University of Antwerp
SuPAR | Sustainable Pavements and Asphalt Research

AIA ASPHALT INDUSTRY ALLIANCE

How data can help plan for lower carbon roads: Using IT to improve the quality of asphalt and to deliver input to Building Information Modelling (BIM)

Sharing Best Practice Nov 2nd 2023

Prof. Dr. Ing. Wim Van den bergh

Content

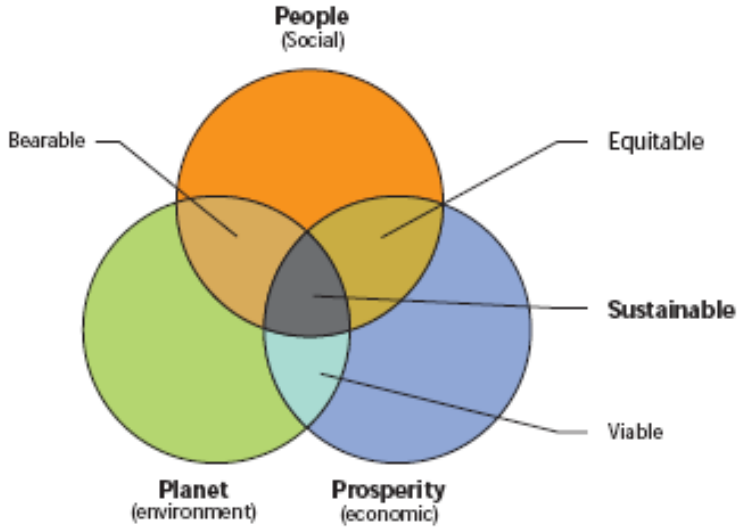
Linking sustainability, data-driven road management and research

Case in Flanders: ROAD_IT

Sustainability

- *Challenge 21st century: from durability to sustainability*
- *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.*

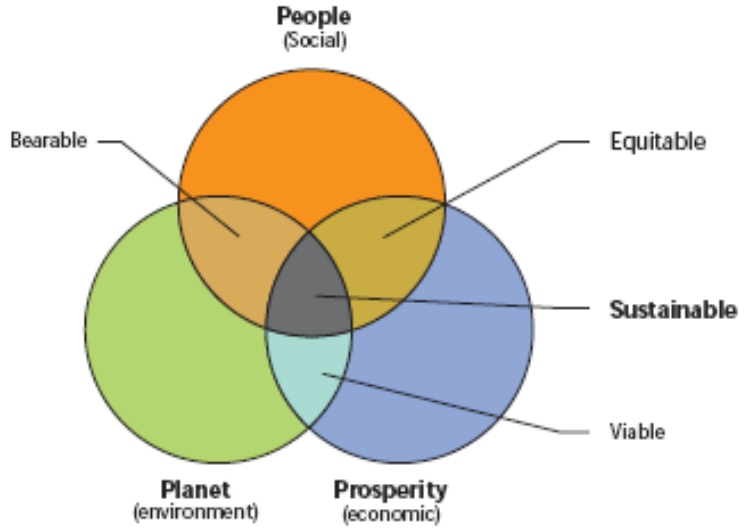
- ***Sustainability is context sensitive and thus the approach taken is not universal, but rather unique for each pavement application***



Sustainability

Context sensitive:

- Materials, processes, use phase, re-use …
  - Less new materials (recycling or other materials flow), optimization of transport, less energy and improve quality
- Guidelines and evaluation: to proof and compare
  - On paper: EAPA, PIARC, EU,…
  - Tools: Edgar, Dubocalc, LCA PAV
  - Cases: Impuls program, RejuveBIT, …
- Multi/interdisciplinary and complex approach



Sustainability challenges

- Main barriers to be solved:
  - Which parameters have the highest impact on “sustainability”
    - initially, in time and circularity
    - variability
  - Time urgency: data today will be used in 10-50 years: vision on future use of bitumen?
  - Management of all data

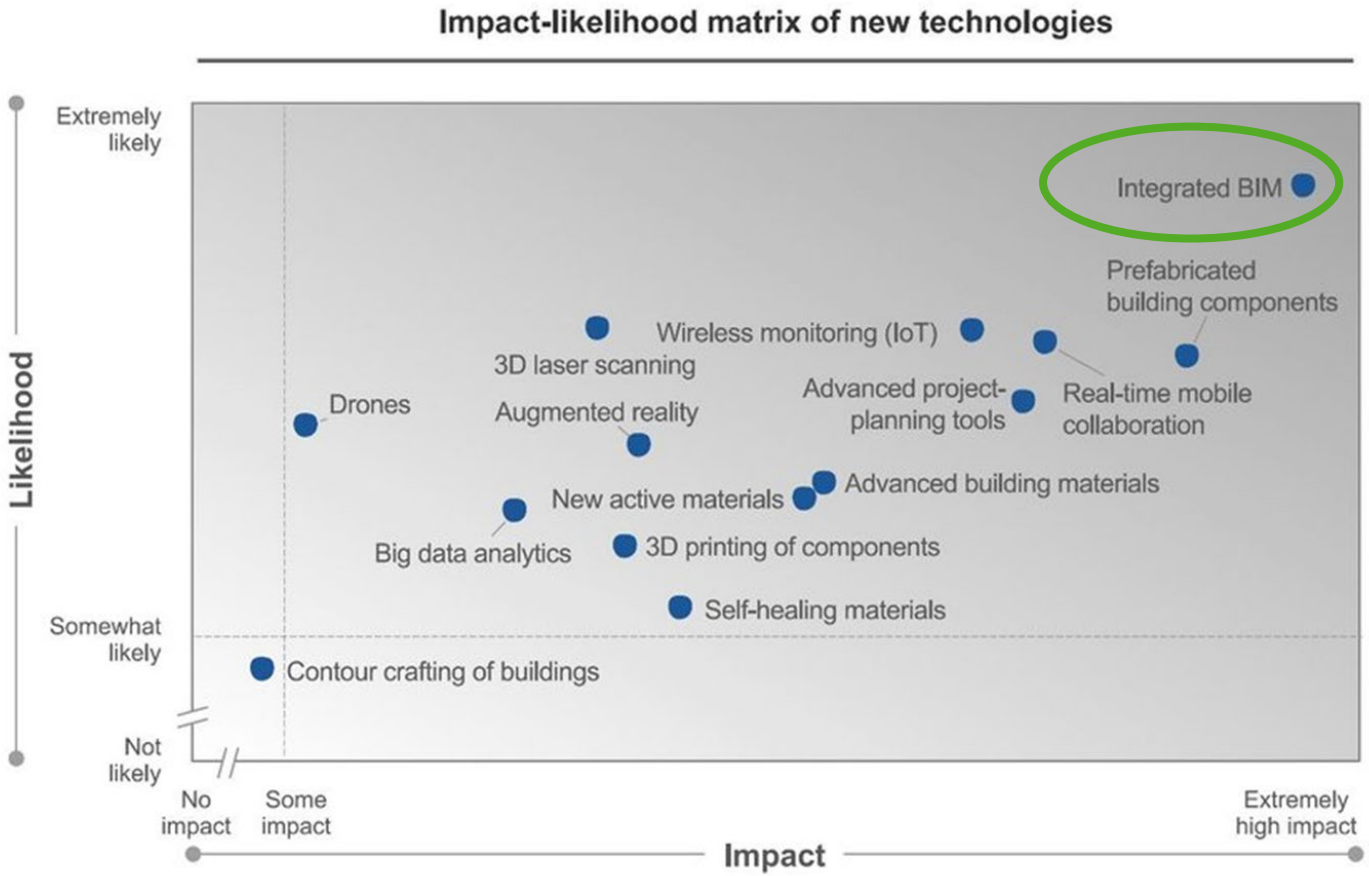
- Preliminary needs:
  - Tools to optimize, manage, see trends,…
  - Acceleration in the implementation process and approach (to get the data ☺)

Next step: digitization of pavement service life

BIM-environment!

Digital data acquisition is feasible to support and/or take smart/intelligent decisions

- Machine learning
- Neural networks
- Possibilities:
  - Actual adjustments in processes
  - Detection of trends in data
  - Optimization of materials, processes
  - Predictions and modelling
  - Health, environmental impact
  - …



Source: Shaping the Future of Construction

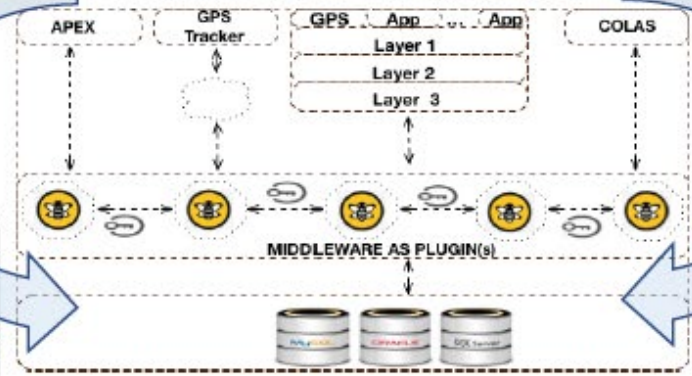
Let’s take a look at a current project

- ROAD-IT: first steps and implemention

4 Case studies

1 Track and trace

Middleware Backbone



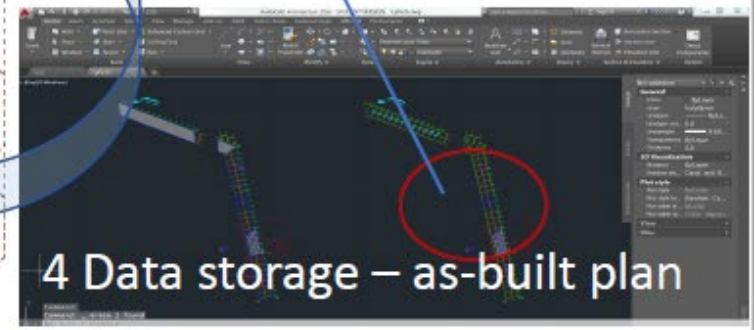
Project & mixture specifications

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

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 1.844474	10h22	51.189910 1.844728	Accepted
1-GPJ-553	SMA-C	25.5	N.A.	9h50						
1-KPO-110	SMA-C	27.3	N.A.	10h1..			51.1888.. 1.845105		51.1887.. 1.845357	Accepted

3 Digital reporting

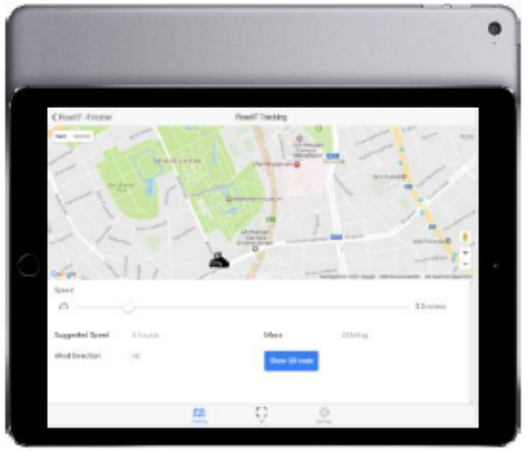


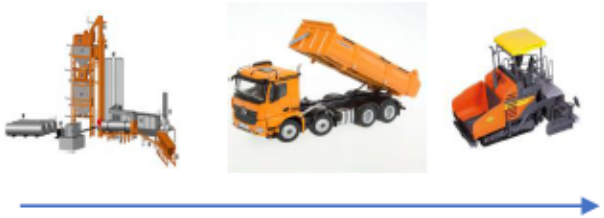
4 Data storage – as-built plan

2 Infrared linescanner

ROAD_IT: case 1 (2)

Optimizing logistic process asphalt production and constructing process

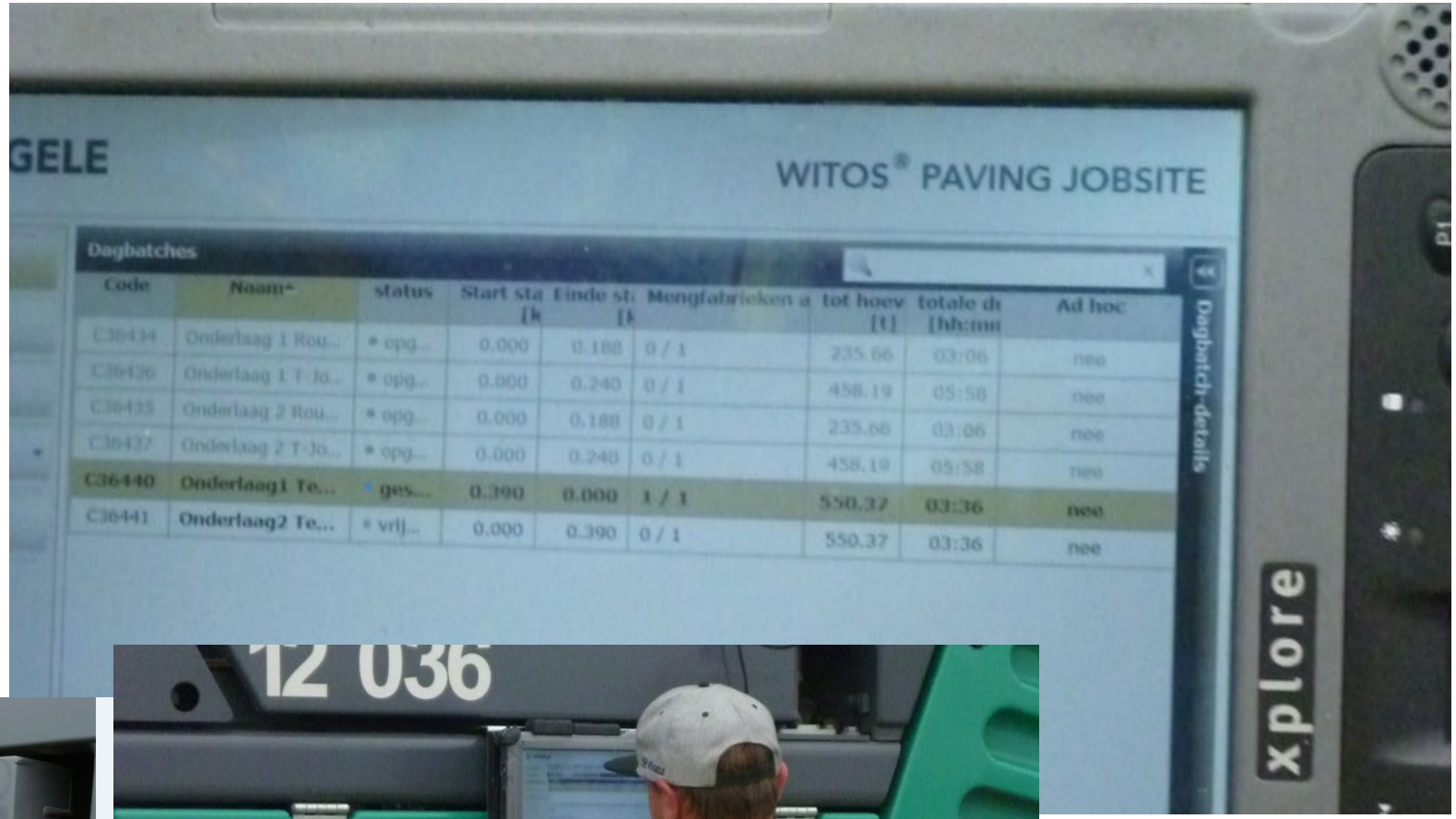




Result: location and time relation between lorry and finisher
Calculate efficiency, truck management, temperature
Mixture verification: go/no-go on site
Speed of finisher can be adopted to truck arrivals

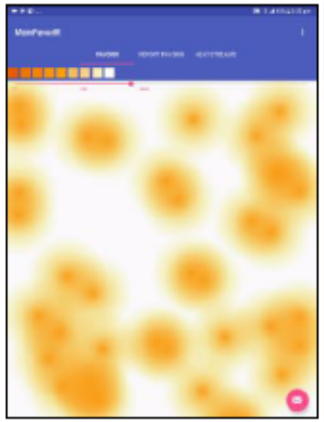
Technical and transport data are gps-related and stored in a database of the road manager.
Each paved quantity from one truck is located and described (material passport and laying parameters)

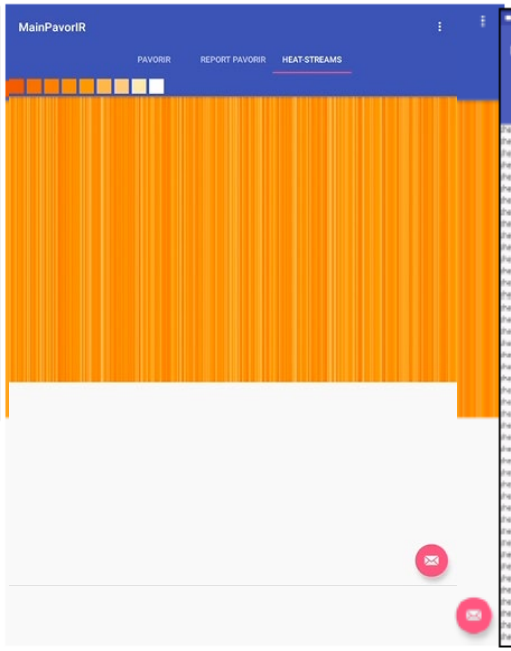
- Track and trace



ROAD_IT: Case 2 (2)

Continuous monitoring homogeneity after the finisher





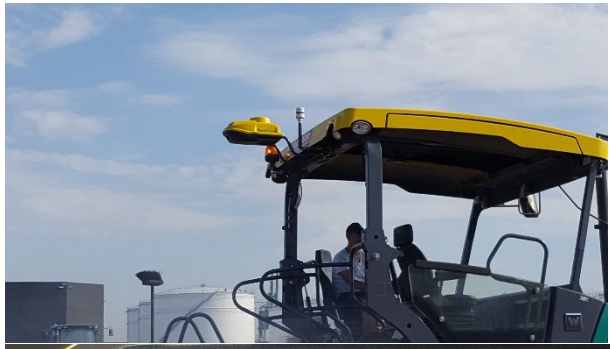
During asphalt laying and compaction process:

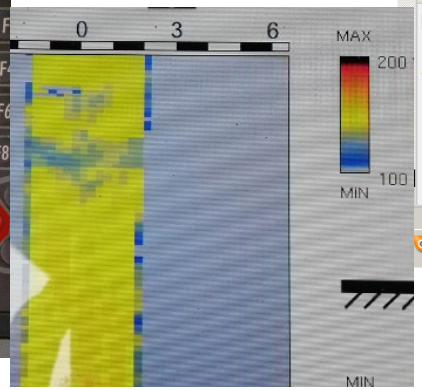
- direct impact on durability of the compacted asphalt: intervention for rollers is possible

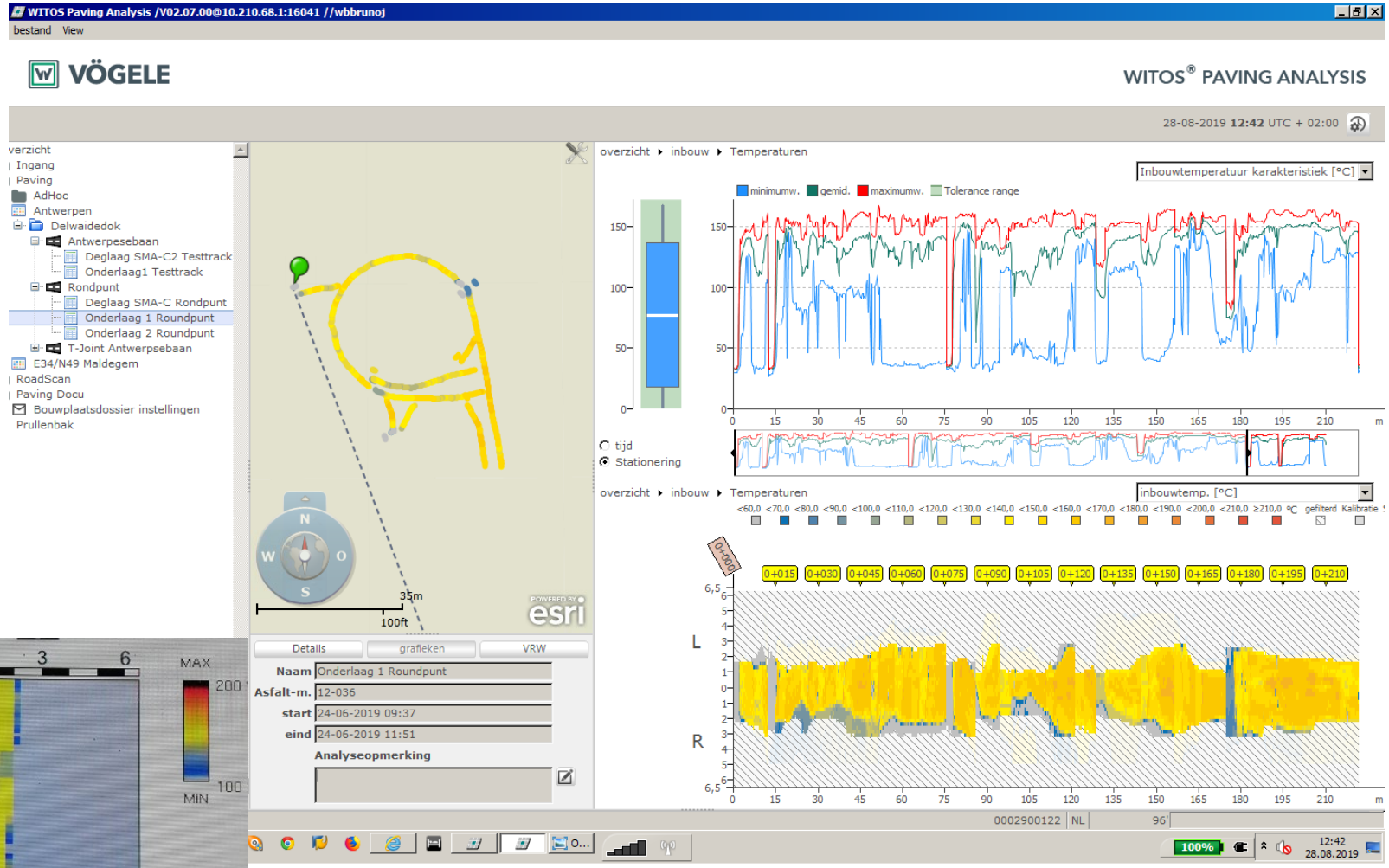
After asphalt construction:

- data-analyse: evaluation, tender specifications, area with good/bad compaction

- Infrared line scanner





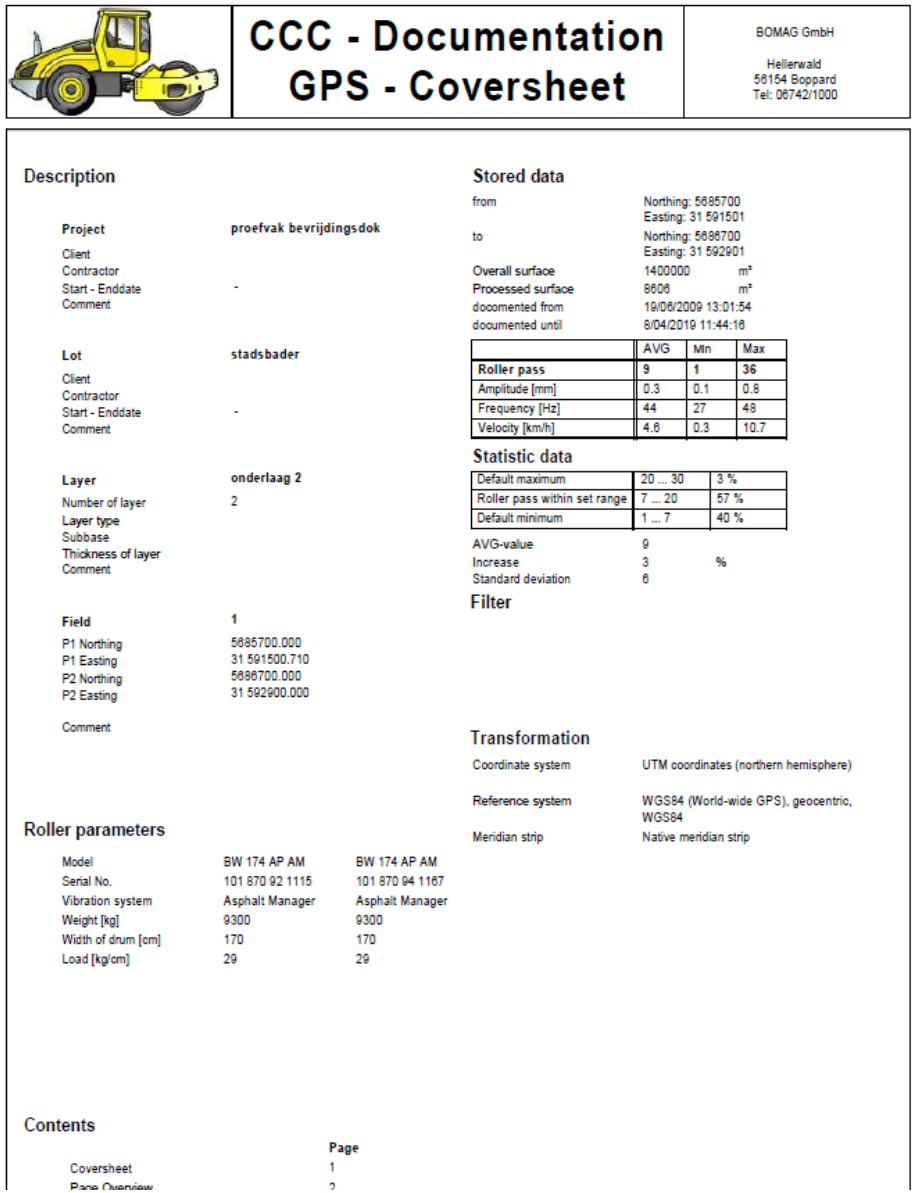


For important – high risk roads: IR-line scanner and Smart compaction are mandatory

- Smart compaction

For important – high risk roads: IR-line scanner and Smart compaction are mandatory

- reports



CCC - Documentation
GPS - Coversheet

BOMAG GmbH
Hellerwald
56154 Boppard
Tel: 06742/1000

Description

Project	**proefvak bevrijdingsdok**
Client	
Contractor	
Start - Enddate	-
Comment	
Lot	**stadsbader**
Client	
Contractor	
Start - Enddate	-
Comment	
Layer	**onderlaag 2**
Number of layer	2
Layer type	
Subbase	
Thickness of layer	
Comment	
Field	**1**
P1 Northing	5685700.000
P1 Easting	31 591500.710
P2 Northing	5686700.000
P2 Easting	31 592900.000
Comment	

Stored data

from	Northing: 5685700 Easting: 31 591501	
to	Northing: 5686700 Easting: 31 592901	
Overall surface	1400000	m²
Processed surface	8606	m²
documented from	19/06/2009 13:01:54	
documented until	8/04/2019 11:44:16	

	AVG	Min	Max
Roller pass	**9**	**1**	**36**
Amplitude [mm]	0.3	0.1	0.8
Frequency [Hz]	44	27	48
Velocity [km/h]	4.6	0.3	10.7

Statistic data

Default maximum	20 ... 30	3 %
Roller pass within set range	7 ... 20	57 %
Default minimum	1 ... 7	40 %

AVG-value	9	
Increase	3	%
Standard deviation	6	

Filter

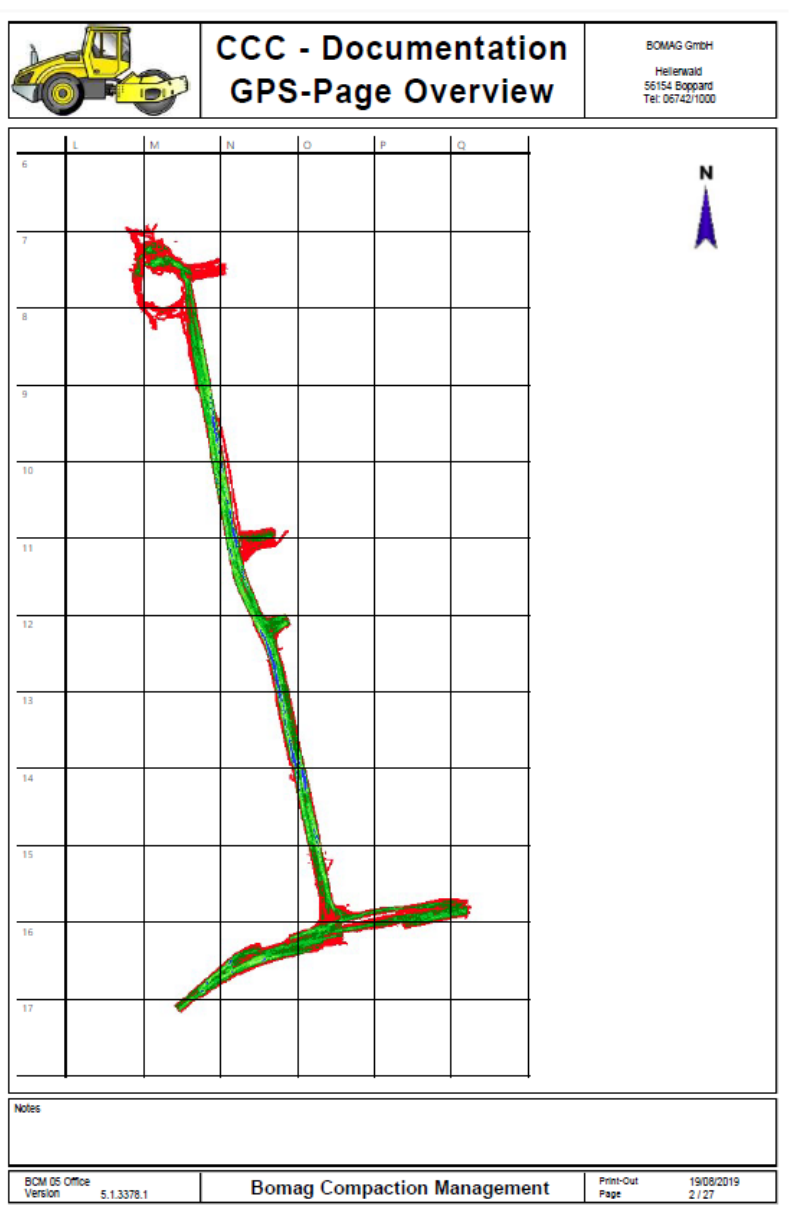
Transformation

Coordinate system	UTM coordinates (northern hemisphere)
Reference system	WGS84 (World-wide GPS), geocentric, WGS84
Meridian strip	Native meridian strip

Roller parameters

Model	BW 174 AP AM	BW 174 AP AM
Serial No.	101 870 92 1115	101 870 94 1167
Vibration system	Asphalt Manager	Asphalt Manager
Weight [kg]	9300	9300
Width of drum [cm]	170	170
Load [kg/cm]	29	29

Contents



CCC - Documentation
GPS-Page Overview

BOMAG GmbH
Hellerwald
56154 Boppard
Tel: 06742/1000

Notes

BCM 05 Office Version 5.1.3378.1 | Bomag Compaction Management | Print-Out 19/08/2019 Page 2 / 27

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

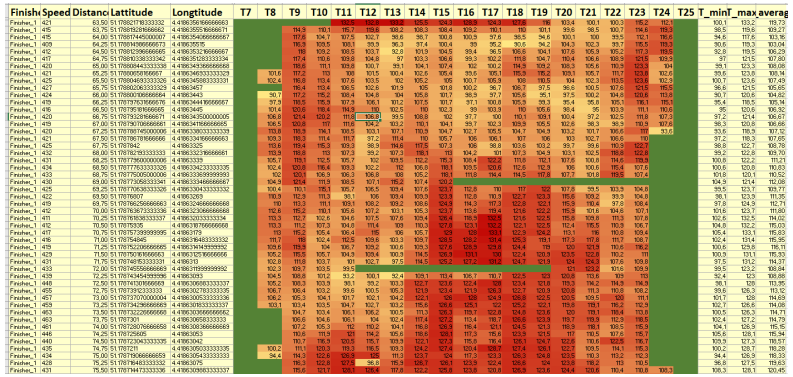
# Trucks	Mixture	Total mass	Avg. mass/truck
3	SMA-C	79.2	26.4

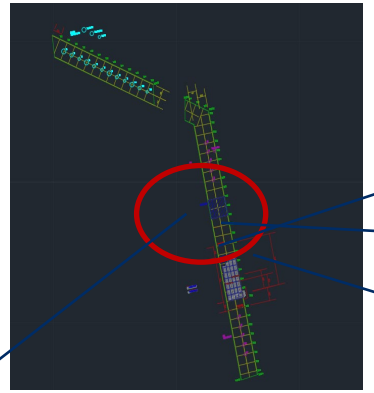
Transport specifications

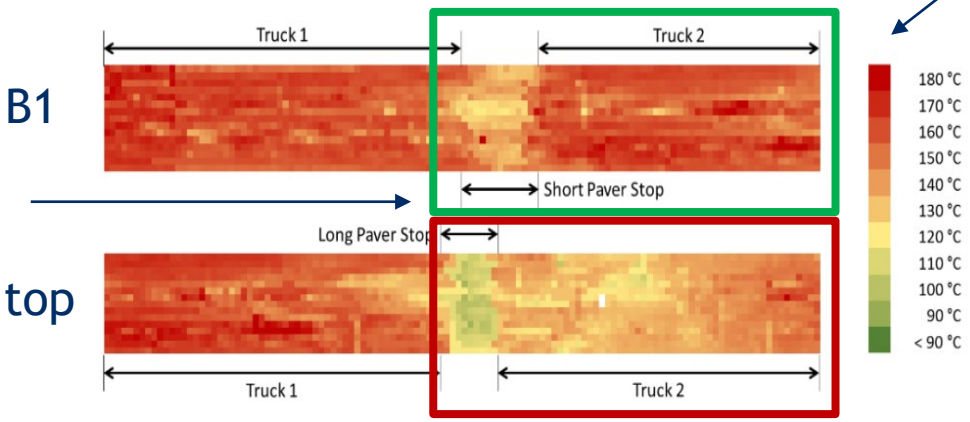
Truck ID	Mixture	Mass (Tons)	Temp.	Time		Coupling		Decoupling		Accepted?
				Plant	Site	Time	GPS	Time	GPS	
1-KTL-629	SMA-C	26.4	N.A.	9h33	10h04	10h09	51.189969 3.844474	10h22	51.189910 3.844773	Accepted
1-GPJ-553	SMA-C	25.5	N.A.	9h50	10h11	10h25	51.189897 3.844858	10h34	51.189857 3.845037	Accepted
1-KPO-110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





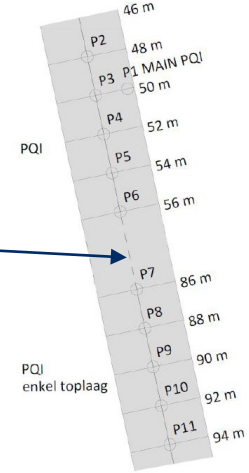


Project & mixture specifications

Construction site ID	CyPaT
Layer type	Base-Layer
Mixture type	------
Accepted temp. range	120-180 °C

Transport specifications

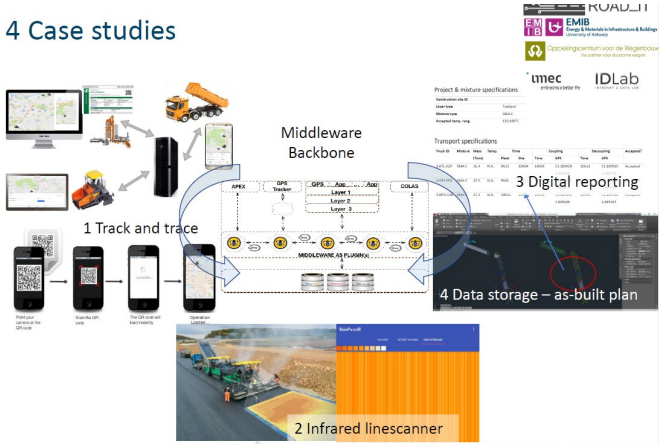
Truck ID	Mixture	Mass (tons)	Temp.	Finisher ID
1-JSJ-306	AB-3B1	24	NA	Finisher - 1

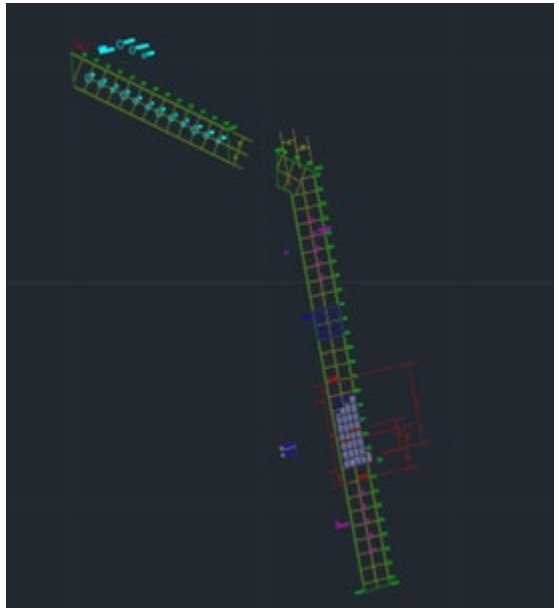


PQI-metingen onderlaag

meetpunt	Datum	Tijdstip	tijd na aanleg	aantal walsovergangen	dichtheid (offsetwaarde 0) kg/m³	oppervlakte temperatuur (°C)
P1	09/25/2017	13:34:56	00:00	0	1972	116
P1	09/25/2017	13:35:52	00:56	0	1977	108
P1	09/25/2017	13:37:09	02:13	6	2103	101
P1	09/25/2017	13:38:29	03:33	6	2059	102
P1	09/25/2017	13:39:32	04:36	6	2061	101
P1	09/25/2017	13:40:22	05:26	6	2031	101
P1	09/25/2017	13:41:30	06:34	6	2034	101
P1	09/25/2017	13:42:23	07:27	6	1988	100
P1	09/25/2017	13:43:09	08:13	6	1982	98
P1	09/25/2017	13:44:10	09:14	6	1935	98
P1	09/25/2017	13:45:09	10:13	6	2033	98
P1	09/25/2017	13:46:13	11:17	6	1992	97
P1	09/25/2017	13:46:19	11:23	6	2016	97
P1	09/25/2017	13:48:09	13:13	6	1958	92
P1	09/25/2017	13:49:15	14:19	6	1961	95
P1	09/25/2017	13:50:29	15:33	10	2058	94
P1	09/25/2017	13:53:08	18:12	14	2070	90
P1	09/25/2017	13:54:10	19:14	14	2072	91

Extension





MIT-SCAN-T3

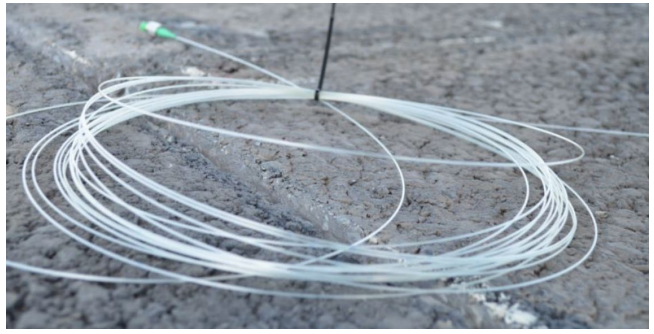
Precise and nondestructive measurement of asphalt and concrete layer thickness in compliance with TP D-StB 12

Smart compaction systems

Layer thickness measurements

Density measurements

Strain measurements



ROAD_IT: implementation

- Now: Used by Port of Antwerp-Bruges, Flemish Road Agency and City of Antwerp as quality parameter (part of procurement)

- Near Future: correlation with
  - performance in time
  - other road performance tests
- Goal: Detection of
  - Adverse conditions
  - Bad/Excellent compositions/combinations
  - E.g. 75% of SMA 14 PmB RA used on secondary road/compacted at 135C and 8 passes fail/work. For same conditions only 10% AC10 fails/works…
  - Step by step resilient structures by measuring impact parameters

Future ROAD_IT

University of Antwerp

BIM: Building information modelling

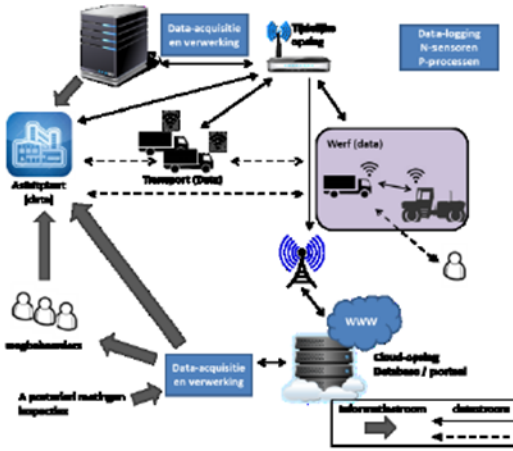
Asphalt process : production – transport – service – renovation – recycling

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

Materials
Energy
Safety
Efficiency

Homogeneity
Temperature
Production
Transport
Processing

Research



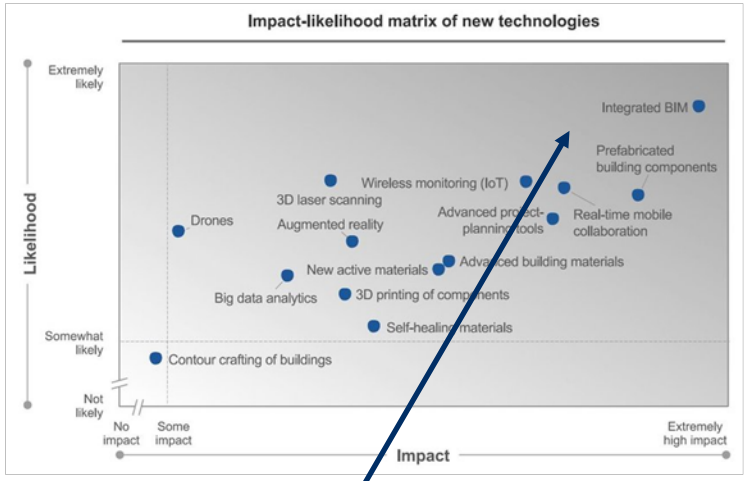
Quality Controll
intern
extern

Short term data use

Long term data archive

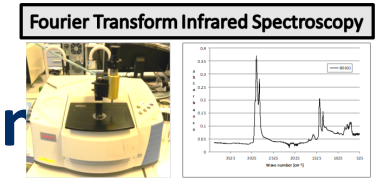
Assisting
personnel

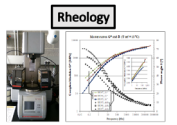
Improve
Process
Quality during
construction
service
recycling
Safety at work
Environmental impact
LCA / CO2 Calculation

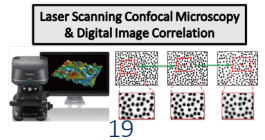


Source: Shaping the Future of Construction

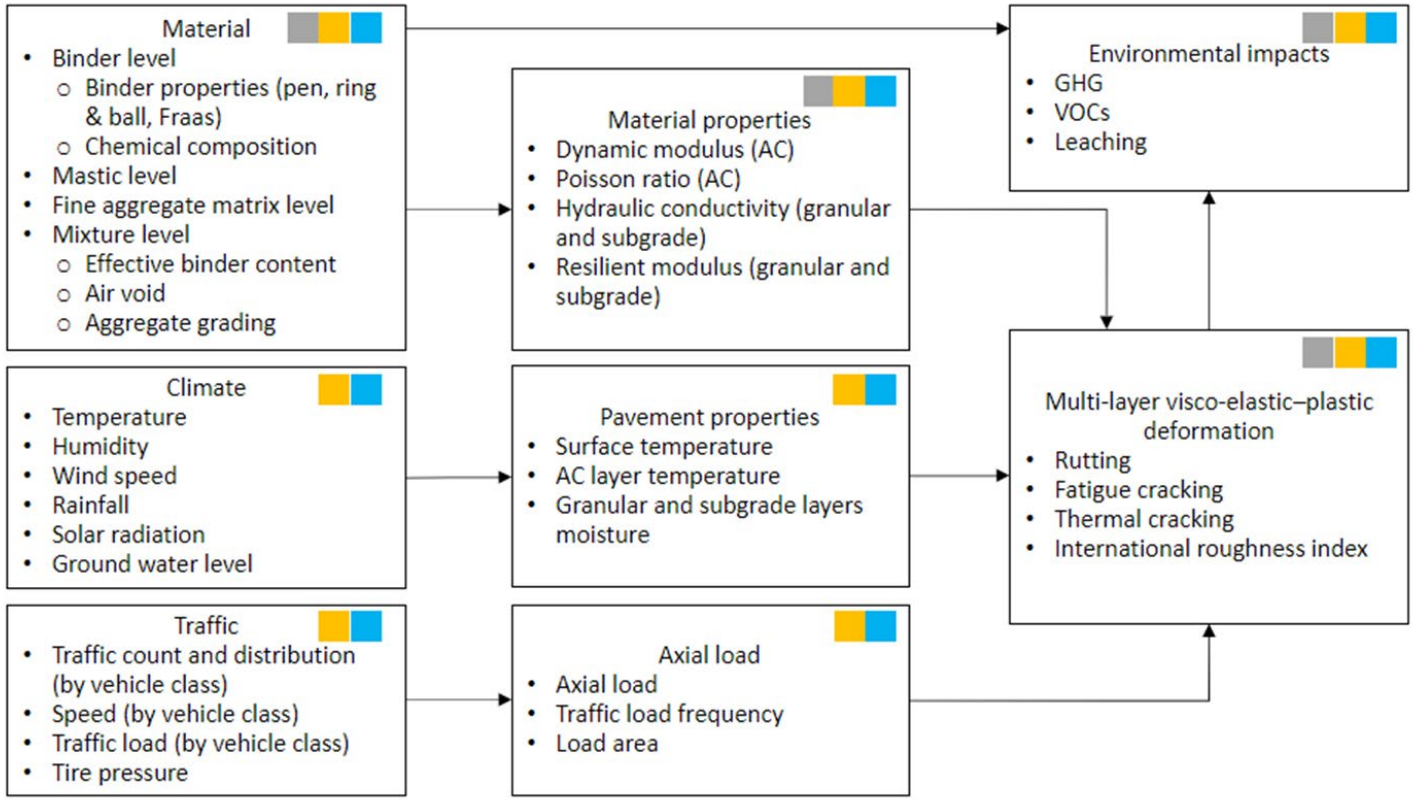
BIM: e.g Impact of bitumer type, source,..potentials circularity…

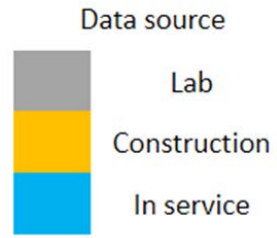






SAPPR: road design





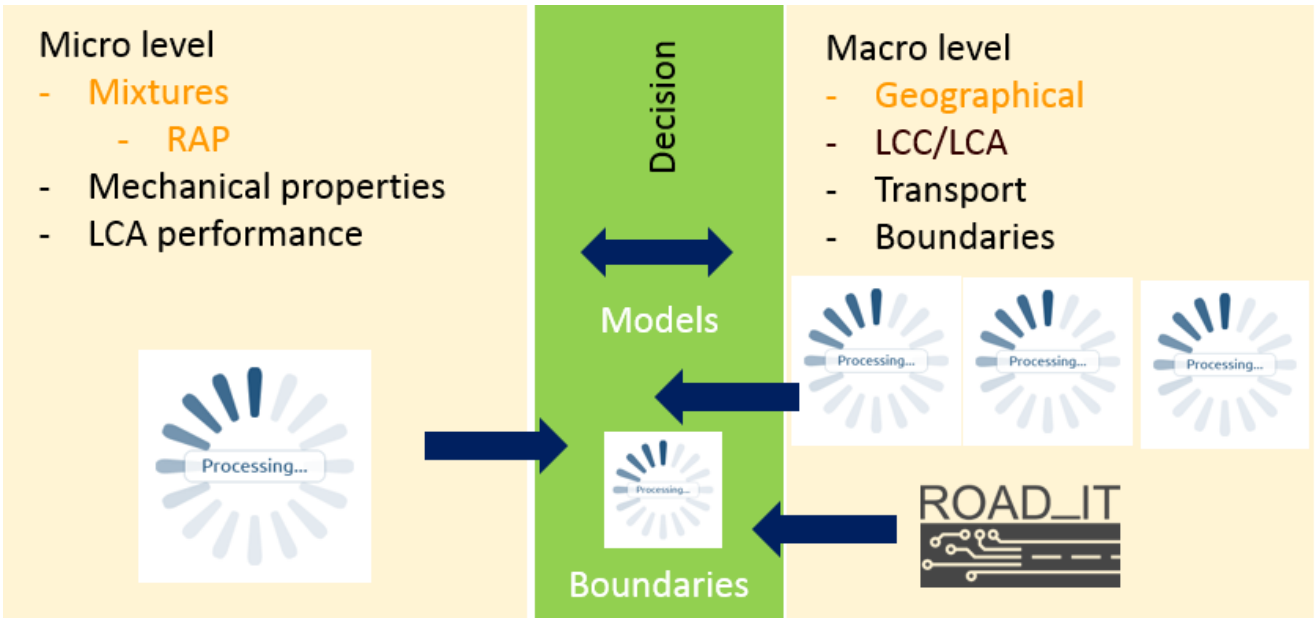
Objectives and Research Needs

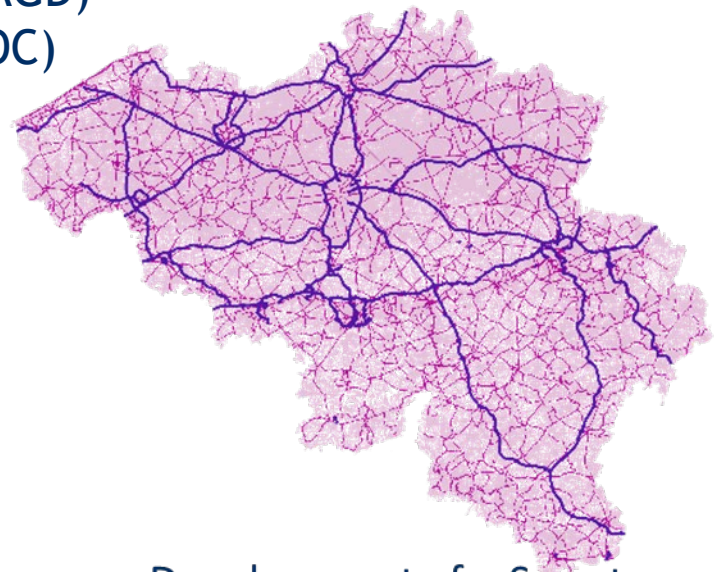
- Objectives: (1) evaluate data sources and accessibility and (2) discuss legal aspects for further research and valorization
- Research at UAntwerp: (1) model the behavior of the road infrastructure (visco-elastic plastic deformation model); (2) correlate actual performance/service life with predicted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

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

SSMARAGD: circular use

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





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

Conclusions

- Technology to generate store data is available
- Use of data as
  - Input/parameters in GPP tools, LCA/LCCA databases
  - Predictive models (PMS, insurance, warranty period)
  - Research and development
- Road structure: not only for asphalt, for all layers
- Properties of Bitumen (virgin, ageing process)
  - Crucial
  - Open database?
  - Future use of bitumen?
- Collaboration and coordination between disciplines

Thank you

University of Antwerp

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Sustainable Pavements and Asphalt Research SuPAR

University of Antwerp

https://www.uantwerpen.be/en/research-groups/supar/

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SuPAR | Sustainable Pavements and Asphalt Research

Asphalt Innovation Symposium

December 13th 2023, Antwerp