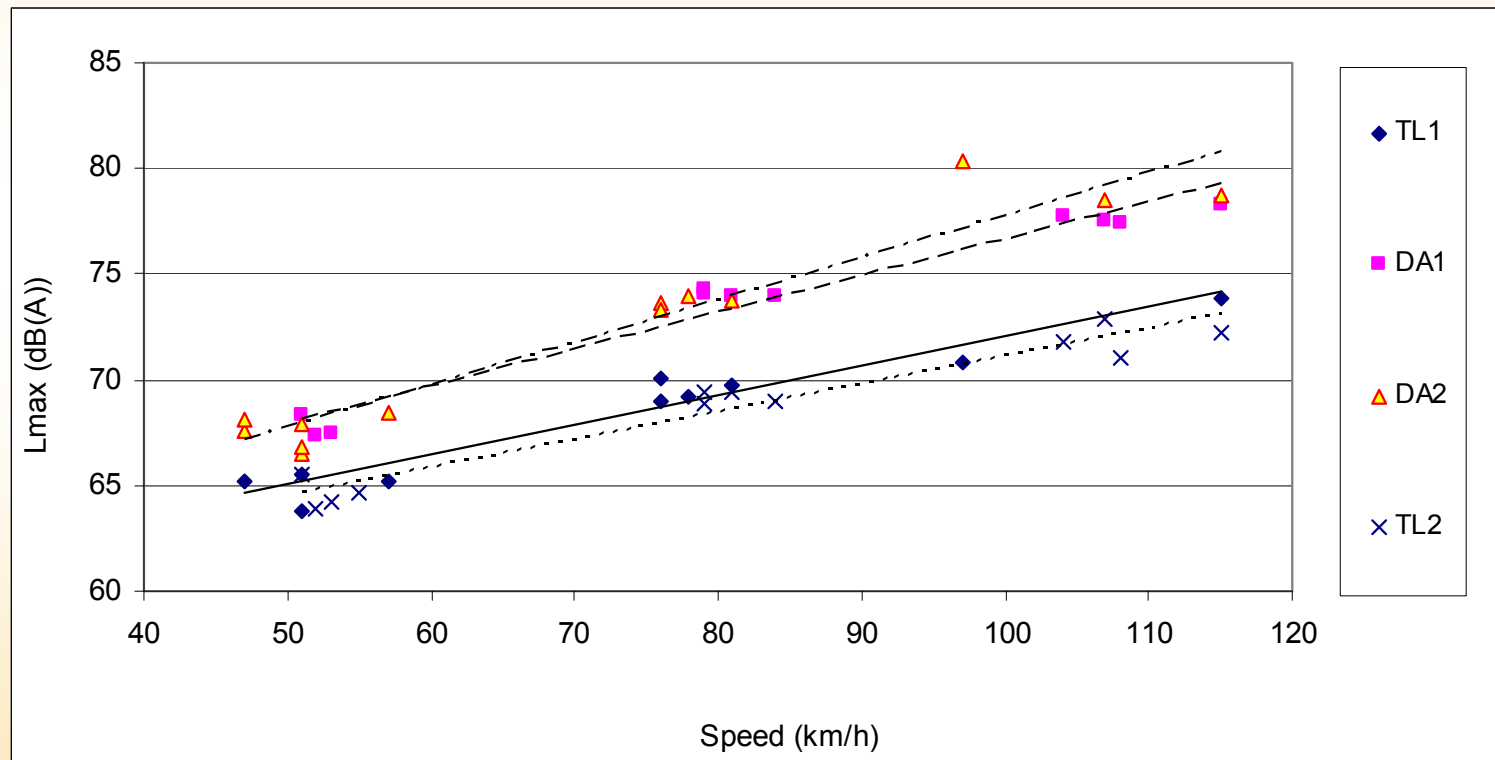
- Heavy vehicle



1st
3rd
4th
2nd

Noise – far field test

- Light vehicles



2nd

3rd

4th

1st

Noise – far field test

- Noise level at reference speed

Type of vehicle	Speed (km/h)	Noise level (dB(A))				
		TL1	DA1	DA2	TL2	Max-Min
Heavy	60	81.6	83.1	82.2	82.8	1.6
	80	85.9	88.9	88.6	87.1	2.9
	90	87.7	91.2	91.2	88.8	3.5
Light	50	65.5	67.0	67.7	63.8	3.9
	80	69.5	73.4	74.1	68.5	5.6
	110	72.2	77.8	78.5	71.7	6.8

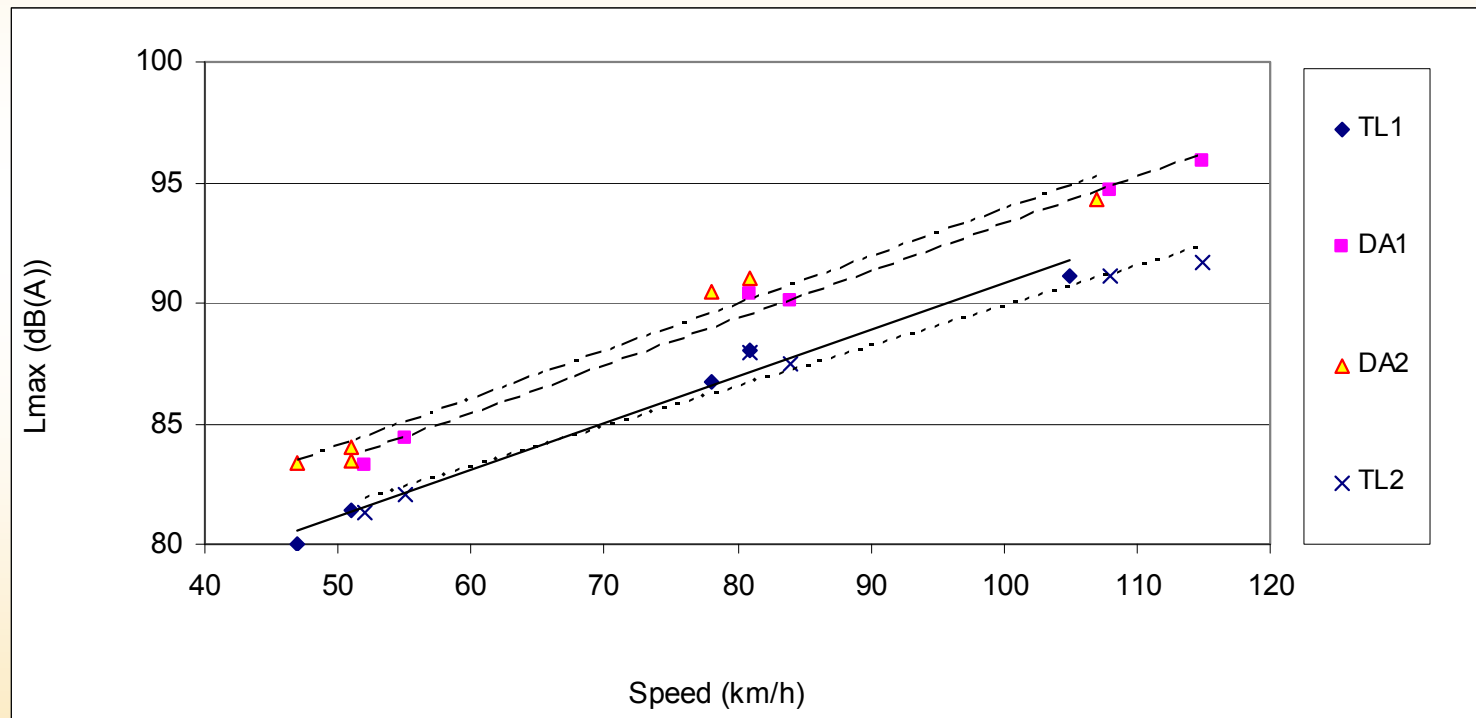
Noise – far field test

- Comparison - TL2 with GG asphalt rubber (10 mm) and DA

Type of vehicle	Speed (km/h)	Noise level (dB(A))			
		DA (0/16)	GGAR (0/10)	DA (0/16) – TL2	GGAR (0/10) – TL2
Light	50	71.2	66.5	7.4	2.7
	80	77.7	71.0	9.2	2.5
	110	82.1	74.1	10.4	2.4

Noise – near field test

- CPX vehicle



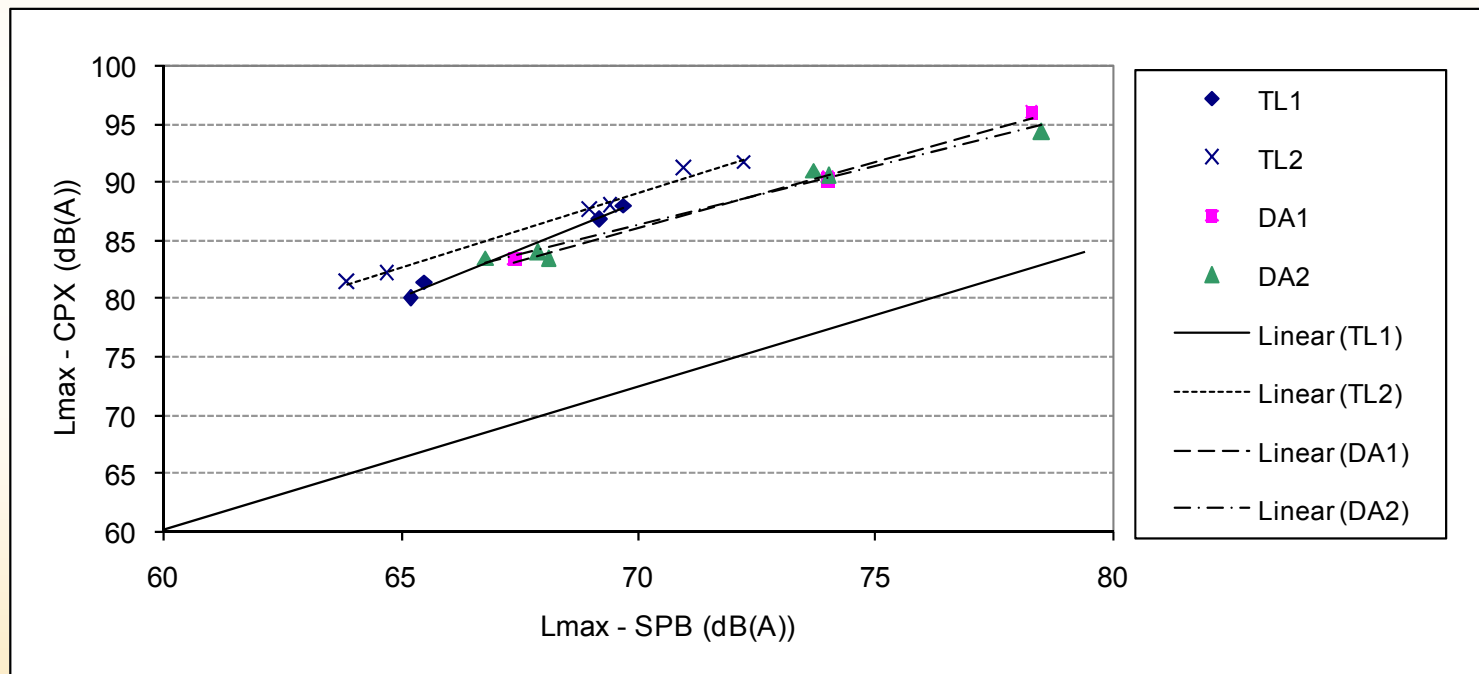
Noise – near field test

- Noise level at reference speed

Speed (km/h)	Noise level (dB(A))				
	TL1	DA1	DA2	TL2	Max-Min
50	81.0	83.8	82.7	80.9	2.9
80	87.4	90.5	90.0	87.1	3.1
110	91.8	95.0	95.0	91.3	3.3

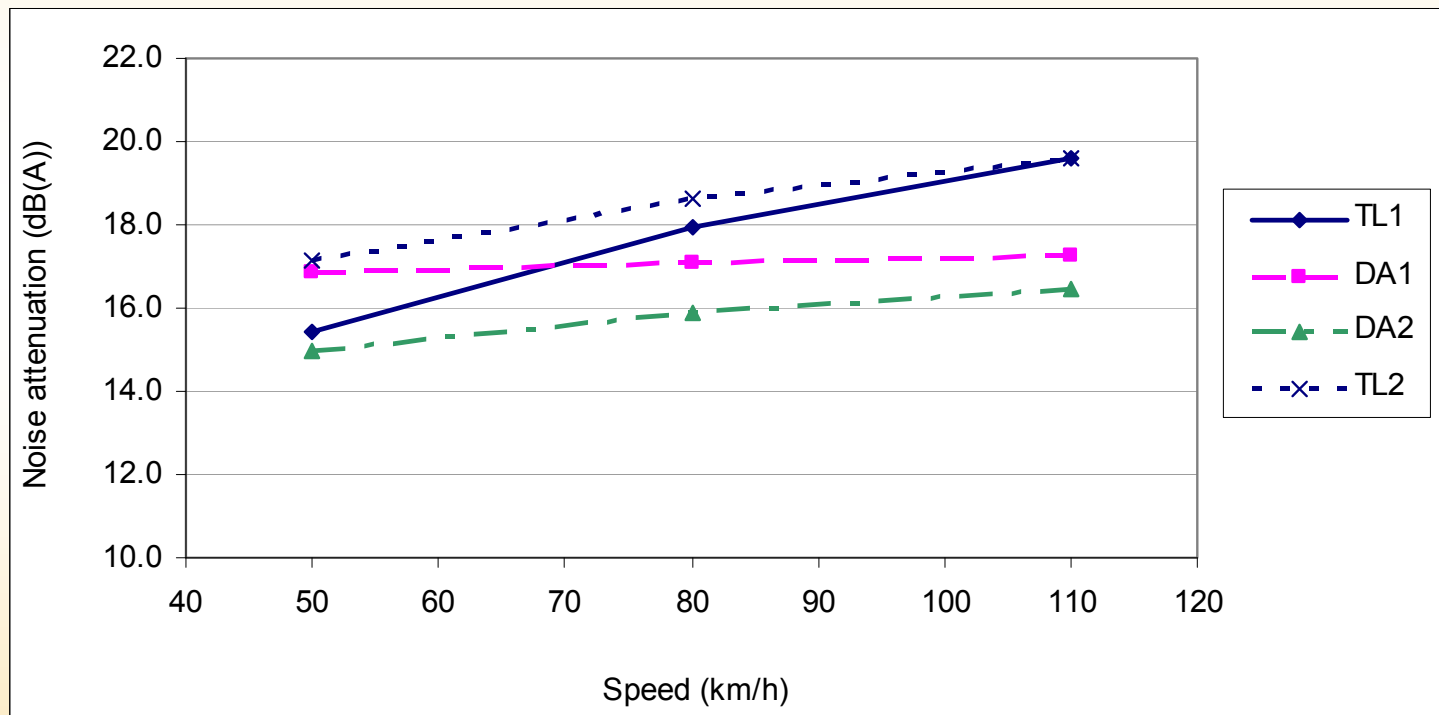
Noise – far field versus near field test

- Noise level at reference speed



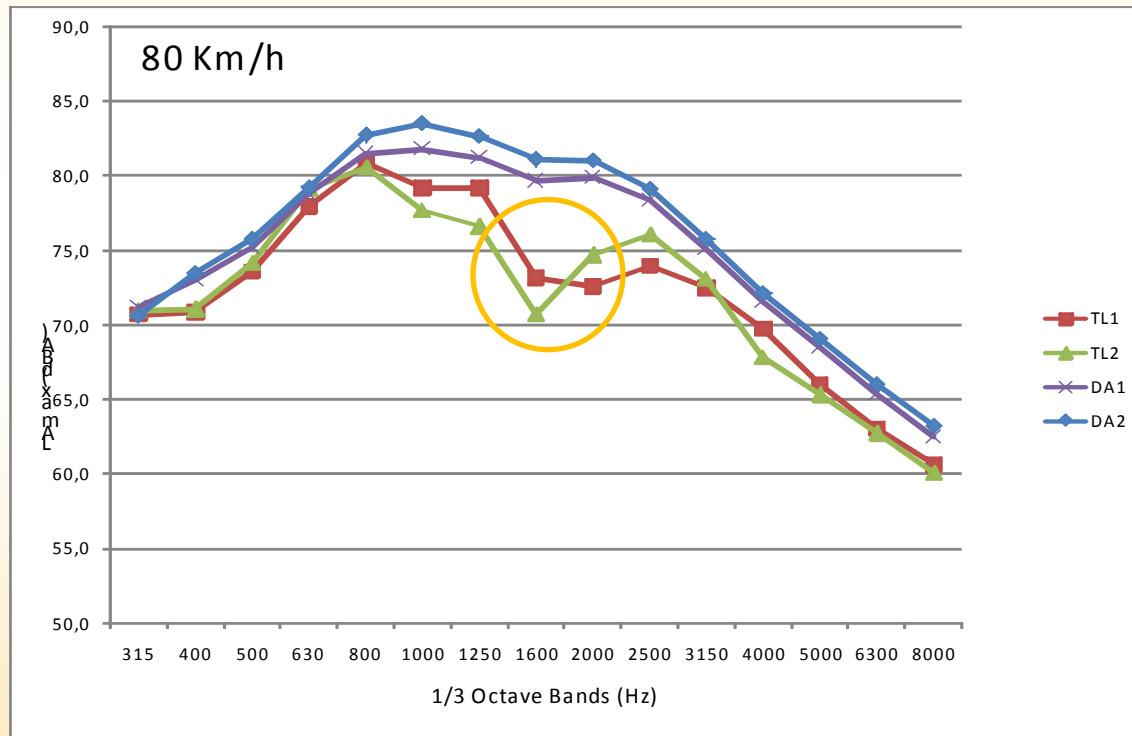
Noise – far field versus near field test

- Noise attenuation



Noise – near field test – noise spectra

- Example spectra at 80 km/h



Cancelling effect
 on thin layers:

after device
 verification, further
 tests have shown
 similar trend

Conclusions

- Silent surfaces need more attention in Portugal
- With the use of the adapted thin layers important noise reductions can be achieved (up to 7 dB(A))
- Based on this experience, the thin layers studied may be recommended to be used in all types of roads (rural and urban)
- It is intended to repeat noise tests every year