



University of Antwerp
EMIB | Energy and Materials
in Infrastructure and Buildings



eurobitume

Het rijke, collectieve geheugen met voortschrijdend
inzicht naar de duurzame wegebouw in 2050.

Bitumen- en Asfaltdag 2022

Wim Van den bergh - UAntwerpen

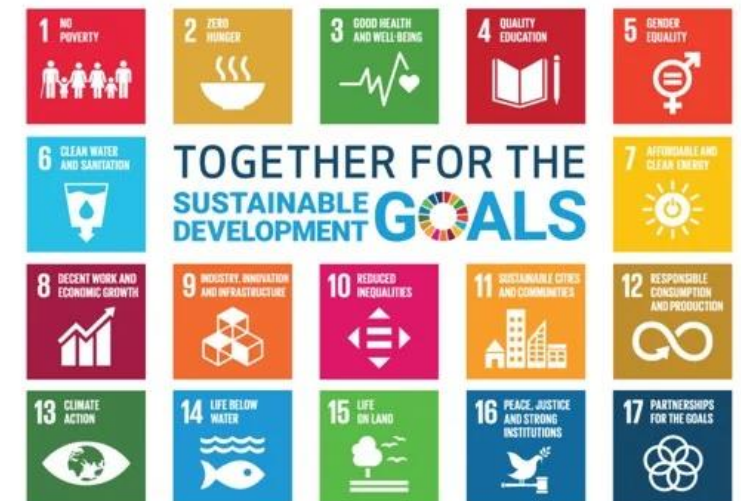
Inhoud

- Ter inleiding – Duurzaamheid
- UAntwerpen: Data-Driven Research: voor nu en nieuwe generatie
 - SSMARAGD
 - Geoptimaliseerd ME-asfaltvervormingsmodel
- Enkele cases
 - ROAD_IT
 - FBG
- Conclusies

Wegen naar de toekomst

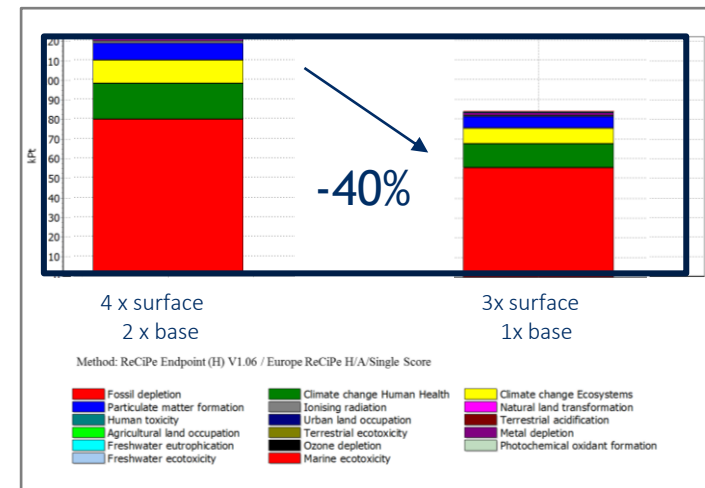
Duurzaamheid

- Wat is duurzaamheid, wat versta je daaronder?
- *FHWA (2014): A sustainable pavement is one that achieves its specific engineering goals, while, on a broader scale, (1) meets basic human needs, (2) uses resources effectively, and (3) preserves/restores surrounding ecosystems. Sustainability is context sensitive and thus the approach taken is not universal, but rather unique for each pavement application*
- Reeds mooie voorbeelden:
 - Op papier: EAPA, PIARC, EU,...
 - Tools: Edgar, Dubocalc,
 - Cases: Impuls programma, RejuveBIT, ...



Duurzaamheid (2)

- Hoe kunnen we asfaltverhardingen verduurzamen?
 - Ontwerp: verbeterde mechanisch-empirische modellen
 - Materiaal innovatie: nieuwe materialen met hun milieu-impact.
 - Life Cycle (Cost) Analysis
 - Opmerking: durability versus carbon footprint versus sustainability!
- Bouwproces
 - Performance – kwaliteit
 - Energie

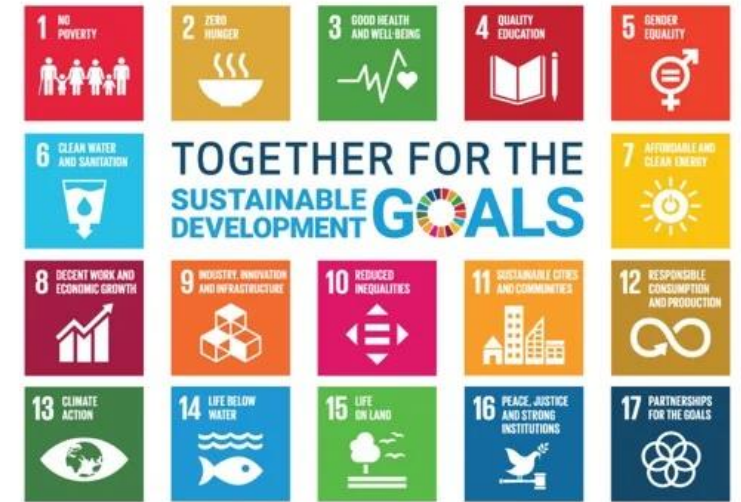


Increase quality
Increase service life
Increase recycling
Decrease transport

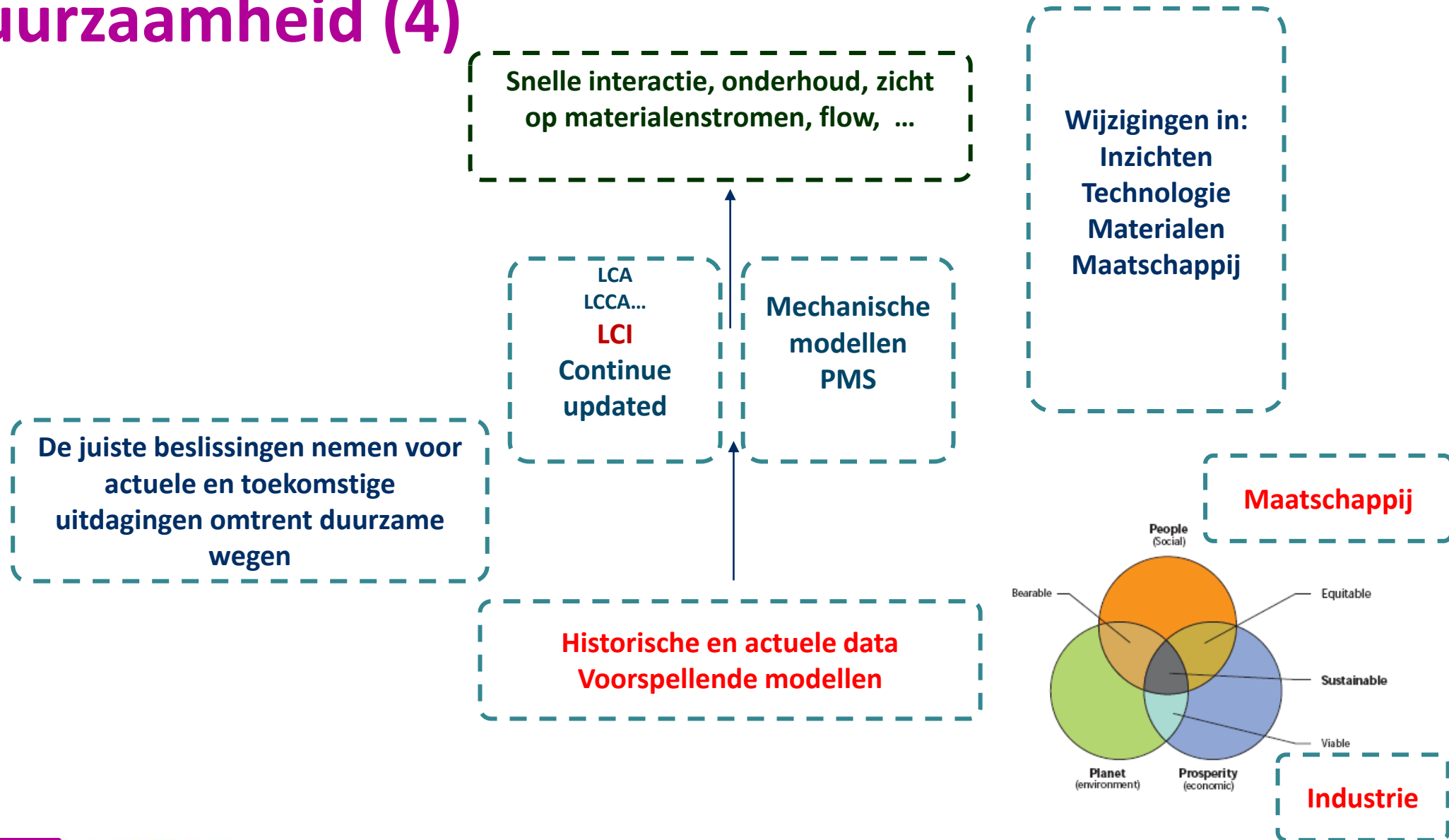
Duurzaamheid (3)

Tandje bijsteken?

- Omdraaien aanpak:
 - Waar willen we naartoe? Waar moeten we naartoe? Waarom?
 - En hoe gaan we dat realiseren?



Duurzaamheid (4)



Waar zit de angel?

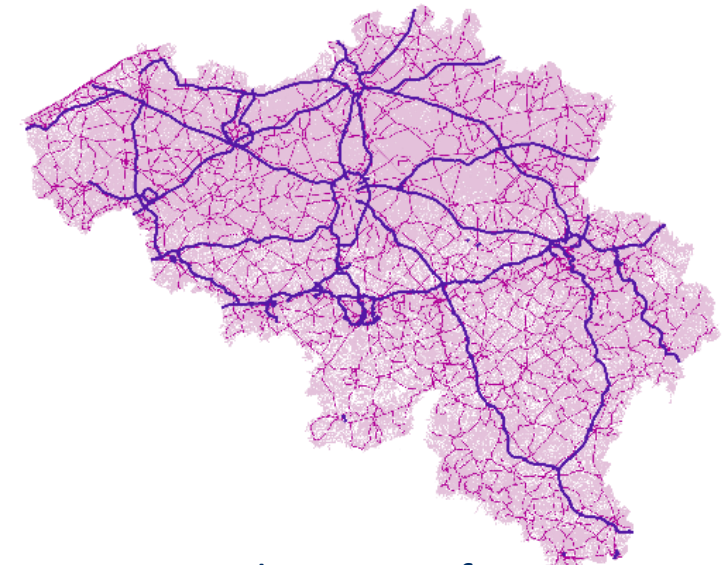
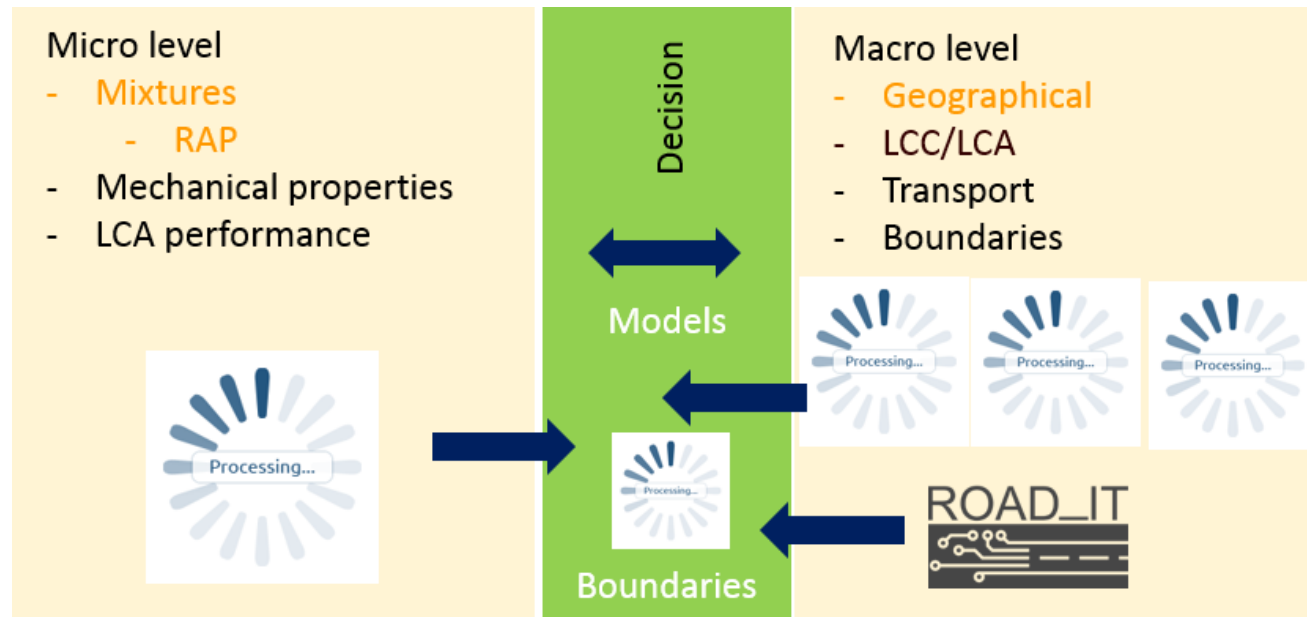
- **Kunnen we berekenen welke parameter best is, meeste impact?**
 - Tools
 - Variaties in kaartbrengen
 - Impactanalyse
 - Tijd – voortschrijdend inzicht?
- Gegevens?
- Waar zijn ze?
- Wat willen we in theorie?
- Het gebruik van digitale data wordt meer en meer mogelijk om ‘intelligent/smart’ beslissingen te nemen.
 - Machine learning
 - Neural networks
- Mogelijkheden:
 - Trends detecteren in data massa
 - Simulaties en voorspelling

Laten we kijken in de toekomst: UAntwerpen

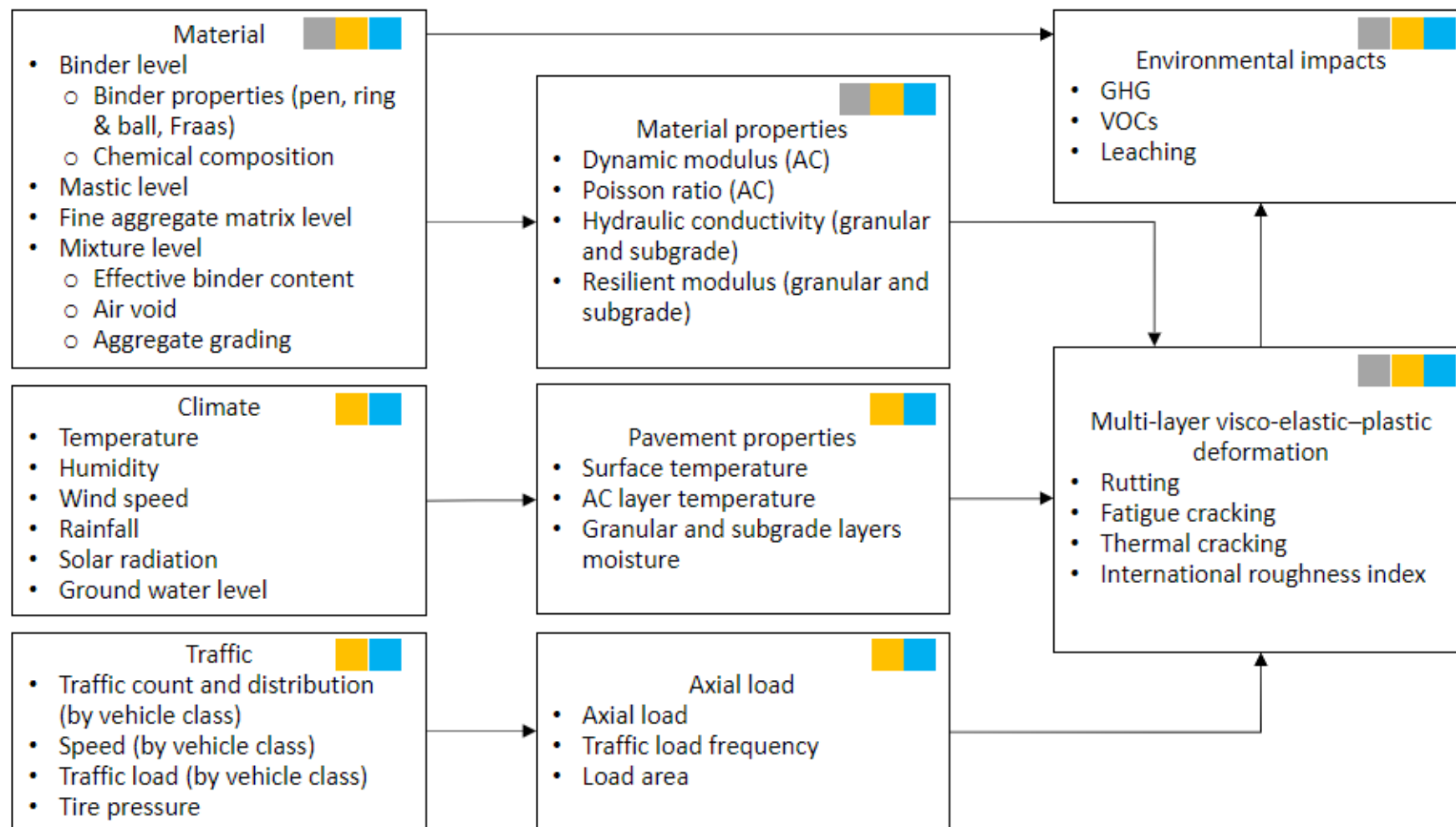
- Innovatief onderzoek naar materialen en technologieën
- Data-driven analytic modelling from nano to meta scale (SSMARAGD)
- Performance model asphalt

SSMARAGD

- **Data-driven analytic modelling from nano to meta scale (SSMARAGD)**
 - LCCA, LCA -social, econ, env impact (e.g. VOC)



Development of a Smart
Selection Model for innovative
Application of Reclaimed
Asphalt Granulate in road
Design SSARAGD
Historical and actual data



Data source

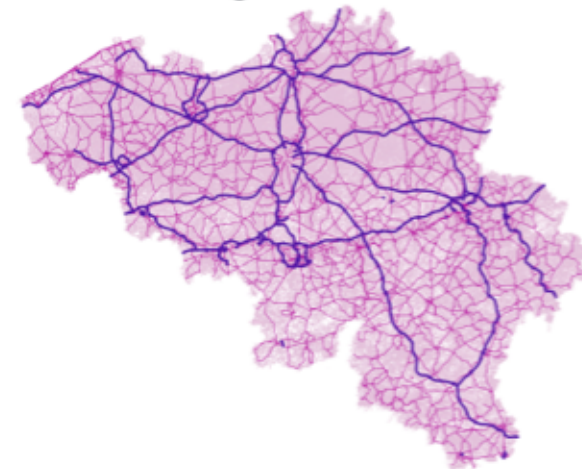


Lab

Construction

In service

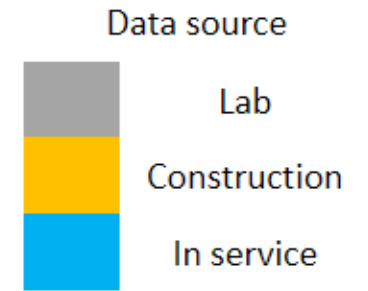
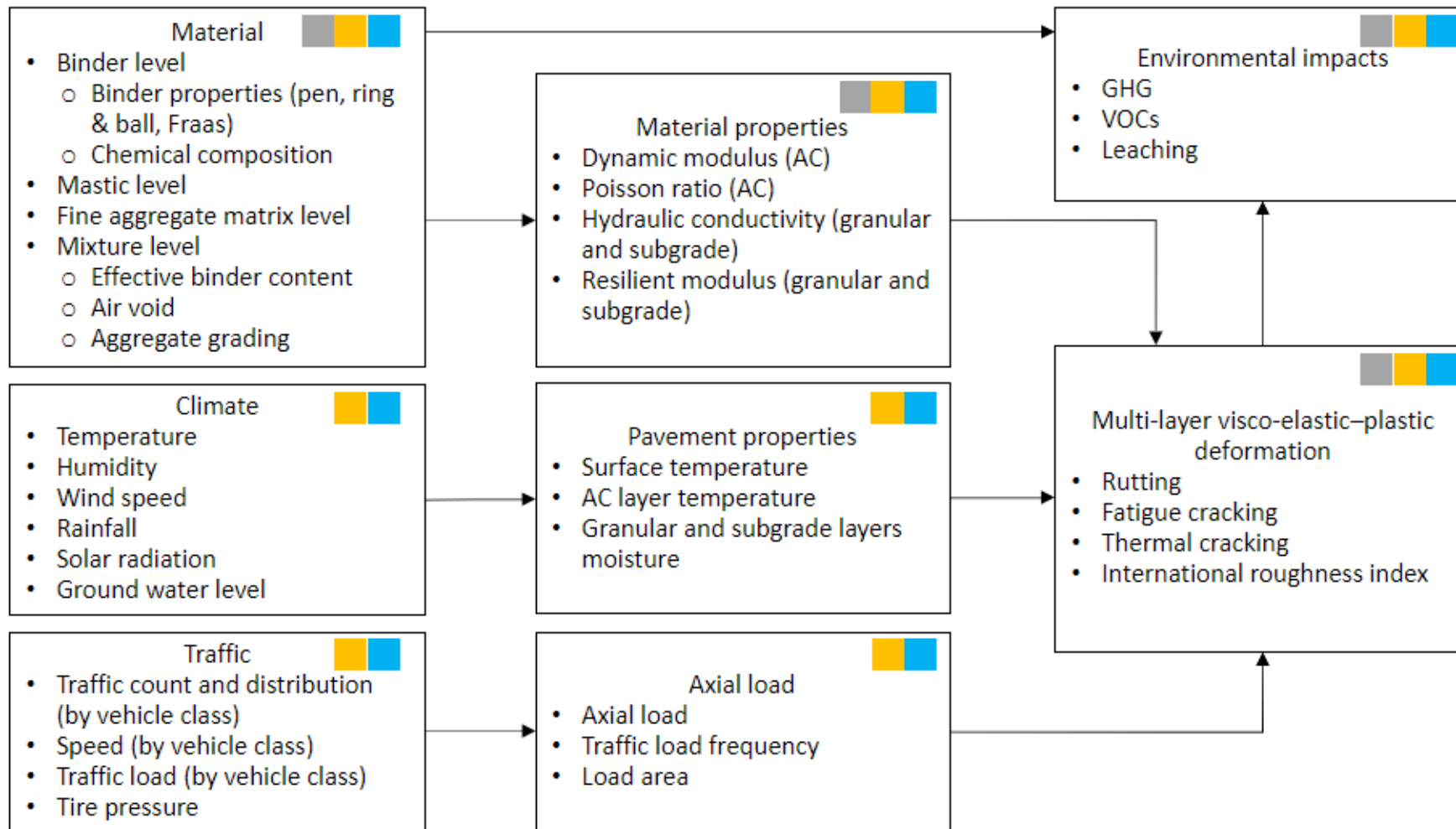
GIS & Machine Learning



Objectives and Research Needs

- Objectives: (1) evaluate data sources and accessibility and (2) discuss legal aspects for further research and valorization
- Research at UAntwerp: (1) model the behavior of the road infrastructure (visco-elastic plastic deformation model); (2) correlate actual performance/service life with predicted performance/service life; (3) evaluate impacts of climate change on road structures; (4) assess sustainability and circularity (Green Public Procurement)





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Development of a
Smart Asphalt
Pavement
performance
response model
Climate change,
traffic,
ageing, healing,
Fatigue,...
Historical and actual
data

Eerste stappen

CyPaTs: Demonstrating novel technologies CyPaTs

100 m Test track at UAntwerpen – Sept 2017

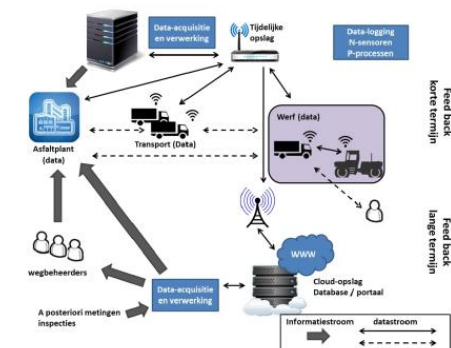
- PQI density device
- Alu plates for thickness
- Construction of a solar heat exchanging asphalt layer (tubes in asphalt layer)
- Fibre-reinforced asphalt surface layer
- ROAD-IT: track and trace, Infrared linescanner, reporting
- Fibre Bragg Grating Sensors
- Warm mix asphalt



<https://www.uantwerpen.be/en/research-groups/emib/projects-publications/road-engineering/cypats/>

<https://youtu.be/2DKTinDCea4>

Improving management process for road construction by
implementation of IT tools (2015-2017-...)

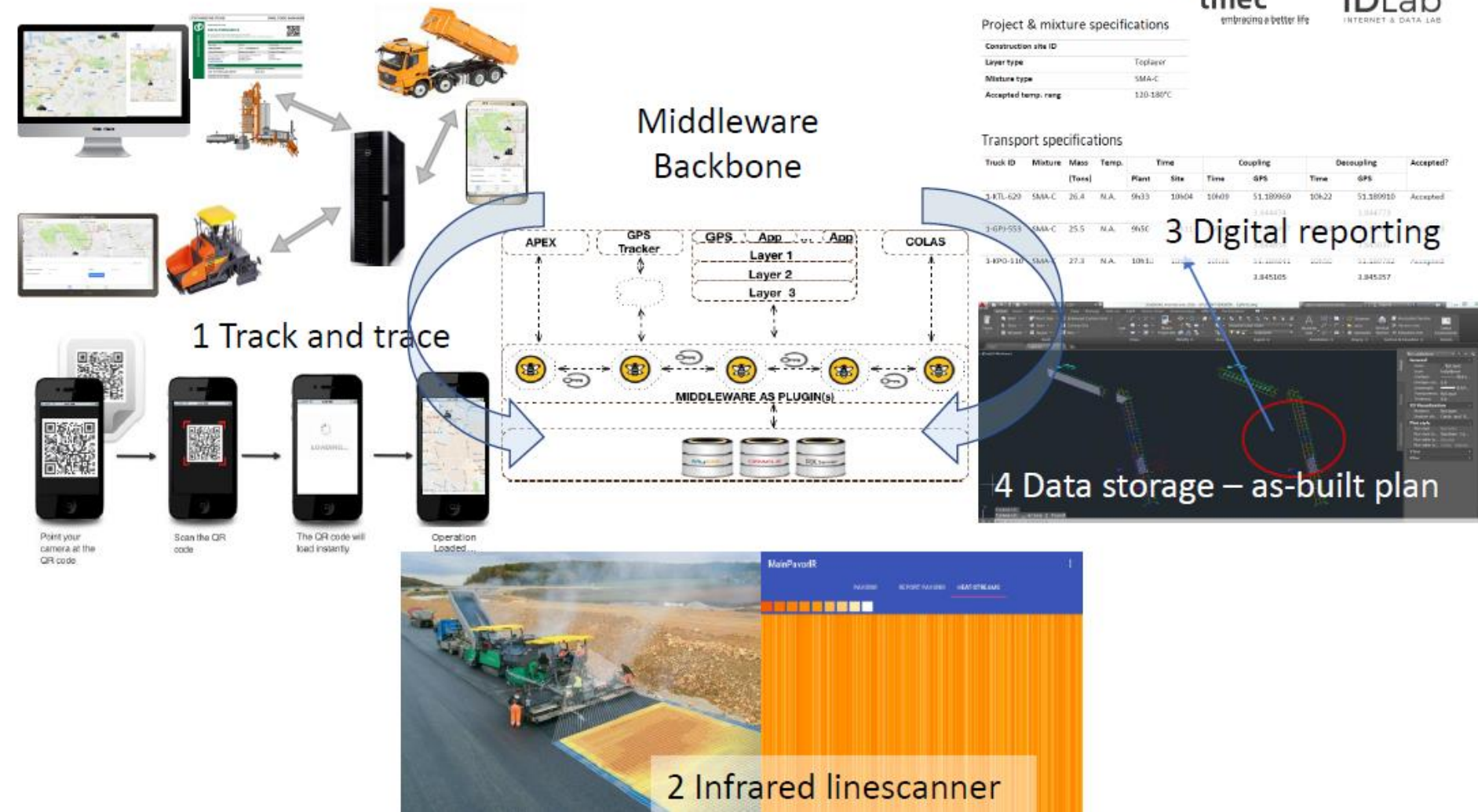


to **develop and demonstrate** an integrated and coherent IT process **control system** (*not*) for the entire Flemish asphalt sector whereby all existing sensors and actuators with their own operational data processing system, communicate with one another, in a workable way and storing data for real time and later purpose.

Quality and transport improvement by
Track and Trace
Infrared linescanner
Digital report
Data Storage

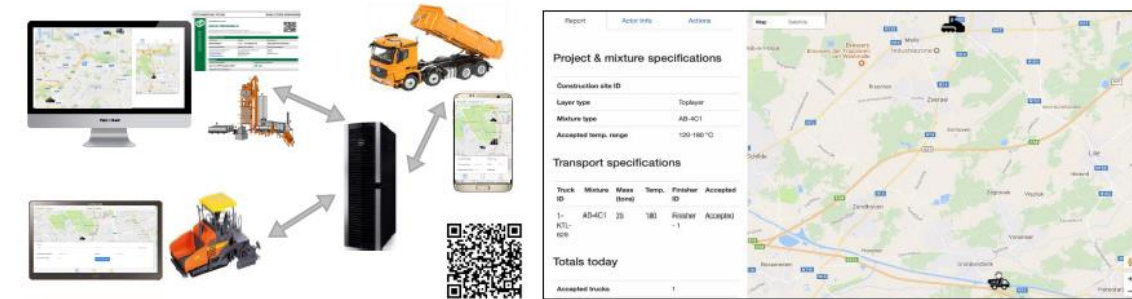


4 Case studies



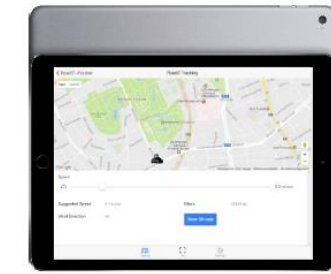
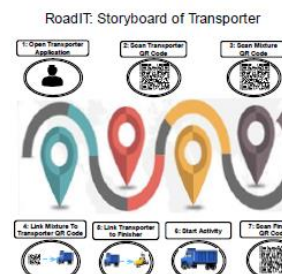
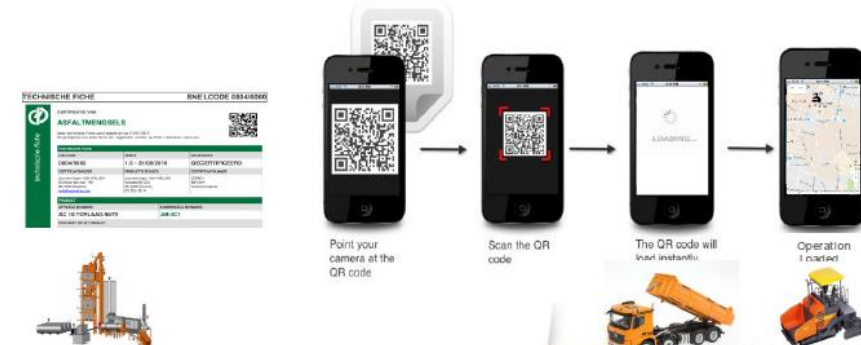
ROAD_IT: Case 1

Optimizing logistic process of asphalt production and constructing process



ROAD_IT: case 1 (2)

Optimizing logistic process asphalt production and constructing process



Result: location and time relation between lorry and finisher
Calculate efficiency, truck management, temperature
Mixture verification: go/no-go on site
Speed of finisher can be adopted to truck arrivals

Technical and transport data are gps-related and stored in a database of the road manager.
Each paved quantity from one truck is located and described (material passport and laying parameters)

ROAD_IT: Case 2

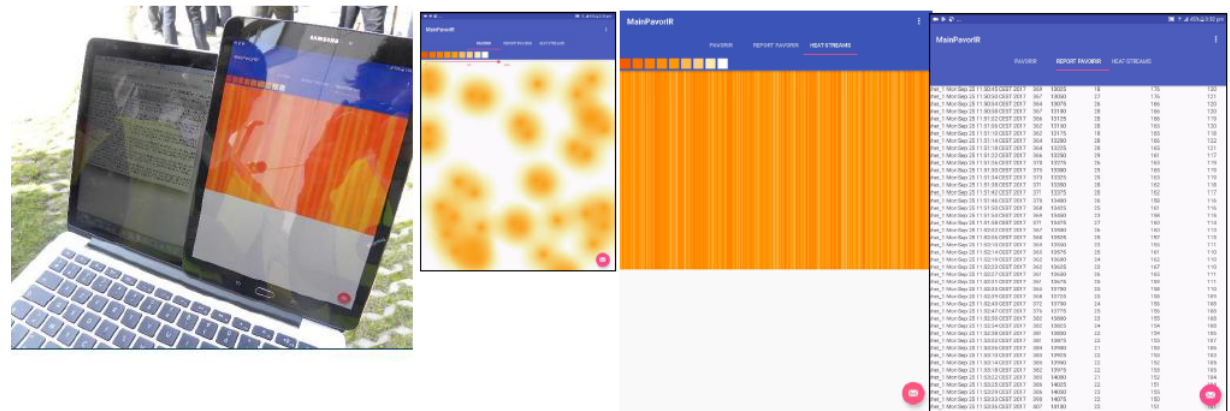
Using infrared camera for continuous temperature measurements



- Infrared camera is linked to GPS-system
- Measurements width of road
- One or more measurements per 25cmx25cm
- Accuracy 1 – 2°C
- Heat maps

ROAD_IT: Case 2 (2)

Continuous monitoring homogeneity after the finisher



- During asphalt laying and compaction process:
- direct impact on durability of the compacted asphalt: intervention for rollers is possible
- After asphalt construction:
- data-analyse: evaluation, tender specifications, area with good/bad compaction

ROAD_IT: Case 3

Data reporting of a construction site

Project & mixture specifications

Construction site ID	
Layer type	Toplayer
Mixture type	SMA-C
Accepted temp. rang	120-180°C

Totals today

# Trucks	Mixture	Total mass	Avg. mass/truck
3	SMA-C	79.2	26.4

Transport specifications

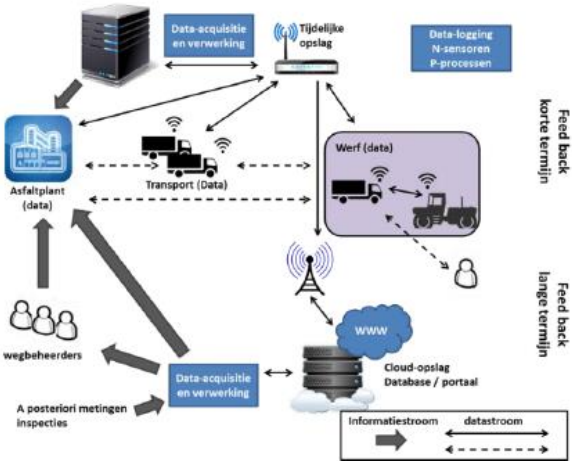
Truck ID	Mixture	Mass (Tons)	Temp.	Time		Coupling		Decoupling		Accepted?
				Plant	Site	Time	GPS	Time	GPS	
1-KTL-629	SMA-C	26.4	N.A.	9h33	10h04	10h09	51.189969 3.844474	10h22	51.189910 3.844773	Accepted
1-GPJ-553	SMA-C	25.5	N.A.	9h50	10h11	10h25	51.189897 3.844858	10h34	51.189857 3.845037	Accepted
1-KPO-110	SMA-C	27.3	N.A.	10h10	10h35	10h38	51.189841 3.845105	10h50	51.189782 3.845357	Accepted

For a whole or a part of a construction site:
Quantities, period, number of trucks, ID of trucks, mixture verification
Contractor, suppliers and road manager

ROAD_IT: Case 4

Data storage for a road or network

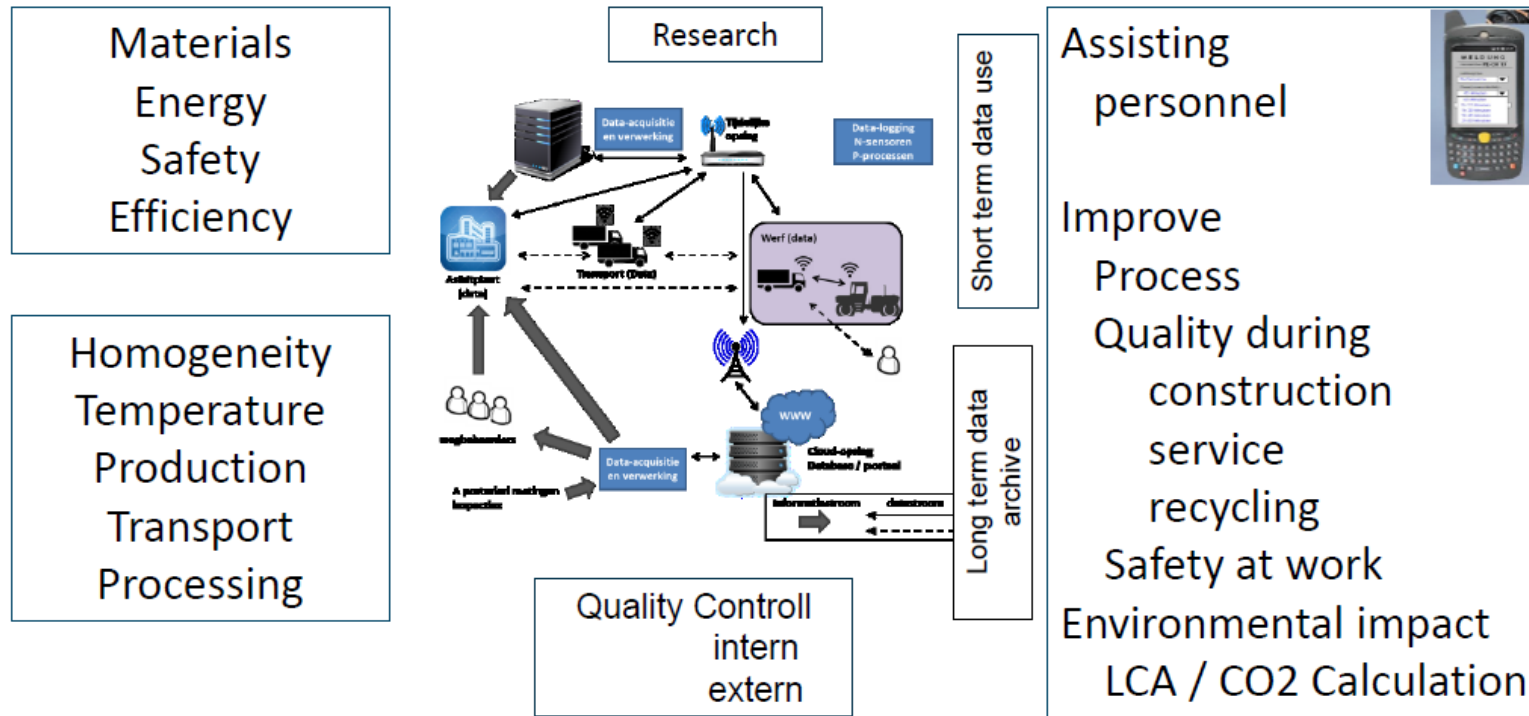
- Database to store all data of the job site
- Demonstrated by CyPaTs



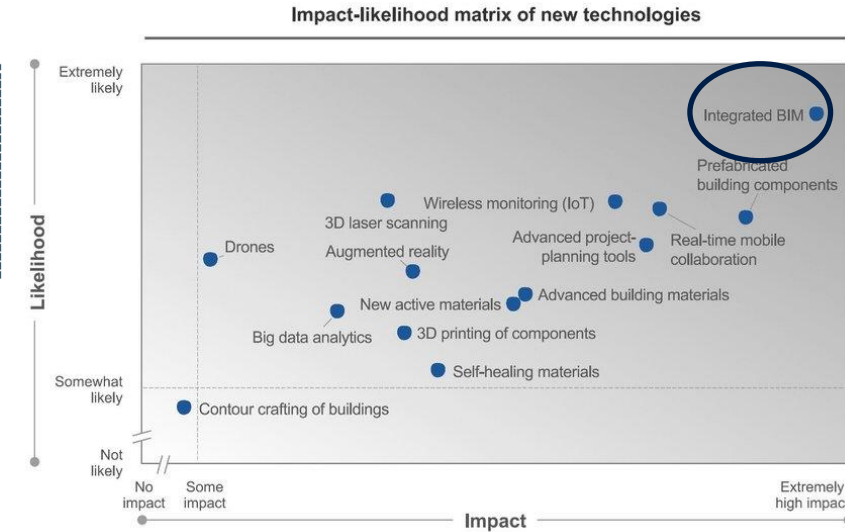
Uitdaging

Asphalt process : production – transport – service – renovation – recycling

ROAD_IT: combining all tools and steps into one system chain with short term and long term archive output



Uitdaging data: registreren, opslag, gebruik, modellen,

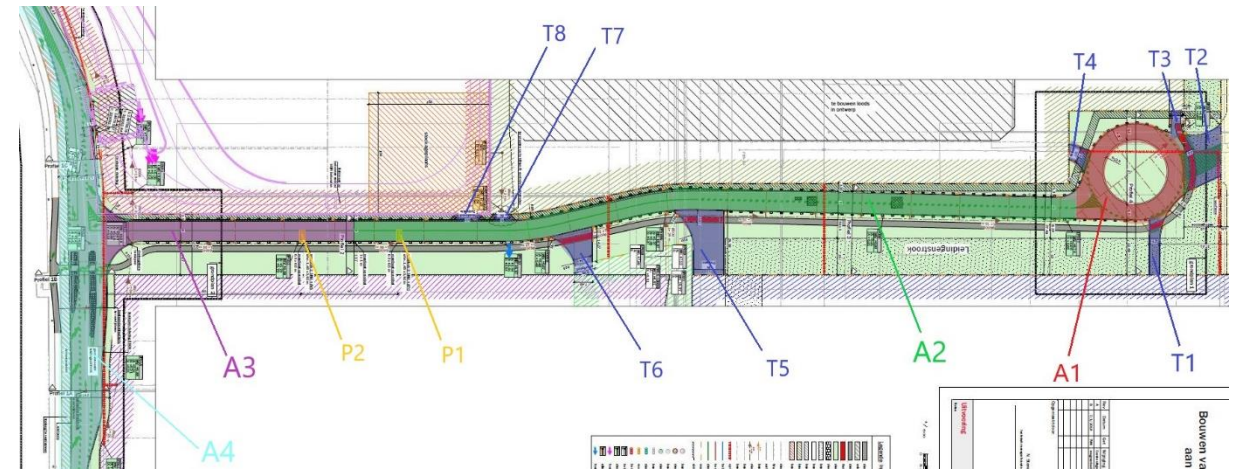
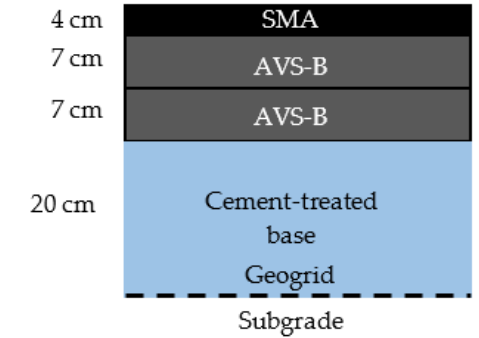
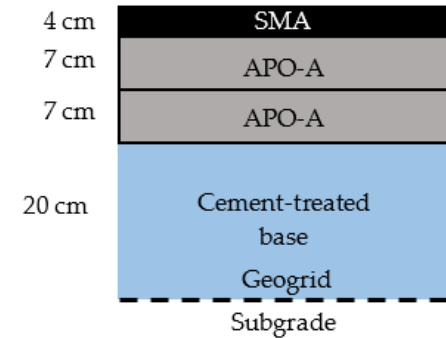


Source: Shaping the Future of Construction



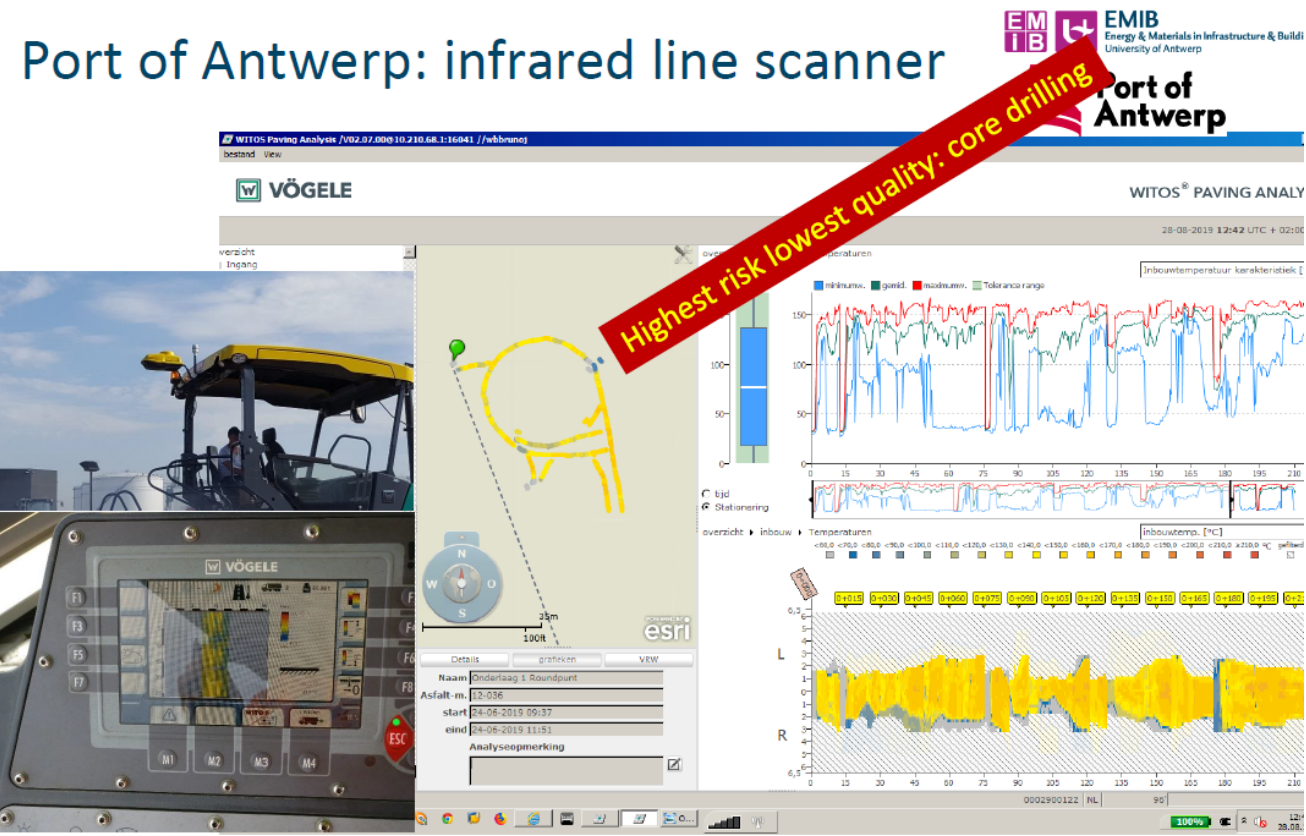
Voorbeeld: Antwerpse Baan

- AC-20 versus EME AC-14
 - Lab tests
 - FWD
 - FBG: monitoring van vervorming in asfaltlagen
- ROAD_IT for QA/QC
 - Track and Trace
 - Diktemeting plaatjes
 - IR-linescanner
 - Smart compaction
 - PQI



Eerste stappen

Port of Antwerp: infrared line scanner



Analyses of quality: impact of temperature on durability

Port of Antwerp: Compaction Degree

Bomag Compaction Management

Plug in system

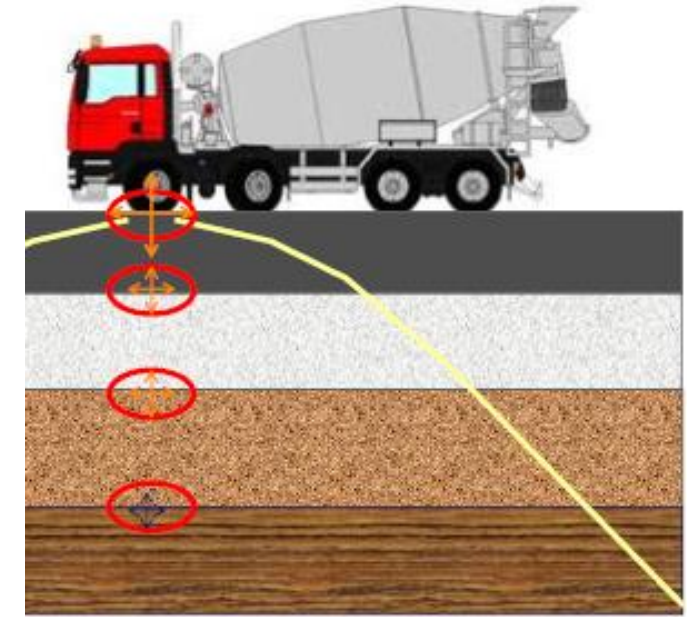


Analyses of quality: impact of compaction degree on durability

Fibre Bragg Grating

Technology:

- Glass fibre light polarization
- Embedded in asphalt (geogrid)
- Measuring strains (μm)



Objectives of FBG:

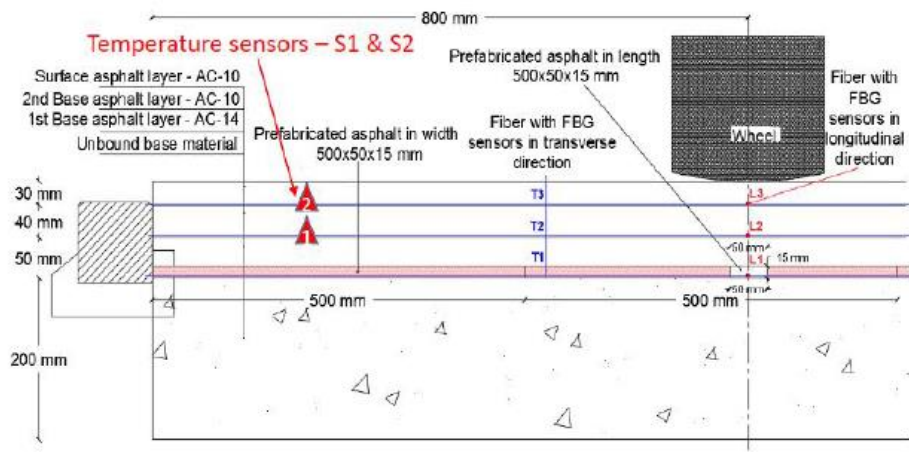
- Analysis of strains
- Monitoring the deformation of the structure (and each asphalt layer)
- Implementation of ageing in asphalt response model

Fibre Bragg Grating

Fibre Bragg Grating

1. FBG monitoring system prototype at CyPaTs

[Phd P. Kara De Maeijer (ongoing)]



The installed FBG monitoring system is based on the in-situ pavement sensors: FBG chains of 30 DTG® (2 fibers), 5 DTG® (4 fibers) and two temperature sensors embedded in three asphalt layers with a cross section configuration (width - 4 m and length - 3.2 m). In total: 82 sensors

YouTube [CyPaTs: Demonstrating New Asphalt Technologies](#)



Monitoring belastingen/vervormingen actueel en gedurende een
→ levensduur verwachting
→ Onderhoud

Fibre Bragg Grating



(c)



(d)

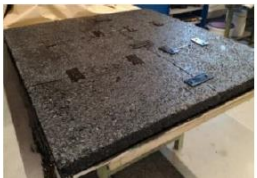


Figure 28: Reference truck used for preliminary measurements in Antwerpsebaan

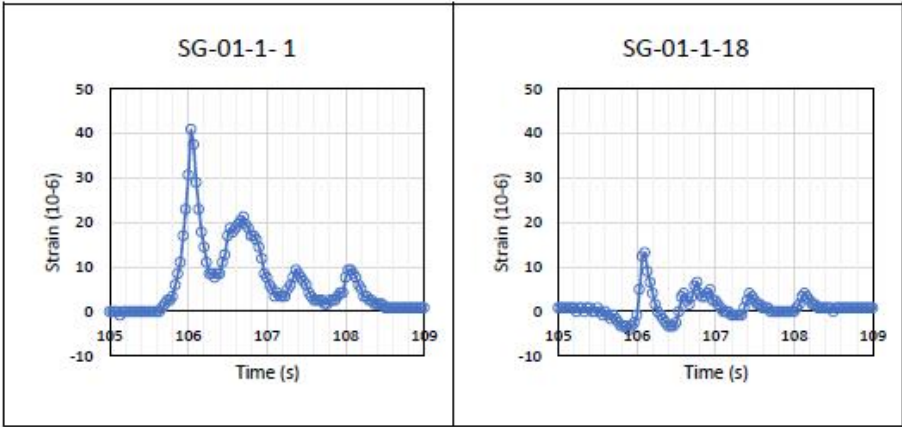
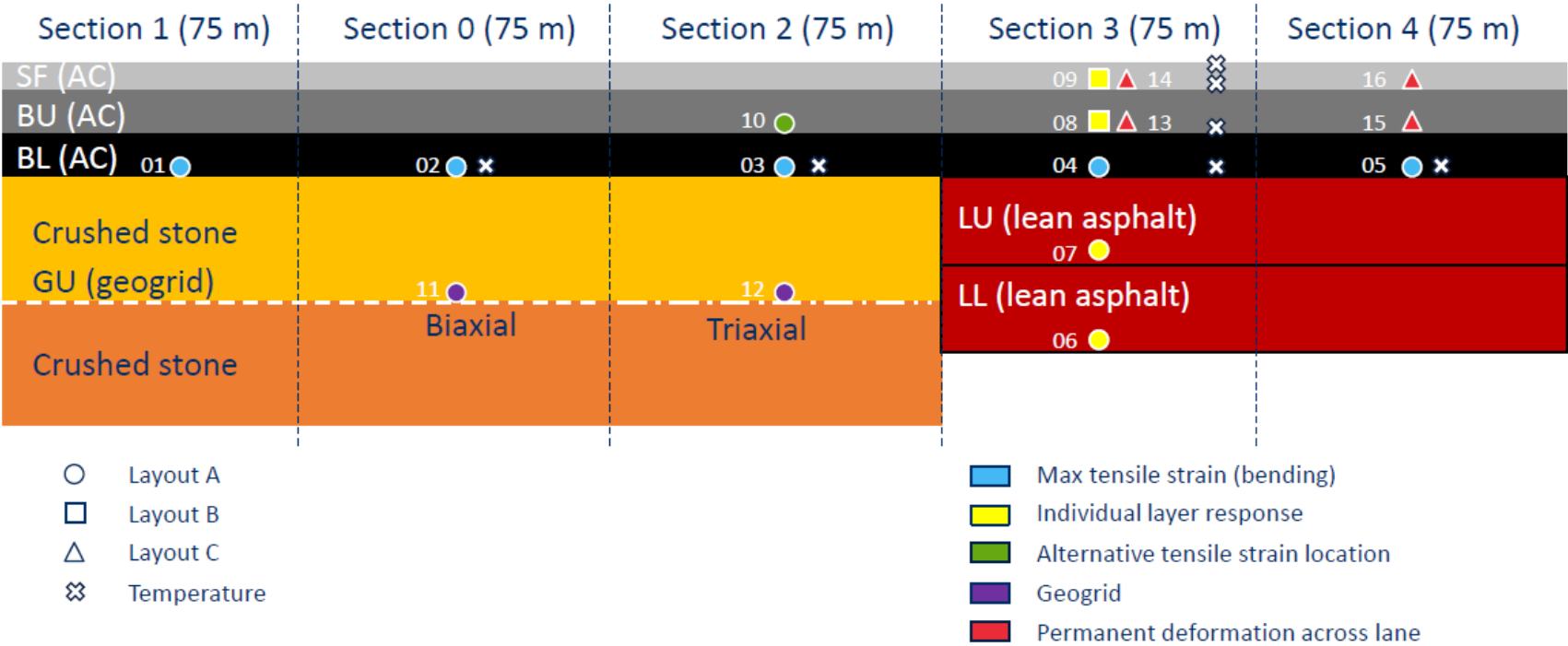
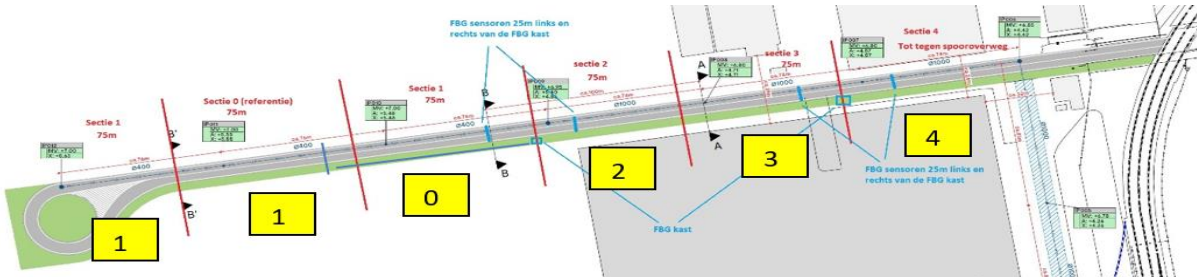
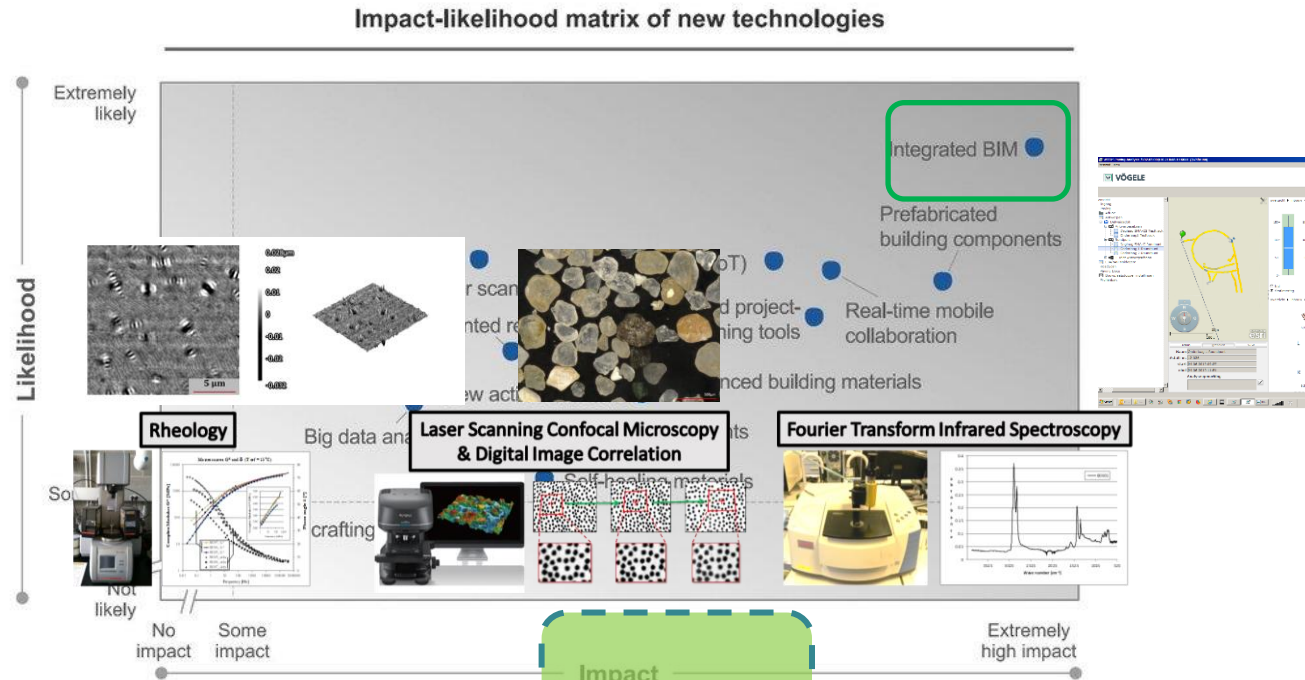


Figure 29: Strain response measured when driving the reference truck at 30 km/h and a sampling frequency of 30

Haven van Antwerpen

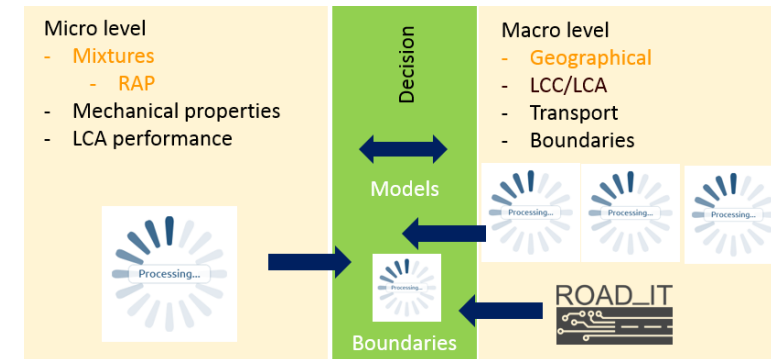
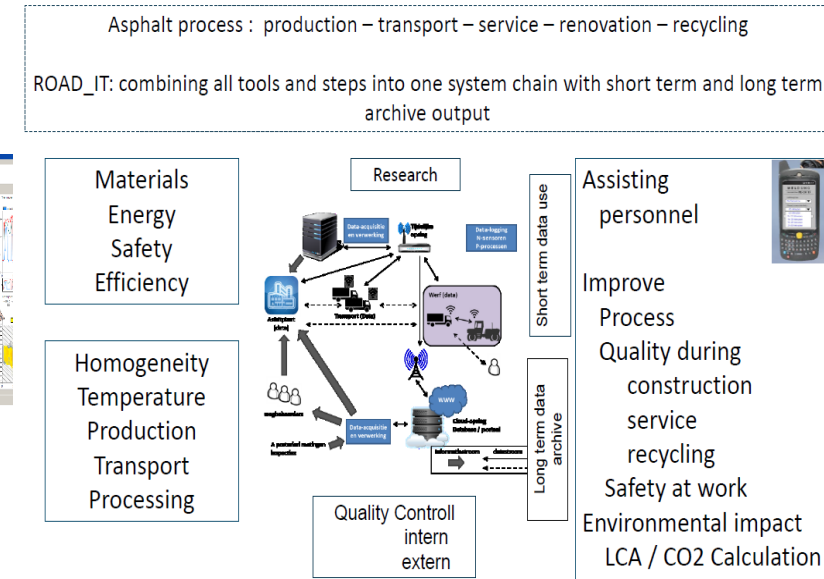


Terug even naar onze droom



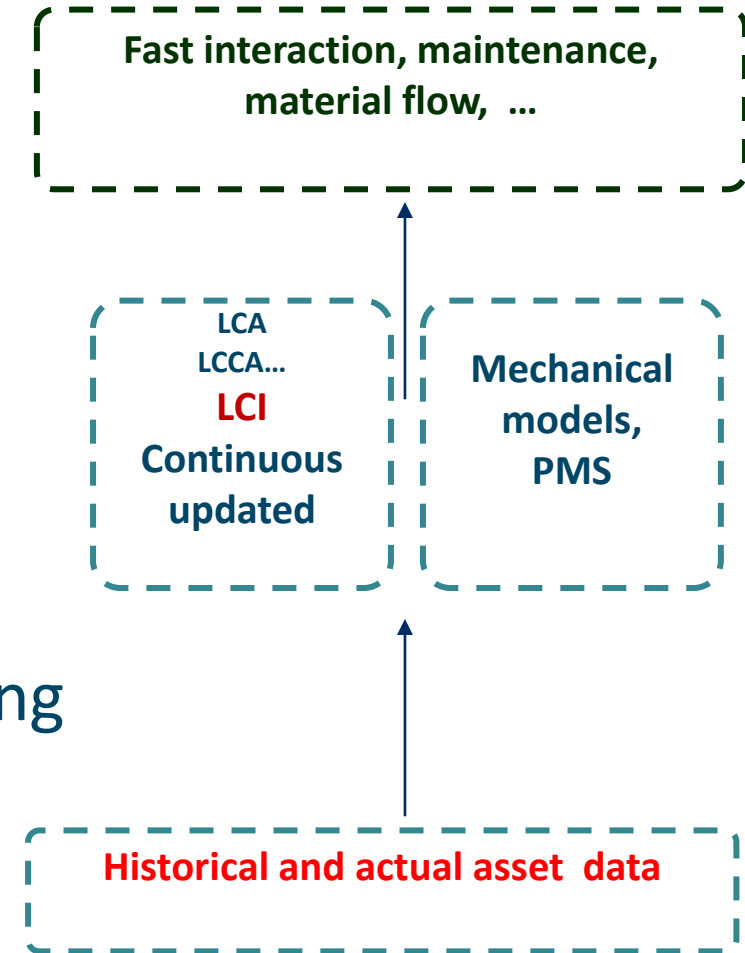
Development of a Smart Asphalt Pavement performance response model
Climate change, traffic, ageing, healing, Fatigue,...
Historical and actual data

Development of a Smart Selection Model for innovative Application of Reclaimed Asphalt Granulate in road Design
SSMARAGD
Historical and actual data



Task Force Data-driven Research (2022)

- UAntwerpen, AWW, OCW, COPRO
- Inventarisatie van data
- Strategie gebruik van data
 - Mechanical asphalt response model
 - GPP (ook funderingen)
 - PMS: actuele staat en impact van klimaatwijziging



Conclusies

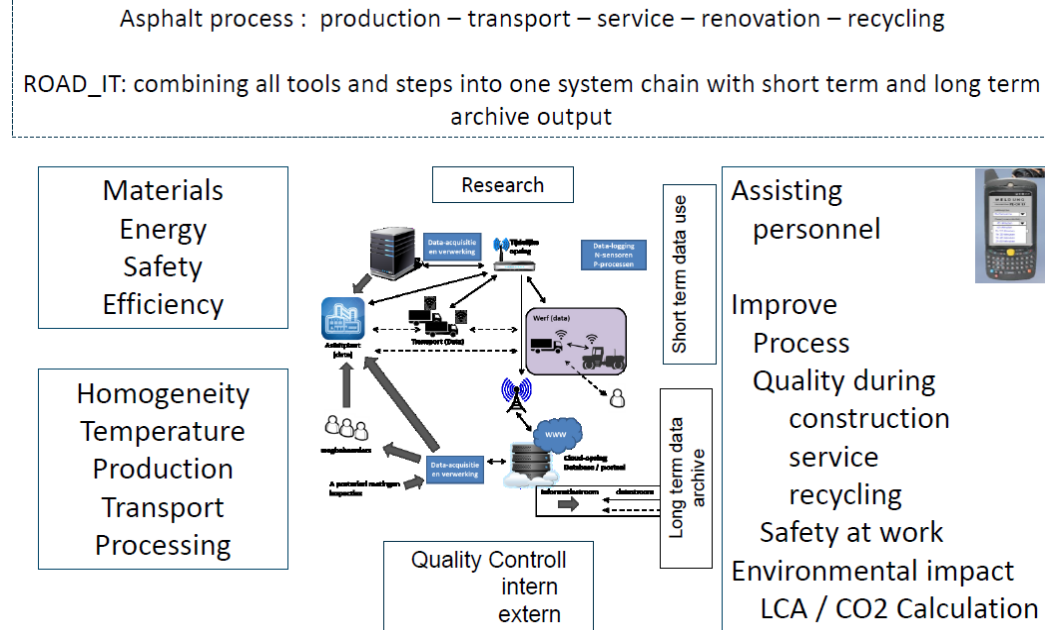


- **Duurzaamheid versus Sustainability**
 - Vele waardevolle initiatieven: waardering en onderbouwing
 - Kwaliteit: Levensduur én Opleiding
 - Optimalisatie transport, energiegebruik en materialenstroom
 - In situ recycling, nabijheid
- **Nieuwe stap 'tool': LCA-LCCA**
- **Nieuwe stap: gebruik van data → verhogen digitalisering**
 - Actueel en toekomst:
 - ROAD_IT – FBG → Asphalt Response Model
 - Opbouw van databank → info omtrent mengsels gebruikt op secties van wegen
- **Samenwerking tussen alle actoren**

SSMARAGD
Meets
BIM

Conclusies

- Samenwerking tussen alle actoren



Hartelijke dank!