



HRVATSKO ASFALTERSKO DRUŠTVO

CROATIAN ASPHALT ASSOCIATION

# USE OF INVENTIVE ASPHALT TRANSPORT TECHNOLOGY TO PREVENT PREMATURE ASPHALT PAVEMENT DAMAGES WITH POSITIVE INFLUENCE ON CO<sub>2</sub> EMISSION

KORIŠTENJE INVENTIVNE TEHNOLOGIJE  
**PRIJEVOZA ASFALTA ZA SPRJEČAVANJA  
PRIJEVREMENIH OŠTEĆENJA ASFALTOG  
KOLNIKA S POZITIVNIM UTJECAJEM NA  
SMANJENJE EMISIJE CO<sub>2</sub>**

MARTIN FLIEGL

**MEĐUNARODNI SEMINAR ASFALTNI KOLNICI 2021**

INTERNATIONAL SEMINAR ASPHALT PAVEMENTS 2021

OPATIJA, 30.09. – 01.10. 2021.

# VSEBINA/CONTENT

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- **Requirements + regulations (theory)**
- **Requirements + Regulations in practice**
- **Segregation – Problems in practice**
  - 1) Mechanical segregation
  - 2) Thermal segregation
  - 3) Binder / bitumen segregation
- **Requirements – regulations / solutions to practical problems**

## **Asphalt temperature from mixer to installation**

-Research by the Technical University of Vienna

## **Temperature progression during asphalt installation with thermally insulated dumper and push-off vehicles**

-research by the Bauamt Berlin (Building Authority)

## **Thermography systems, the current state of the art**

## **Preventing accidents – safe construction site**

## **Costs / benefits for the contracting construction company / contract-awarding building authorities**

## **Environmental Protection**

## Requirements and regulations Theory

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- The mix in the paver bucket should
  - a) in regard to the **temperature** (in accordance with ZTV Asphalt)
  - b) in regard to the **grain structure** (grading curve) be **evenly** distributed
  
- The basic prerequisite for long-lived asphalt surfaces !!!

# Mix temperatures

**As specified by ZTV Asphalt-StB 07:**

Tab.: Lowest and highest temperature of the asphalt mix in °C

Binding agent	Type of asphalt mix	
	AC	SMA
TL bitumen		
30/45	155-195	
50/70	140-180	150-190
70/100	140-180	150-180
10/40-65	160-190	
25/55-55	150-190	150-190

- The lower limits apply with deliveries to the construction site

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25/55-55	150-190	150-190

- The lower limits apply with deliveries to the construction site
- The upper limits when leaving the asphalt mixing plant and the silo. Information provided by the manufacturer must also be observed
- Mixing temperatures must be reduced by -> CO2 emissions! + MAK values = lower aerosols + fumes in the workplace



# PROBLEMS IN ASPHALT ROAD CONSTRUCTION

**With conventional  
transport technology**

Even when transporting mix materials with conventional **thermally insulated (dumper) vehicles**, one of the main problems in asphalt road construction has not been solved – **SEGREGATION**



## Requirements and regulations – practical problems

### 1. MECHANICAL AND GRANULAR SEGREGATION

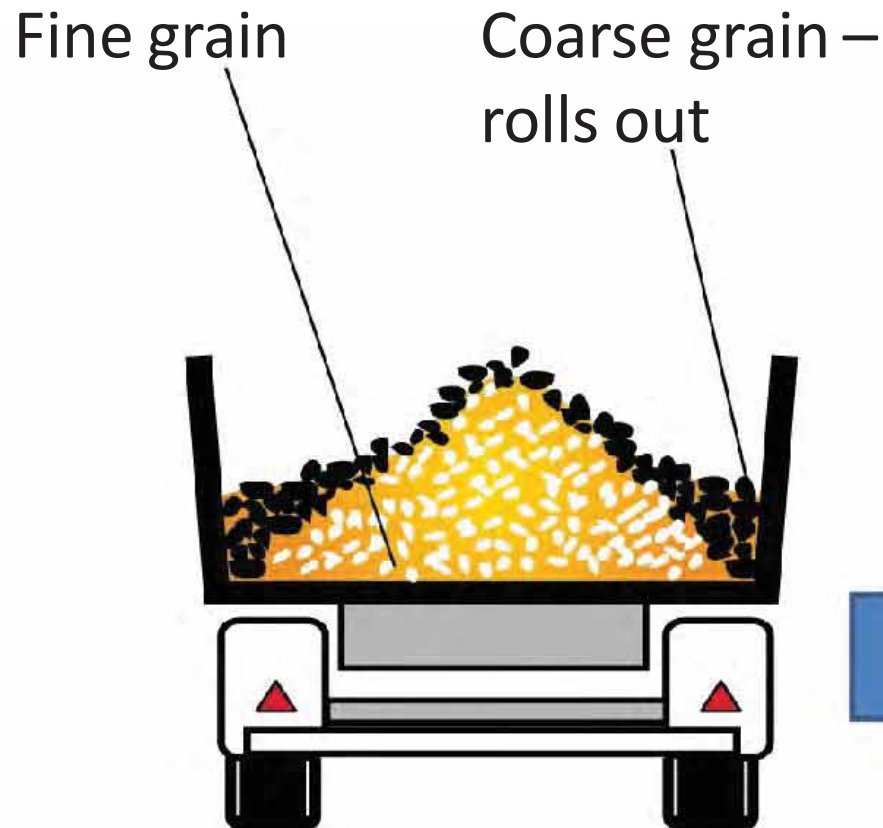
## Homogeneous mix ??

Early consequential damage, e.g. loss of material, grain break out, frost damage, is inevitable here



## Cause of granular segregation

coarse grains roll outward – coarse grains come out at the start



**Clusters of coarse grain usually occur at intervals**



$$\frac{\text{Tonnage per truck load}}{\text{Installation depth (m) x installation thickness (m) x } 2.5 \text{ to/m}^3} = \text{Distance (m) from clusters (coarse grain and cold spots)}$$

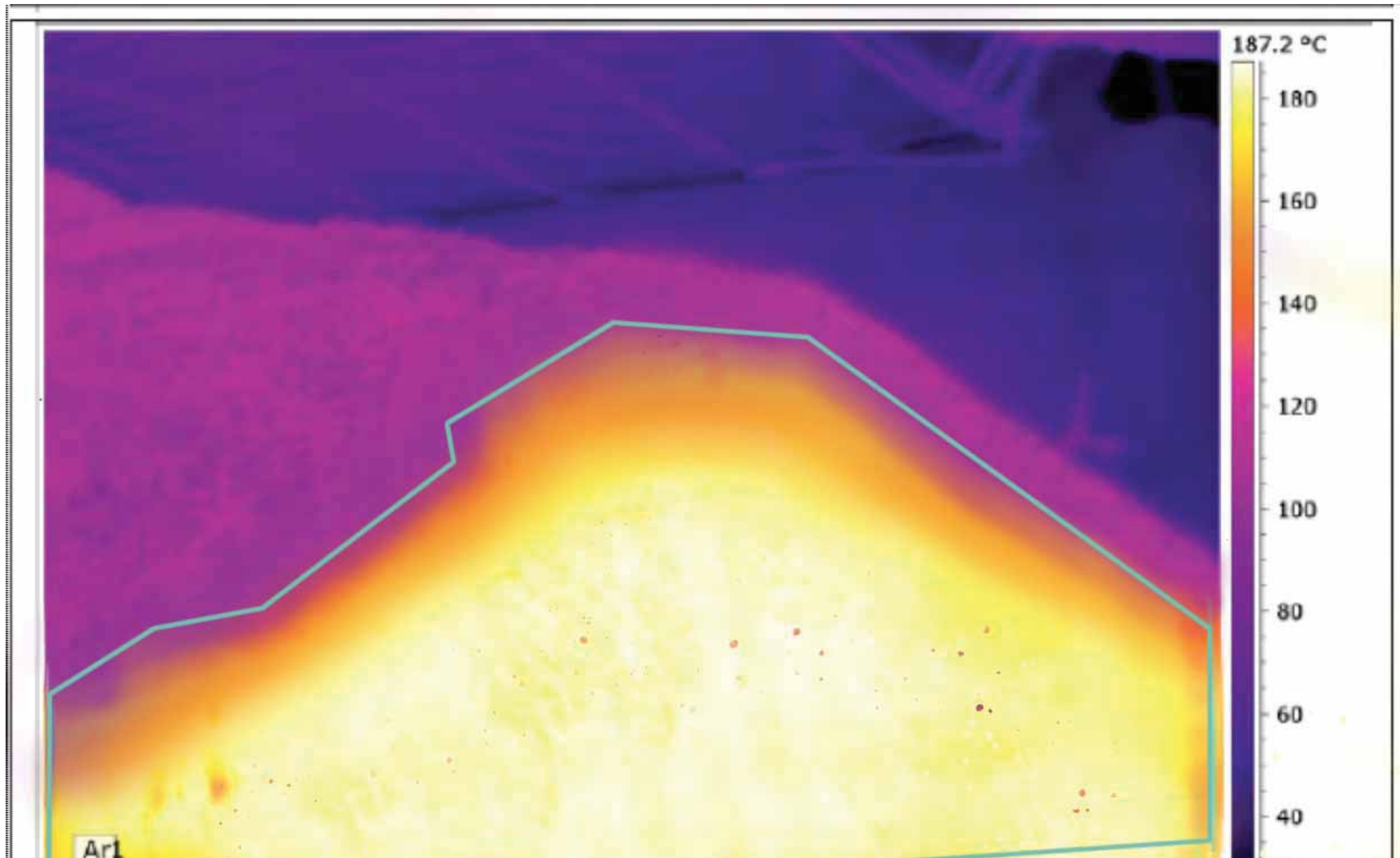




## 2. THERMAL SEGREGATION

Requirements and regulations – practical problems

### Causes of thermal segregation – cold layer clearly visible on the top

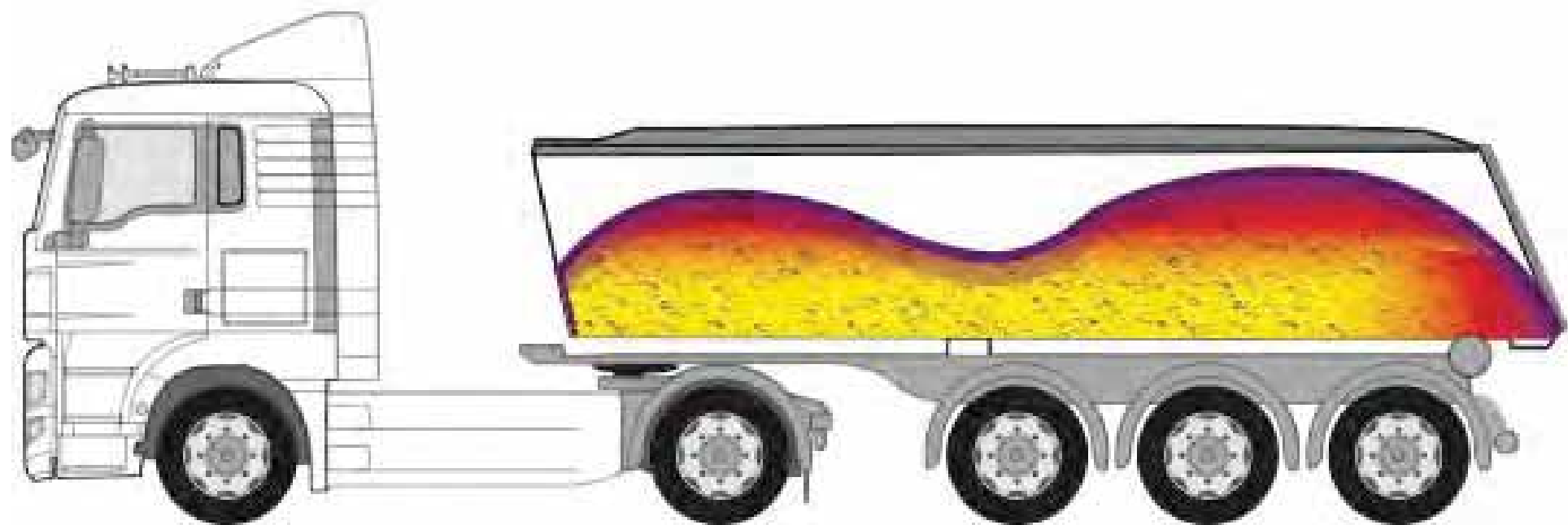




## Requirements and regulations – practical problems

### 2. THERMAL SEGREGATION

#### Causes of thermal segregation – cold layer clearly visible on the top

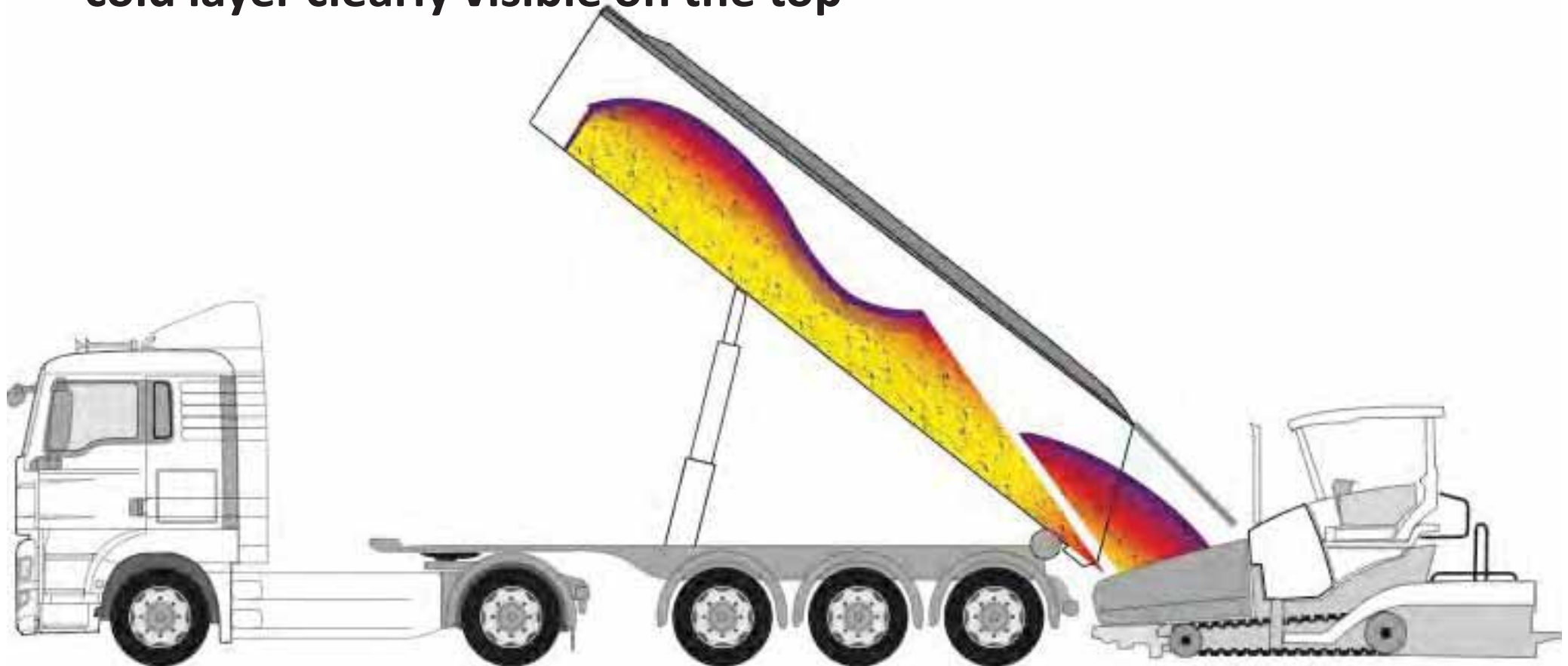




## Requirements and regulations – practical problems

### 2. THERMAL SEGREGATION

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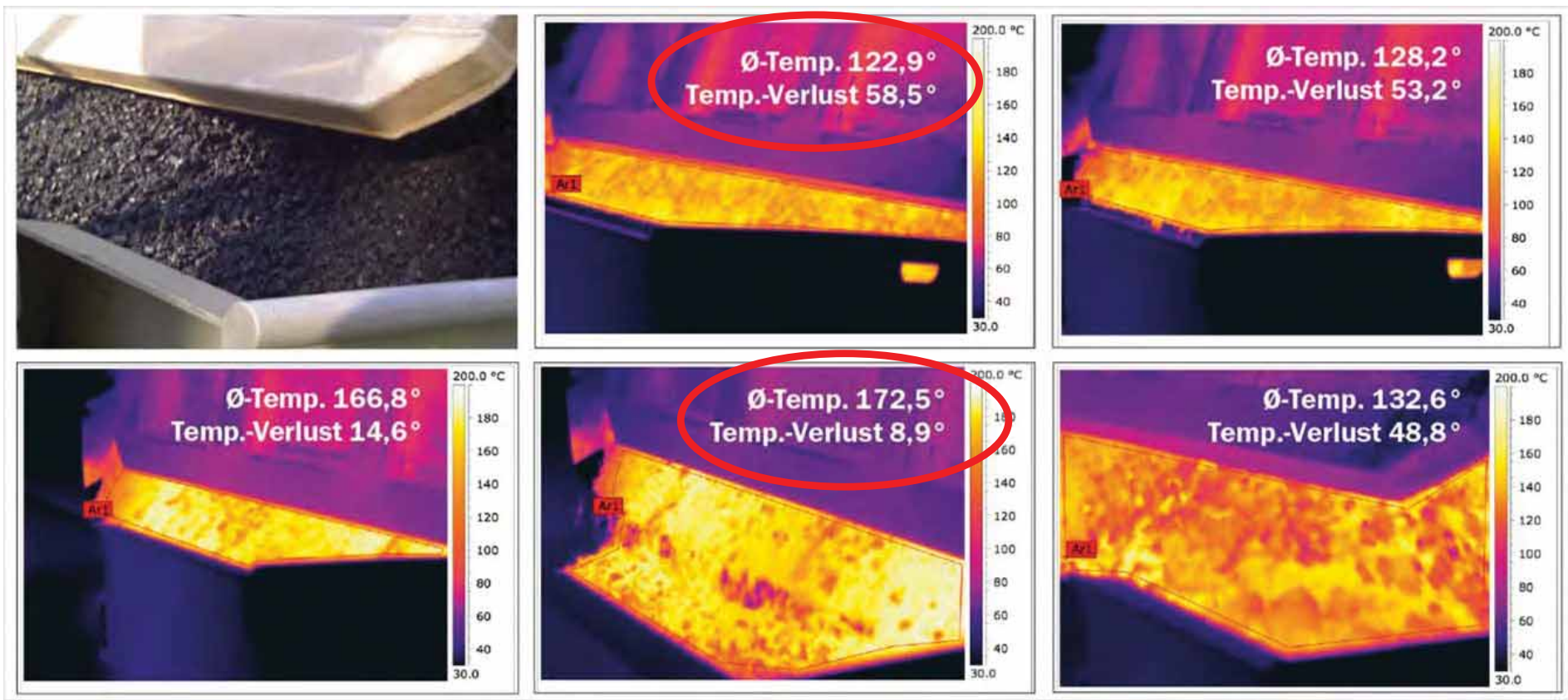


# Requirements and regulations – practical problems

## 2. THERMAL SEGREGATION

### Thermal segregation during asphalt transport

#### Temperature progression during unloading (thermal dumper)



$$\frac{\text{Tonnage per truck load}}{\text{Installation depth (m)} \times \text{installation thickness (m)} \times 2.5 \text{ to/m}^3} = \text{Distance (m) from clusters (coarse grain and cold spots)}$$

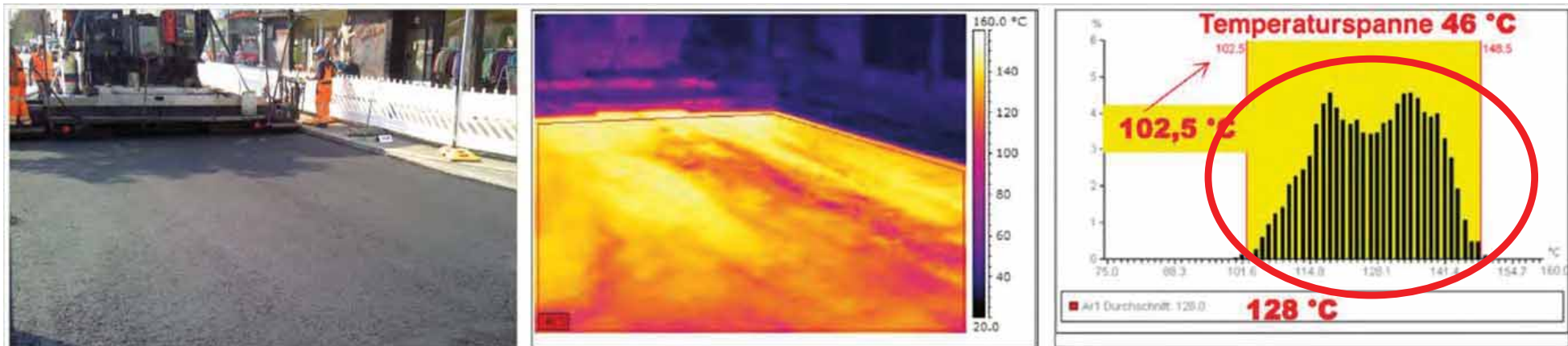
## Requirements and regulations – practical problems

### 2. THERMAL SEGREGATION



## Thermal segregation during asphalt transport

➔ Sometimes significant temperature differences on dumper vehicles before the first roller pass



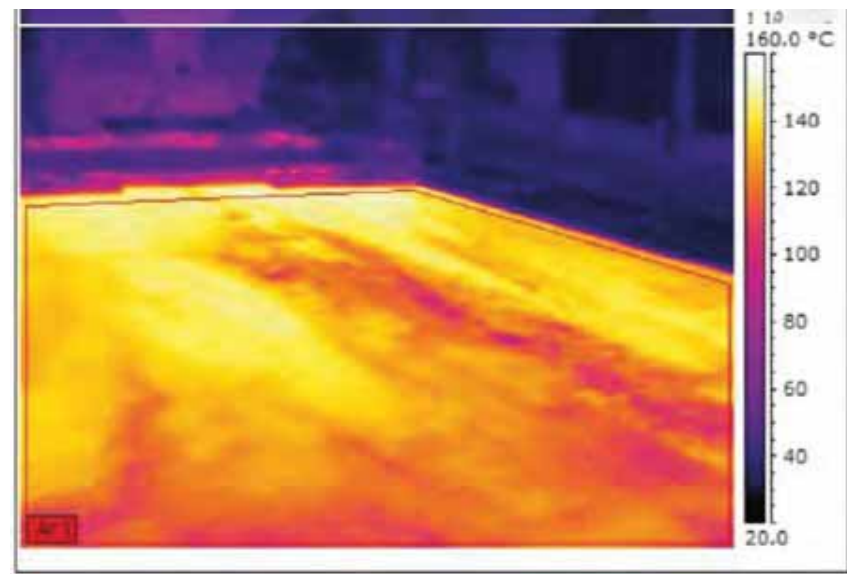
The use of thermally insulated vehicles reduces the average loss of temperature by around 3-5°C compared with conventional vehicles that are not insulated –  
**but doesn't solve the problem of segregation.**

## Relationship between compaction and mix temperature

### 2. THERMAL SEGREGATION

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- In practice, this leads to higher mixing temperatures in asphalt production**
- > in the upper range exponentially increasing energy and raw material requirements and CO2 emissions
  - > Higher mixing temperature -> increased MAK values / vapors / aerosols



MAK value: Maximum workplace concentration value



# SOLUTION: PERMANENT MIXING

**Basic prerequisite  
for high installation quality**

## Requirements and regulations from practical applications

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### CIVIL ENGINEERING

Transportation of concrete?

How would you handle transportation?



With dumper??

➔ Considerable segregation



**‘The main thing is that it's cheap??’**



**‘Quality has priority!!!’**



## Requirements and regulations from practical applications

### CIVIL ENGINEERING

Transportation of concrete?

How would you handle transportation?



With dumper??

➔ Considerable segregation



with concrete mixer!

➔ Continuous mixing

**‘The main thing is that it's cheap??’**



**‘Quality has priority!!!’**



Requirements and regulations from practical applications

# ASPHALT ROAD CONSTRUCTION Transportation of asphalt?



**'Quality has priority!!!'**



Requirements and regulations from practical applications

## Naturally with push-off technology

"Bit by bit" mechanical and thermal mixing No problem in the event of obstacles, e.g. overhead lines, avenues, traffic lights, underpasses...





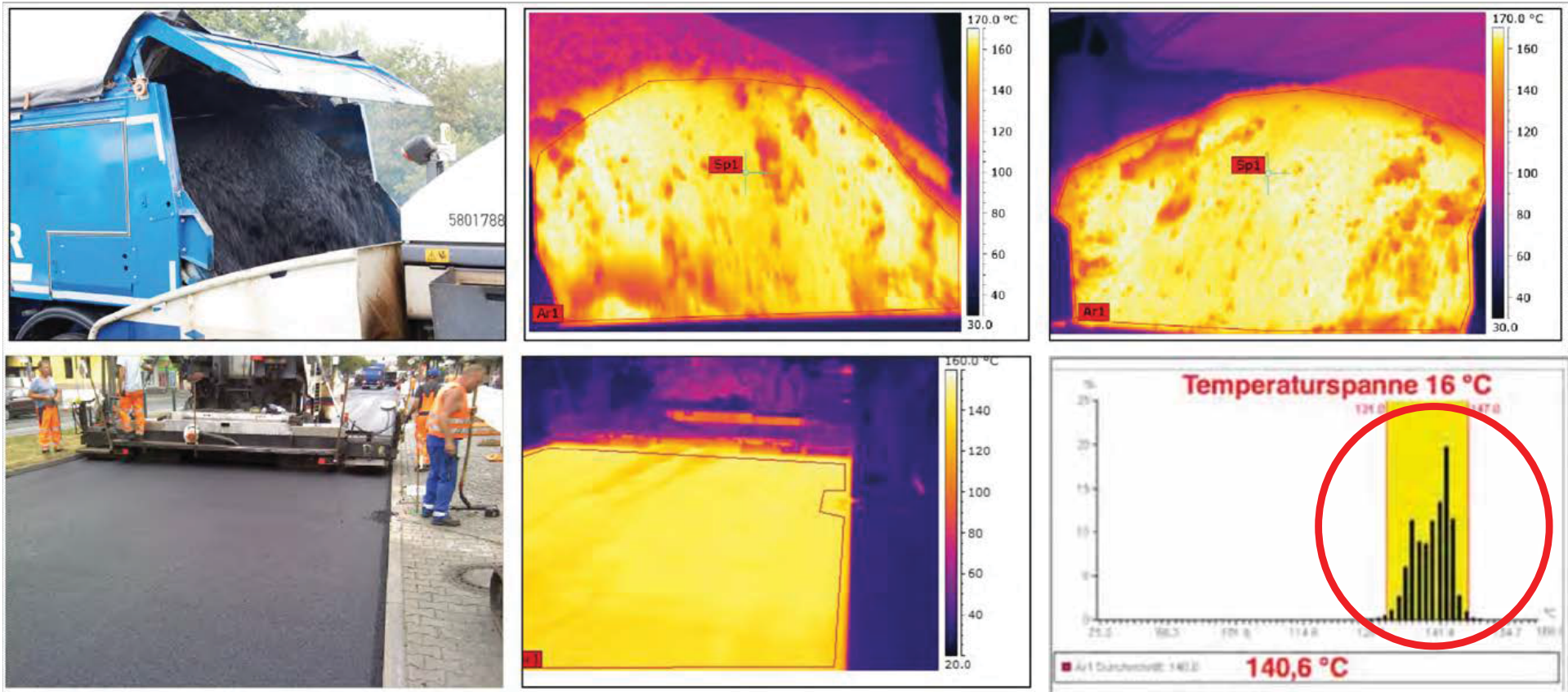
### **Continuous mixing throughout the unloading process** (of temperature as well as bitumen and binder-agent proportions)

- ➔ even distribution of grain sizes (in accordance with grading curve)
- ➔ Dumper bodies clean and completely emptied – also without "Near-East" separator (diesel)



# Requirements and regulations from practical applications

## Continuous mixing

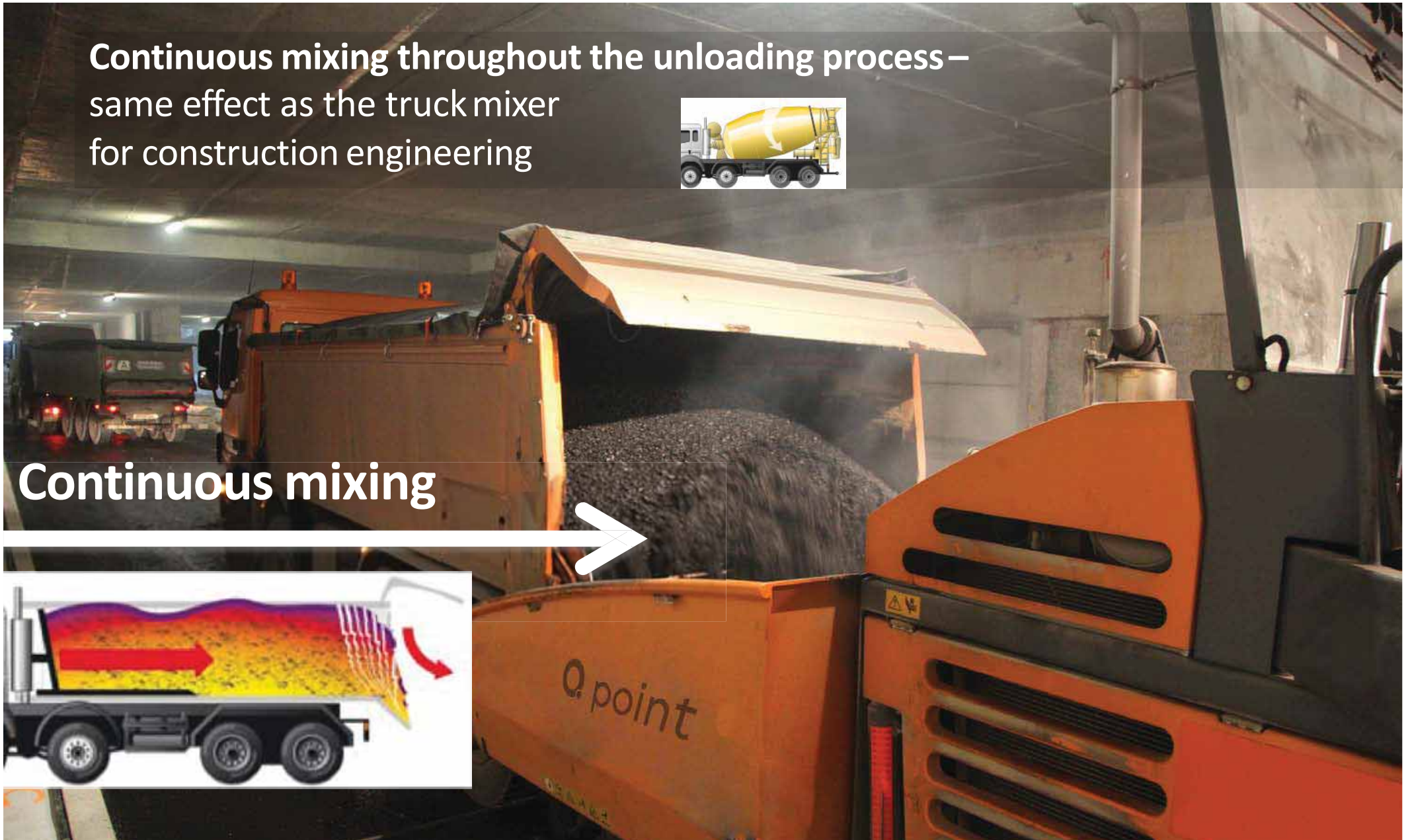




Continuous mixing throughout the unloading process –  
same effect as the truck mixer  
for construction engineering



Continuous mixing



Clean and completely emptied with the push-off technology



**Even with difficult mixes, such as OPA, PMA, LOA, DSHV, rubber or polymer-modified bitumen**



**Result WITHOUT separating agent in the body**



## Distribution screw "Wiesel"

### Professional closing of excavations - direct and metered transfer in pavement pavers

Installation of asphalt for "ancillary areas" such as sidewalks and excavations of utilities - without excavators

- less manual labor
- fast and effective
- hot and homogeneous
- direct trench and benquet filling

Distribution screw "Wiesel" is easy

 attachable / retrofittable







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# Results from a number of studies (PRACTICE)

- **TU Darmstadt**
- **TU Vienna**
- **TU Brunswick**
- **BA Berlin**
- **BPS Austria**
- **KLB Cologne**
- **RUB Ruhr University**
- **Installation of noise-reducing  
layers OPA – Porous Asphalt  
LOA 5 D  
PMA – porous mastic asphalt**



TECHNISCHE  
UNIVERSITÄT  
WIEN  
Vienna University of Technology

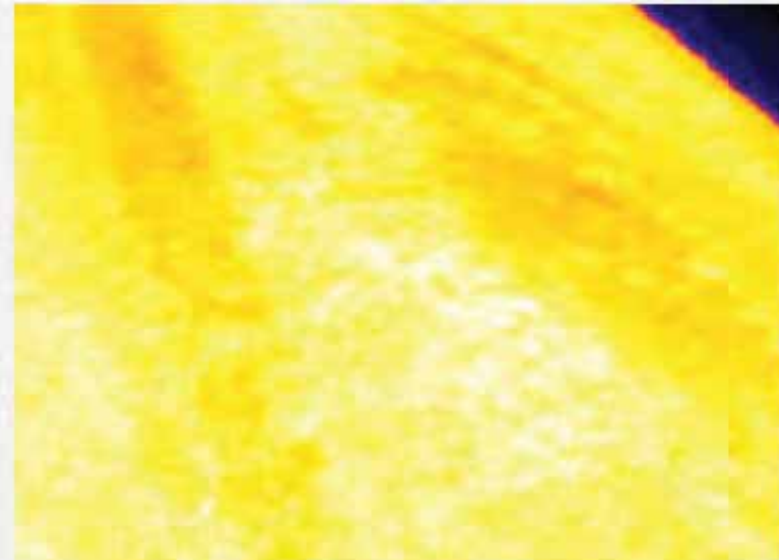
**bi.ivws**

Fakultät für Bauingenieurwesen  
Institut für Verkehrswissenschaften  
Forschungsbereich Straßenwesen

# Asphalt temperature from mixing plant to installation

Temperature measurements taken during construction and  
asphalt technology studies

Project number D230 0615 4003 / 15406



## Im Auftrag des

Magistrats der Stadt Wien  
Magistratsabteilung 28  
Straßenbau und Straßenverwaltung  
Lienfeldergasse 96  
1171 Wien



**Wien, im Dezember 2015**

## 2.1 Construction project / task

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MA 28 installed a new road surface along a **section of approx. 465 metres** on Pausingergasse in 1140 Vienna in March / April 2015.

The following structure was realised:

- 3 cm AC11 surface, PmB 45/80-65, A2, G1
- 8 cm AC22 binder agent, PmB 25/55-65, H1, G4
- 9 cm AC32 base, 50/70, T1, G4
- 20 cm non-bonded top base layer, U1, 0/63

The difference between two types of delivery, one with conventional dumpers (KK truck) and one with push-off trailers (TA truck), are to be compared and their effect on the installation temperature quantified.

Construction fields

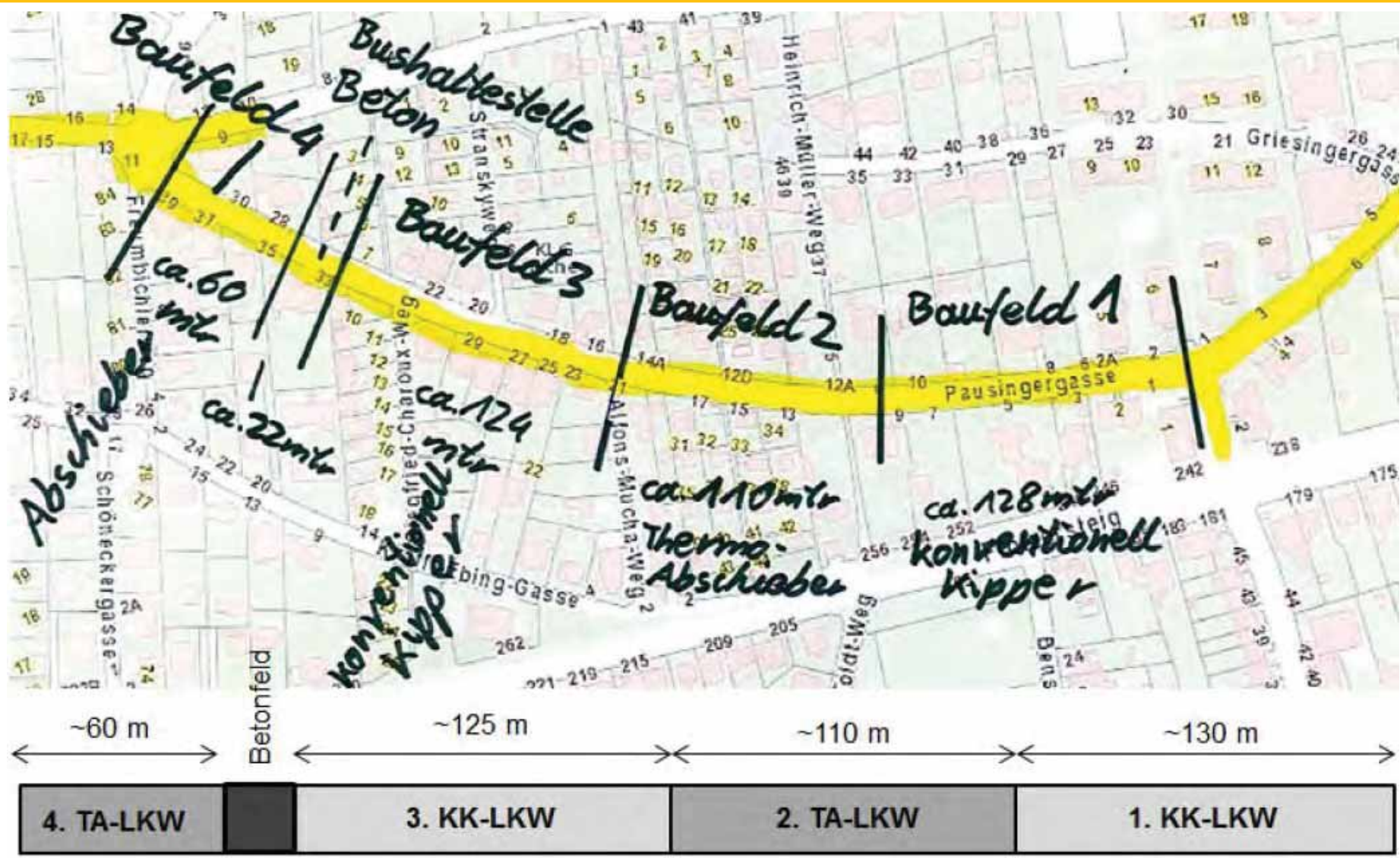


Fig. 1: Layout of the four construction plots

Temperature measurements taken  
from the installed material

The asphalt temperature was measured from the paver directly behind the paving screed. **Two images** (left / right) **were taken for each 5 m subsection.**



At least 30 images were taken for each construction field and layer within a measured section of 75 to 80 metres.

**Fig. 4:**  
Thermal imaging for each 5 m section,  
Laying time approx. 1 min

## Temperature measurements using thermal imaging camera

The thermal images were analysed using the testo IRSoft Version 3.6 software. **The software makes it possible** to show the minimum value, maximum value and average value and indicate **the distribution of the individual values (per pixel) in a single histogram for selected areas.**

**Fig. 7 shows an example of the temperature distributions** over the asphalt surface for an inhomogeneously cool and homogeneously warm area.

From around 30 thermal images for each construction field and asphalt layer, the minimum, maximum and average values for each five-metre section were determined and analysed on the basis of the histograms.

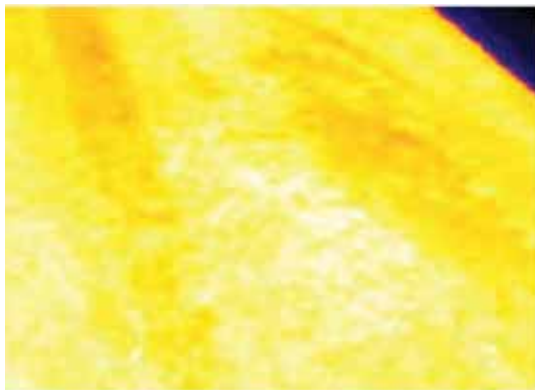




Fig. 7.1: Example of the thermal image analysis of a 5-m section with inhomogeneous

**cool temperature distribution – frequent on (KK) truck changes**

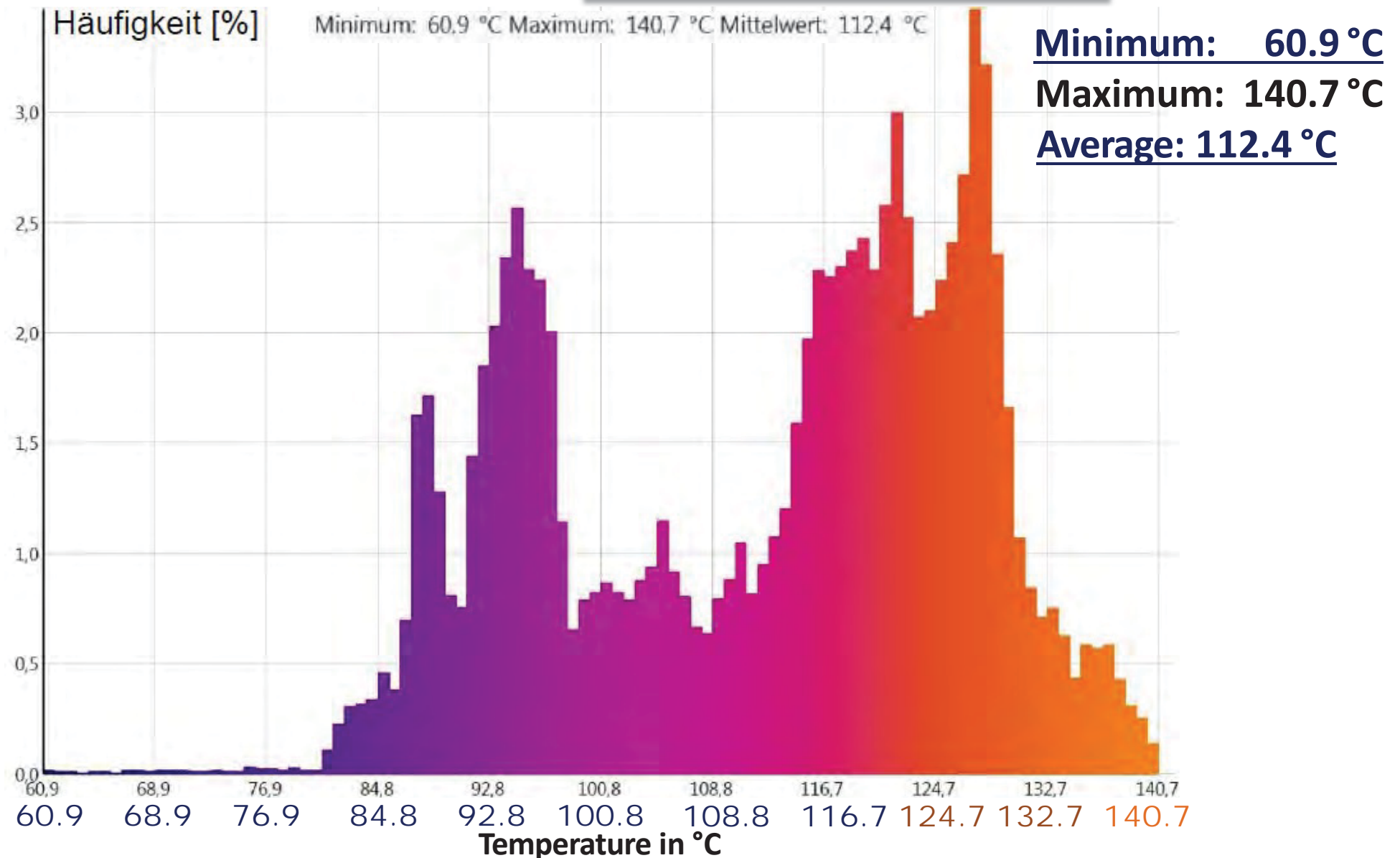
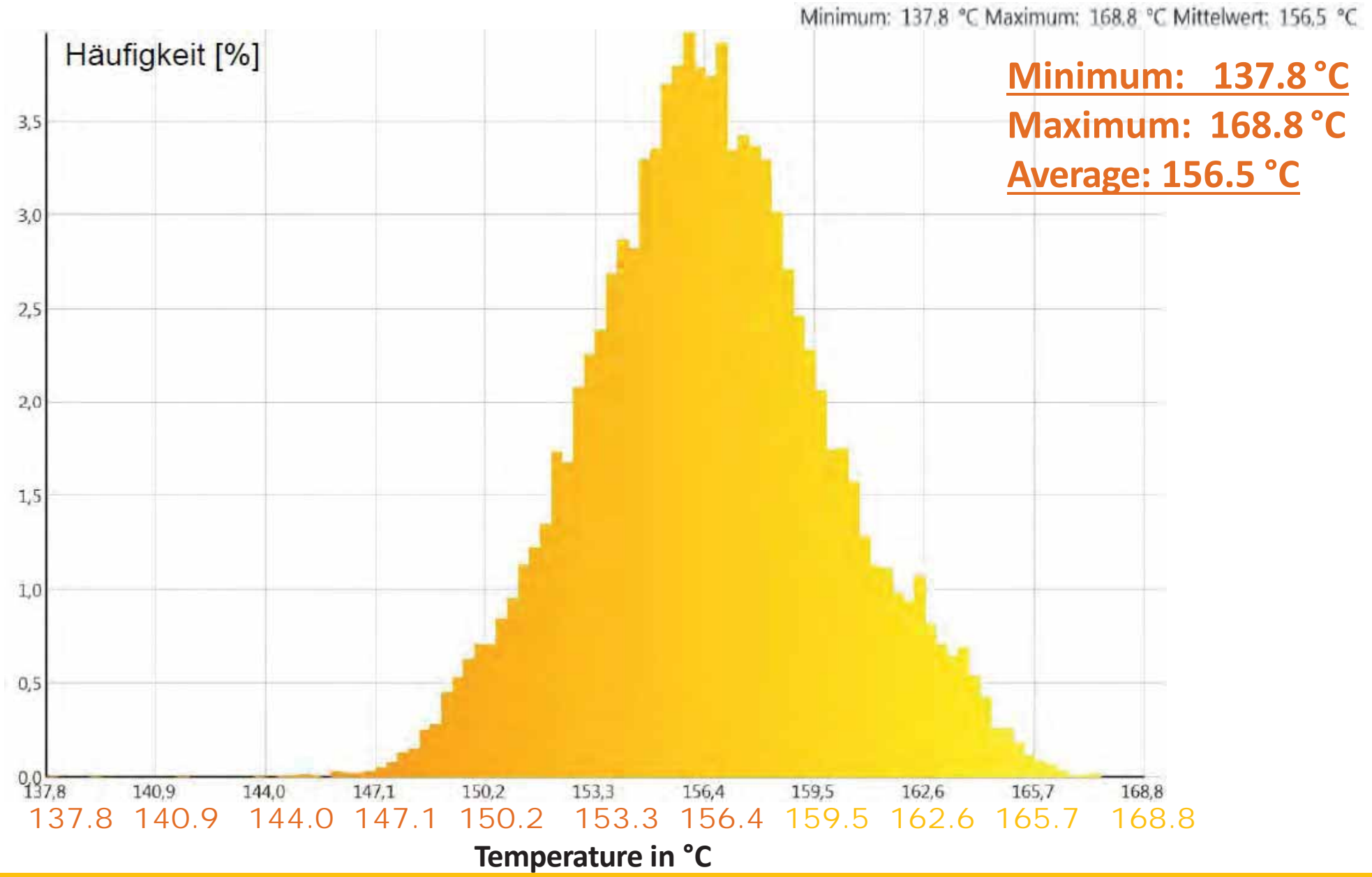


Fig. 7.2: Example of the thermal image analysis for a 5-m section with homogeneous, warm temperature distribution



### 3.2.4 Difference in the asphalt surface temperature with KK and TA after installation

The three asphalt layers (base, binding, surface layers) revealed sometimes large differences in the surface temperature between KK and TA trucks.

**Fig. 9 below shows as an example**

**the average surface temperatures for each 5-m section across the entire length of Construction Fields 1 and 2**  
**for the two versions of delivery (KK truck / TA truck).**

## Average asphalt temperature per 5-m section

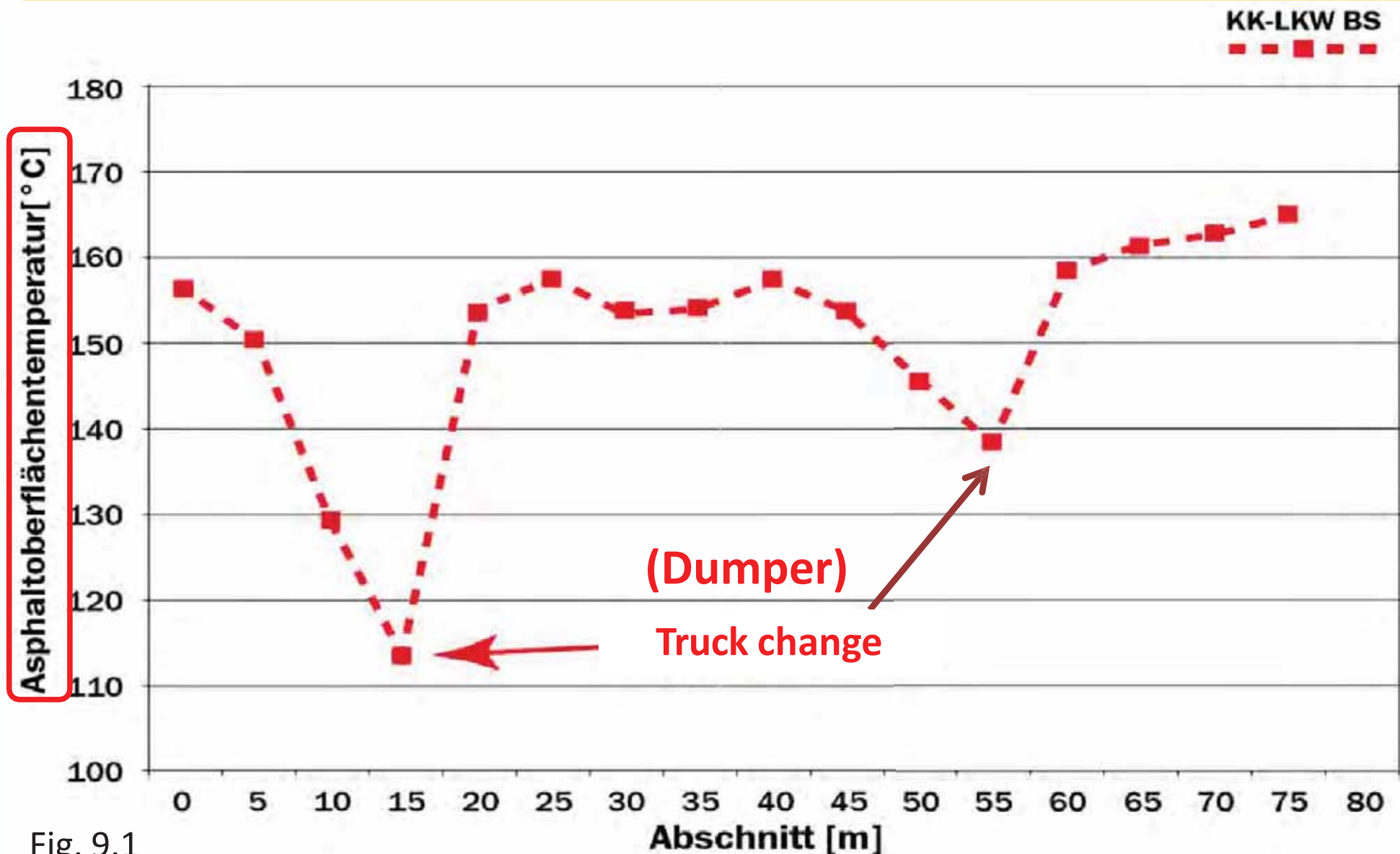


Fig. 9.1

Progression of the **average asphalt surface temperature** after installation for all layers (thermal image)

## Average asphalt temperature per 5-m section

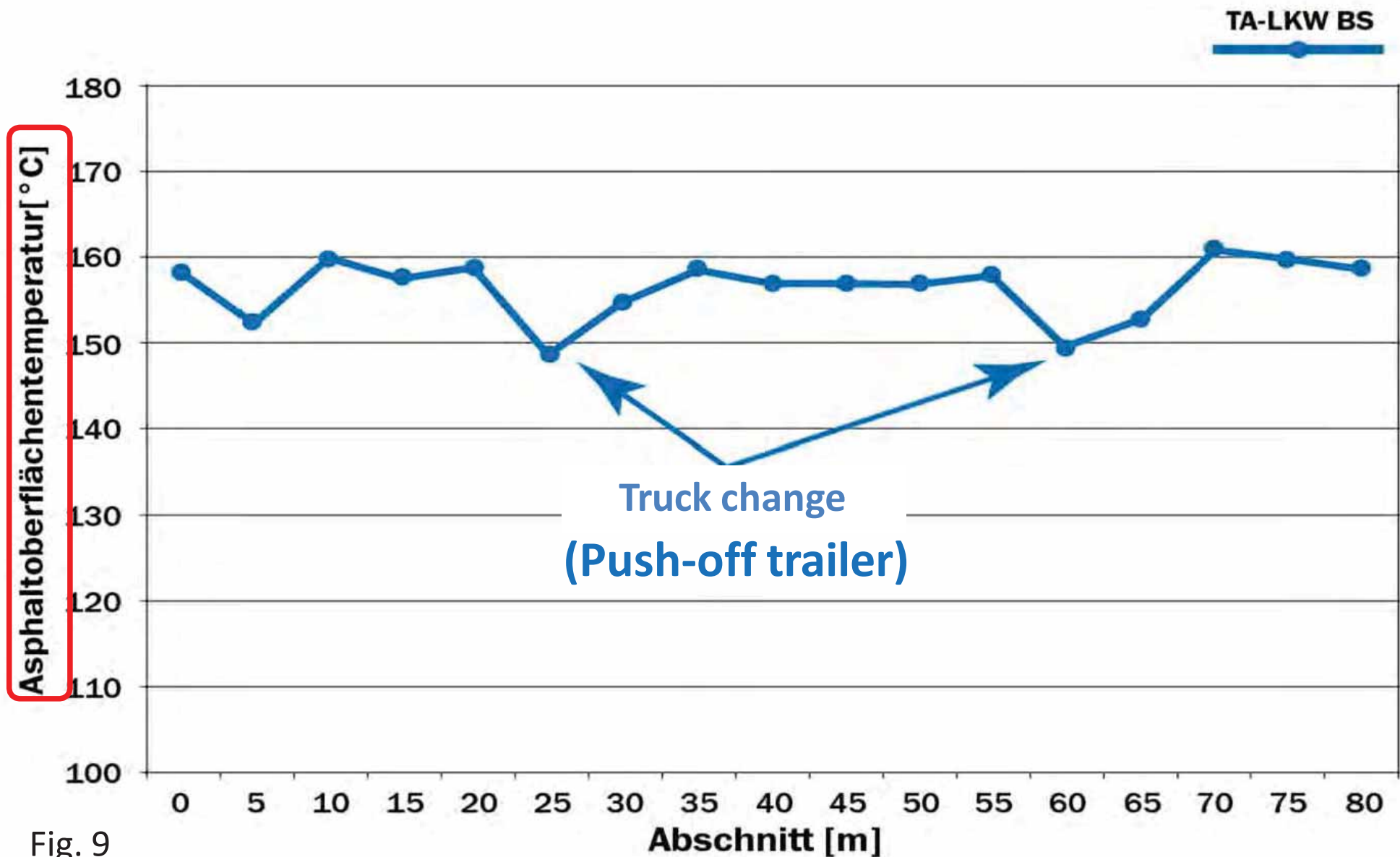


Fig. 9

Progression of the **average asphalt surface temperature** after installation for all layers (thermal image)

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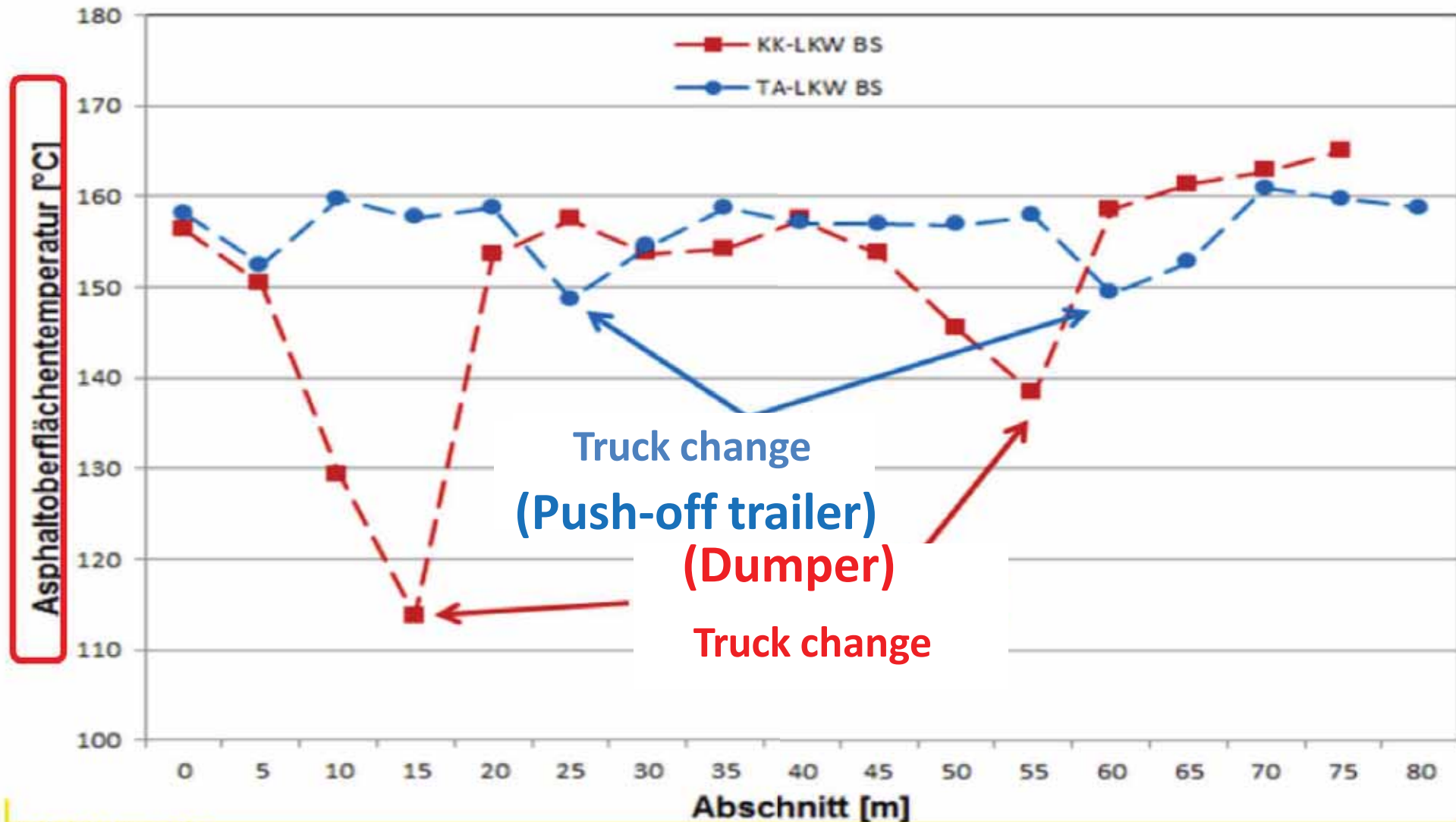


Abbildung 9:

Verlauf der **mittleren Asphaltoberflächentemperatur** nach Einbau für alle Schichten (Wärmebild)

## 5. SUMMARY AND INTERPRETATION

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- **The risk of cold nests occurring was reduced significantly when vehicles with push-off technology were used and a more homogeneous temperature distribution was achieved with the bit-by-bit transfer of mix to the paver.**
- **Using transport vehicles with push-off technology in urban areas also reduces the risk of damage to overhead lines during unloading; they can also be used more easily in tunnels, under bridges in avenues than dumpers can.**

## Construction site report by ASFINAG: VIENNA

"Tunnel rehabilitation – push-off technology secures high quality of road"



**"Around 150,000 m<sup>2</sup> of asphalt with around 50,000 tonnes of mix were installed using push-off technology in the Kaisermühlentunnel, the longest road tunnel in Vienna."**



## Temperature progression during asphalt installation

### Berlin, B96 Residenzstraße

### Installation with thermal bodies

(as required in the specifications)

Sunshine, approx. 25 – 35°C

Binder layer: —

Mix transport with thermally insulated **dumper bodies**

Installation of asphalt binder, two layers, total 10 cm

Designation: AC16 B S, rubber-modified bitumen

Surface layer:

Mix transport in thermally insulated **push-off vehicles**

Installation of a 2.5 cm thick noise-optimised asphalt surface layer

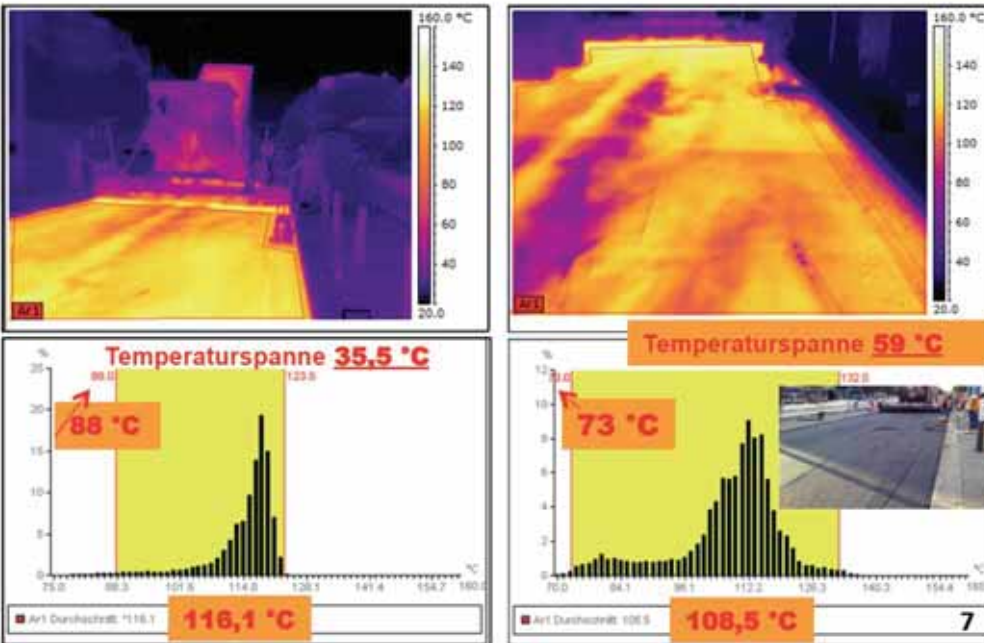
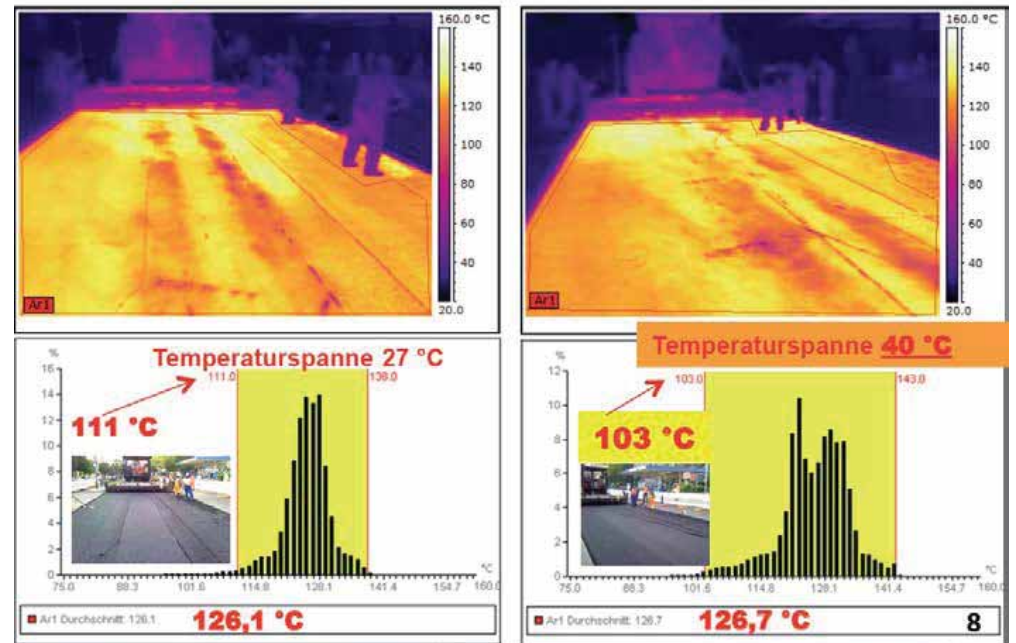
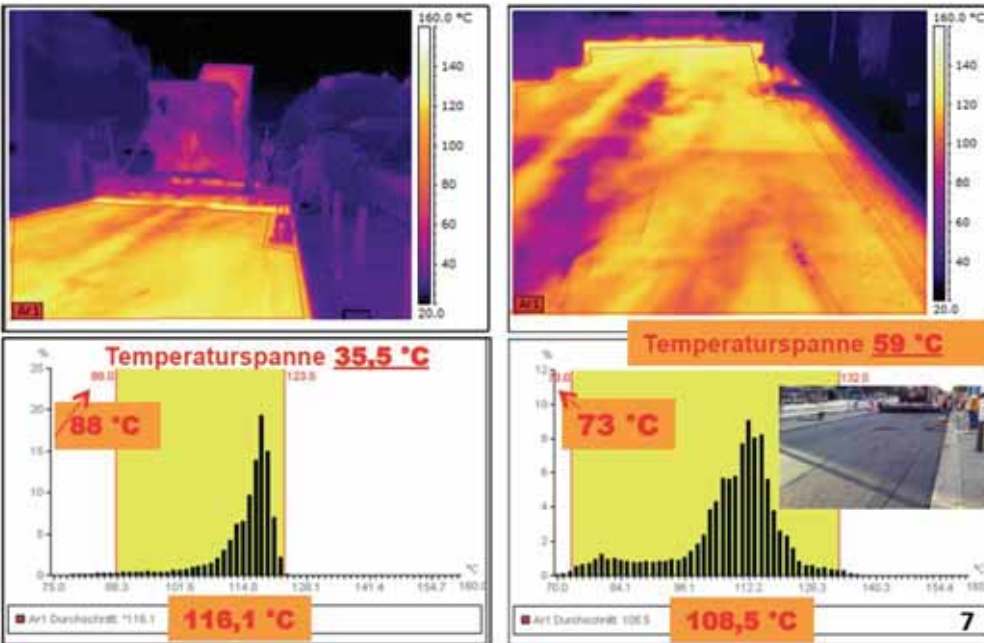
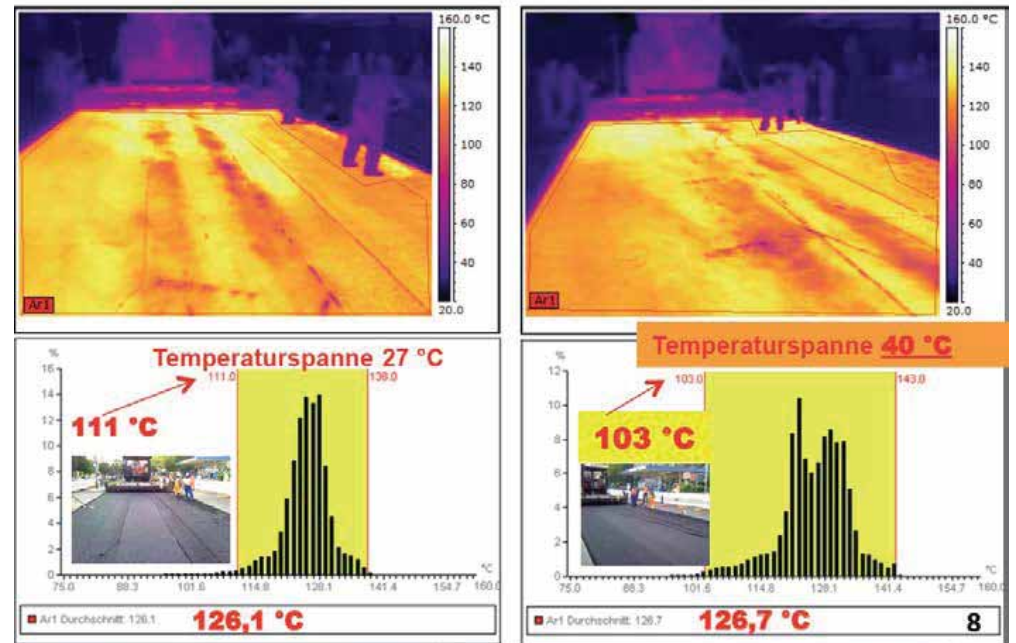
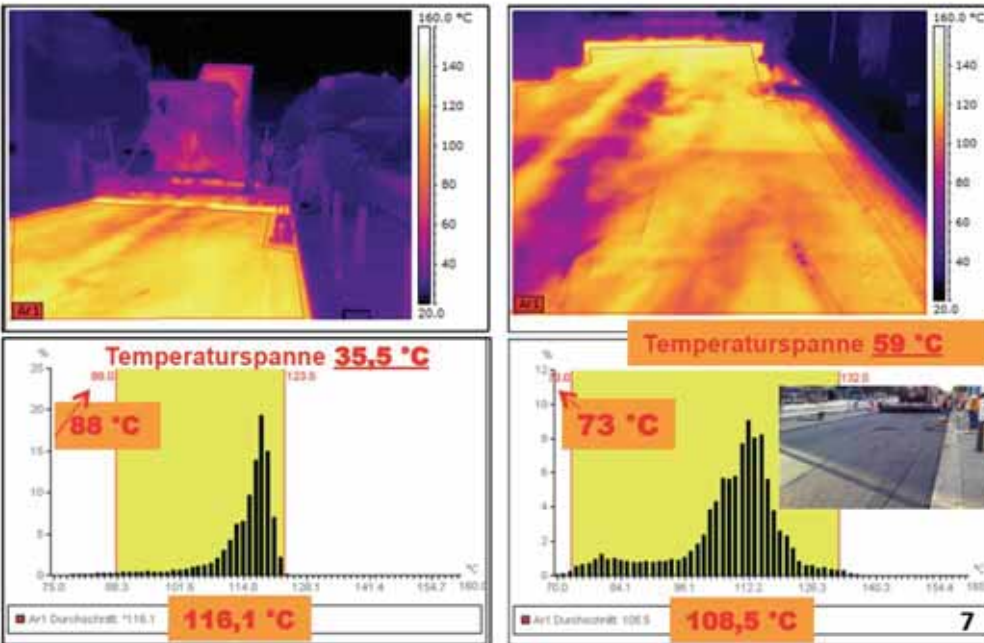
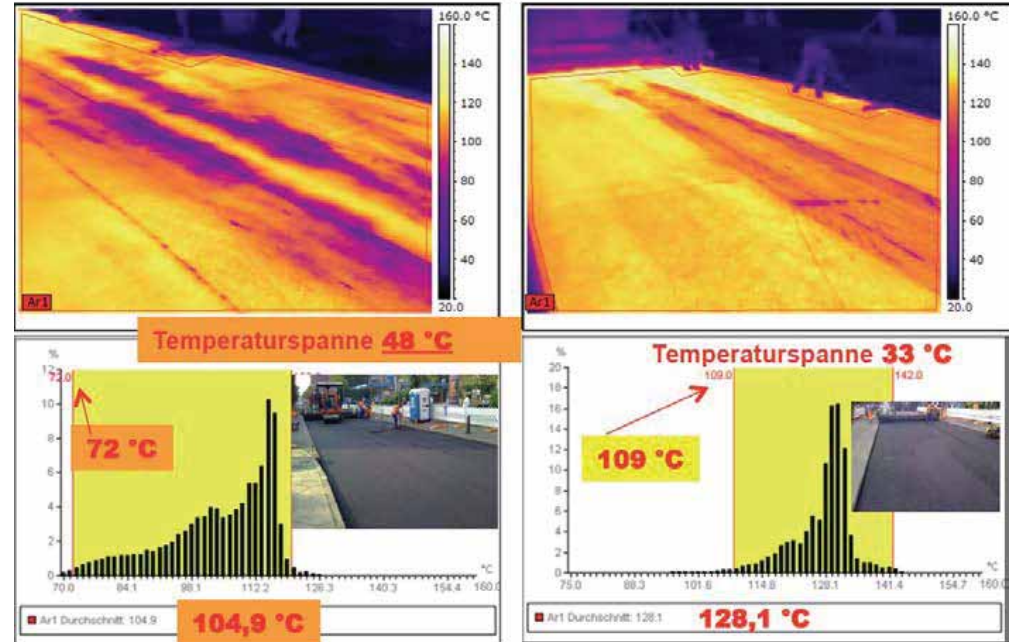


# Temperature progression with thermal bodies – dumpers



Berlin, B96-Residenzstraße\_Einbau mit Thermomulden-Teil 1  
 Witterung: Sonnenschein, windstill, ca. 25 - 28 °C  
 Einbau von Binderschicht von ca. 8.30 Uhr bis 9.15 Uhr

Berlin, B96-Residenzstraße\_Einbau mit Thermomulden-Teil 1  
 Witterung: Sonnenschein, windstill, ca. 25 - 28 °C  
 Einbau von Binderschicht von ca. 8.30 Uhr bis 9.15 Uhr

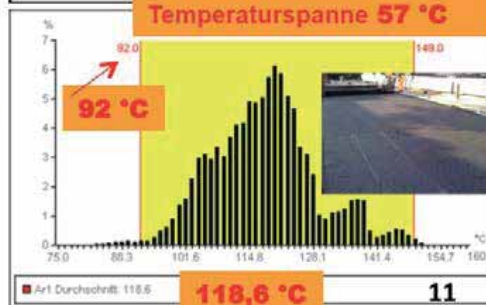
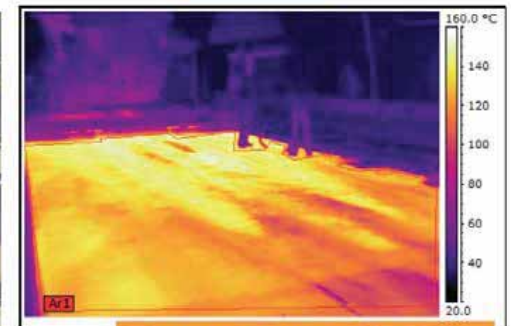
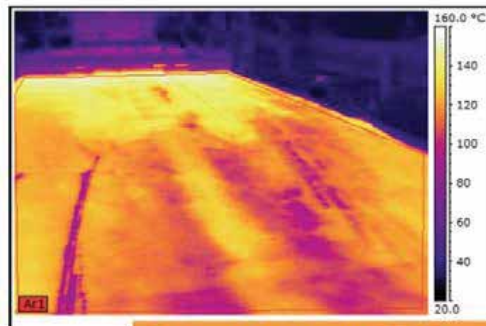
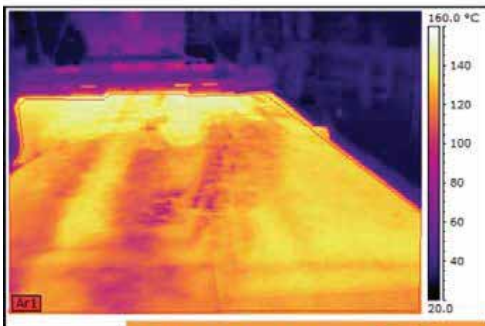
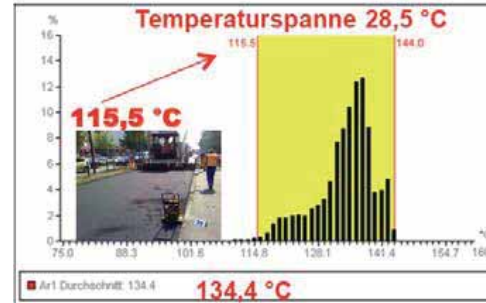
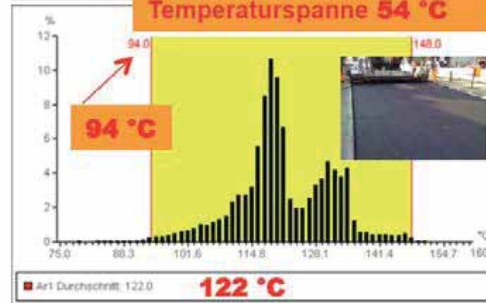
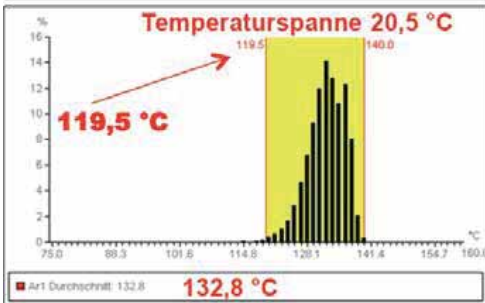
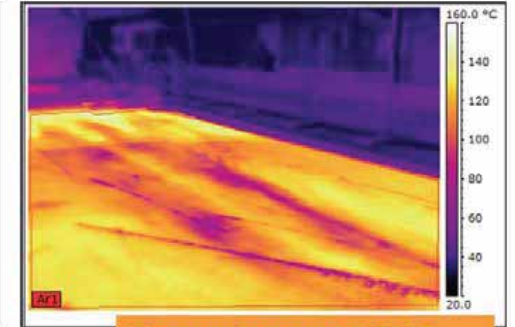
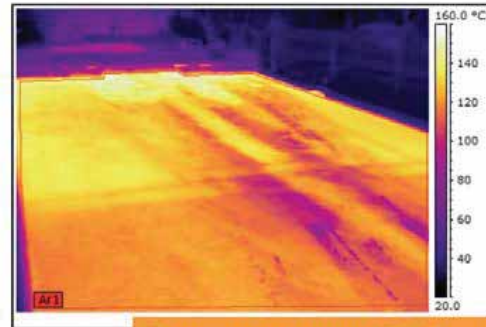
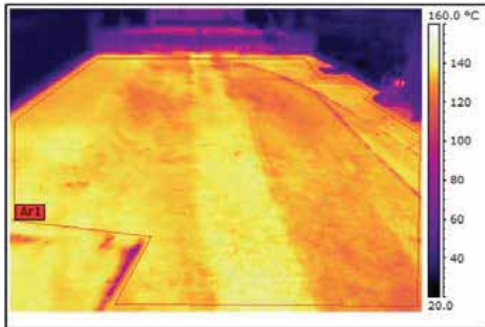


# Temperature progression with thermal bodies – dumpers

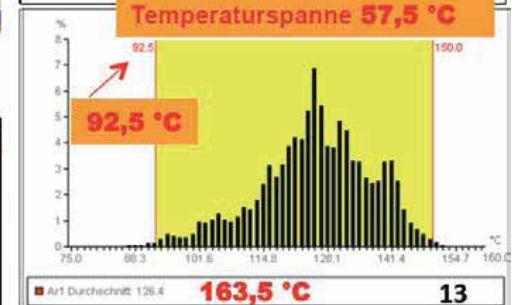


**Berlin, B96-Residenzstraße\_Einbau mit Thermomulden-Teil 2**  
 Witterung: Sonnenschein, windstill, ca. 28-30 °C  
 Einbau von Binderschicht von ca. 9.15 Uhr bis 9.35 Uhr

**Berlin, B96-Residenzstraße\_Einbau mit Thermomulden-Teil 3**  
 Witterung: Sonnenschein, windstill, ca. 30-32 °C  
 Einbau von Binderschicht von ca. 9.35 Uhr bis 10.30 Uhr



Fahrzeugtyp	Thermomulden
Hindernisse wie Ampeln, Bäume, Oberleitungen verursachen Stillstände und Unterbrechungen. Qualitätseinbußen sind unvermeidbar	





## Berlin, B96-Residenzstraße\_Einbau mit Abschiebefahrzeuge

### Temperaturverlauf beim Abschieben

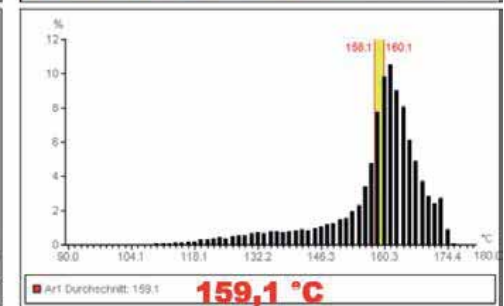
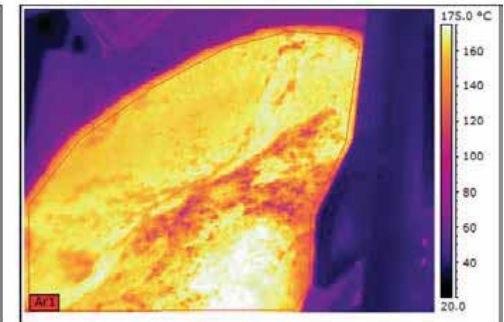
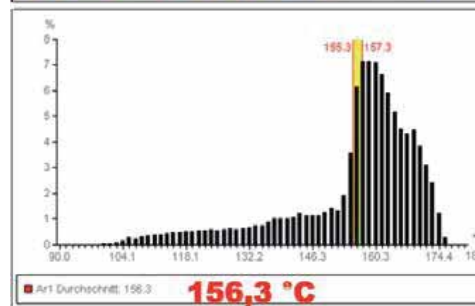
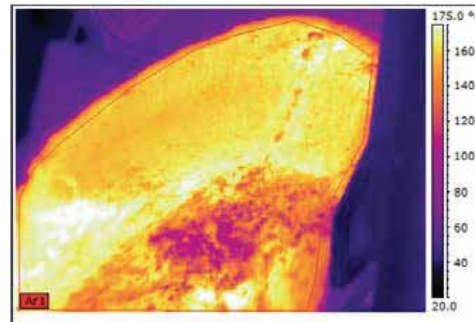
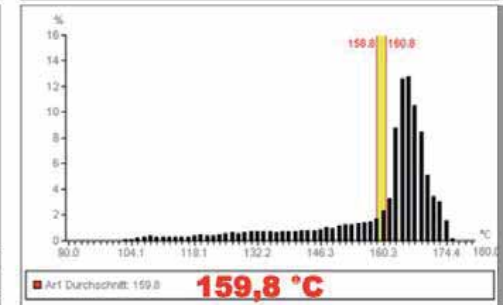
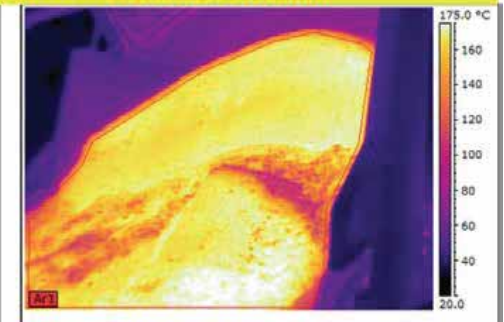
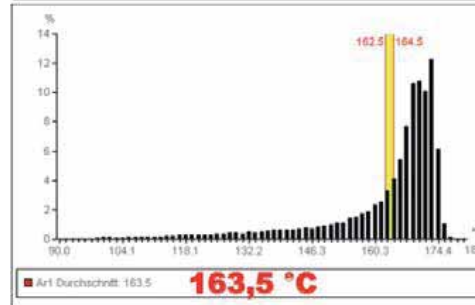
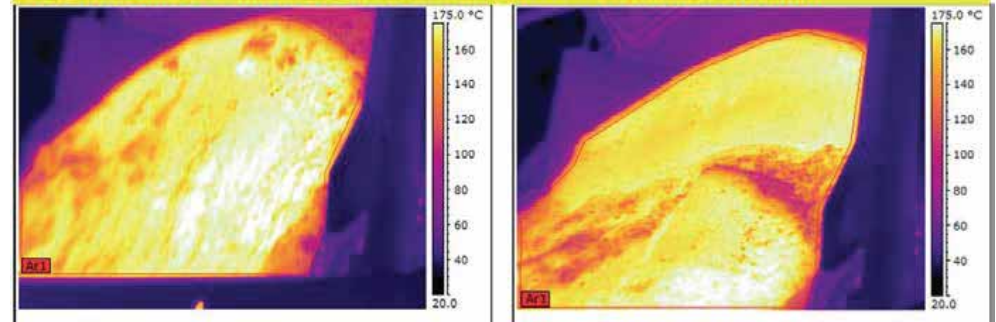
Nachfolgende 4 Aufnahmen entsprechen EINEM Abschiebevorgang



## Berlin, B96-Residenzstraße\_Einbau mit Abschiebefzg.-

### Temperaturverlauf beim Abschieben

Nachfolgende 4 Aufnahmen entsprechen EINEM Abschiebevorgang





## Berlin, B96-Residenzstraße\_Einbau mit Abschiebefzg.-Teil1

Einbau von Deckschicht als **Dünnschichtbelag (2,5cm.)**

Witterung: Bewölkt, windig, Gewitterneigung, ca. 28 -30 °C

15.August, Einbau ca. von 18.00 bis 19.00 Uhr

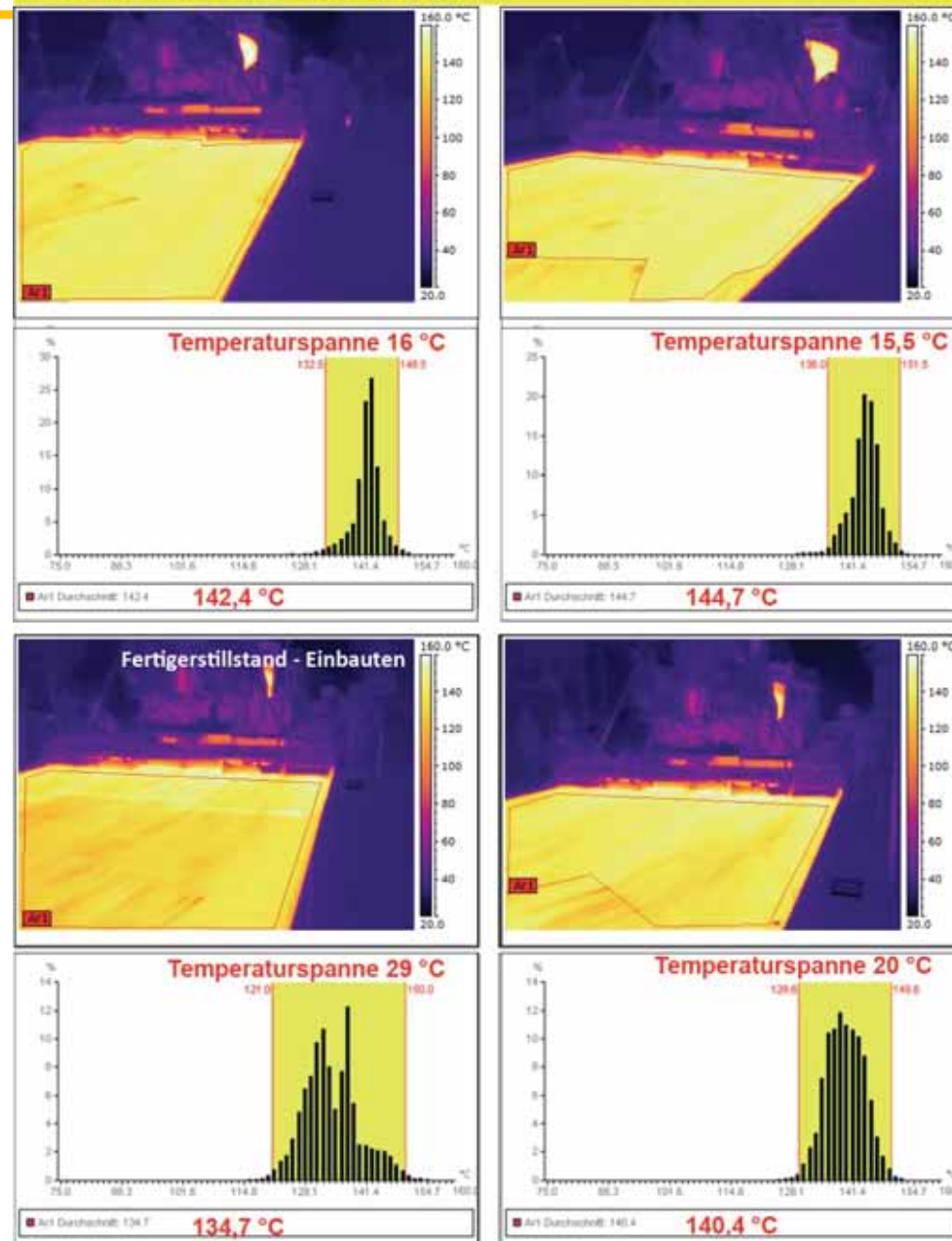


## Berlin, B96-Residenzstraße\_Einbau mit Abschiebefzg.-Teil1

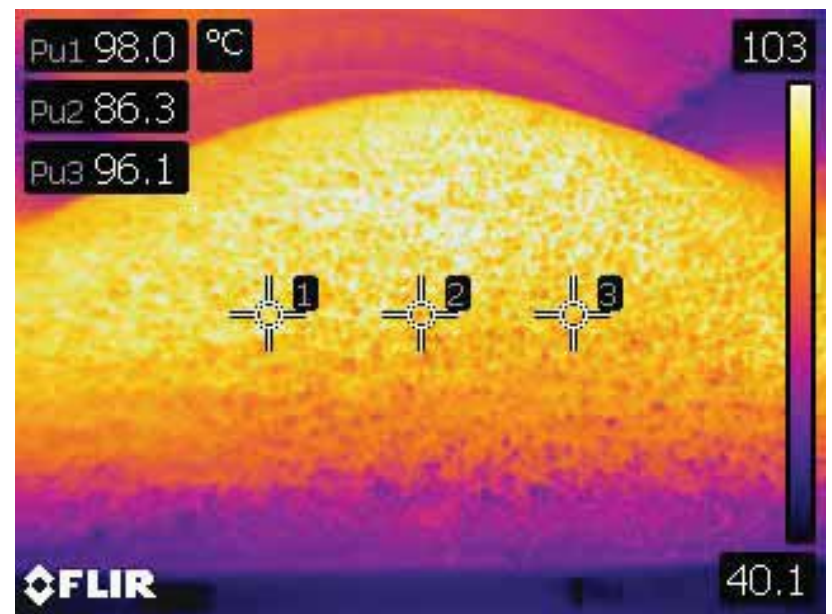
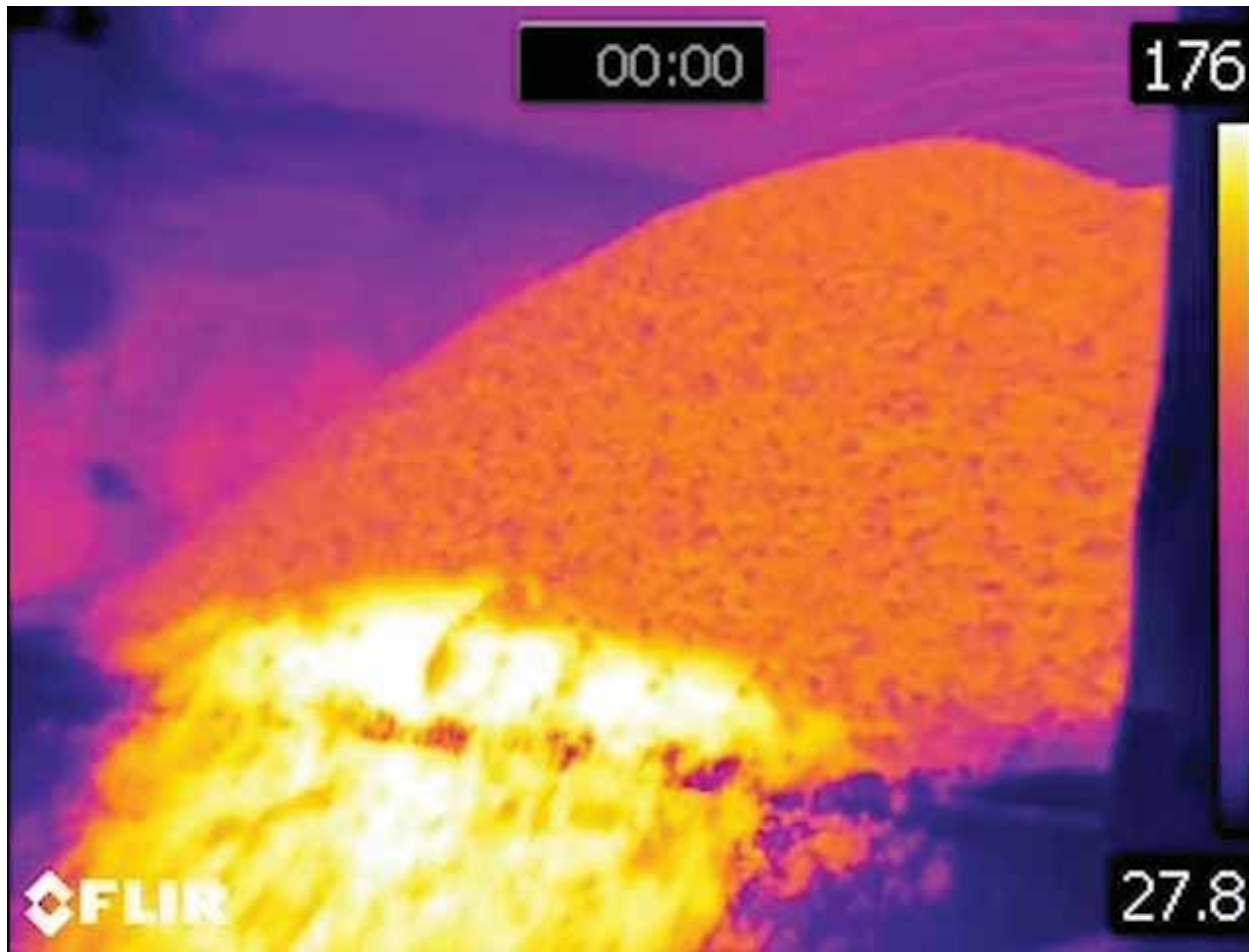
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# Construction site report by road authority: MUNICH

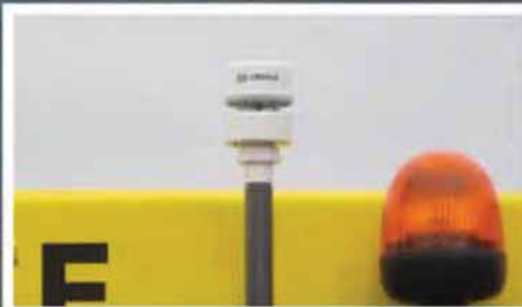


# Construction site report by road authority: MUNICH

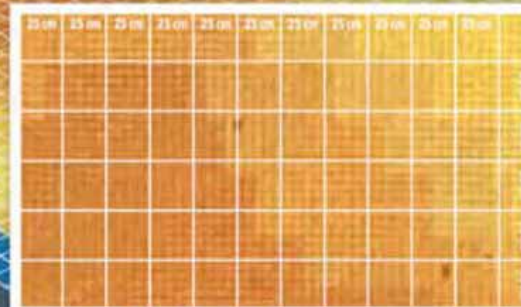


Thermal imaging systems that have proved themselves in practice e.g. Vögle Road Scan

High-precision infrared camera with 100% measuring cover



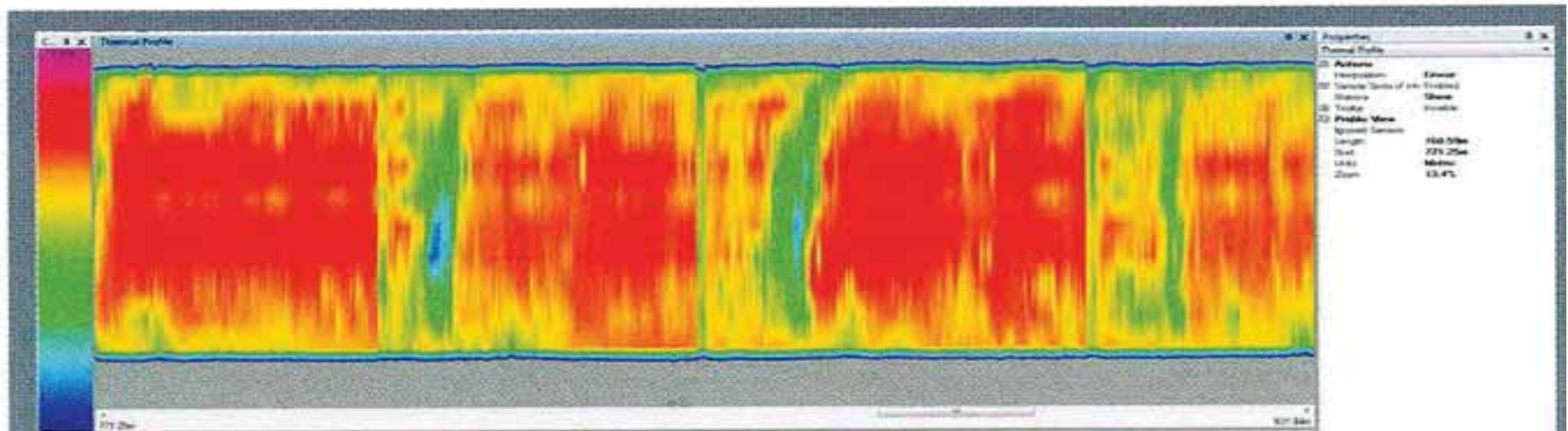
The wind strength, wind direction, ambient temperature, air pressure and humidity may also be documented in addition to the asphalt temperature using a weather station.



The measuring width of 10 metres comprises 40 squares sized 25 x 25 centimetres. Each of these grid areas contains up to 16 individual measuring points from which an average value was calculated. The measurable temperature range is between 0°C and 250°C with a tolerance of just  $\pm 2^\circ\text{C}$



## Thermal imaging systems that have proved themselves in practice e.g. Moba Pave – IR Scan



"Truck changes are often the cause of temperature differences in the mix and may be quickly identified as a clear cold point."

# Site investigations in Bohinj Slovenia, with thermography systems from Vögele

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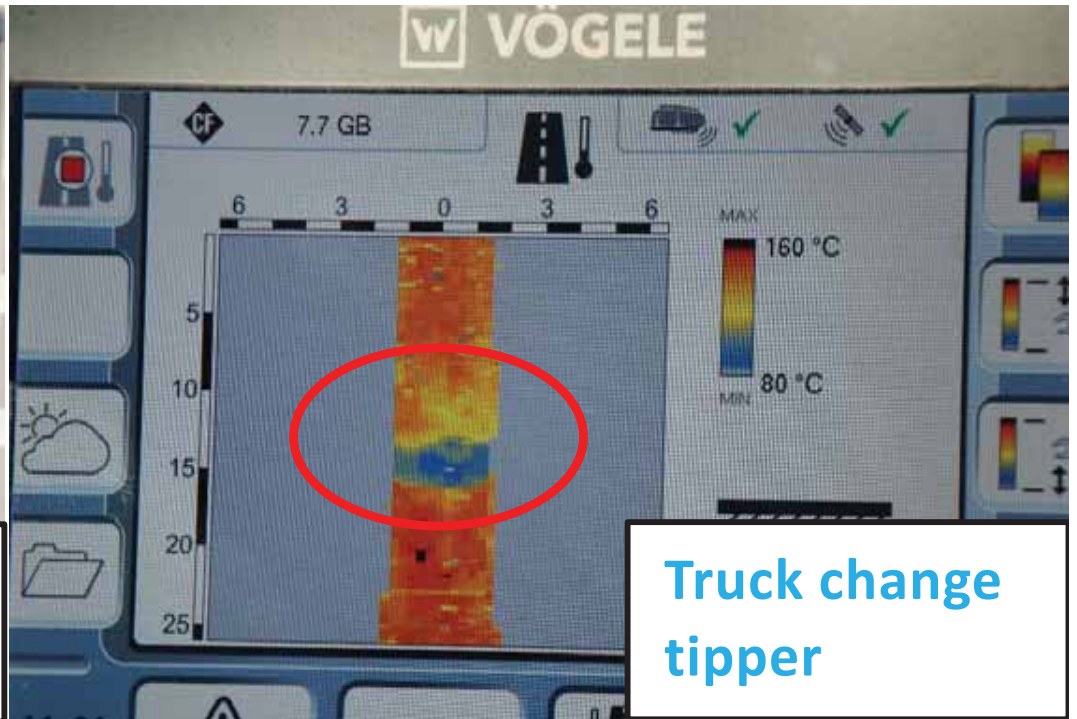
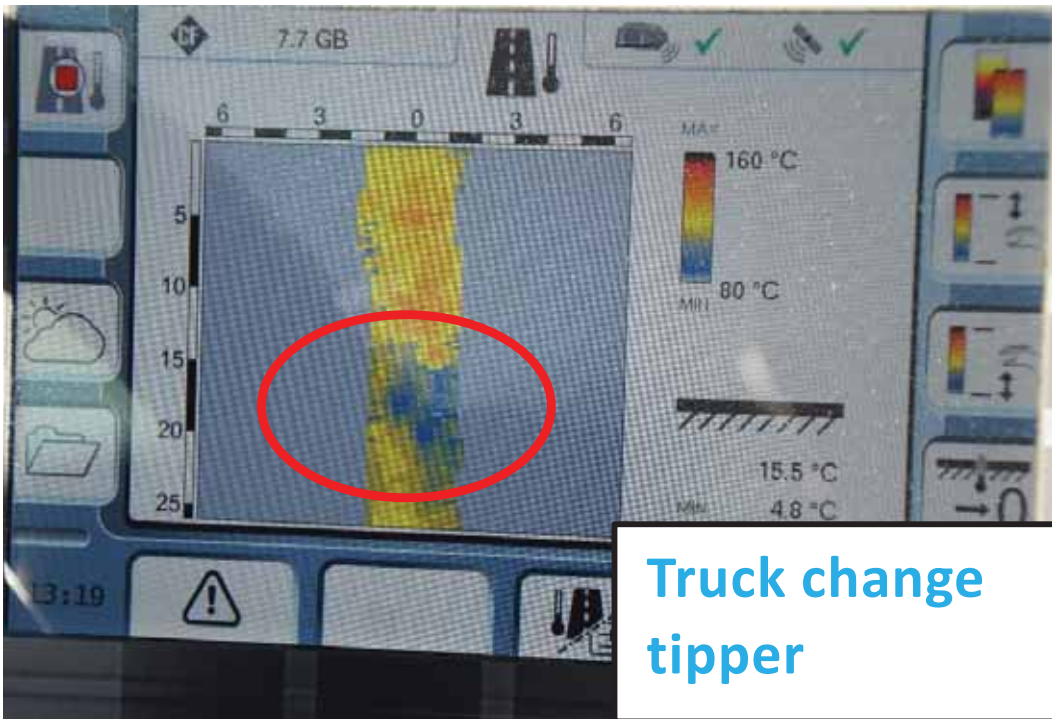
**a) Conventional dump trucks**



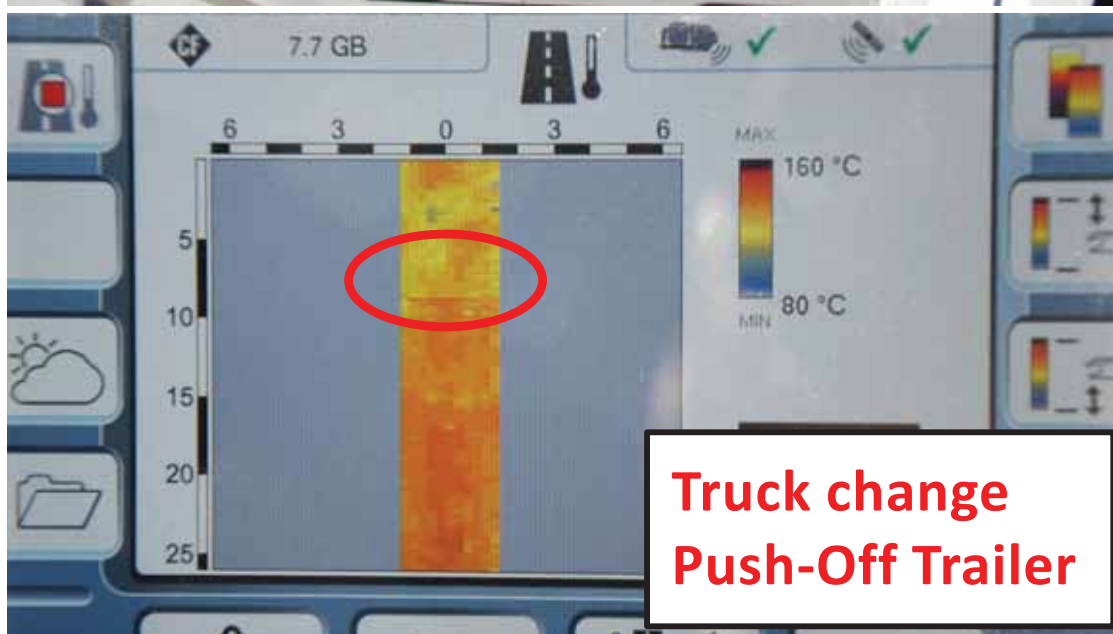
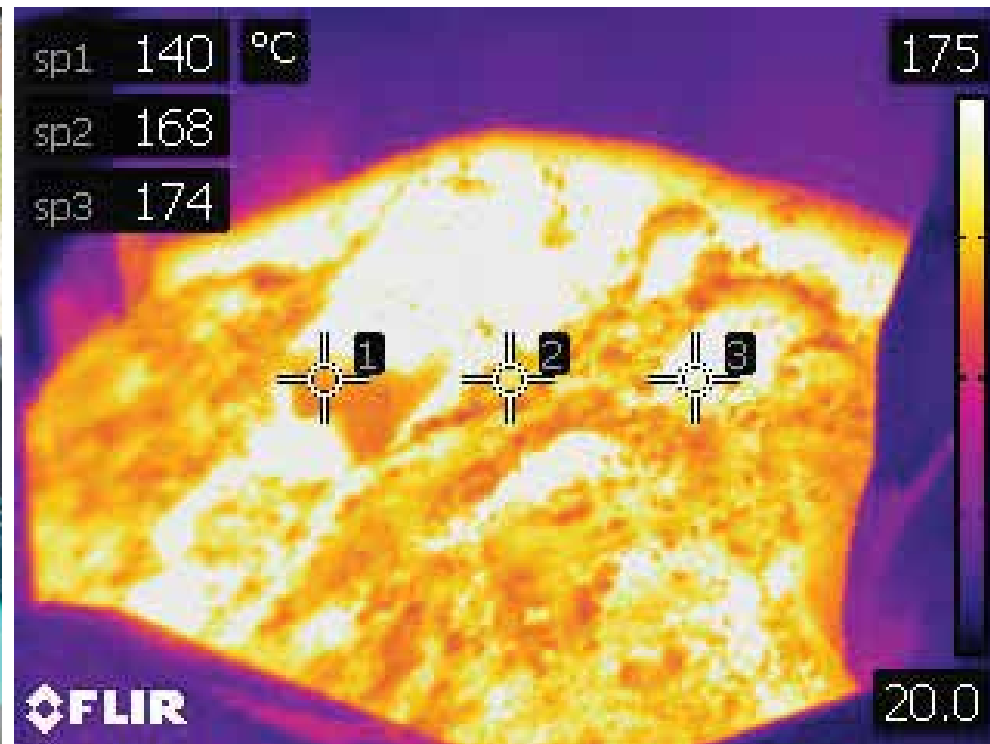
**b) Push-Off Trailer**

# Site investigations in Bohinj with thermography systems from Vögele

## Tipper changing - high temperature fluctuations

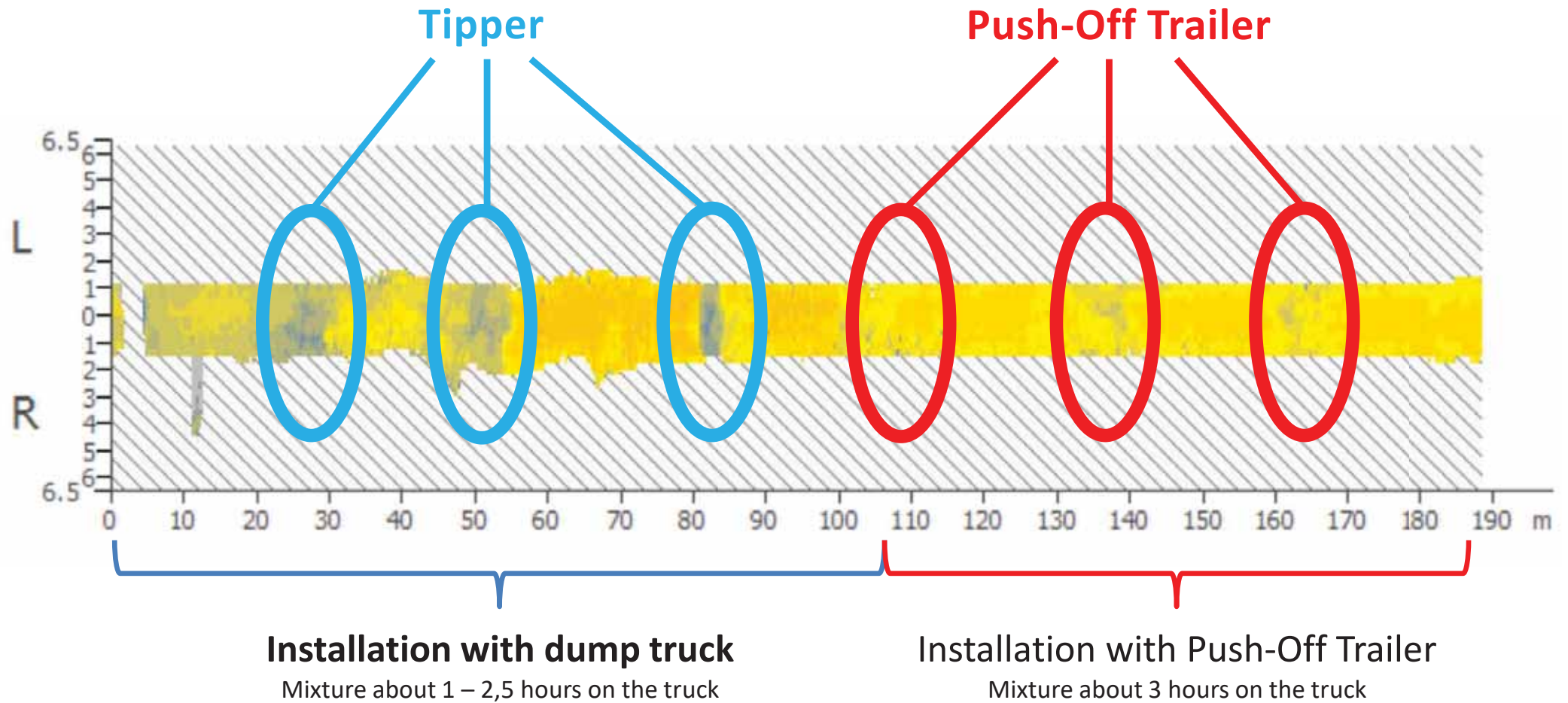


# Push-Off Trailer



# Temperature evaluation with Vögele Road Scan

## Truck change



## Costs / benefits for thermal bodies with push-off technology?



- The use of push-off technology may, however, increase the installation quality and durability of asphalt surfaces to a **significant** degree
- **One complaint alone in a year** due to segregation or the lack of an adequate compaction ratios will **cost YOU a great deal**
- The additional costs for the use of the Asphaltprofi Thermo with push-off technology amount to **approx. 1,2 to 6 per mill (not percent!!)** of the asphalt construction work or **approx € 0,50 to € 1,50 per tonne of mix**  
(depending on availability, whether the transport company with push-off vehicle has been firmly incorporated into the logistics process and on the distance to the side)
- **Incorporate your transport company with push-off technology FIRMLY into the mix-material logistics and reduce costs in this way!!**

## Costs / benefits for thermal bodies with push-off technology?



- Use push-off technology to avoid stop and go
- Faster and quicker installation of asphalt surfaces – **YOU** can in this way realise more running metres a day and so reduce your costs
- Significantly lower loading sill will also make loading on the construction site with small wheel loaders easier...



## Costs / benefits for thermal bodies with push-off technology?



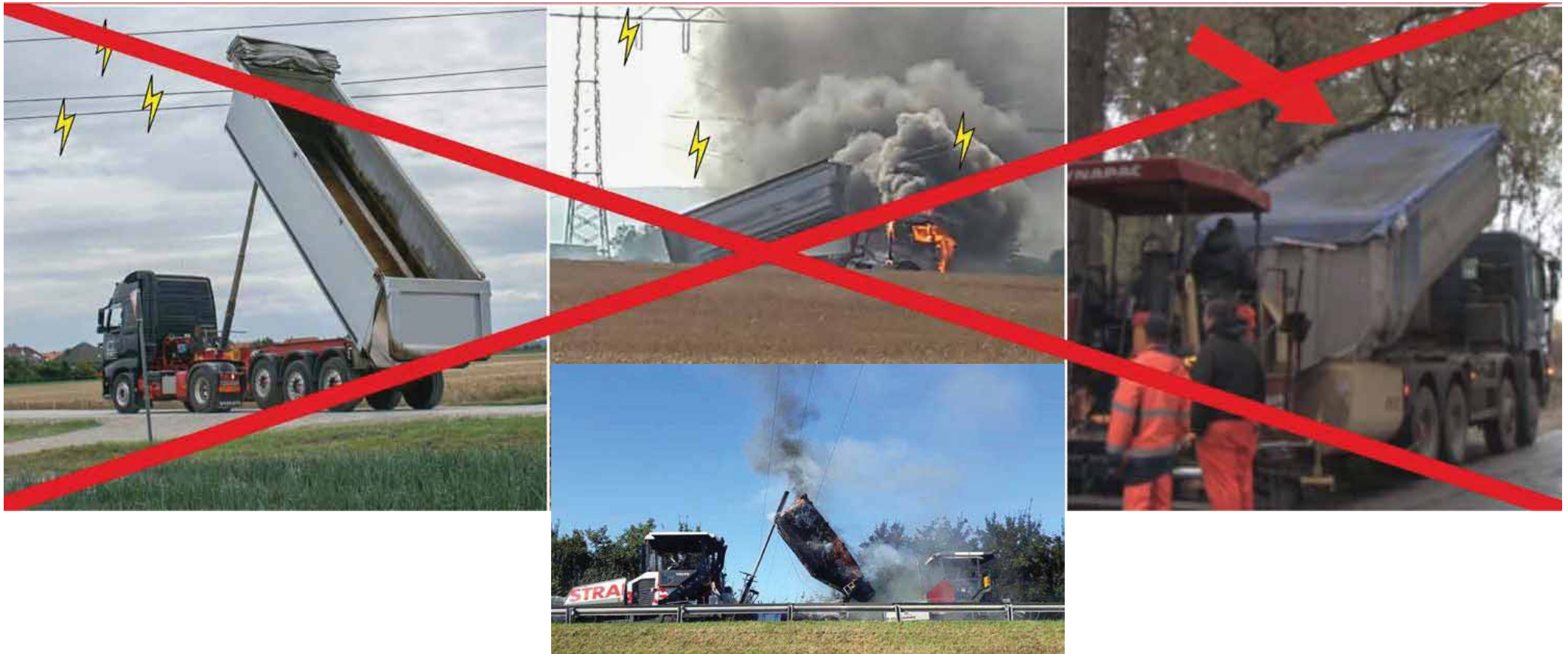
- **Shorter cycle times resulting from the immediate transfer of the mix at docking (not only after 1-2 minutes)**
- **No residual quantities in the bodies that have to be disposed of (without separating agent in the body) even with OPA, PMA, PmB, split mastic, ...**
- **No excavator required at the cleaning yard to scrape out the bodies**





## For more safety at work

The push-off technology offers maximum tilt stability.  
The dangers during unloading are minimal - a major plus in occupational safety.  
Power lines, avenues, manual cleaning or bridges are a big risk for tippers.  
A risk that can be eliminated with the push-off technology.





Costs / benefits for thermal bodies with push-off technology?



- **Continuous asphalt installation with push-off technology**
  - even in municipal road construction, avenues, underpasses, sign gantries, traffic management systems...



## Costs / benefits for thermal bodies with push-off technology?



- Asphalt installation while airport operations continue without restrictions from air-traffic control's radar
- Not necessary to shut down flight operations for the rehabilitation of aprons
- Shorter cycle times permit faster construction
- Improvement of durability and quality on heavily used asphalt areas
- Fewer rehabilitation cycles



- Asphalt installation of the runaway at airport Belgrad and Salzburg

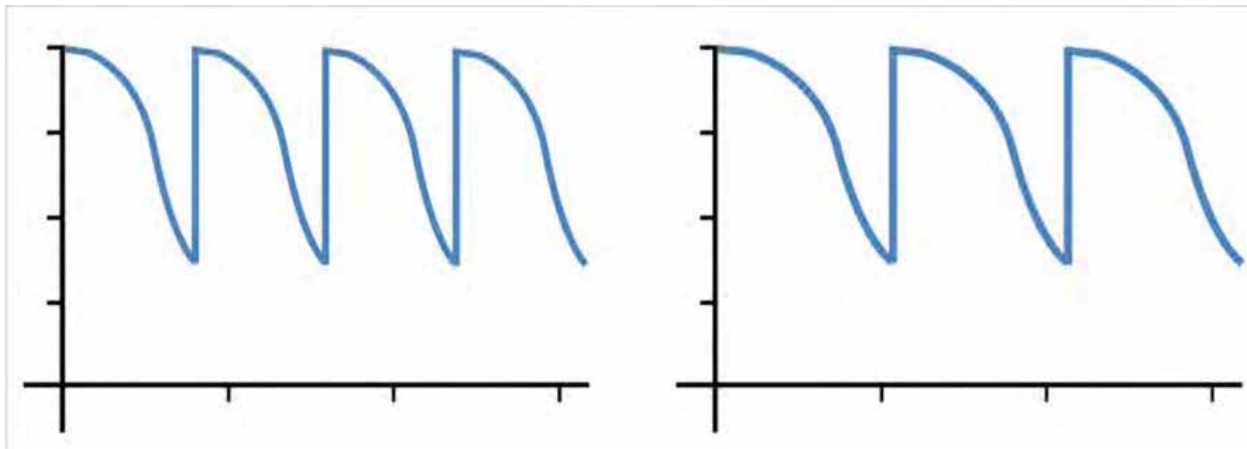


Trucks with push-off technology were in use to guarantee a smooth and fast handover to the asphalt paver

## Costs / benefits for the consortium

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- **Particularly when budgets for road maintenance and construction have been cut, it is all the more important for the measures for which tenders are being requested to last for as long as possible !!!**
- **Protect your already very tight budgets by demanding improved installation methods – that have already been state-of-the-art for a long time – and so realise longer lasting road rehabilitations.**



**Reduce the necessary rehabilitation cycles**



## Costs / benefits for the consortium

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- **If you want quality, YOU will have to require it in your specifications!**  
You will in this way be making an active contribution to **ENVIRONMENTAL PROTECTION** and will be safeguarding the value of your fixed assets
- **It costs money to build to a good level of quality** (minimum additional costs per m<sup>2</sup>!!!)
- **It costs significantly more to build to a bad level of quality ! !**
- In many countries road authorities e.g. RVS and ASFINAG, CZ... have already included push-off technology as a best-bidder criterion ore demanding it in their specifications
- Vehicles with push-off function (recommended by EAPA)
- **Reduced asphalt segregation in the silo Continuous homogenisation of the material during unloading**



## Vehicles also available regionally and nationally







## Environmental Protection

Protecting the environment through low CO2 emissions during asphalt production≈

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Continuous and continuous mixing of the asphalt during the transfer into the paver / feeder while at the same time improving the processability during installation. Thus, the production temperature in the asphalt production can be reduced a bit -> reduced energy consumption and reduced CO2 emissions

Thus, e.g. for the rehabilitation of a **500 meter** long road (binder and top layer) required asphalt already at an **approximately 5 percent reduction** in temperature (without asphalt additives !!) in the production of CO2 emissions are reduced by about **2 tons on average !!**





## Environmental Protection

Protecting the environment through low CO2 emissions during asphalt production≈

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**Reduced temperature during the production of mix reduces the load of vapors and aerosols for jobs in asphalt construction (MAK values)**

**Improved homogeneity during installation allows longer life of the asphalt pavements  
-> thereby improved overall CO2 balance over the period of use**



## Environmental Protection

Protecting the environment through low CO2 emissions during asphalt production≈



## Transportation of concrete for engineering

### CIVIL ENGINEERING

Transportation of concrete?

How would you handle transportation?



With dumper??

➔ Considerable segregation



with concrete mixer!

➔ Continuous mixing



**‘The main thing is that it's cheap??’**



**‘Quality has priority!!!’**

## Transportation of concrete for engineering

### How would you handle transportation?



With dumper??

➔ Considerable segregation



With push-off function!

➔ CONTINUOUS mixing during the unloading process with push-off vehicle!

'The main thing is that it's cheap??'

