Road auscultation and condition assessment

ANNE BEELDENS

AB-ROADS

14/10/2020

Road auscultation and condition assessment

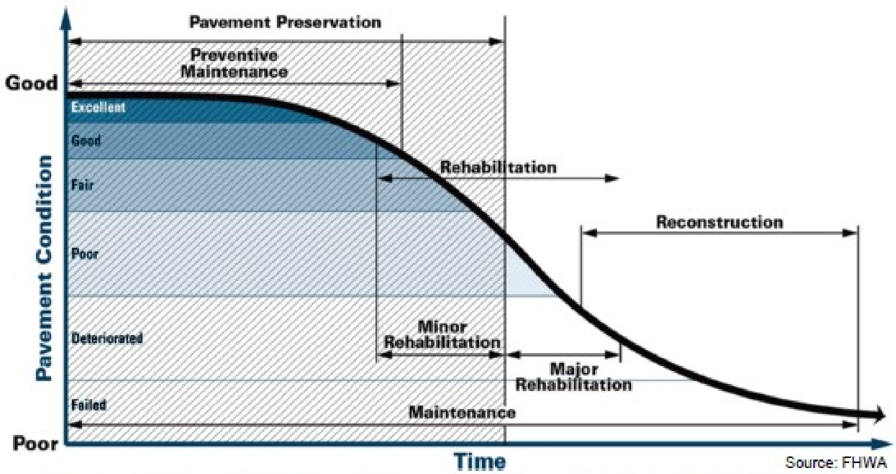


Figure 1-1. Pavement preservation activities and pavement condition (Smith et al. 2014).

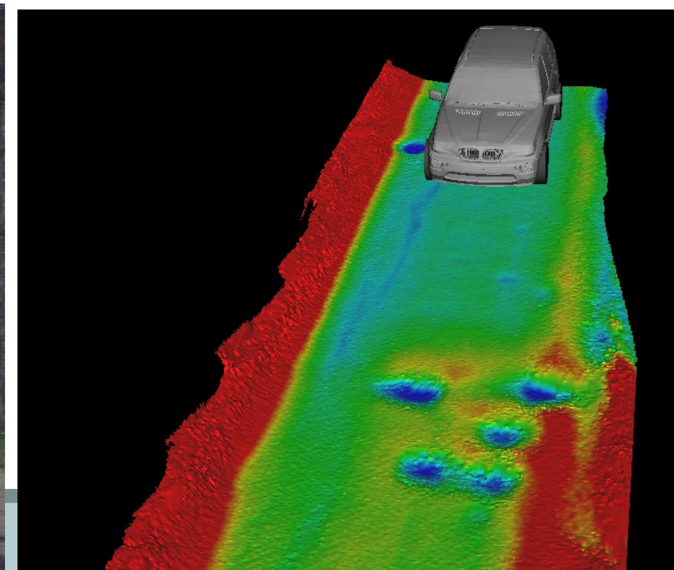
- Acceptance of new roads
- Monitoring of existing roads

=> Pavement management system

- Determination of residual life time

=> end-of-life strategy

Assessment of the condition of the pavement – non-destructive testing techniques

Evaluation of existing concrete pavements

- Evaluating structural adequacy: ability to withstand repeated structural loading

- Assessing the durability of the pavement materials: ability to withstand environmental deterioration

- Assessing the functional adequacy of the pavement
  - Smoothness
  - Noise
  - Skid resistance…

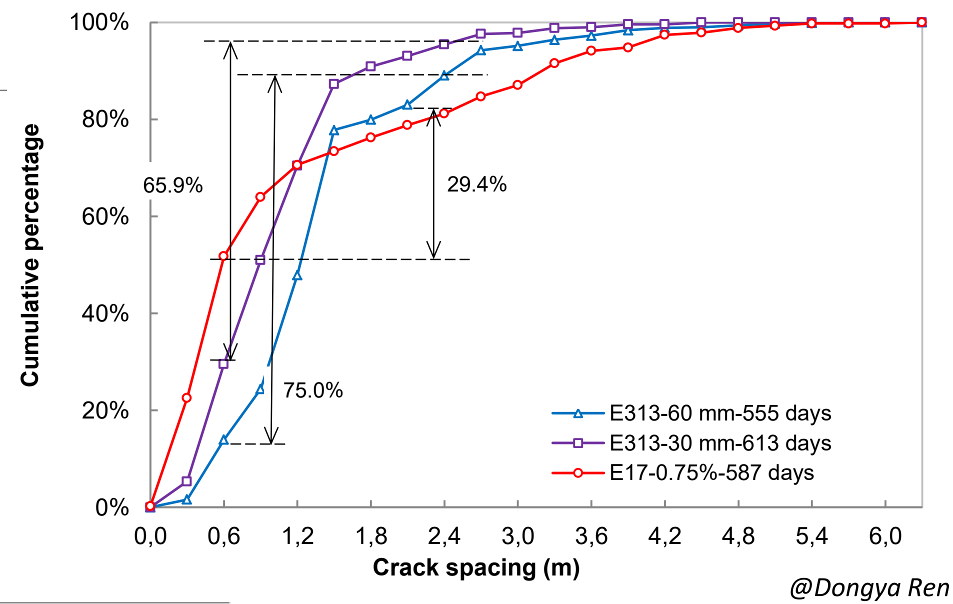
Structural adequacy of the pavement structure CORE DRILLLING!

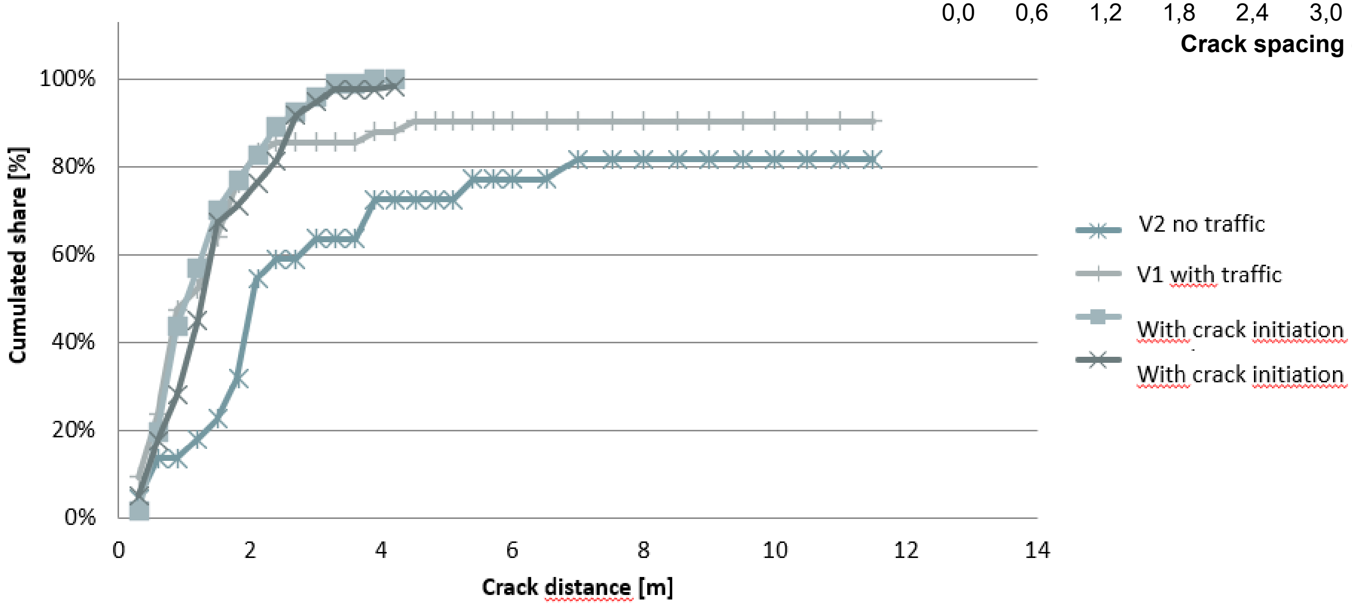
- Layer thicknesses
- Layer strength and stiffness
- Degree and uniformity of support
- Joint load transfer efficiency

EVALUATION METHODS

- Core drilling: structure from (sub)base layer to pavement – thickness, strength and stiffness
- Visual evaluation: cracks, faulting, scaling, curling
- Georadar/ultrasonic tomography
- Faulting/joint load transfer: faultimeter or falling weight
- Smoothness

CRCP: crack distance – Transverse crack: clustering? Large crack distances?





CRCP: crack width (?)

≤ 0,4 mm to 0,5 mm

At which height?

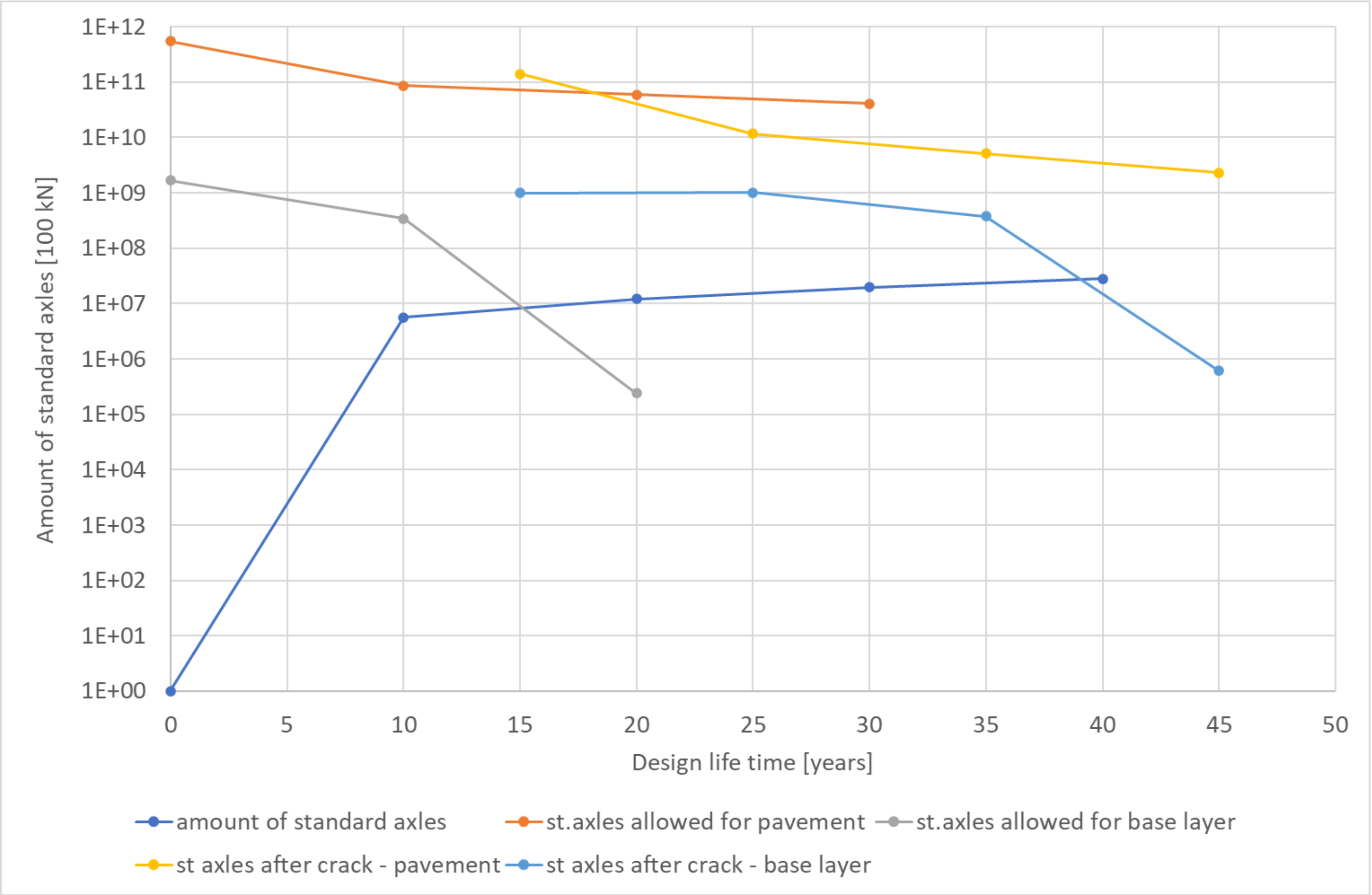
How to measure at the surface, especially with exposed aggregate surface?

=> design parameter but not a valid parameter for on site evaluation

Evaluation of results of core drilling - CRCP

200 mm CRCP – 60 mm asphalt interlayer – 250 mm lean concrete – 200 mm coarse sand – 300 mm fine sand
Construction: 2003 CRCP and ABT, lean concrete: 2003 or older…

Theoretical calculation: amount of standard axles present versus allowed



Example: E40, constructed in 1971-1972, overlayed in 2007, core drilled in September 2020

Degradation: erosion + locally fatigue (or quality) of base layer

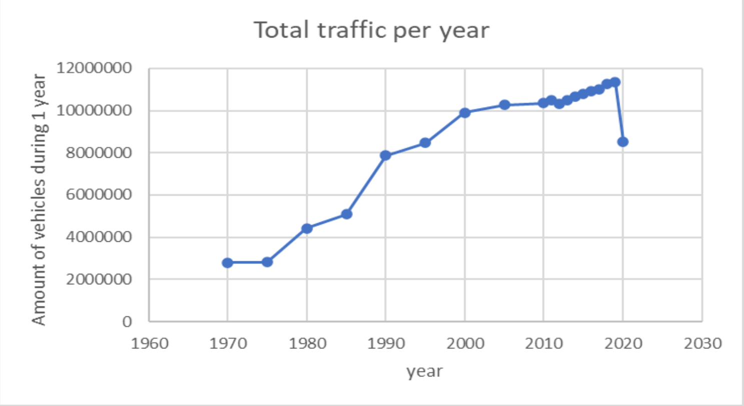
Quality of base layer!

Design of E40 : > 50 years of design life time

- 230 mm CRCP (0,85% reinf.), 40 mm asphalt interlayer, 230 mm lean concrete, 200 mm cement stabilised sand

- constructed: 1969-1972

- traffic over 50 years: $120*10^6$ standard axles ($121 * 10^6$ vehicles) +/- 40,000 vehicles per week day



- calculation:

no cracks after 50 years with

Concrete strength of 62,5 MPa

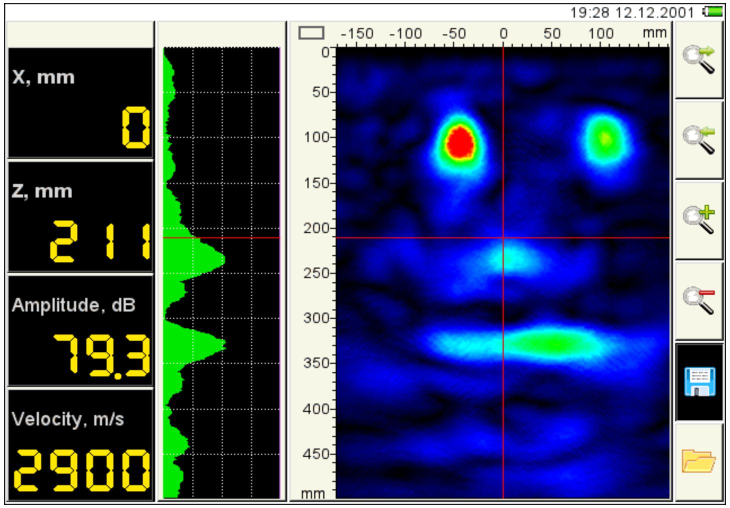
Lean concrete bending strength of 1,2 MPa

With strength of 1,15 MPa: crack in base layer after 42 years

Reality: erosion of surface of base layer + at some places with low density: crack

NDT – thickness/reinforcement

In the concrete pavement: ultrasonic tomograph

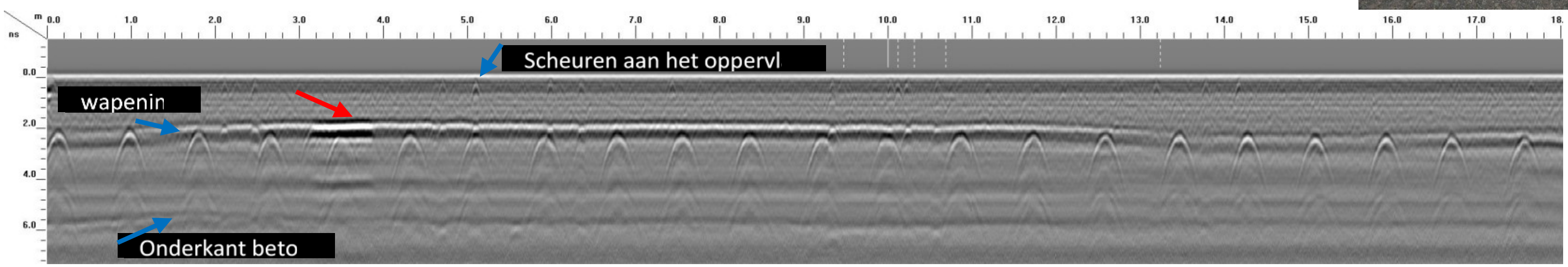


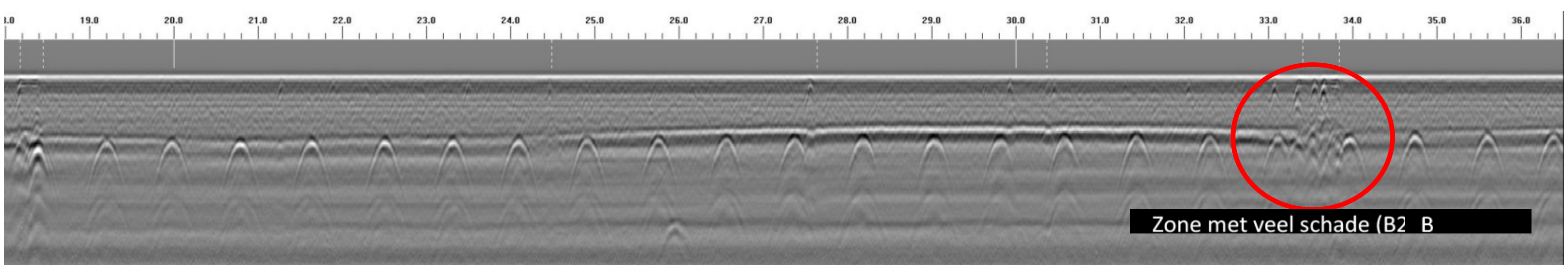
Opzoekingscentrum voor de Wegenbouw
Uw partner voor duurzame wegen

NDT – thickness/reinforcement

Over the whole structure: georadar

Opzoekingscentrum voor de Wegenbouw
Uw partner voor duurzame wegen





Crack formation – joint layout!

JPCP - Curling due to temperature differences or moisture differences or internal curling

Vibrations due to curling?

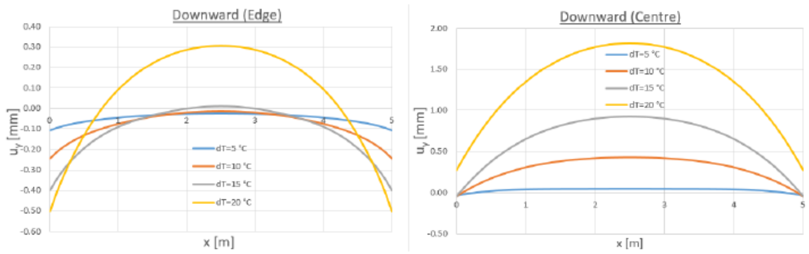


FIGURE 3.11: Downward curling.

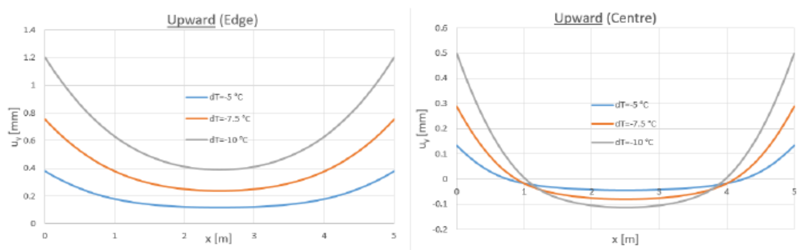


FIGURE 3.12: Upward curling.

Importance of dowels and asphalt interlayer in order to prevent curling

New constructed JPCP without dowels on a cement treated base or subbase layer in a town centre

=> complaints of vibrations

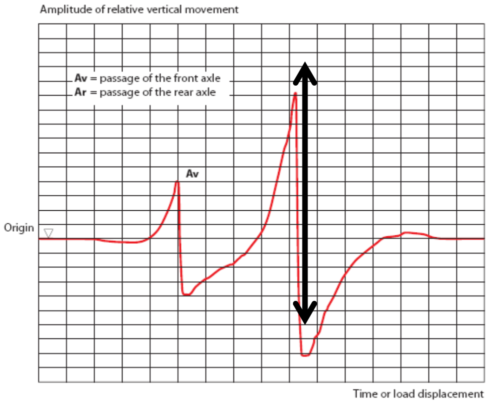
Measurement of faulting of slabs and measuring of vibrations in houses, results strongly depend on type of foundations of houses

Faulting – slab movement

Measurement of the faulting during the passage of a truck with 11 ton axle load

- Evaluation of the relative movement of adjacent plates
- Determination of the need of stabilisation prior to overlay
- Result is temperature dependent: by preference in autumn

Limit 0,4-0,7 mm

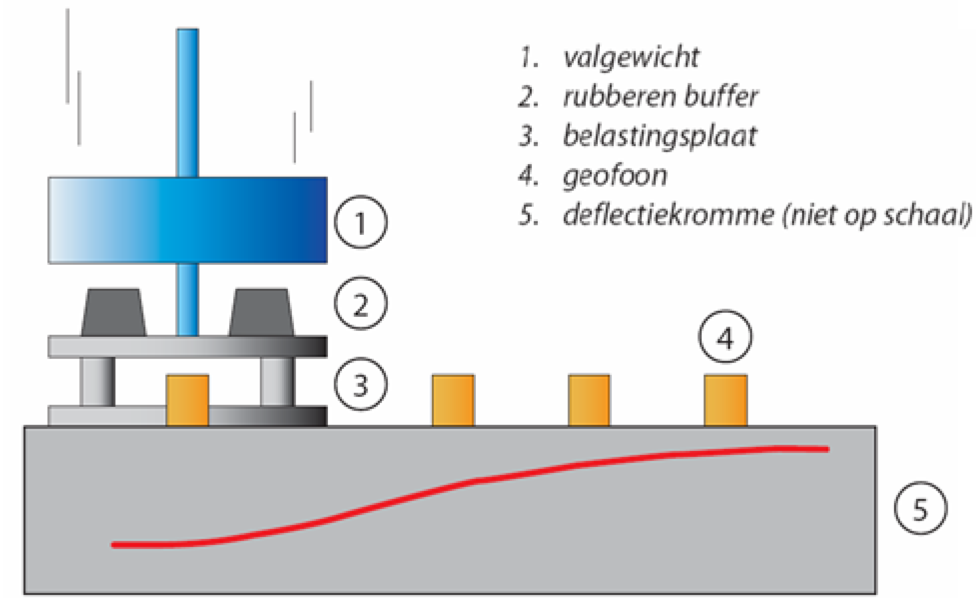


Falling weight deflectometer (FWD) – bearing capacity and load transfer

Static

Non-destructive

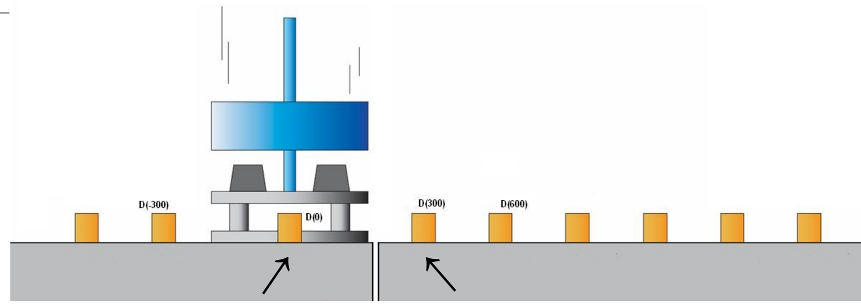
Deflection



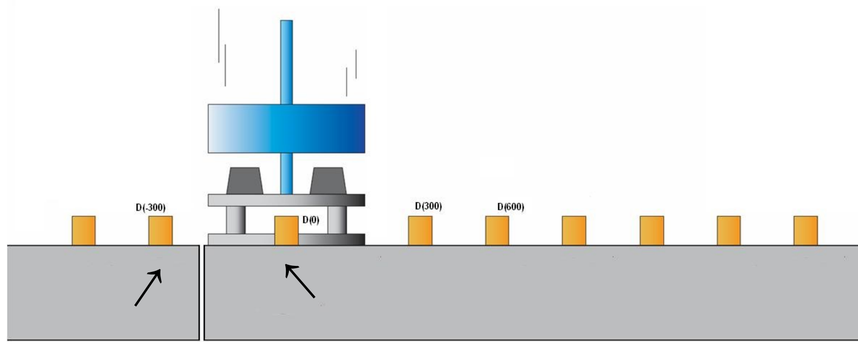
Load Transfer Efficiency at joints

$$LTE_{na} = D_{unloaded}(-300) / D_{loaded}(0) \cdot 100\%$$

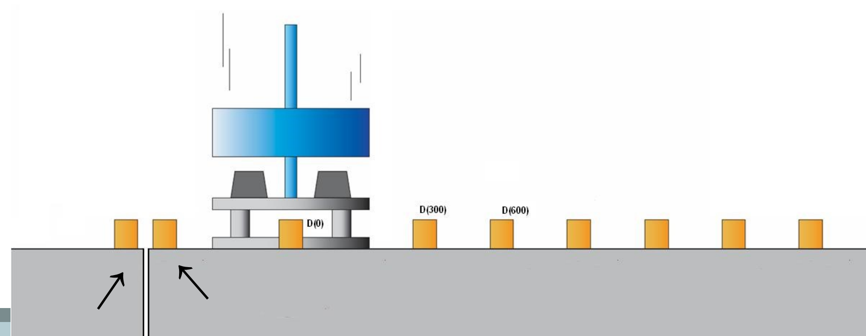
FWD with 40 kN:



Prior to the joint:



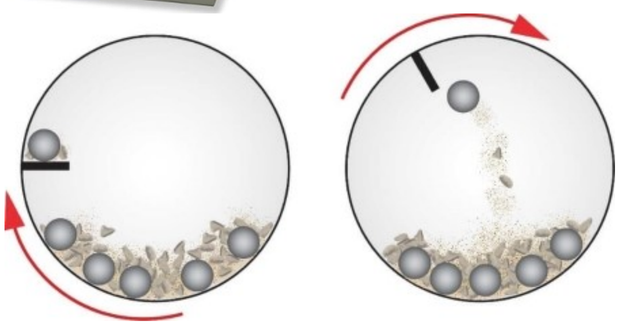
After the joint:



Curviameter: with traffic

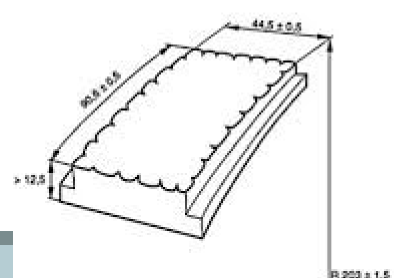
Falling weight deflectometer

Durability of the pavement materials – concrete composition



Raw materials – aggregates

- Los Angeles coefficient: resistance to abrasion
- Micro-Deval: resistance to abrasion in the presence of water
- PSV: polished stone value
- Frost resistance!



No frost resistant aggregates: pop-outs

Physical and mechanical properties of concrete

- Properties of the fresh concrete: air content

- mechanical properties of the hardened concrete: laboratorium ≠ on site conditions: influence of temperature and humidity

- resistance to scalling due to freeze-thaw cycles in the presence of de-icing salts
  - Importance of air content
  - Each test method has its own (very important) parameters, e.g. type of salt, type of cycles and by consequence its own limits!

Resistance to scaling due to freeze-thaw cycles

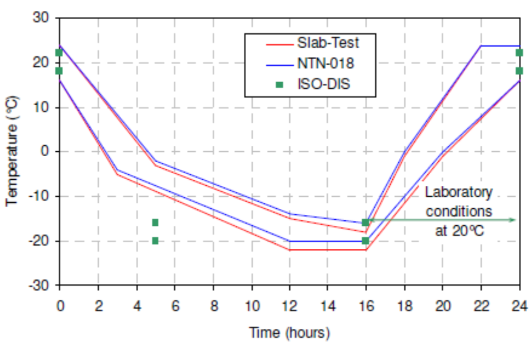
Testing of concrete on drilled cores

Test methods for freeze/thaw resistance CEN/TS 12390-9 and ISO-DIS 4846-2

Limits for Belgian applications

ISO-DIS: 5 to 10 g/dm²

SLAB-test: 1,5 to 3 kg/m²



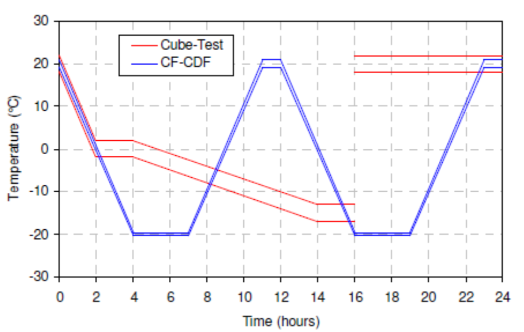


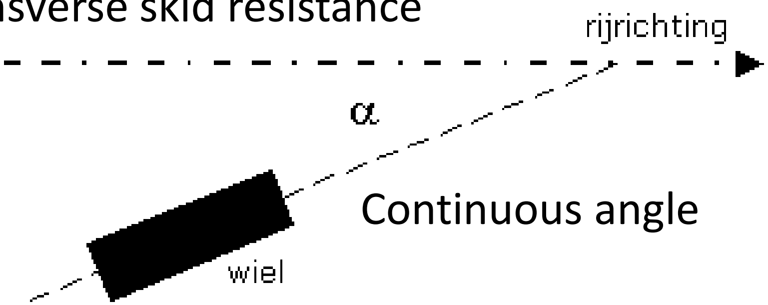
Table 2: Preparation of the samples

Test method	Surface in contact with electrolyte	Pre-treatment	Example
Slab-test	Upper surface	7D under water at 20°C + 21 D at 20°C and 65% R.H.	
NTN-018	Upper surface	7D under water at 20°C + 21 D at 20°C and 65% R.H.	
Cube-test	Every surface	7D under water at 20°C + 21 D at 20°C and 65% R.H.	
CDF	Lower surface	7D under water at 20°C + 21 D at 20°C and 65% R.H.	
ISO-DIS	Upper surface	14 D under water at 20°C + 14 D at 20°C and 65% R.H.	

ROADS

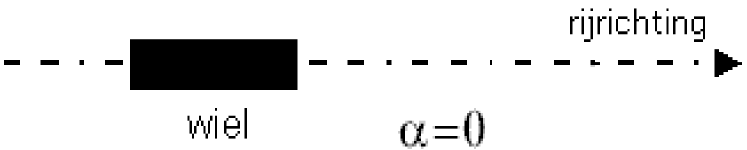
Functional adequacy – skid resistance – scrim – odoliograph …

Transverse skid resistance



Continuous angle

Transverse skid resistance



Blocked wheel

Skid resistance – measuring method

Type of tyre:
- SCRIM: 3,00” x 20
- odoliographe: PIARC band 165 x 15

Vertical force of:
- SCRIM: 1,9 kN
- Odoliographe: 2,7 kN

Wheel turned over 20°

Water film of 0,5 mm thick before the tyre:
- SCRIM: width 0,3 m
- odoliographe: width 0,6 m

Speed:
- SCRIM: 60 or 80 km/h
- Odoliographe: 50 or 80 km/h (65 km/h on air field)

Surface temperature between 5°C and 35°C

By preference not on rainy days

Griptester

SRT-pendulum

Texture depth

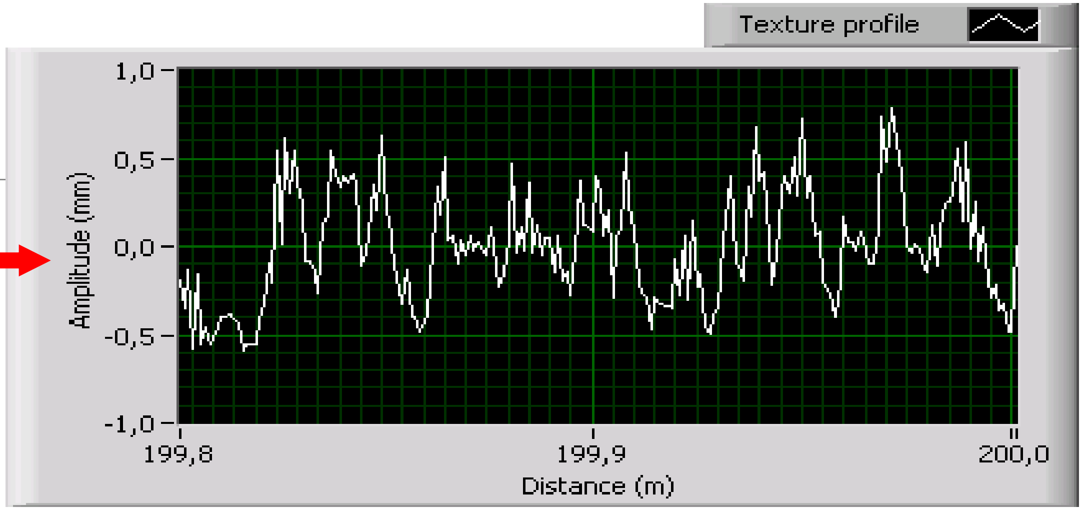
Texture is determined by the MPD (mean profile depth)

- MPD: 0,7/0,8 (two layered/one layered) to 1,5

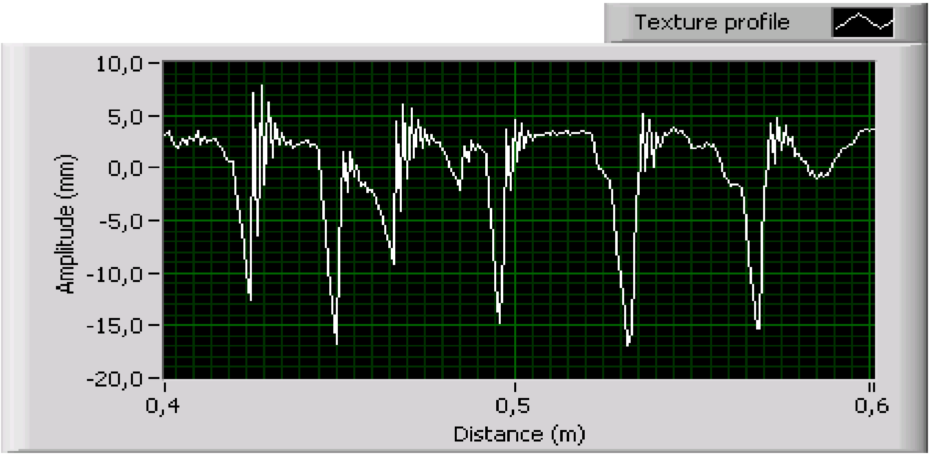
Laser profilometer

Sand patch test

Texture



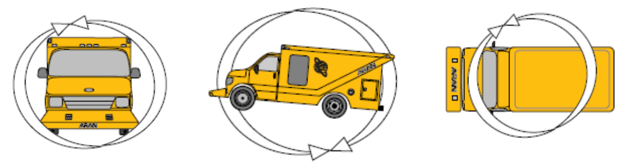
Exposed aggregate concrete 0/6

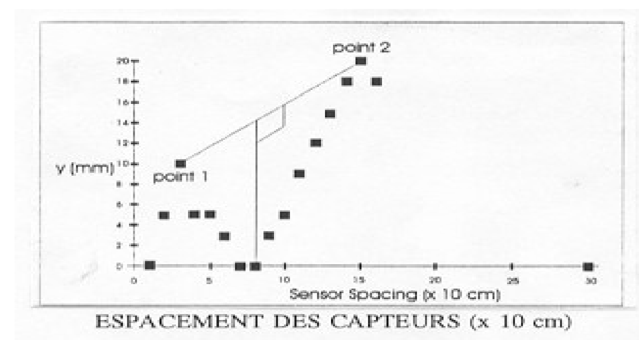


Porous concrete 0/14

Transverse evenness: measurement with ARAN (automatic road analyser)

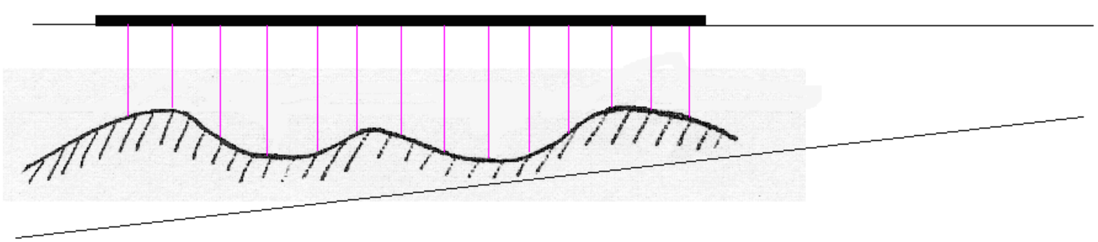
Gyroscopen: roll, pitch, yaw



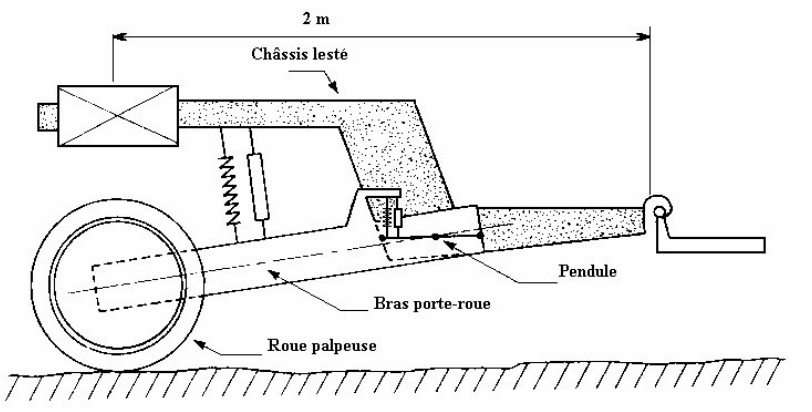


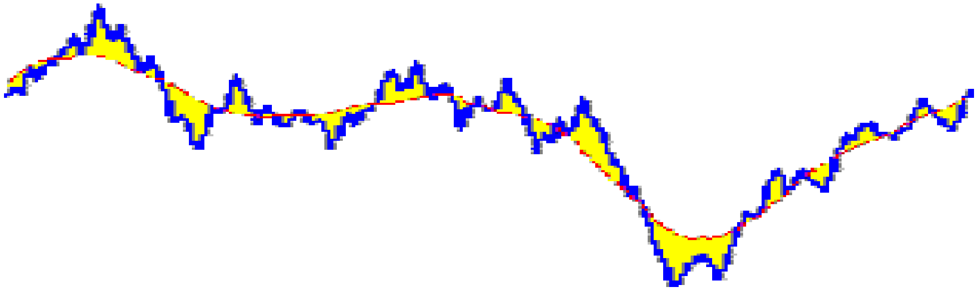
Water drainage!

No rutting on concrete pavements!



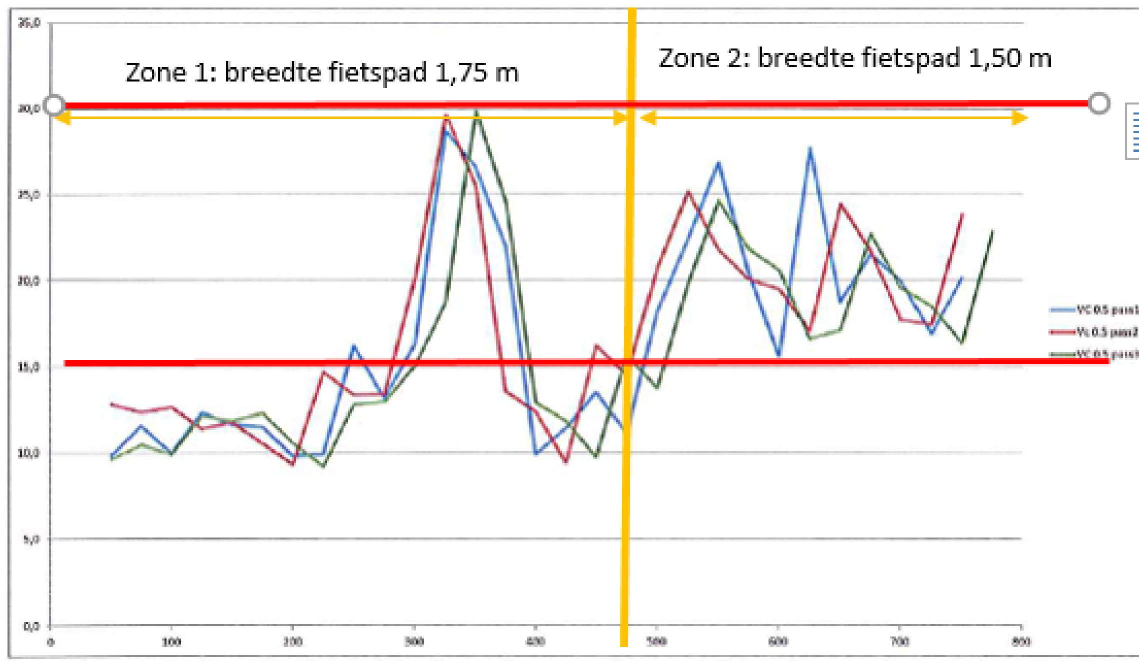
Longitudinal evenness – directly after the slipform paver or as condition assessment



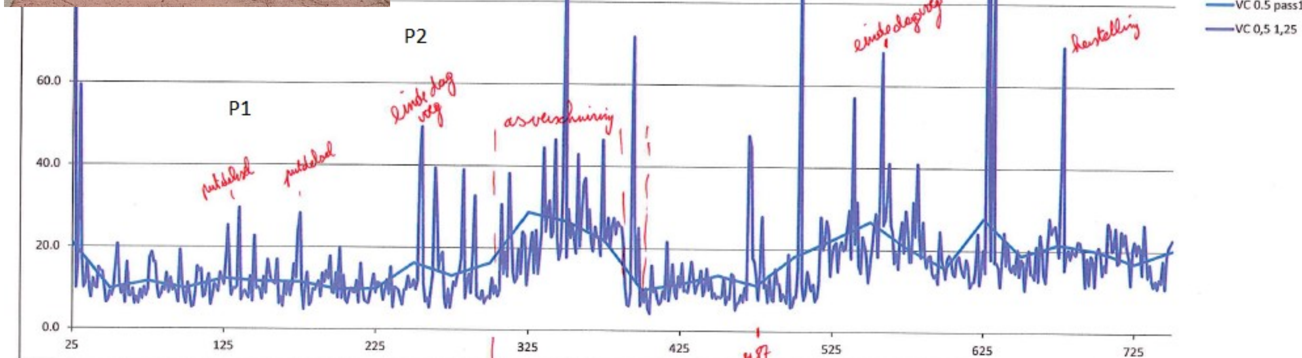


Evenness measurements (of bicycle lanes)

Measurement every 30 mm – reported over lengths of 25 m up to 100 m, wavelengths from 0,5m up to 40 m



Results are in relation with design, execution and measurement techniques



op 300m herstelvak door put.

P3

machinaal naar handmatig + einde dag voeg

P5

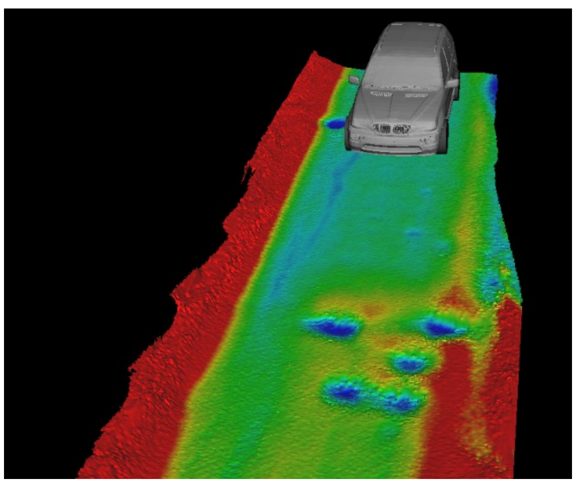
van 1,75m breedte naar 1,50m

→ daarom de rest van de sectie handmatig uitgevoerd!

bij handmatige verwerking worden de putten eerst geplaatst en werkt men rond de putten aan

→ daarom hogere pieken in 2e deel van de sectie

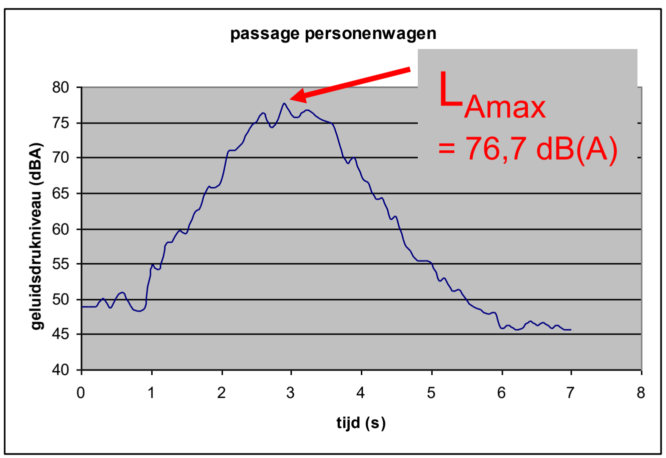
Other techniques for measuring evenness



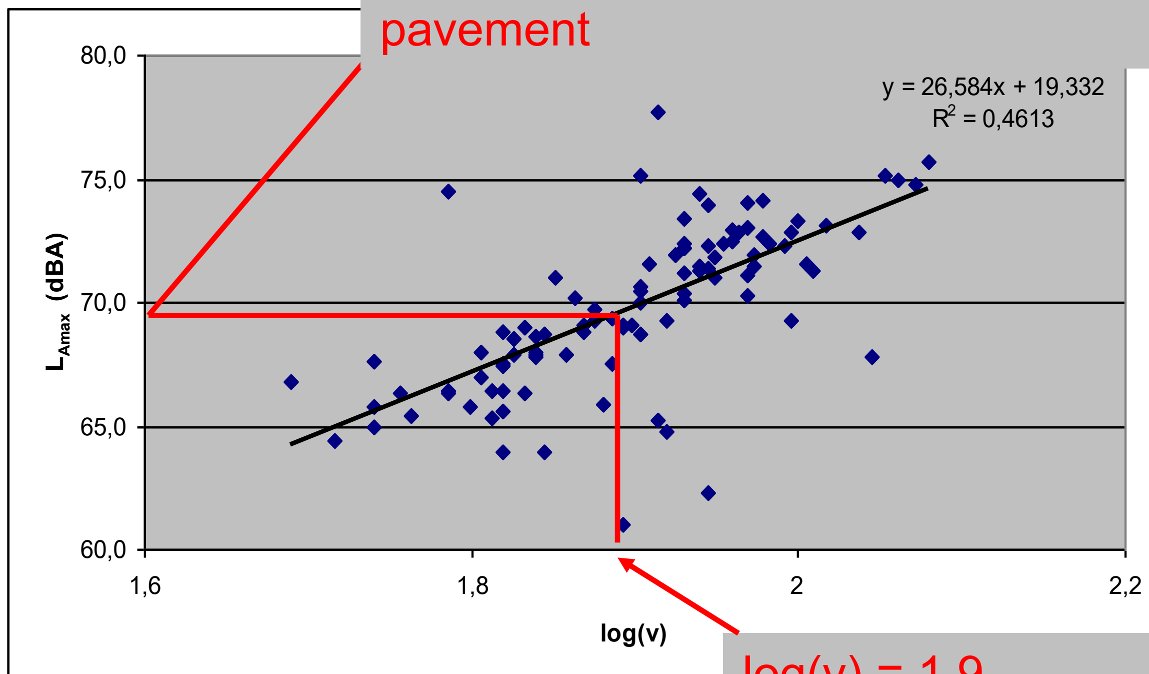
LIDAR: Laser Image Detection and Ranging

Real-time evenness measurements on slipform paver or directly after slipform paver

Noise level measurements: Statistical pass by measurement (ISO 11819-1)



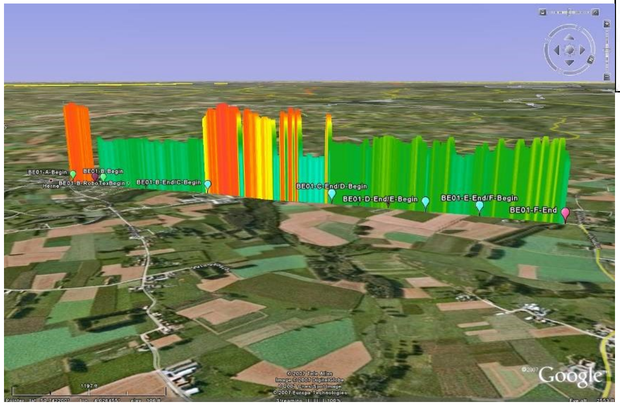
L_{Amax}
= 76,7 dB(A)

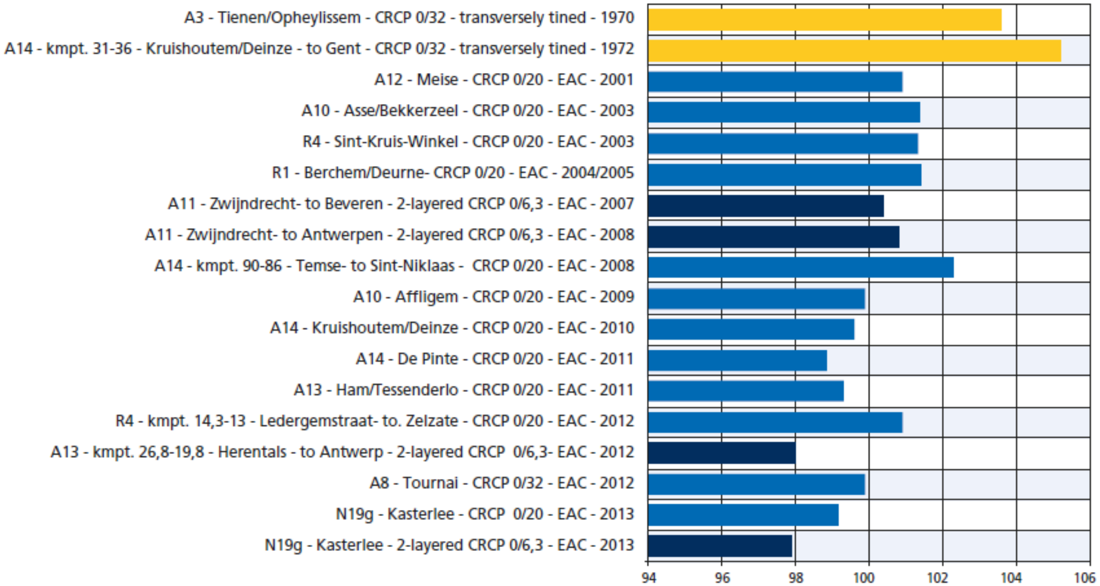


L_{Amax} at reference speed
= 69,3 dB(A) = “L_{veh}”
= measure for acoustic quality of pavement

log(v) = 1,9
v = 80 km/hour
= reference speed

CPX (close proximity) measurements

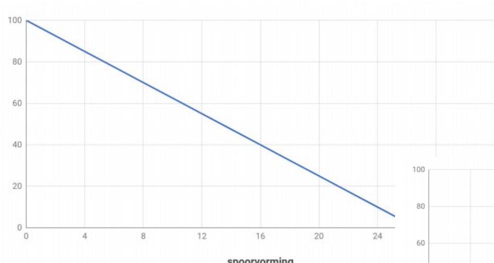


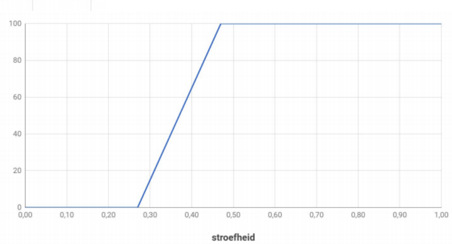


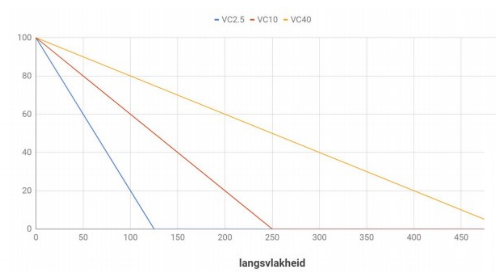
EUPAVE
EUROPEAN CONCRETE PAVING ASSOCIATION

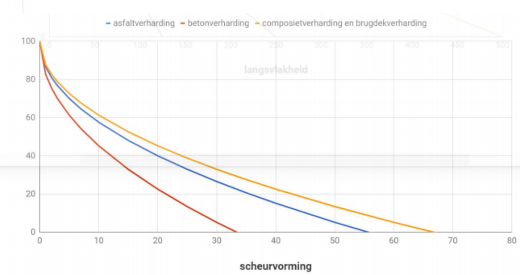
Limits (in Flanders) for new and existing pavements

	Maintenance limit	Intervention limit	Limit for new pavements (SB 250)
Skid resistance (DWC - SKM)	0,39	0,35	0,43
Rutting [mm] (asphalt)	10,7 mm	16,0 mm	
Longitudinal evenness (VC)	50/100/200	75/150/300	25/50/100
Crack formation	8,9 % for asphalt pavements 5,3 % for concrete pavements 10,7 % for composite roads and bridge decks	20,0 % for asphalt pavements 12,0 % for concrete pavements 24,0 % for composite roads and bridge decks	









Thank you for your attention!

And keep it safe