CPX NOISE MEASUREMENTS IN DIFFERENT ROAD SURFACES

Authors:
L. PARRA, T. CASAS & R. ALVAREZ DE SOTOMAYOR
CEDEX (Spain)
J. del CERRO & E. CASTILLO
MINISTRY OF PUBLIC WORKS (Spain)

PURPOSE OF THE INVESTIGATION

How can tyre-road noise be reduced?? What surfacing properties influence tyre-road noise emission??

HOW TO DO IT

- **Let's measure CPXI sound pressure levels in different road surfaces.**
- **Let's study time evolution of tyre-road noise.**
- **Let's analyse the influence of road surface layer characteristics on tyre-road noise.**

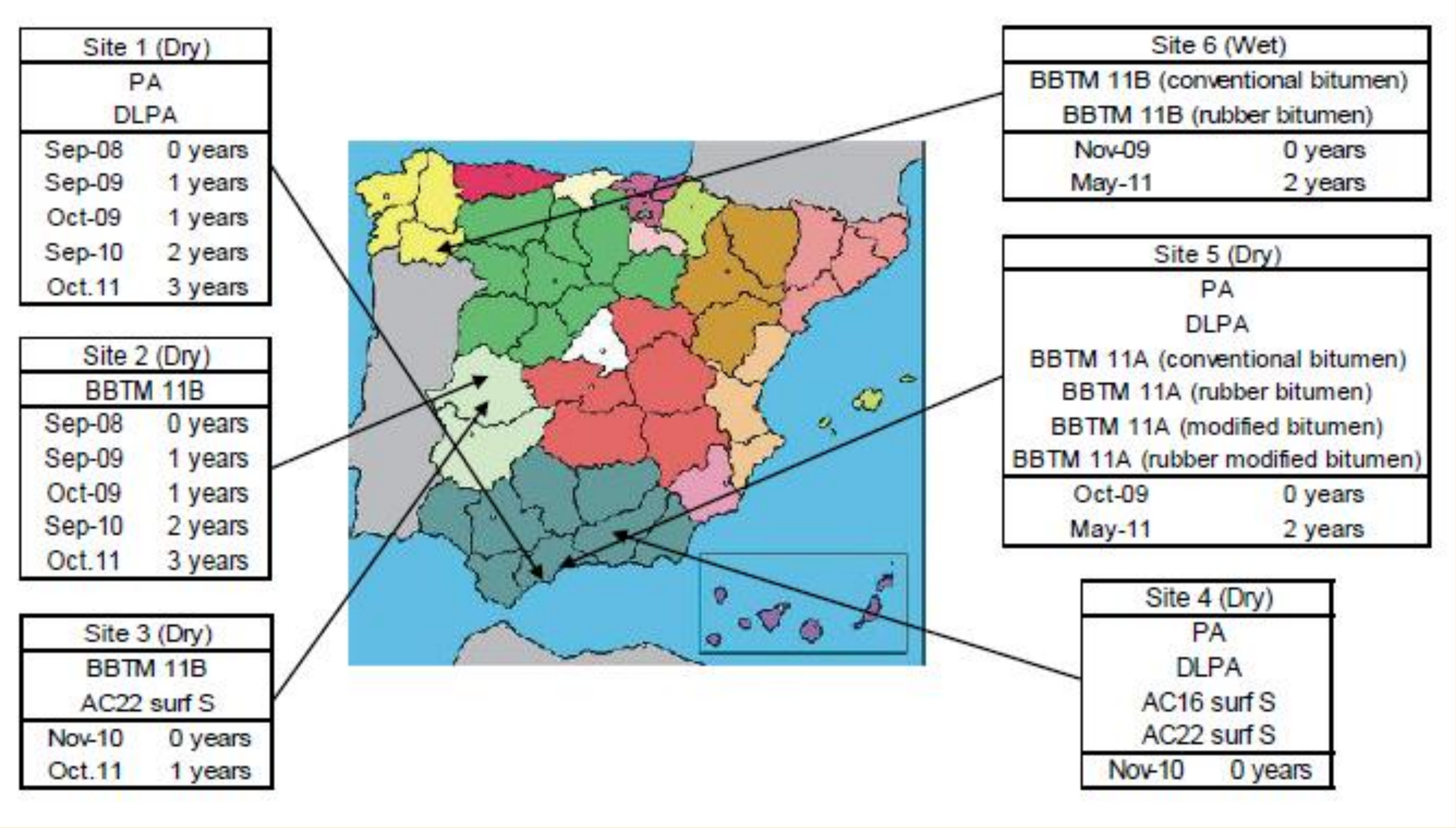
CEDEX CPX DEVICE

- 2 wheels
- Semi-anechoic chamber

CPX METHOD

- **ISO 11819-2 *“Acoustics – Measurement of the influence of road surfaces on traffic noise – Part 2: The close-proximity method”***
- **Still Draft Committee… This implies problems when doing measurements over time…**
  - ✓ **Measures before 2009 according to ISO/CD 11819-2:2000**
  - ✓ **Measures after 2009, according to ISO/CD 11819-2:2008**
  - ✓ **More changes since ISO/CD 11819-2:2008, but CEDEX has not implemented them yet.**

TEST SECTIONS



ROAD SURFACES

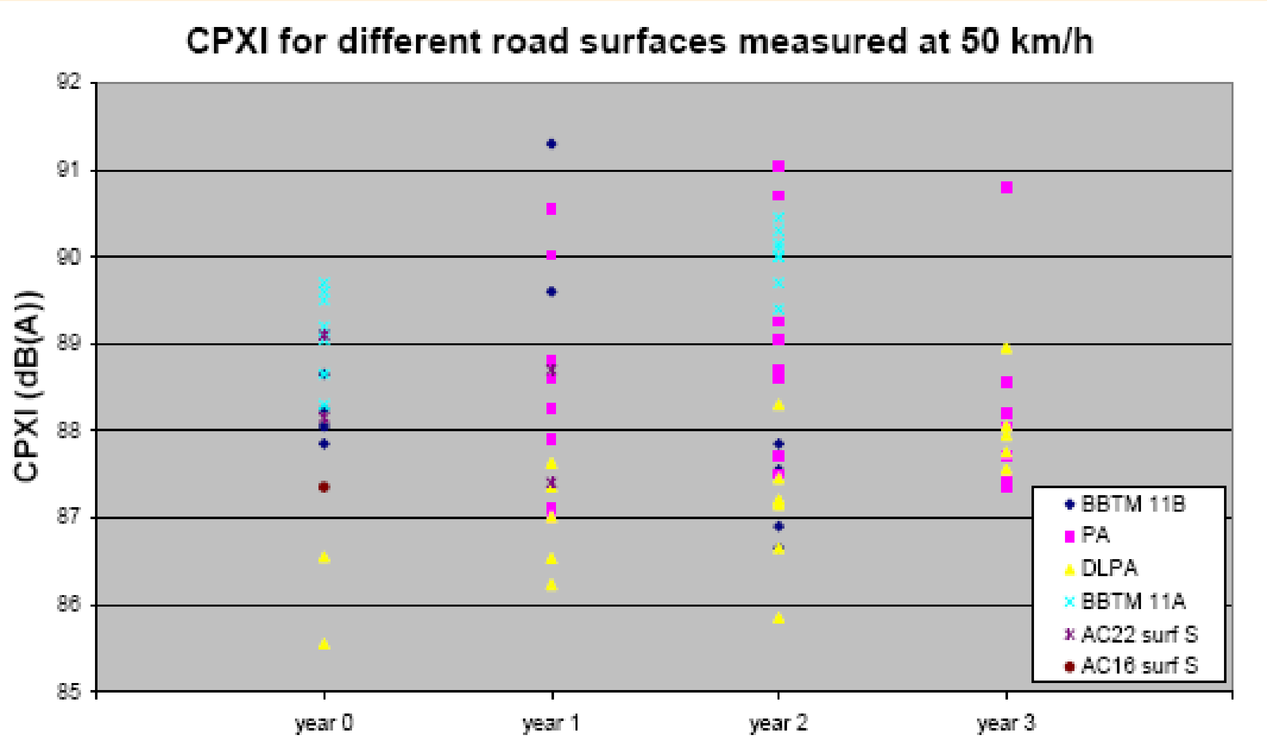
BBTM 11B.

AC 16 surf S.

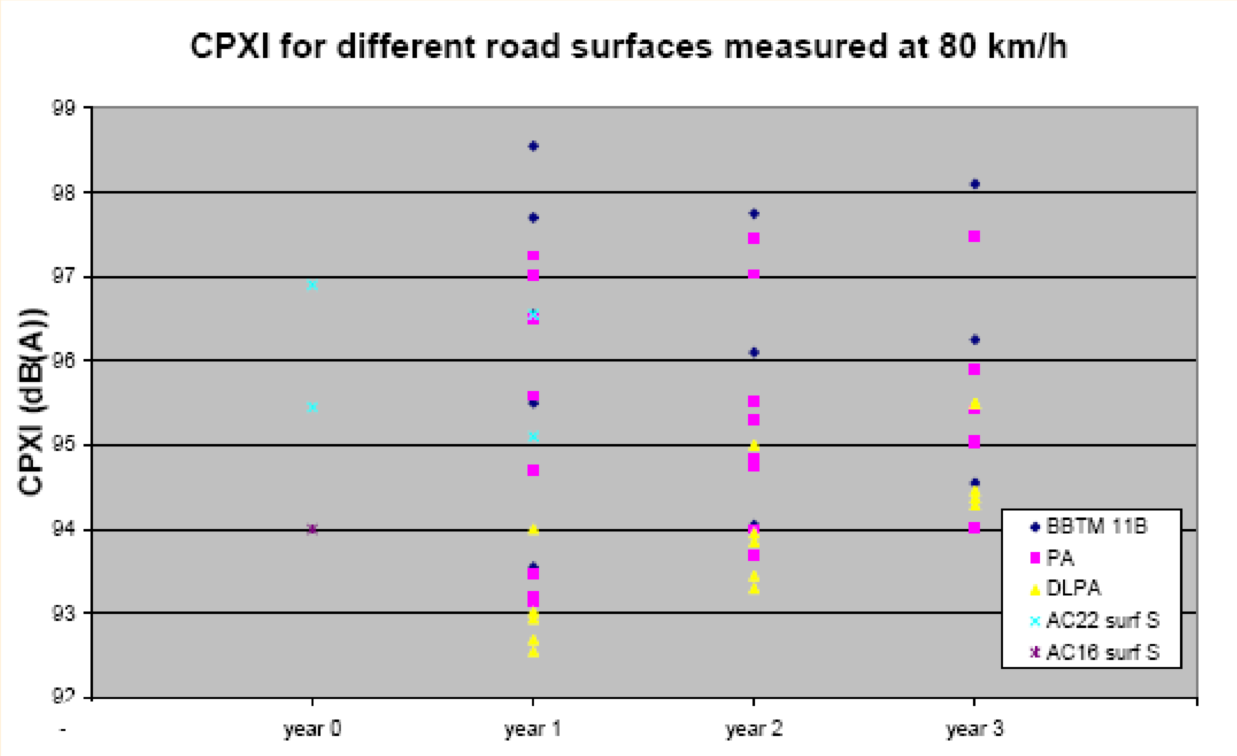
Porous Asphalt.

Double Layer Porous Asphalt.

OVERALL RESULTS (I)



OVERALL RESULTS (II)



OVERALL RESULTS (III)

Great variability!

Large differences in CPXI for the same road surface type

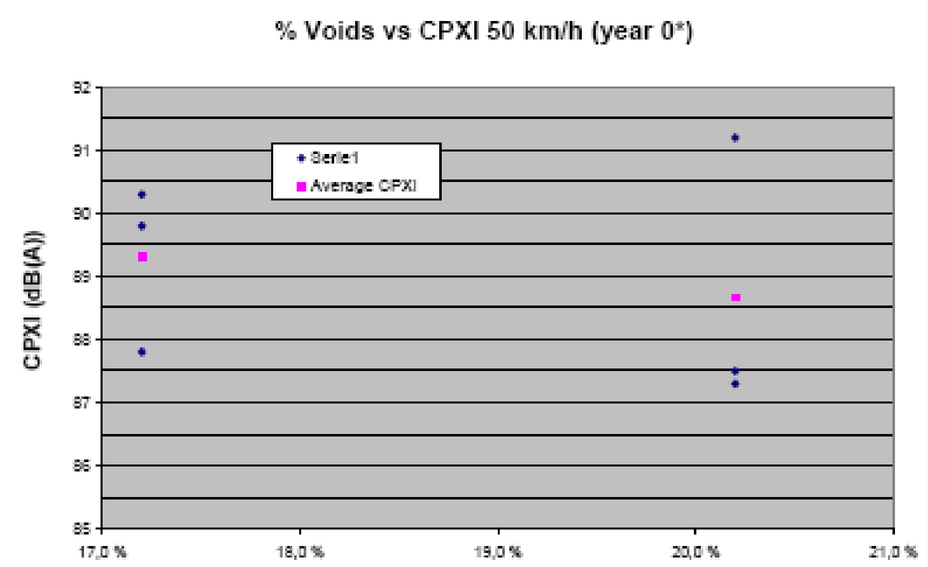
↓

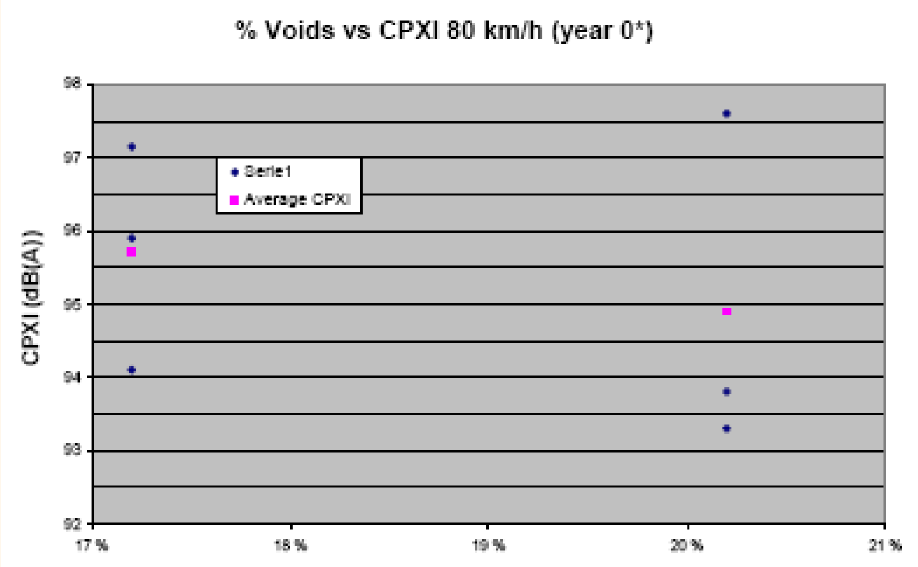
Analysis of factors that may influence tyre-road noise

POROUS ASPHALT (PA)

- Sites 1, 4 and 5
- Voids content: from 17,2 to 20,2%
- Layer thickness: from 3,0 to 4,0 cm
- Maximum aggreggate size: 5 to 11 mm
- Age of the layers: from 0 to 3 years old

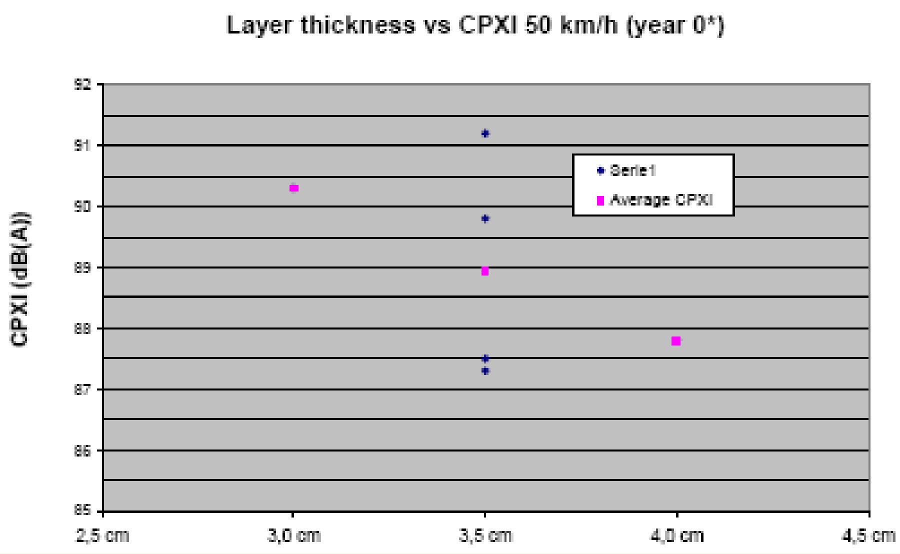
PA– VOIDS CONTENT

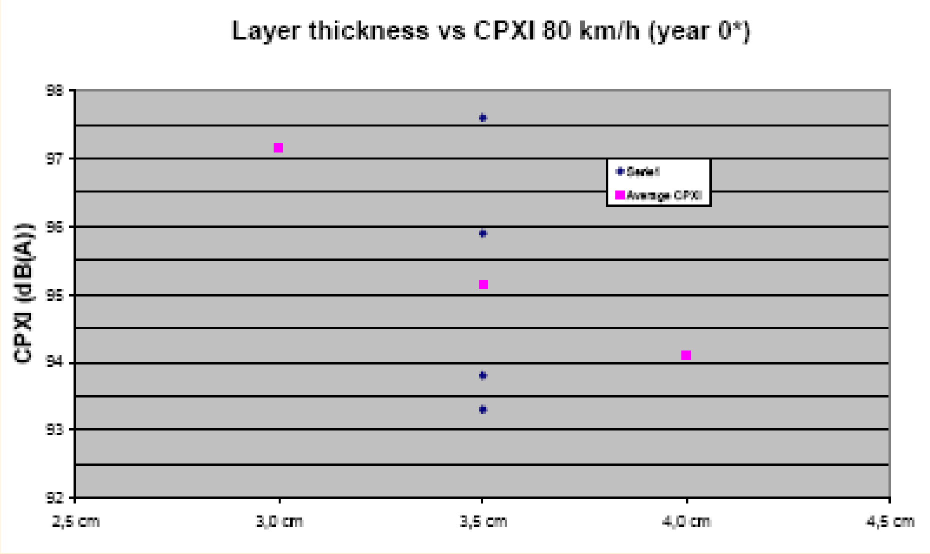




- More voids contribute in reducing noise generation, although not all results are consistent

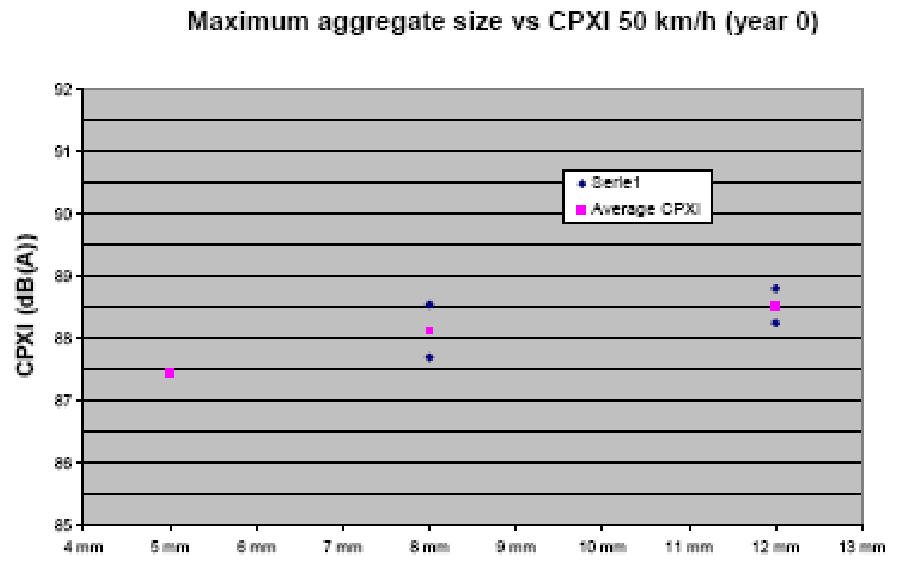
PA– LAYER THICKNESS

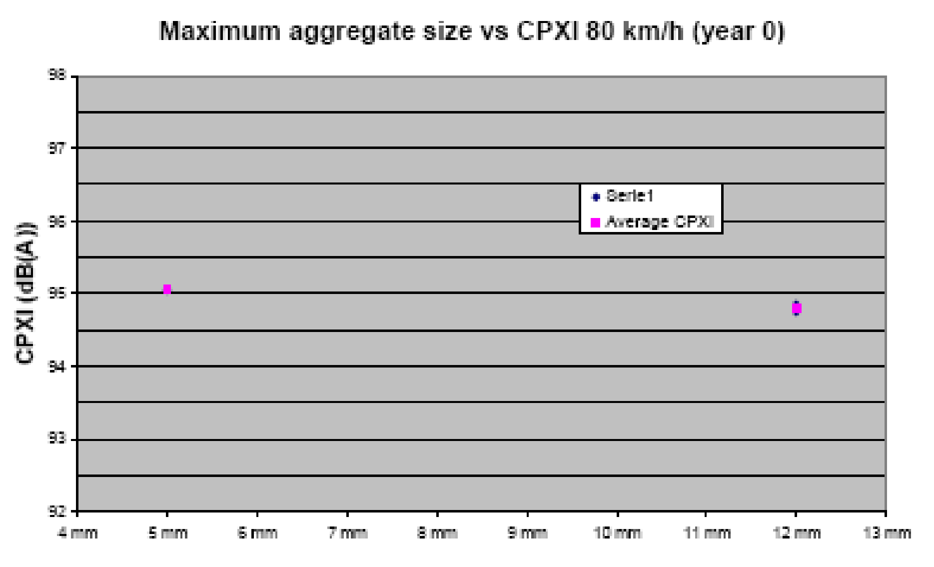




- When the PA layer is thicker, the average CPXI obtained is lower

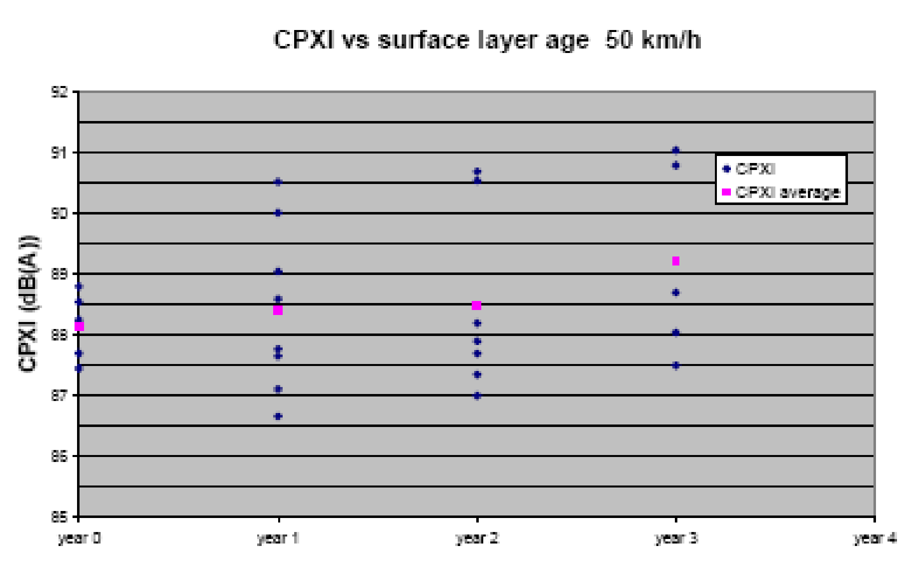
PA–AGGREGATE SIZE

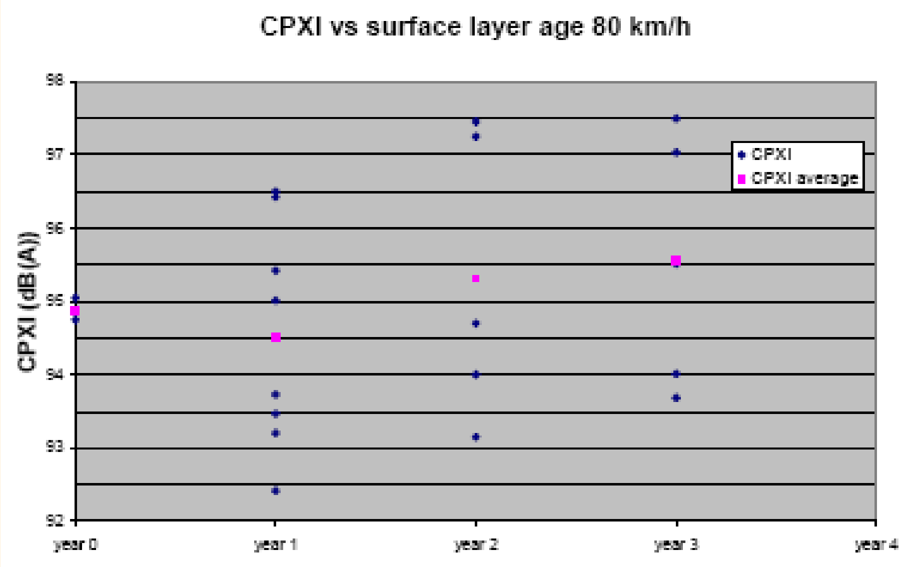




- **Larger maximum aggregate sizes result in higher average CPXI values**

PA–TIME EVOLUTION



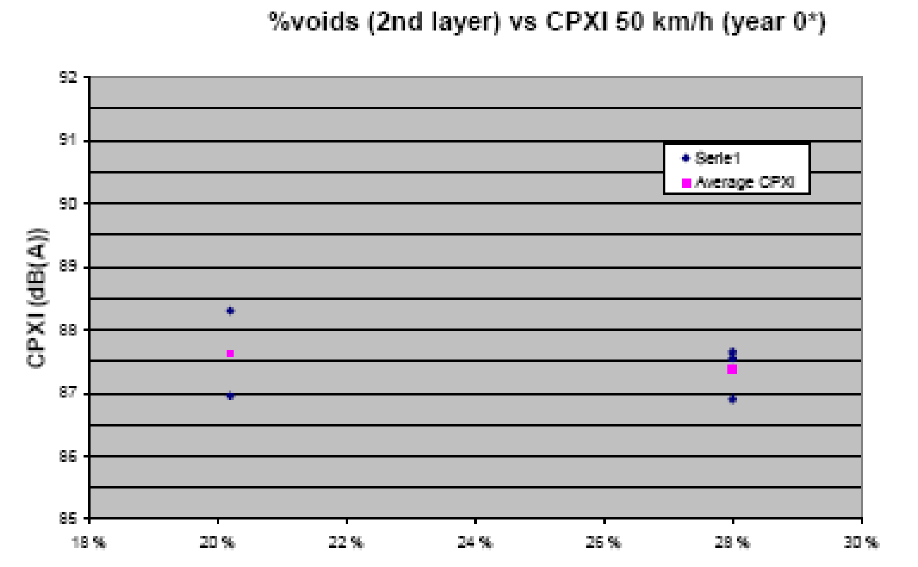


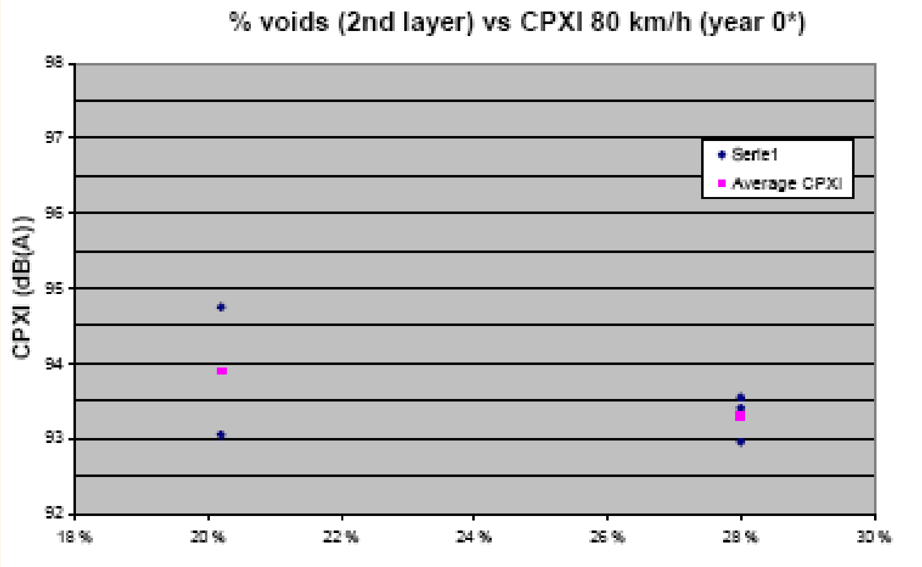
- **CPXI increases with the age of the surface layer**

DOUBLE LAYER POROUS ASPHALT (DLPA)

- **Sites 1, 4 and 5**
- **Voids content (2nd layer): from 20,2 to 28,0%**
- **Voids content (1st layer): 20,0%**
- **Total layer thickness: from 6,5 to 7,0 cm**
- **Maximum aggreggate size: from 8 to 11 mm**
- **Age of the layers: from 0 to 3 years old**

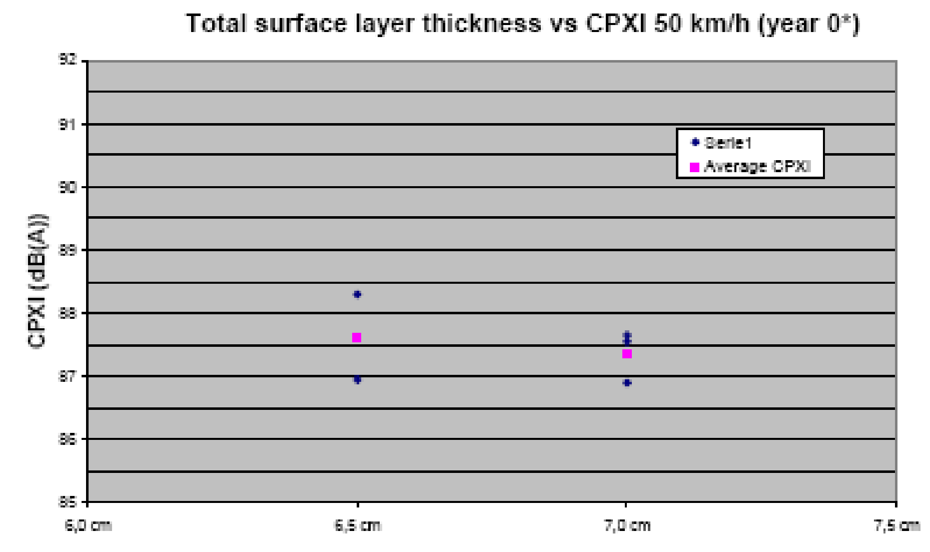
DLPA – VOIDS CONTENT (2ND LAYER)

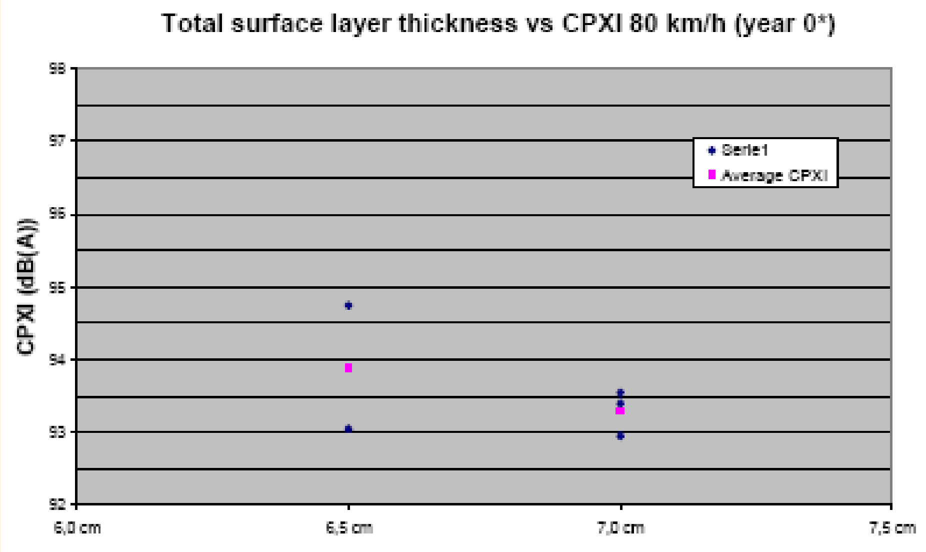




- Not very big differences

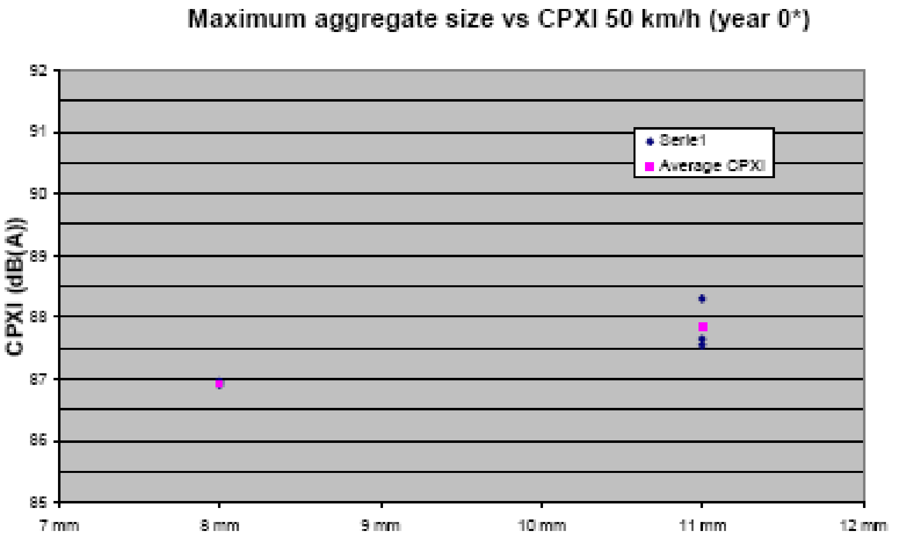
DLPA– LAYER THICKNESS

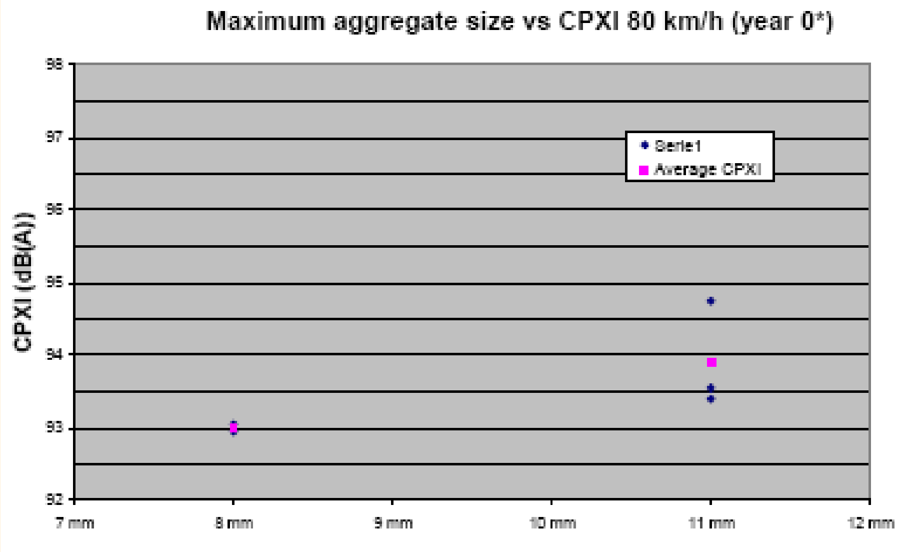




- **DLPA 7 cm is less noisy than 6,5 cm, being the difference bigger at 80 km/h**

DLPA–AGGREGATE SIZE

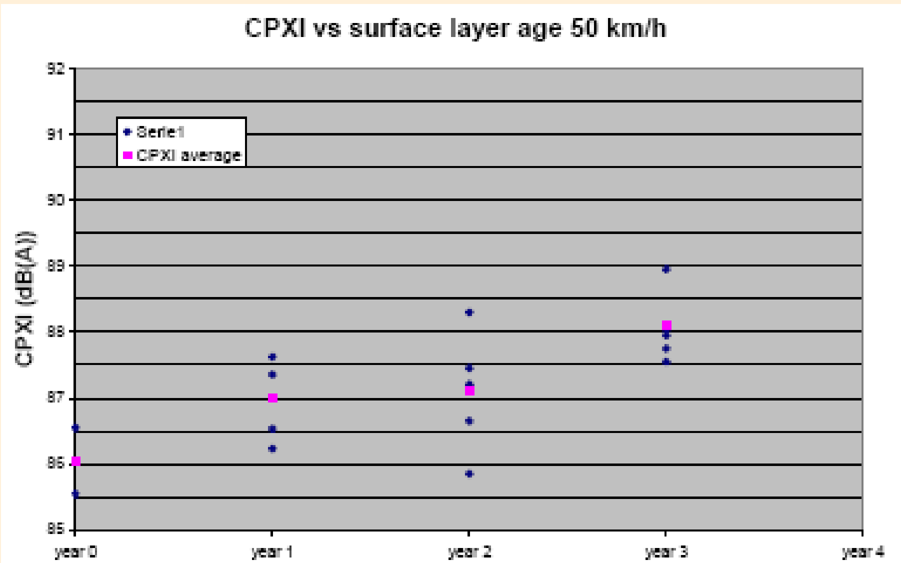


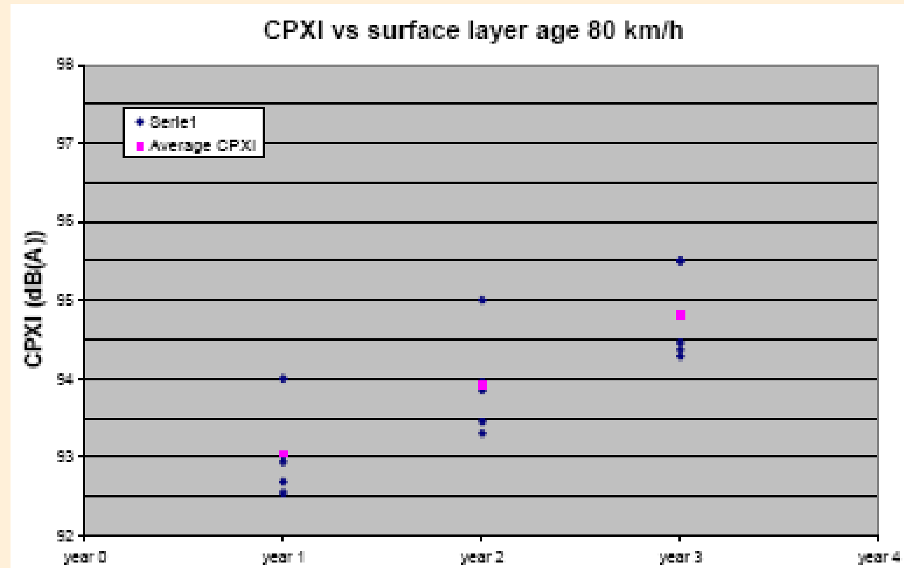


- **Larger maximum aggregate sizes generate higher sound pressure levels**

**** Results obtained in sections with a maximum aggregate size of 5 mm were higher than expected***

DLPA– TIME EVOLUTION



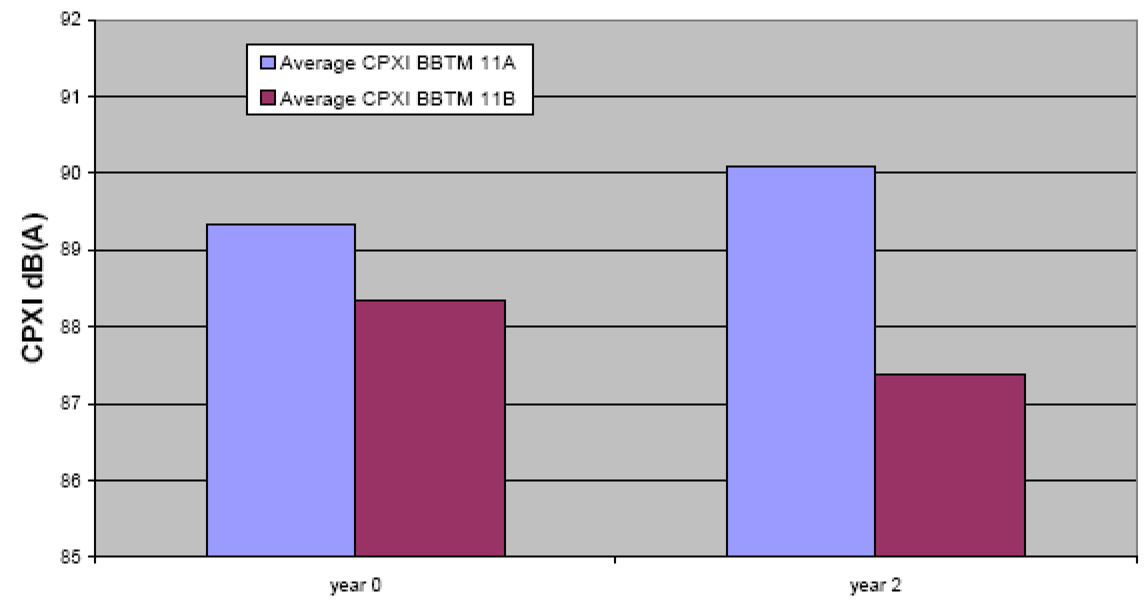


- **It was measured an average increment of 1,0 dB(A) per year, both at 50 and 80 km/h**

THIN LAYERS (BBTM)

- **BBTM 11A and BBTM 11B**
- **Sites 5 and 6**
- **Only CPXI 50 km/h**
- **Voids content (BBTM 11A): 7,0%**
- **Voids content (BBTM 11B): 18,0%**
- **Age of the layers: 0 and 2 years old**

BBTM – VOIDS CONTENT

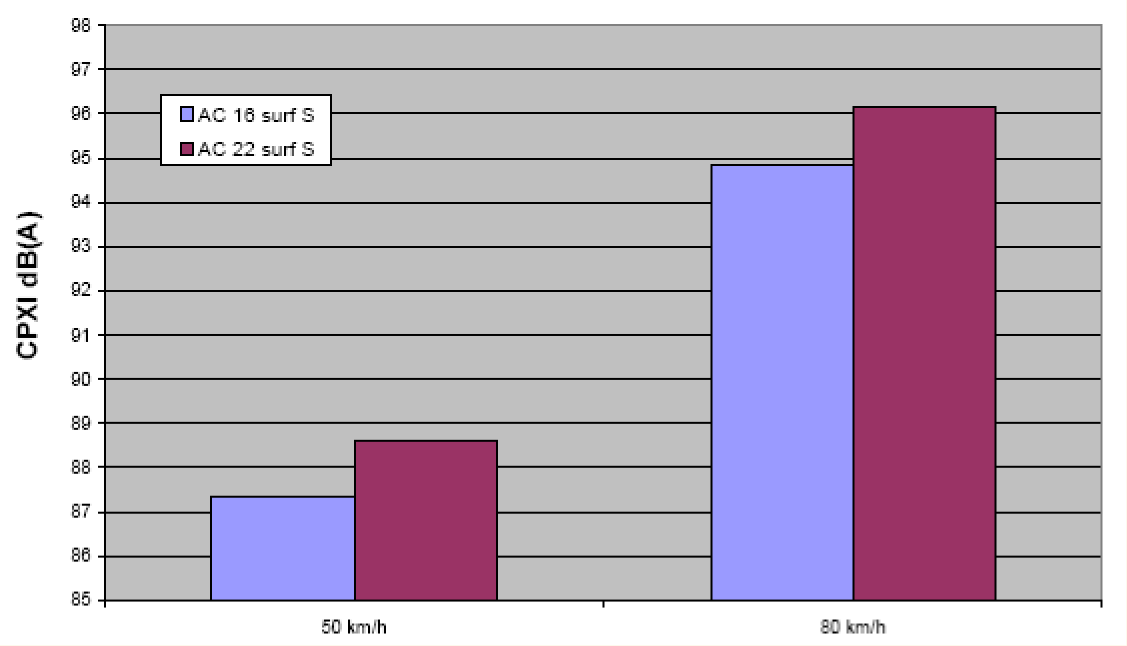


- BBTM 11B (more voids) are less noisy than BBTM 11A
- BBTM 11B CPXI in year 2 was 1,0 dB(A) lower that in year 0. Maybe due to temperature differences during measurements!!!!

ASPHALT CONCRETE (AC)

- **AC16 surf S and AC22 surf S**
- **Sites 3 and 4**
- **Maximum aggregate size (AC16 surf S): 16 mm**
- **Maximum aggregate size (AC22 surf S): 22 mm**
- **Age of the layers: 0 years old**

AC– MAXIMUM AGGREGATE SIZE

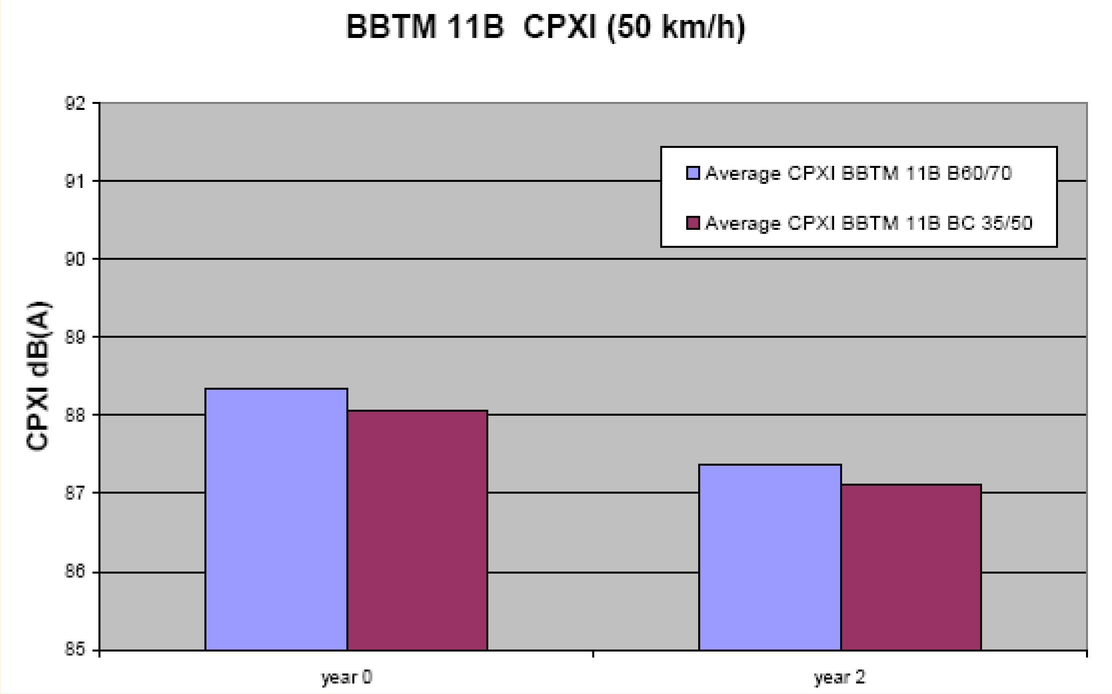


- **AC16 surf S sections (smaller maximum aggregate size) are less noisy than AC22 surf S**

TYPE OF BINDER (I)

- **Crumb rubber improved bitumen (BC 35/50) vs conventional bitumen (B 60/70)**
- **BBTM 11B**
  - ✓ **V=18,5%**
  - ✓ **Thickness of the layer: 4 cm)**
- **Site 6**
- **50 km/h**
- **Age of the layers: 0 and 2 years old**

TYPE OF BINDER (II)

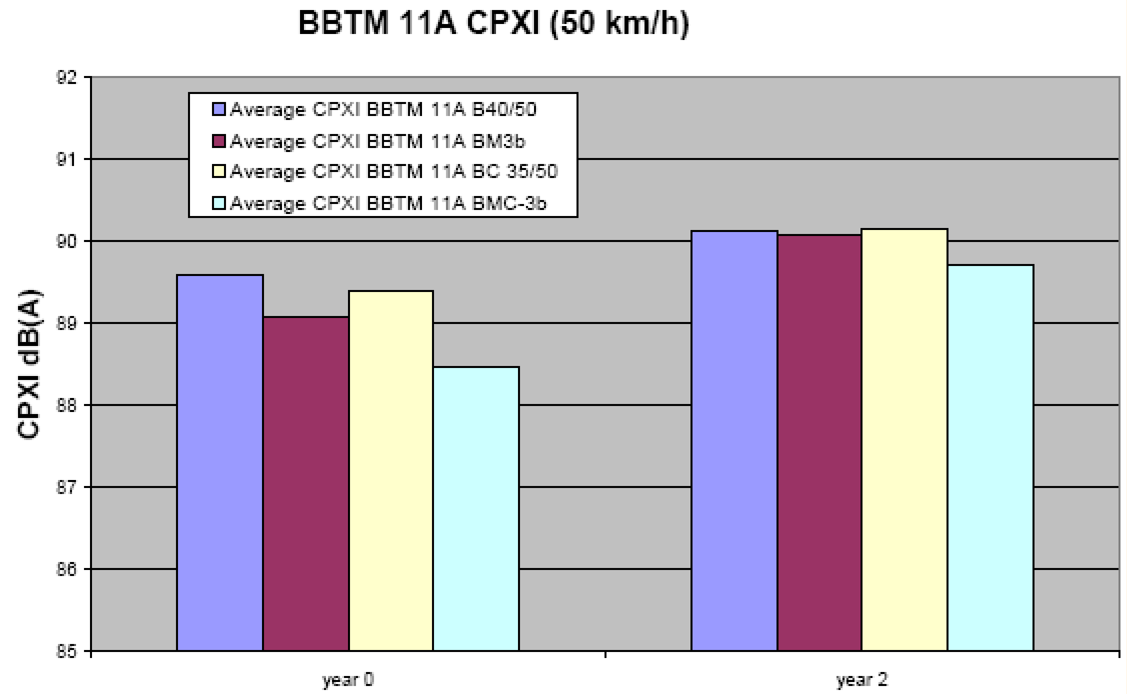


- Sound pressure levels are similar on both surfaces

TYPE OF BINDER (III)

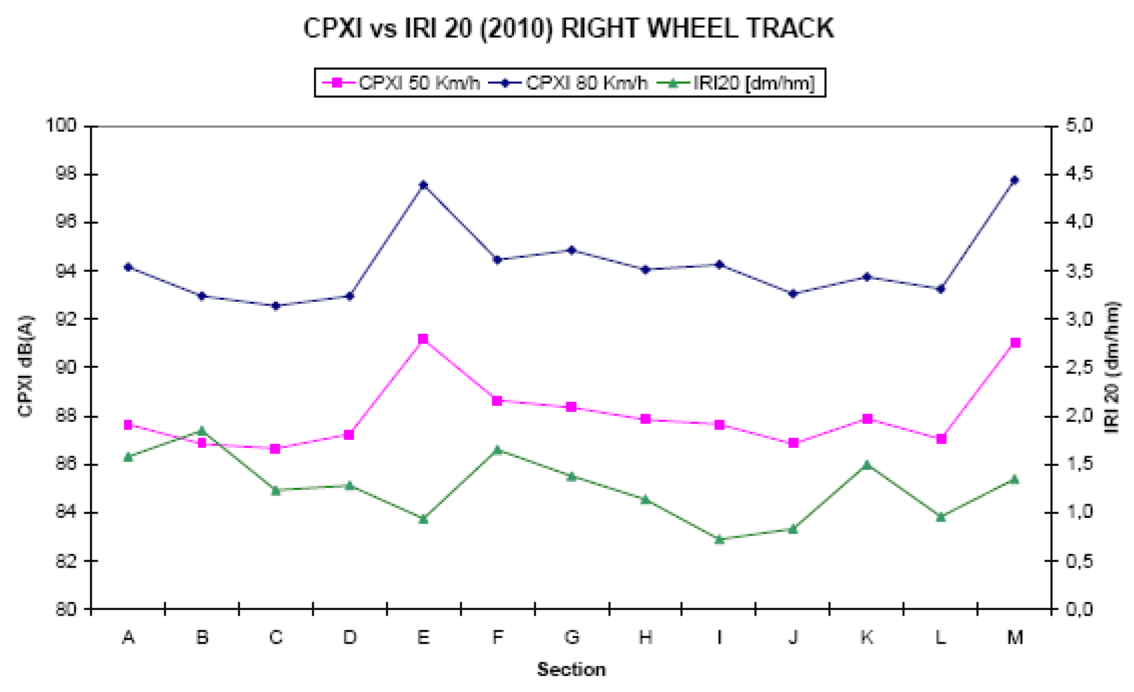
- Influence of polymer bitumen
- BBTM 11A (BC 35/50)
  - ✓ V=7,2% and thickness of the layer: 2,6 cm
- BBTM 11A (B 40/50, BM3b, BMC3b)
  - ✓ V=7,0% and thickness of the layer: 3,1 cm
- Site 5
- 50 km/h
- Age of the layers: 0 and 2 years old

TYPE OF BINDER (IV)



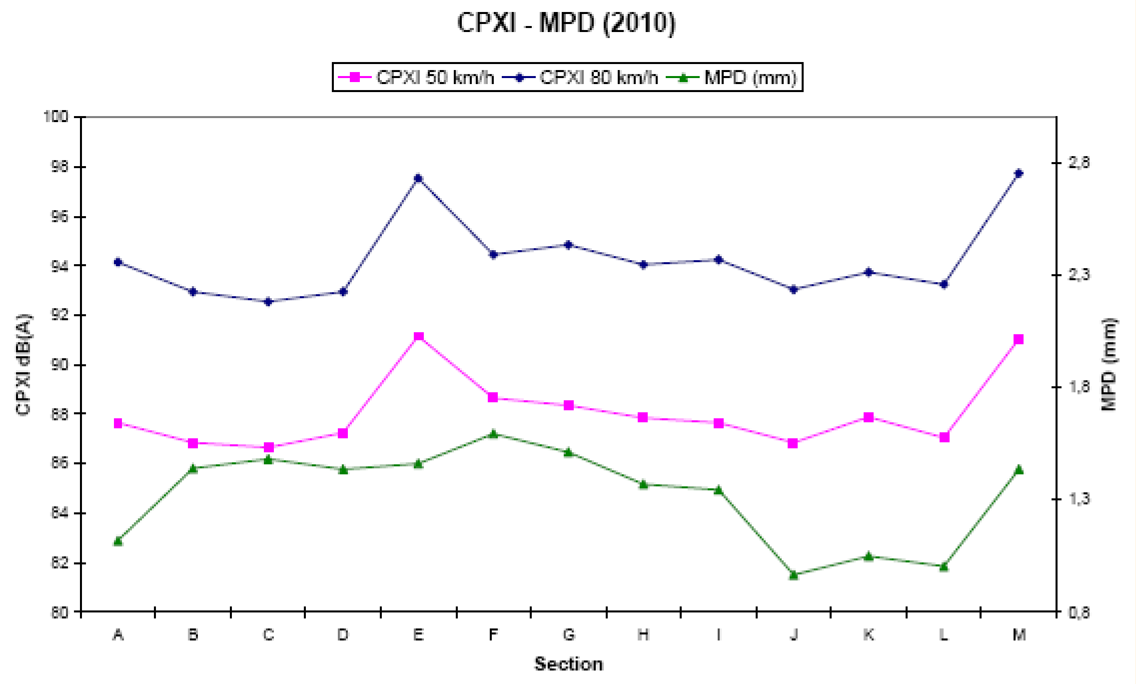
- **Small noise reducing effect of surfaces with crumb rubber (more important in the beginning)**

UNEVENNESS (IRI 20)



- In all cases R^2 is under 0,05

MACROTEXTURE (MPD)



- Partial relationship between noise and macrotexture (R^2 under 0,4)

CONCLUSIONS (I)

- **CPX measurements in different types of road surfaces (PA, DLPA, BBTM, AC)**
- **Influence of surface layer characteristics**
  - ✓ **Voids content**
  - ✓ **Layer thickness**
  - ✓ **Maximum aggregate size**
  - ✓ **Age**
  - ✓ **Type of binder**
  - ✓ **Unevenness and macrotexture**

CONCLUSIONS (II)

- **Very big variability in the results (up to 4,5 dB(A) for the same road surface)**
- **Therefore, surface layer characteristics have to be taken into account!**
  - ✓ **Higher voids percentage**
  - ✓ **Smaller max aggregate size**
  - ✓ **Thickness (PA and DLPA)**

CONCLUSIONS (III)

- **Some concerns…**
  - ✓ **Influence of temperature**
  - ✓ **Use of crumb rubber modified bitumen**
  - ✓ **CPXI partial relationship with macrotexture**

All these considerations should be taken into account when designing low noise road surfaces!!!

Thank you very much for your attention!!!!

It will be a pleasure to answer any questions

Laura PARRA, CEDEX (Spain)