Using modern transport technology to avoid pemature road damage during asphalt paving and protecting the environment through lower CO_2 emissions

CONTENTS

- **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 instllation with therminaly 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

- 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	
TL bitumen	**AC**	**SMA**
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 to delivery to the site

Mix temperatures

As specified by ZTV Asphalt-StB 07:

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30/45	155-195	
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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
- 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

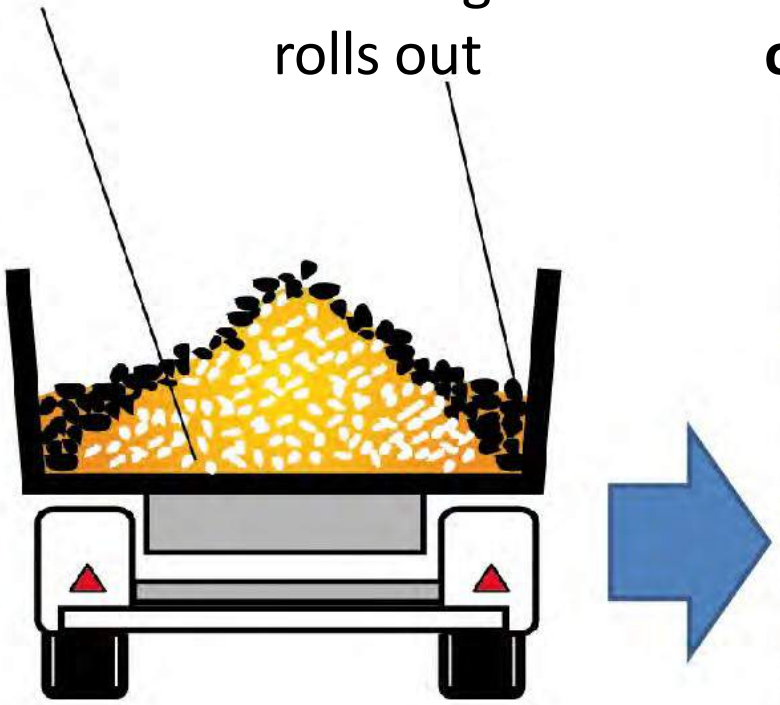
Even when transporting mix materials with conventional thermally insulated (dumper) vehicles, one of the main problems in asphalt road construction has not been solved – SEGREGATION

Consequences of mechanical segregation with conventional transport technology

Cause of granular segregation
coarse grains roll outward – coarse grains come out at the start

Fine grain

Coarse grain – rolls out



Clusters of coarse grain usually occur at intervals

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

Homogeneous mix ??

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

Requirements and regulations – practical problems

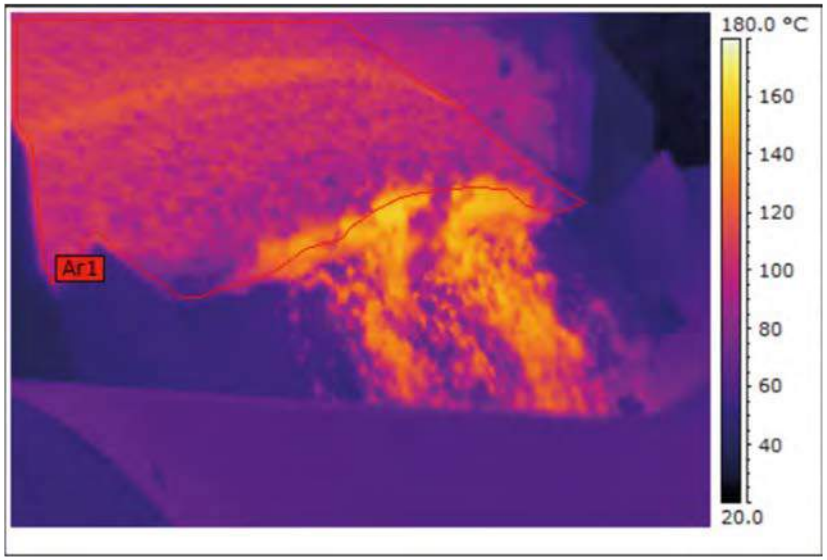
2. THERMAL SEGREGATION

Average mixing temperature of approx. 165°C

distance from mixing plant to construction site: approx. 15 km / max. 20 min.

weather: Sunshine, no wind, approx. 33-35°C

"Crust" temperature on thermal vehicles: approx. 99°C

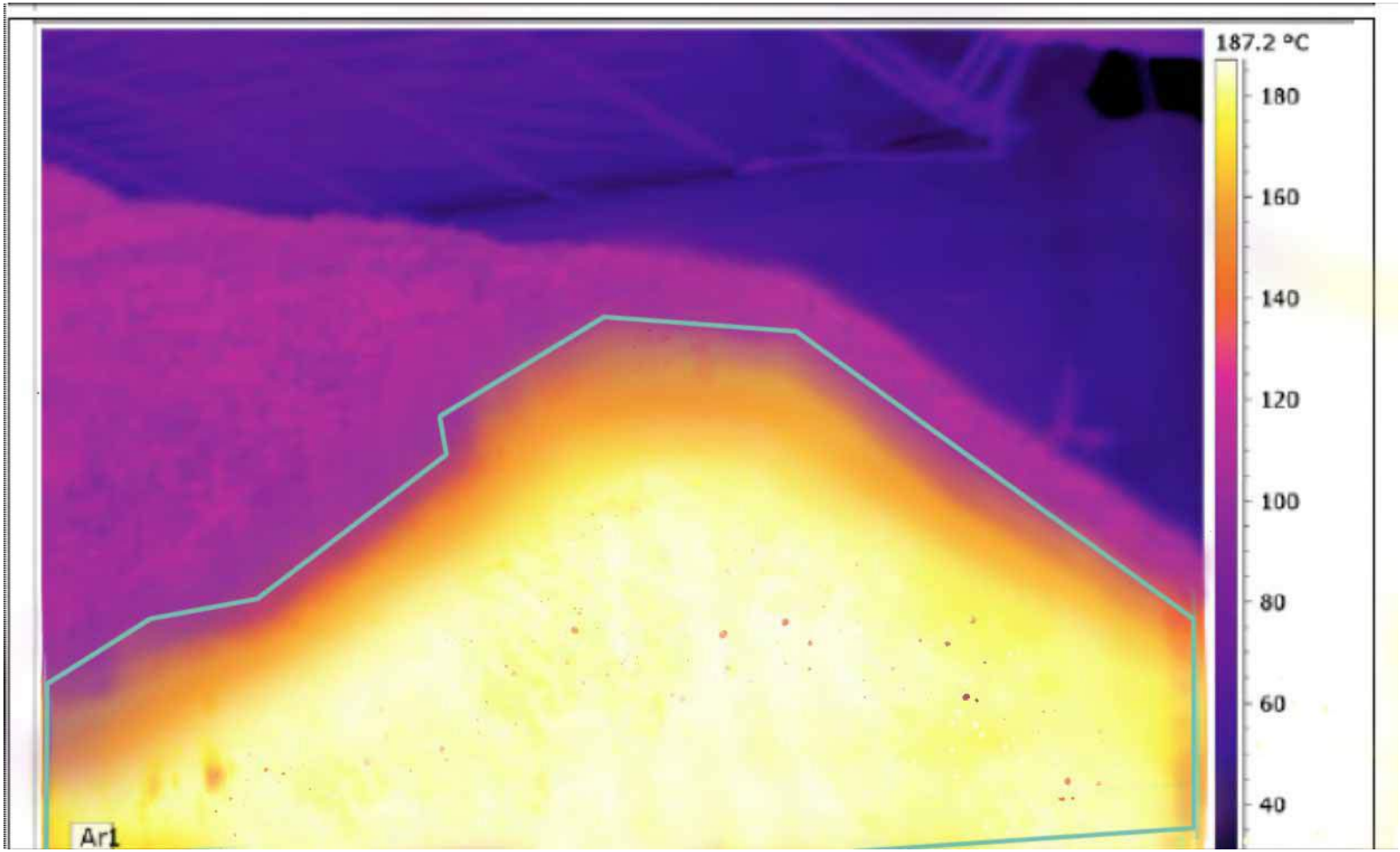


$$\frac{\text{Tonnage per truck load}}{\text{Installation depth (m) x installation thickness (m) x 2.5 to/m}^3} = \text{Distance (m) from clusters (coarse grain and cold spots)}$$

Requirements and regulations – practical problems

2. THERMAL SEGREGATION

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



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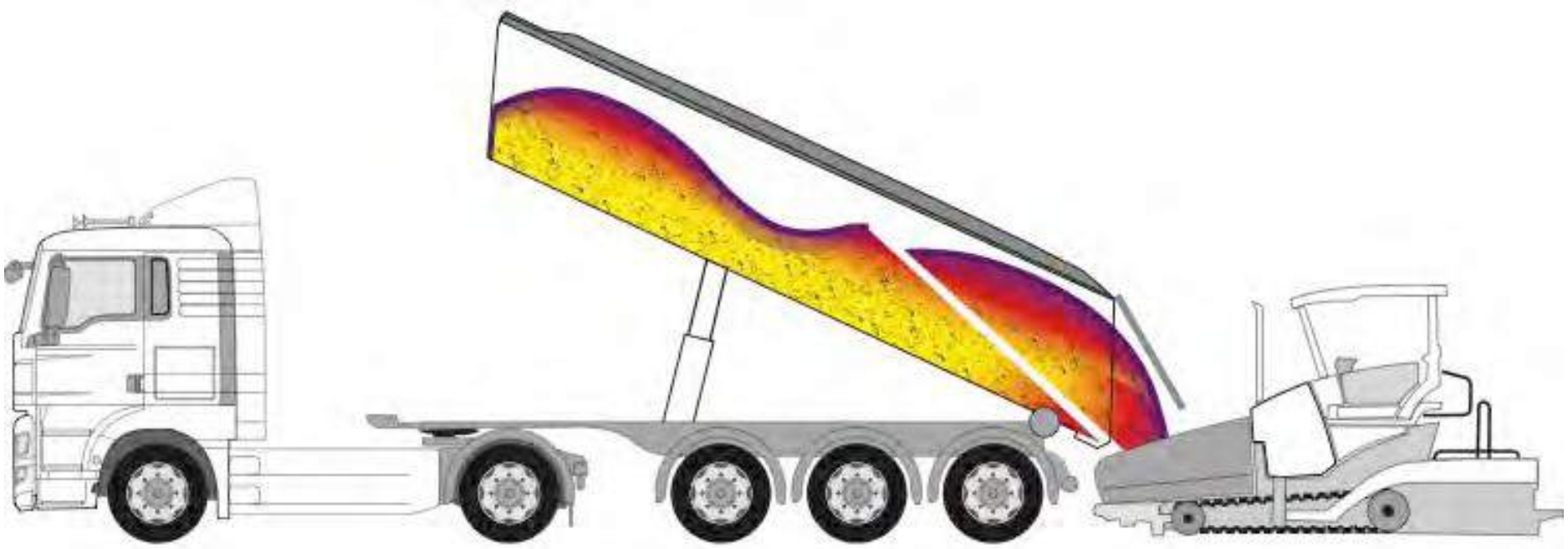

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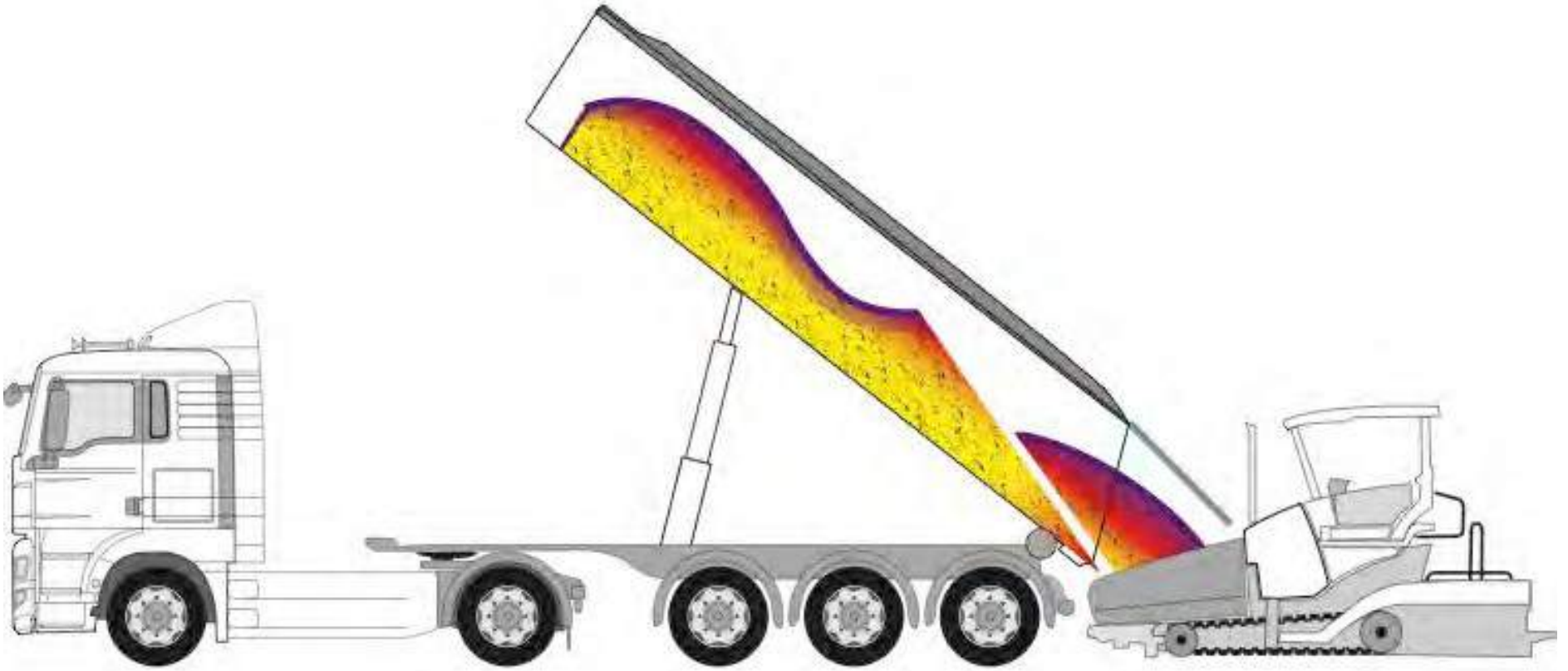
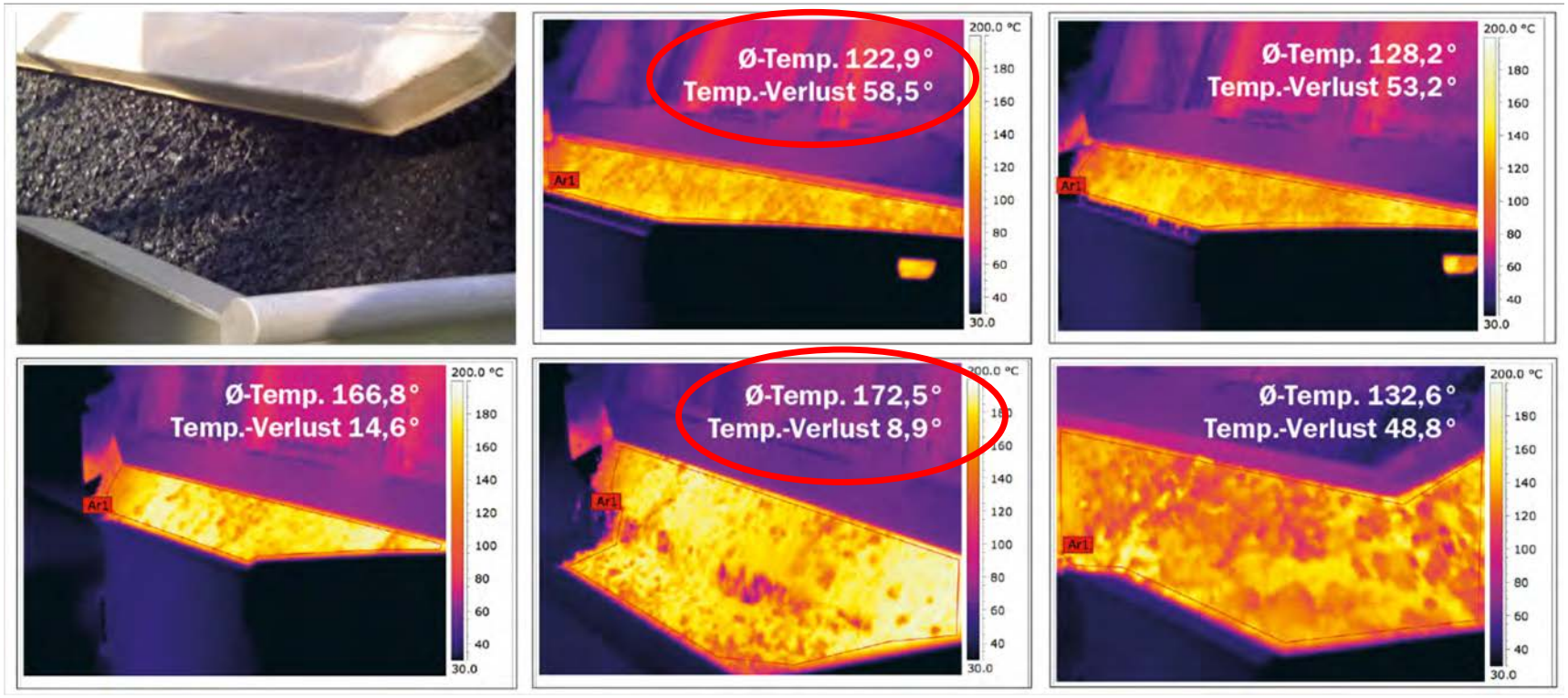


Thermal segregation during asphalt transport

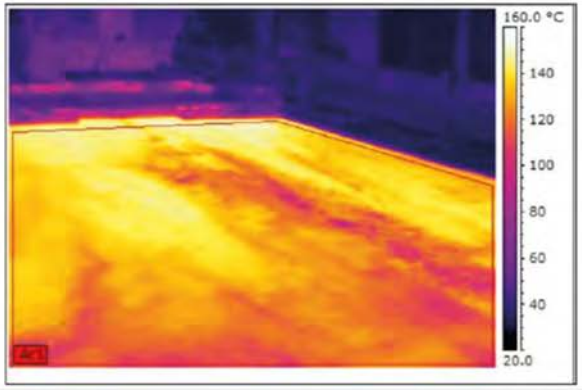
Temperature progression during unloading (thermal dumper)

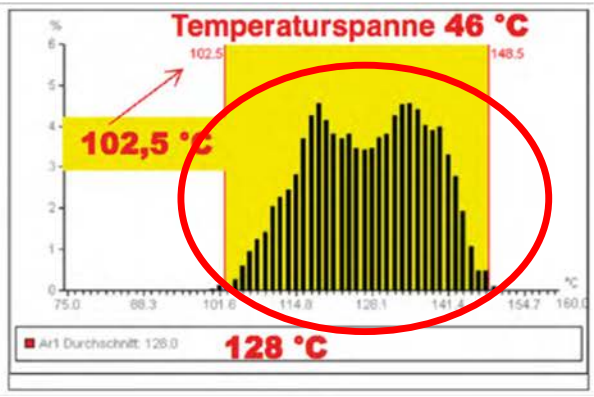


$$\frac{\text{Tonnage per truck load}}{\text{Installation depth (m) x installation thickness (m) x 2.5 to/m}^3} = \text{Distance (m) from clusters (coarse grain and cold spots)}$$

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.

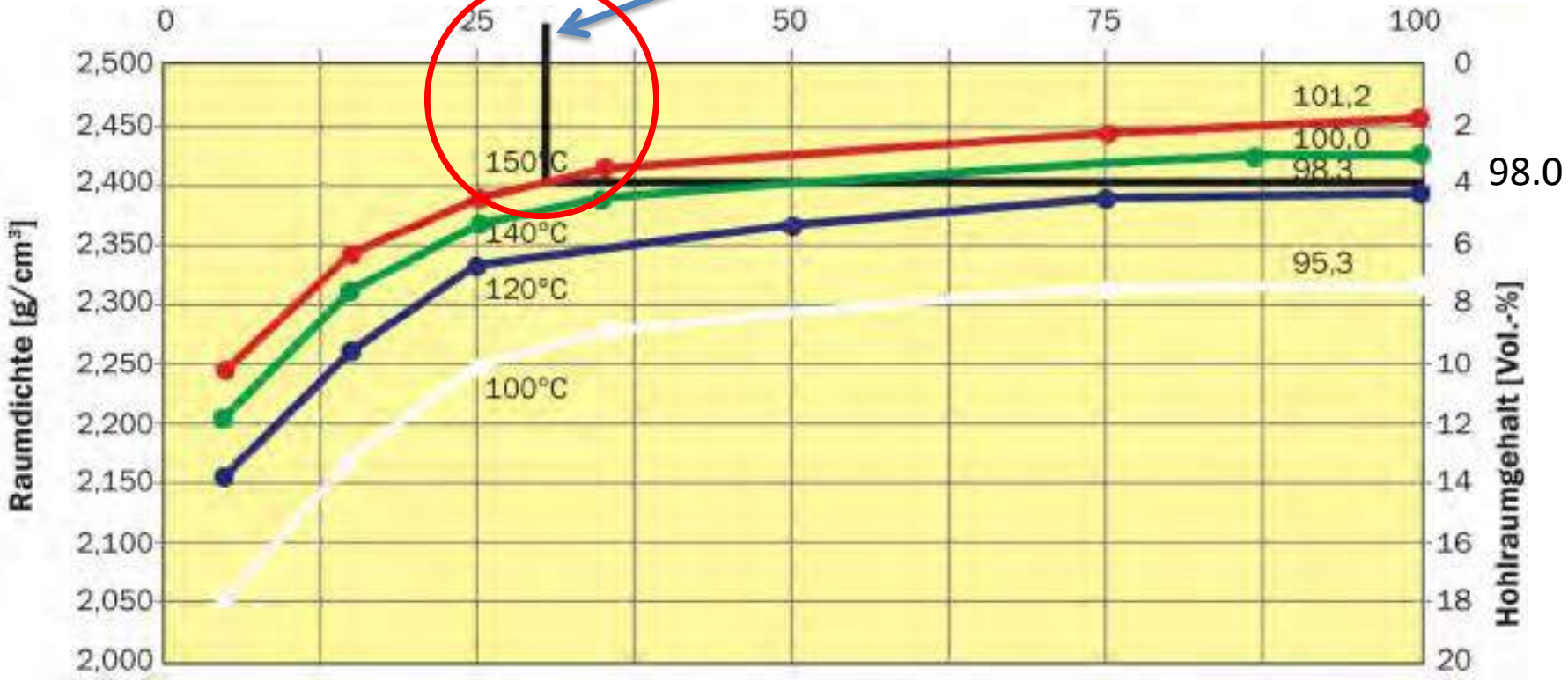
Analyses of different mix formulations

- E.g. for a compaction ratio of 98% (in accordance with ZTV-Asphalt), approx. 27 strokes are required for a mix temperature of 150°C

Relationship between compaction and mix temperature

2. THERMAL SEGREGATION

Marshall compaction of 98% after 27 strokes

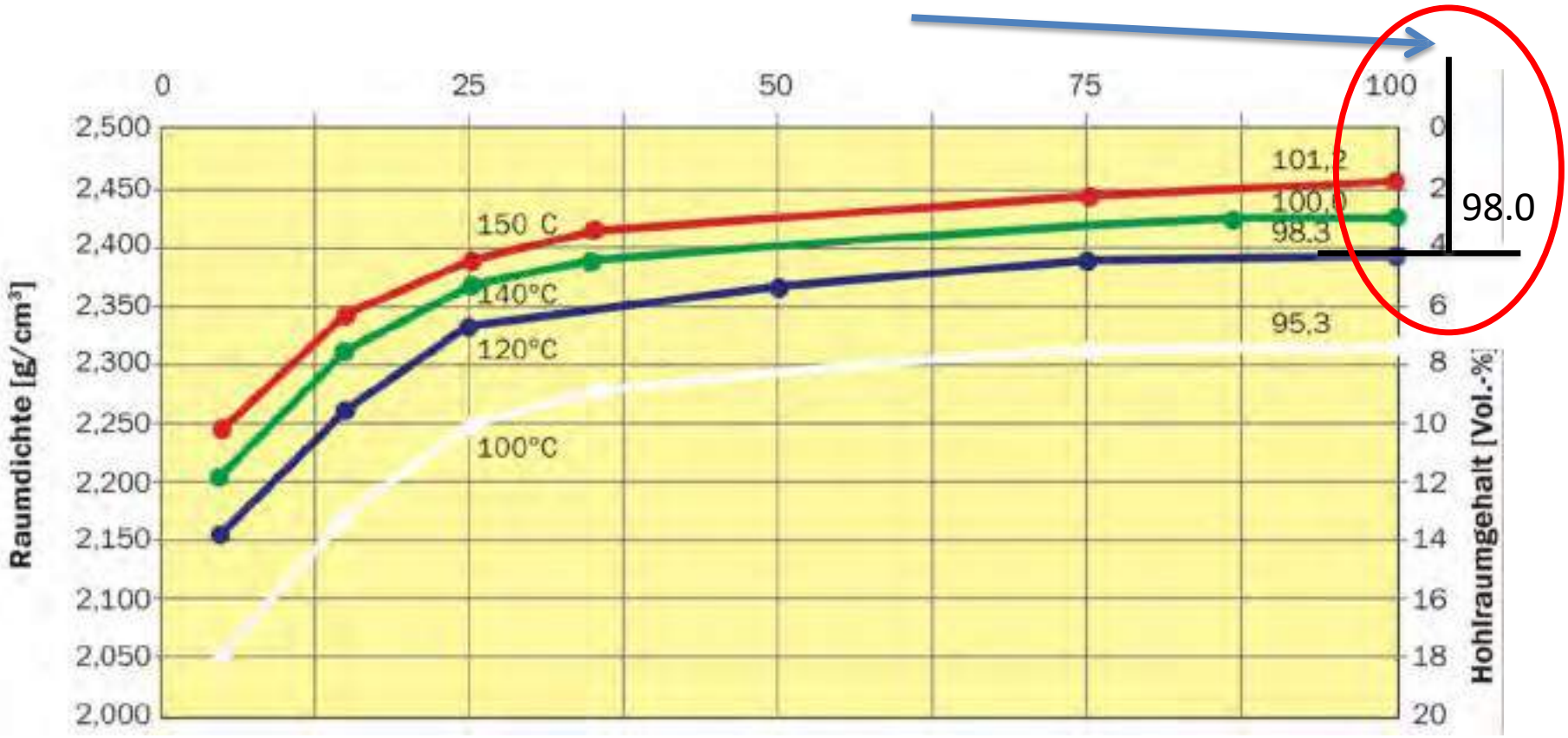


98% ≙ Minimum compaction ratio

Relationship between compaction and mix temperature

2. THERMAL SEGREGATION

Marshall compaction of 98% after more than 100 strokes



98% ≙ Minimum compaction ratio

Relationship between compaction and mix temperature
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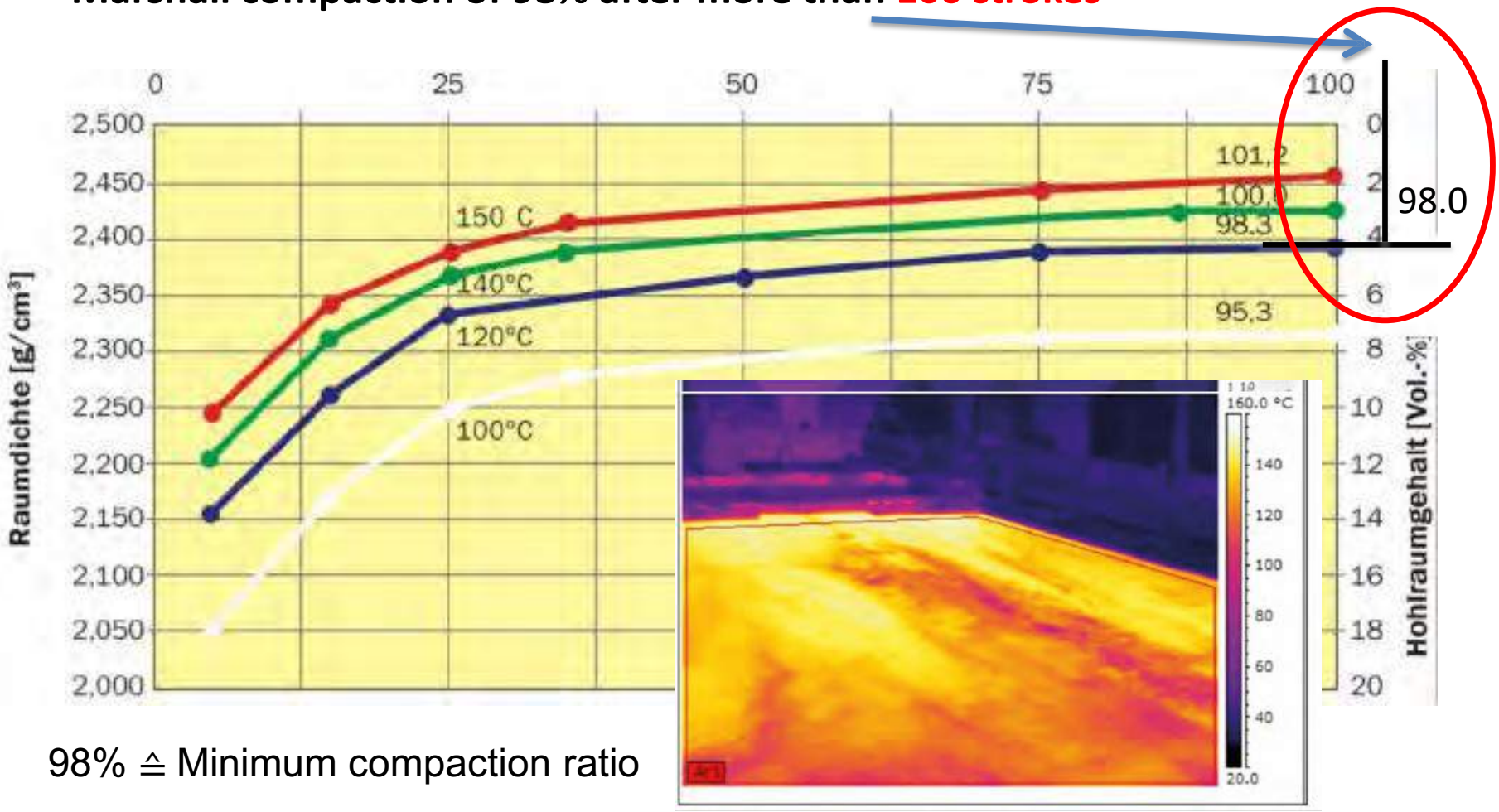
Marshall compaction of 98% after more than 100 strokes



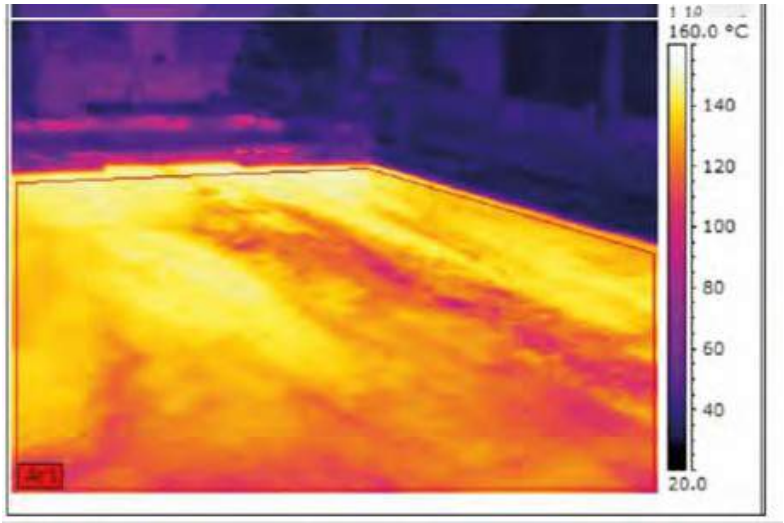
98% ≙ Minimum compaction ratio

Relationship between compaction and mix temperature
2. THERMAL SEGREGATION

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

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??’

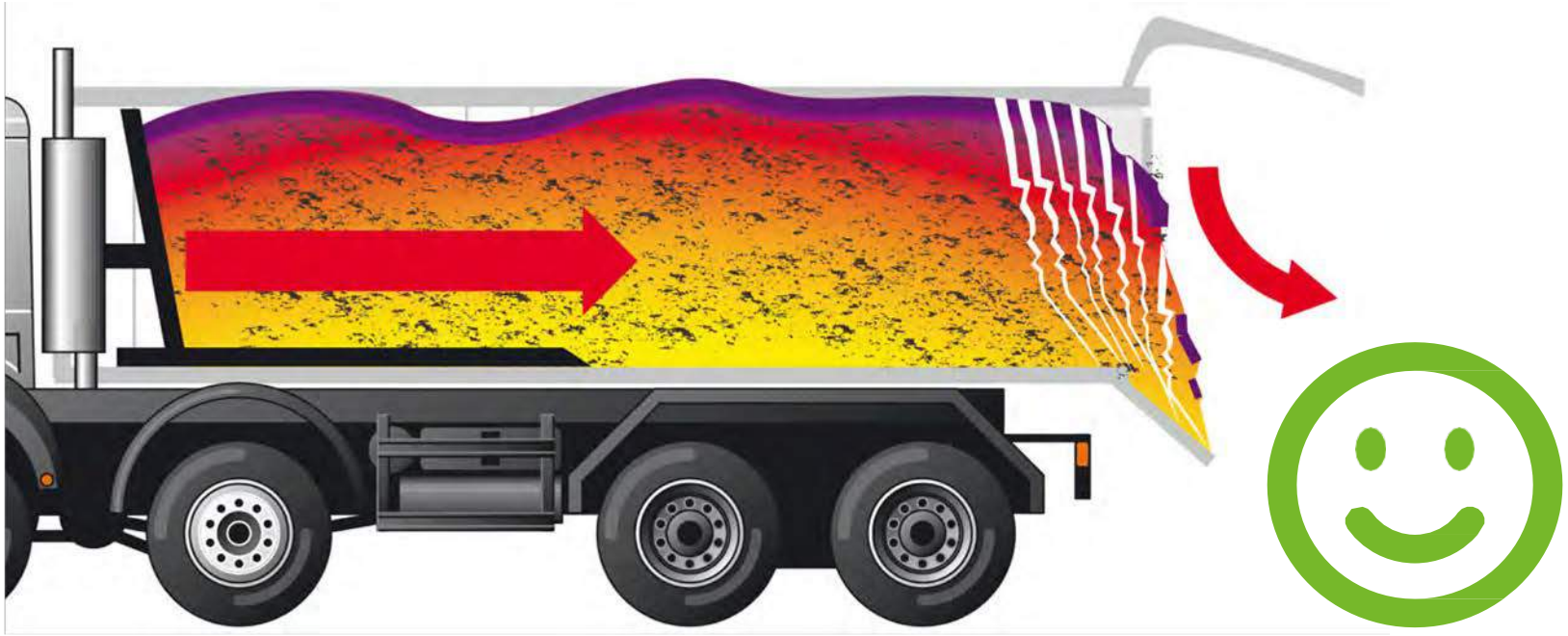
‘Quality has priority!!!’

Requirements and regulations
from practical applications

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…

Requirements and regulations
from practical applications

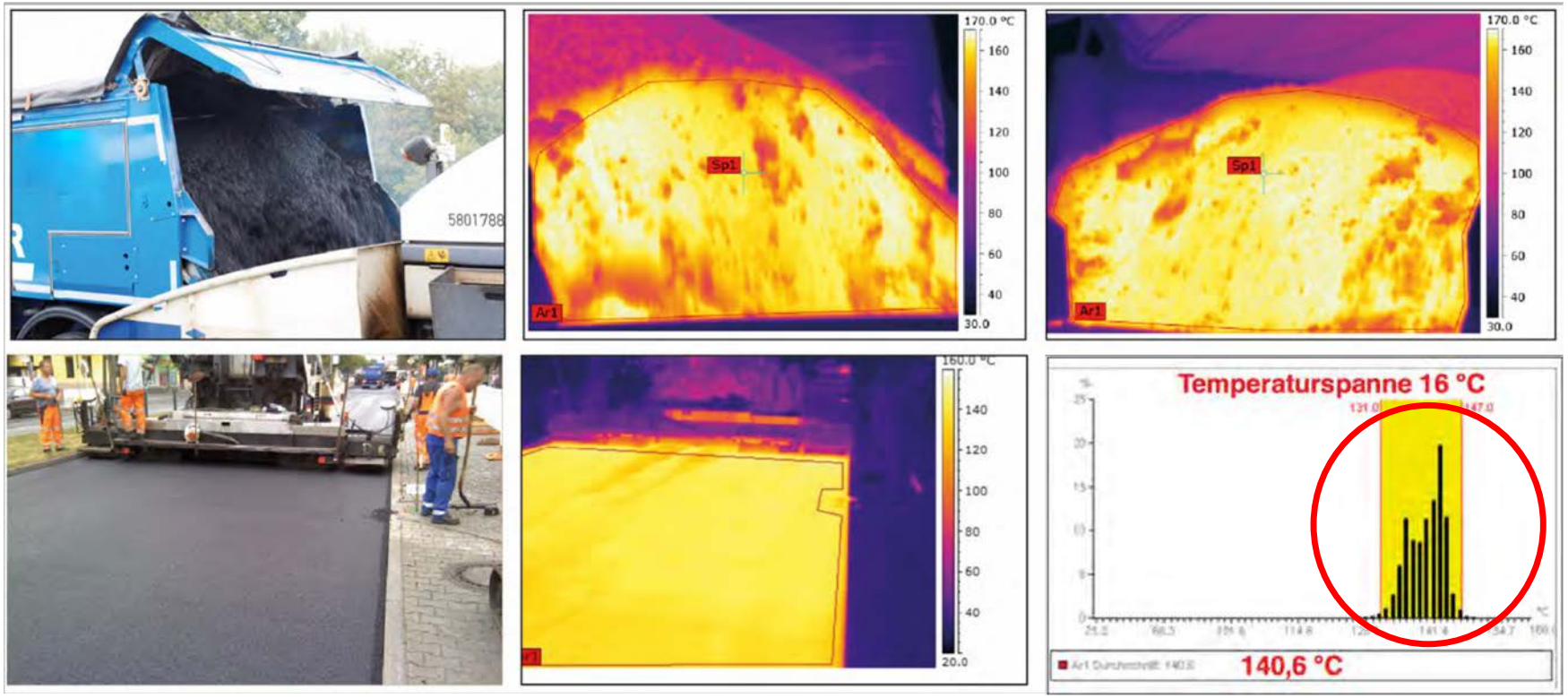


Continuous mixing throughout the unloading process
(of temperature as well as bitumen and binder-agent proportions)

- 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

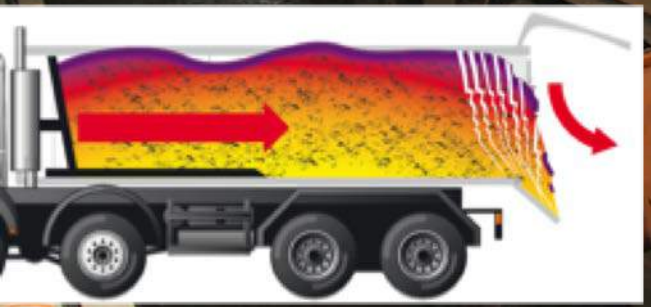
Continuous mixing



Munich Mittlerer Ring orbital motorway, Luise Kisselbachplatz
Leitenmaier

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

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
- long-lasting

- Direct trench and banquet filling

Distribution screw "Wiesel" is easy
→ attachable / retrofittable


Fliegl
MO-
SHIEBER
5801788
EUROVIA

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

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

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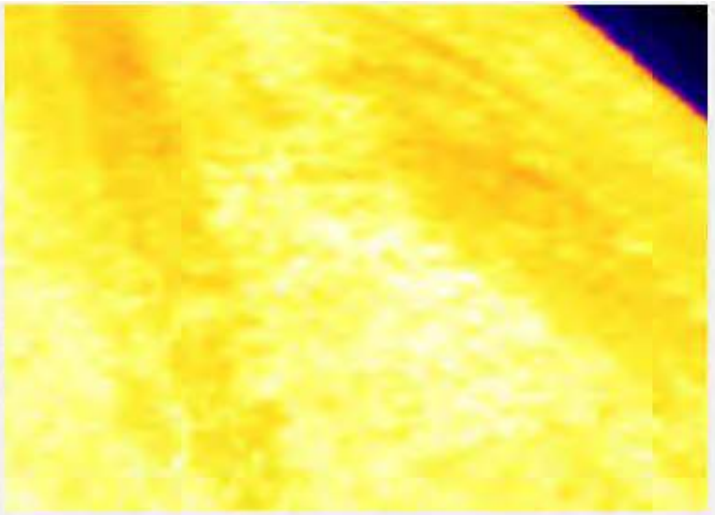
bi.ivws
Fakultät für Bauingenieurwesen
Institut für Verkehrswissenschaften
Forschungsbereich Straßenwesen

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

straßenwien
MA 28 / planen bauen erhalten
StoDt Wien

Wien, im Dezember 2015

2.1 Construction project / task

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Vienna University of Technology

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

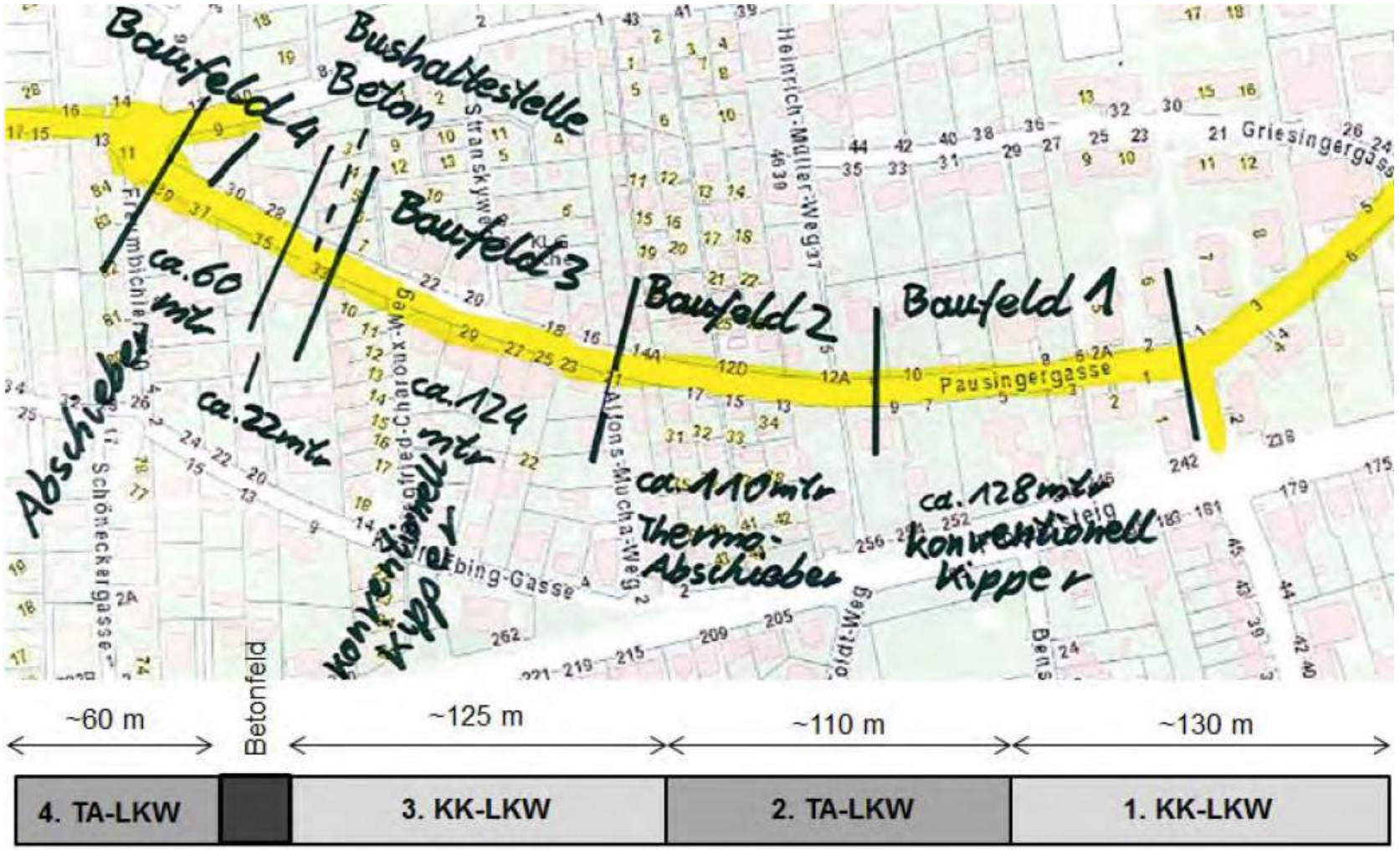

Fig. 1: Layout of the four construction plots

Temperature measurements using thermal imaging camera

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Vienna University of Technology

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.

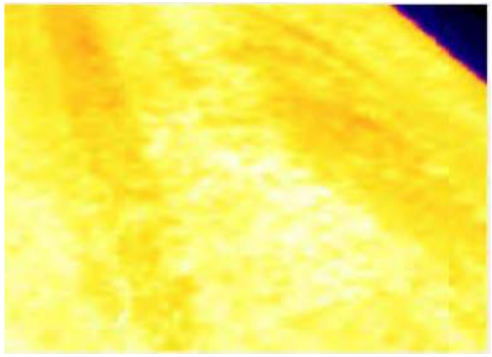

Fig. 7.1: Example of the thermal image analysis **of a 5-m section with inhomogeneous, cool temperature distribution – frequent on (KK) truck changes**

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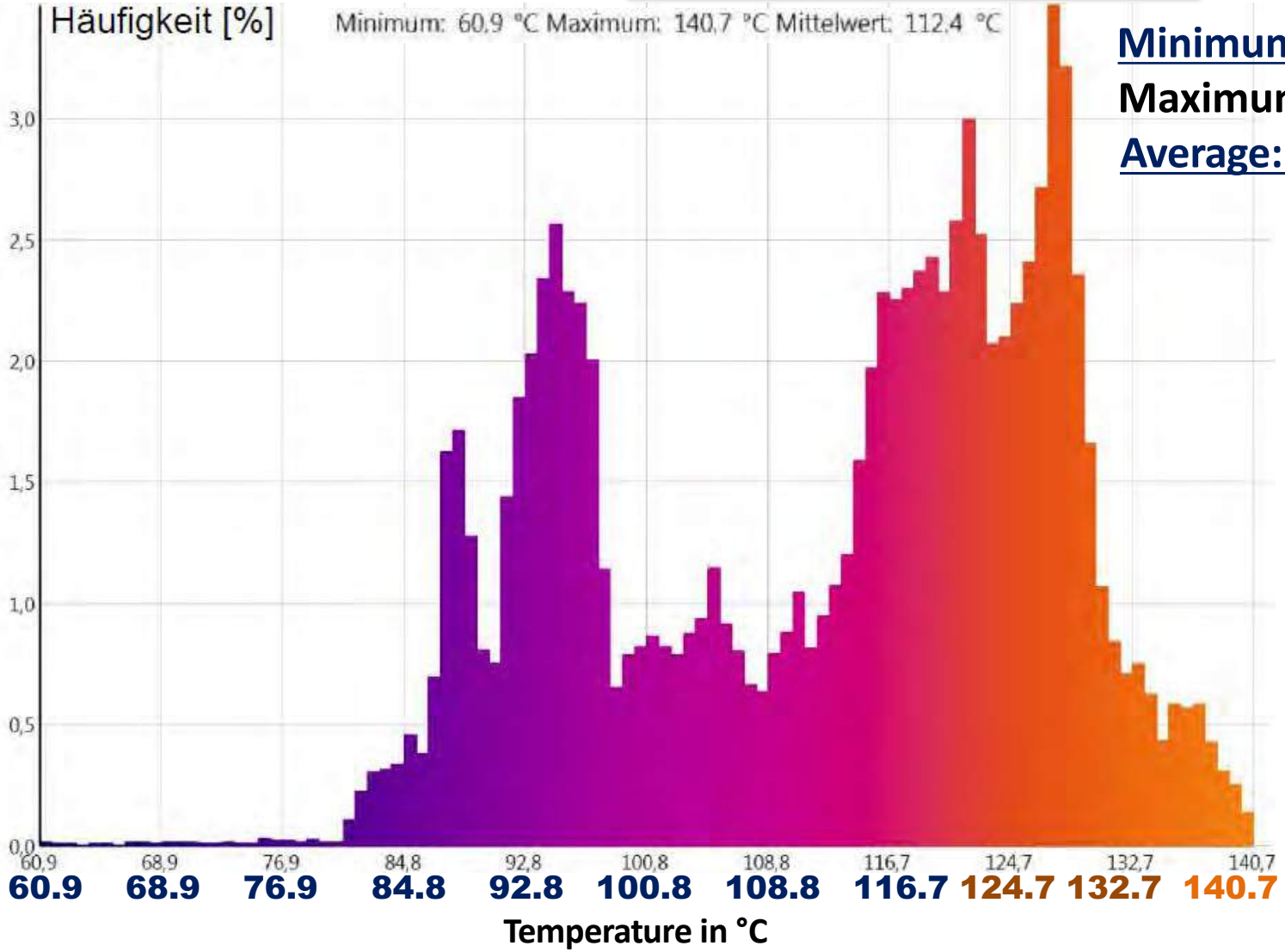
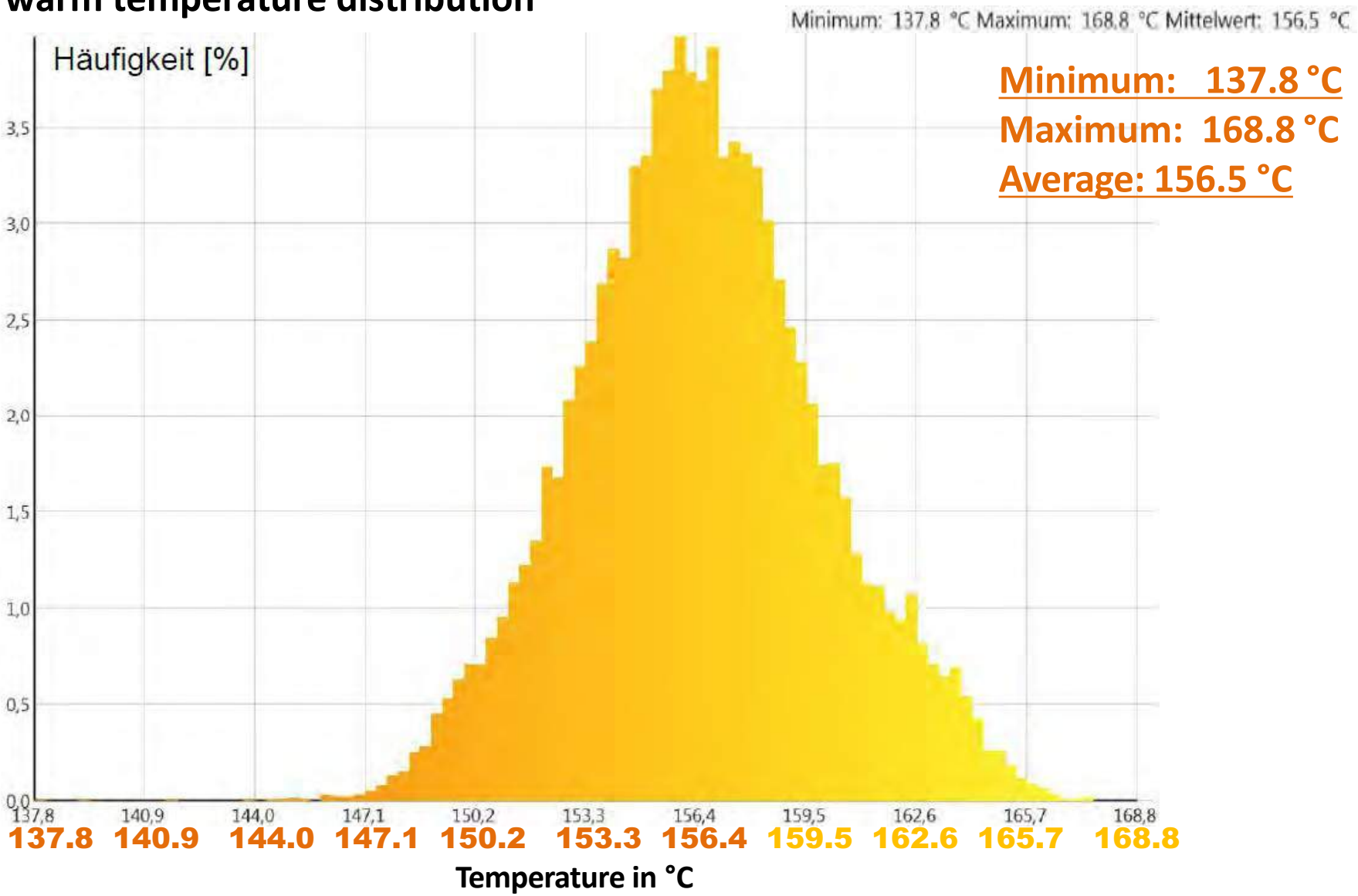


Minimum: 60.9 °C
Maximum: 140.7 °C
Average: 112.4 °C

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

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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

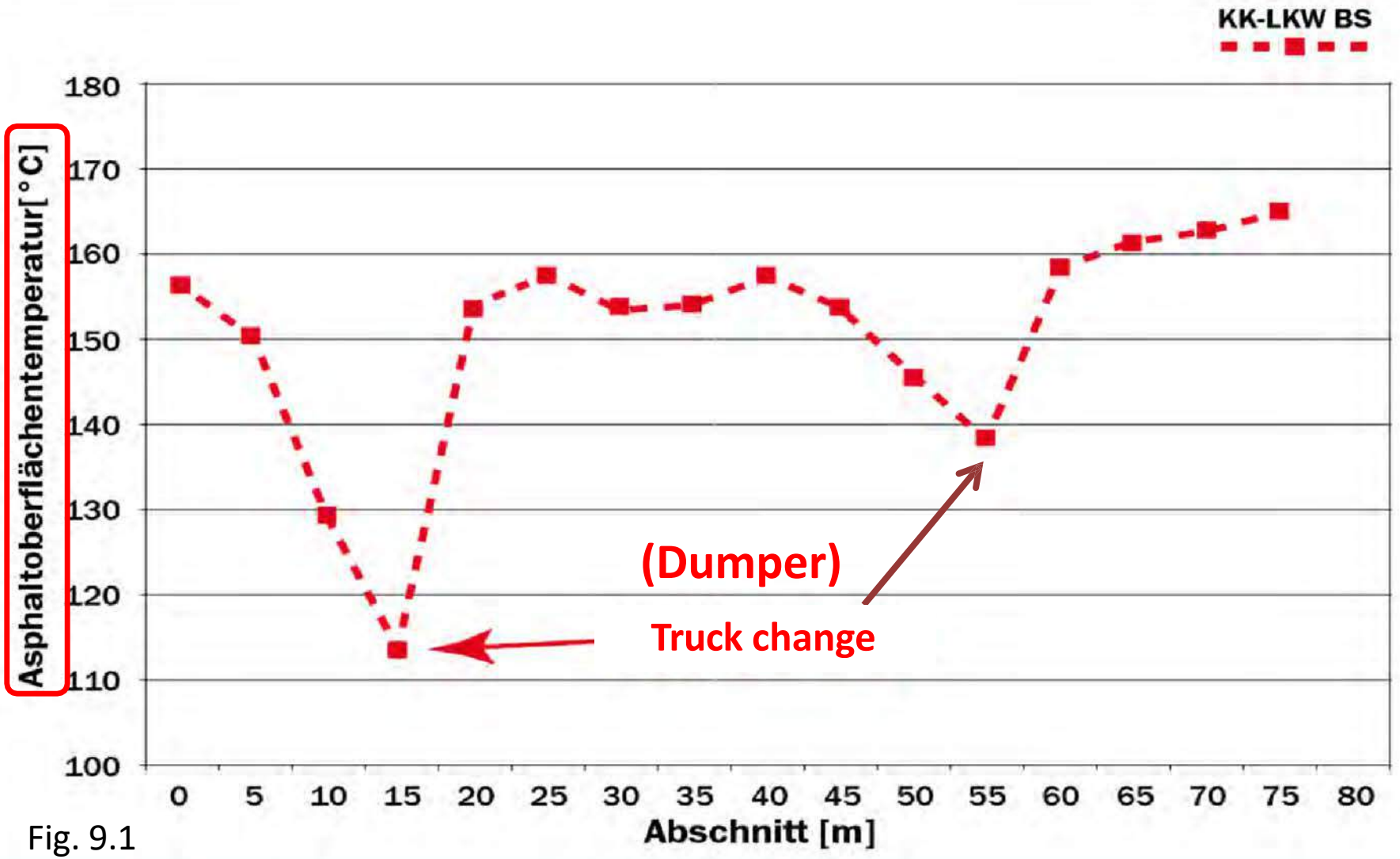

Fig. 9.1

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

Average asphalt temperature per 5-m section

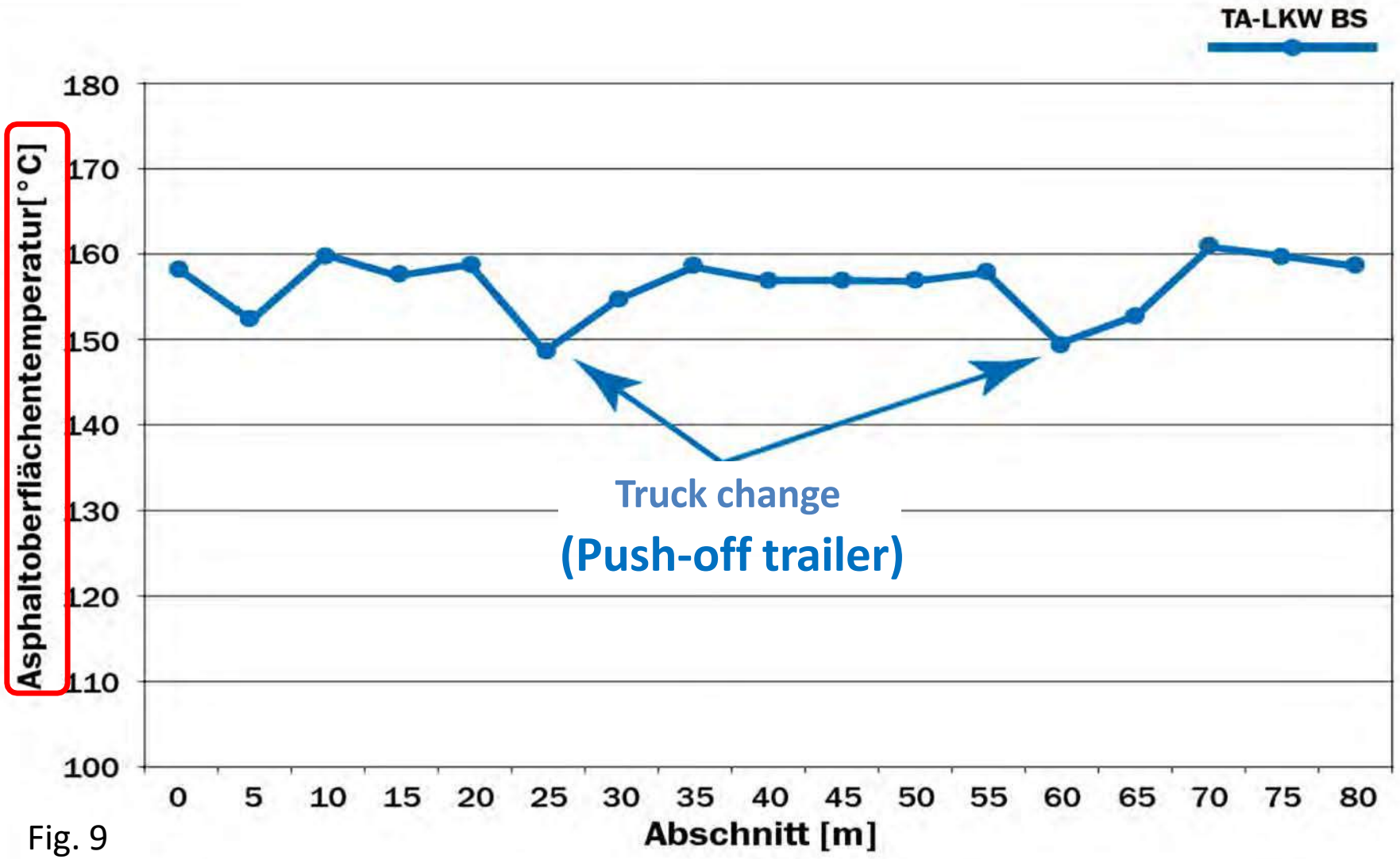

Fig. 9

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

Average asphalt temperature per 5-m section

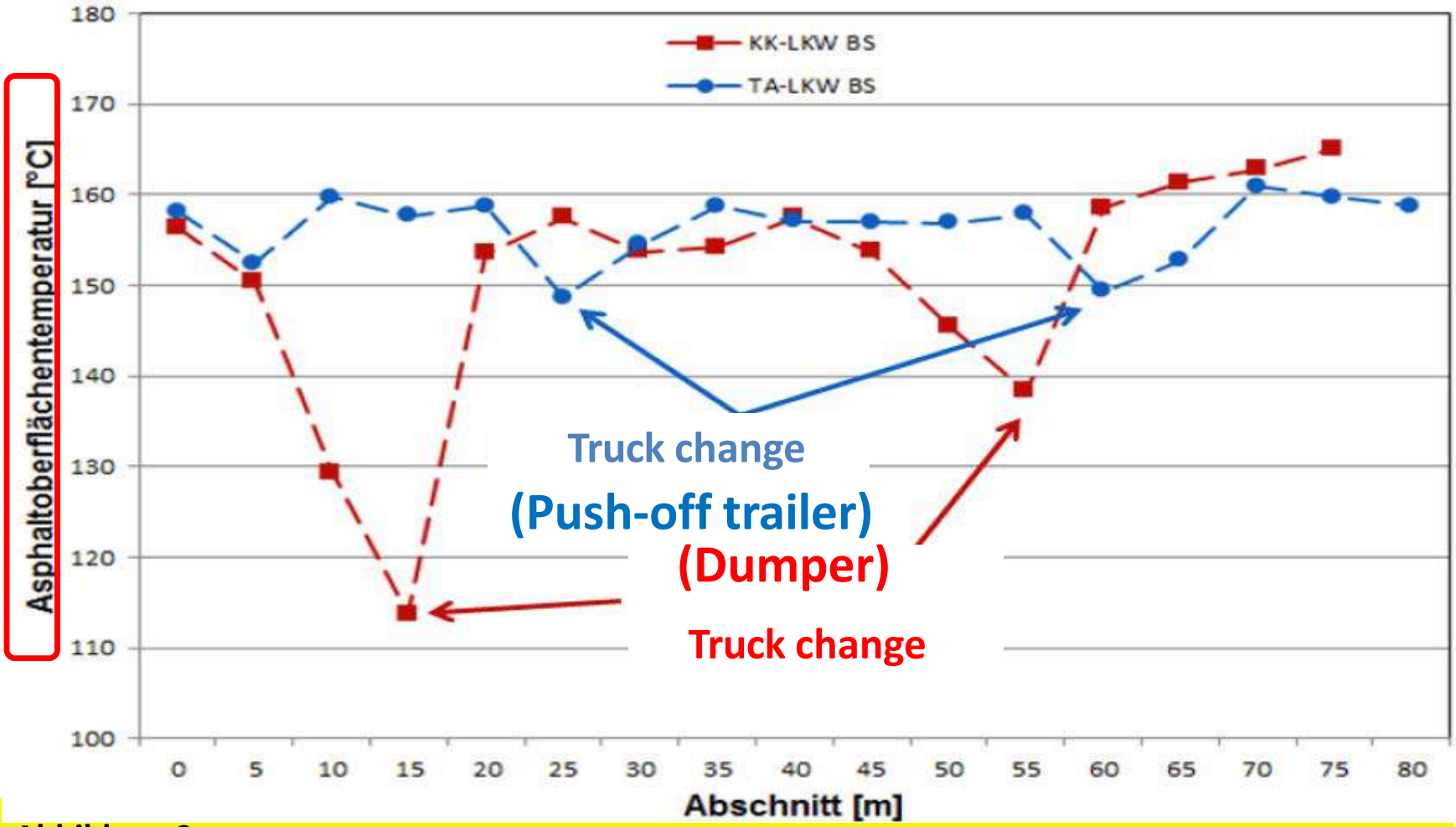

Abbildung 9:
Verlauf der **mittleren Asphaltoberflächentemperatur** nach Einbau für alle Schichten (Wärmebild)

5. SUMMARY AND INTERPRETATION

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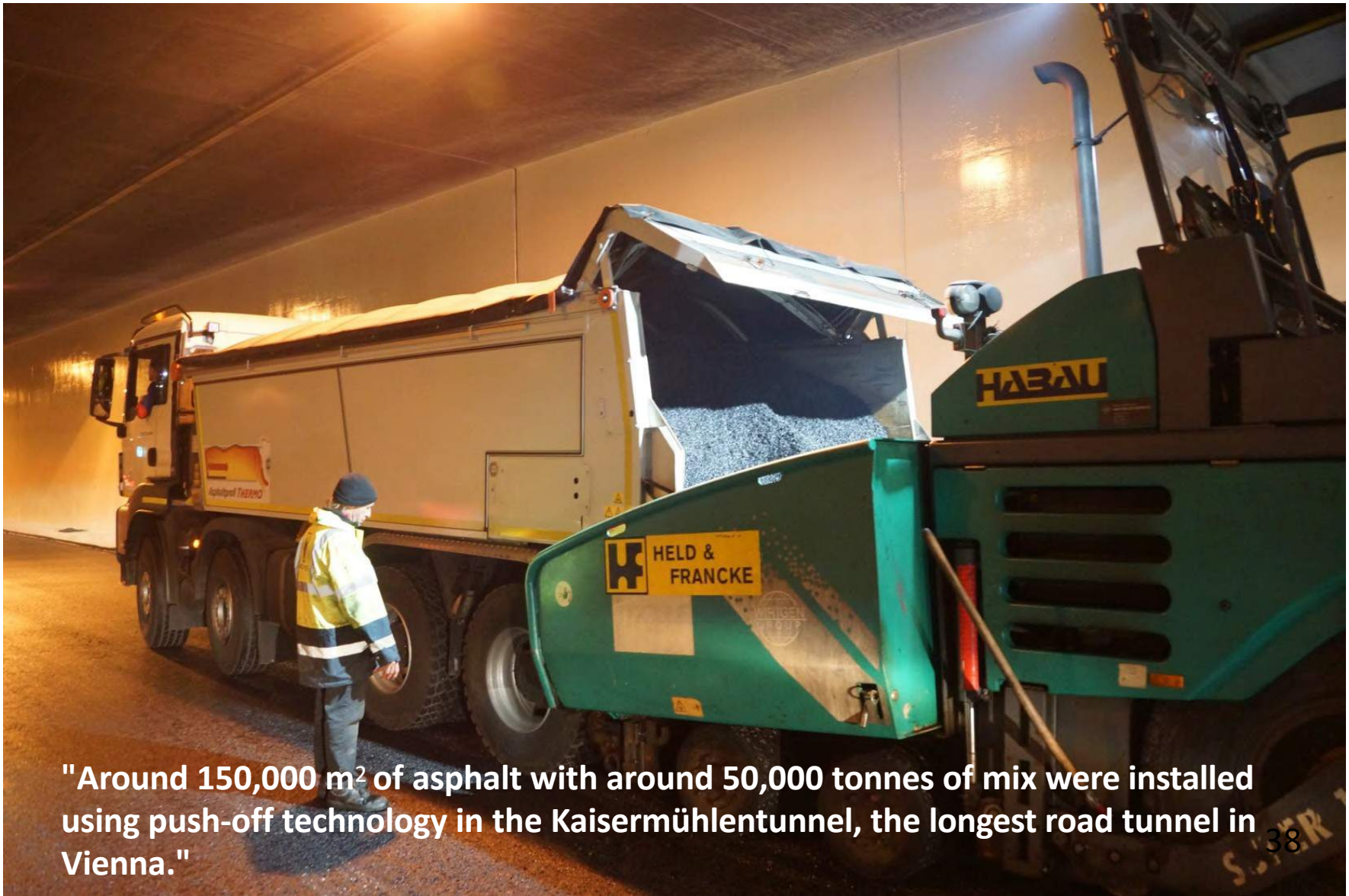
- **The risk of cold nests occurring was reduced significantly when vehicles with push-off technology were used and a more homogeneous temperature distribution was achieved with the bit-by-bit transfer of mix to the paver.**

- **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:

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



"Around 150,000 m² 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)

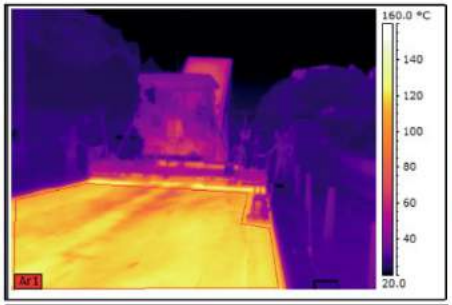
Sunshine, approx. 25 – 35°C

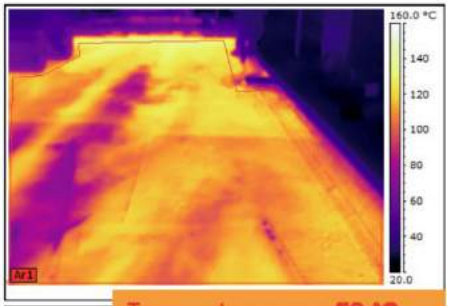
Binder layer:
Mix transport with thermally insulated dumper bodies
Installation of asphalt binder, two layers, total 10 cm
Designation: AC16 B S, rubber-modified bitumen

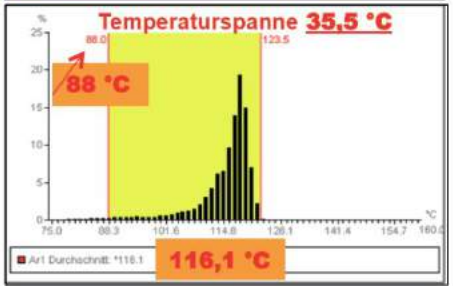
Surface layer:
Mix transport in thermally insulated push-off vehicles
Installation of a 2.5 cm thick noise-optimised asphalt surface layer

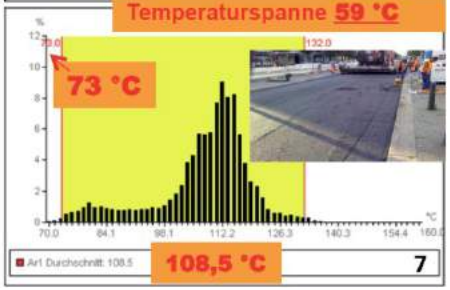
Temperature progression with thermal bodies – dumpers

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









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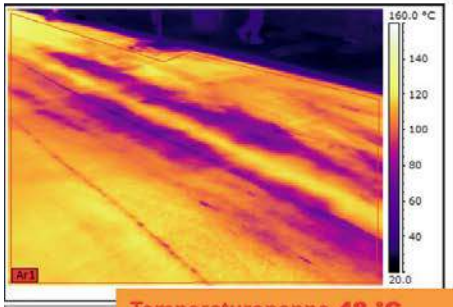
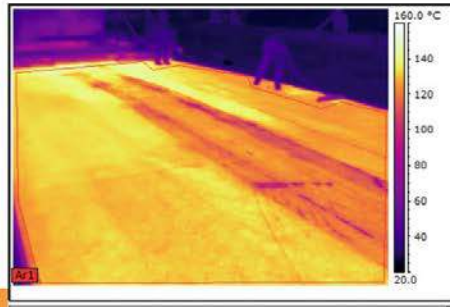
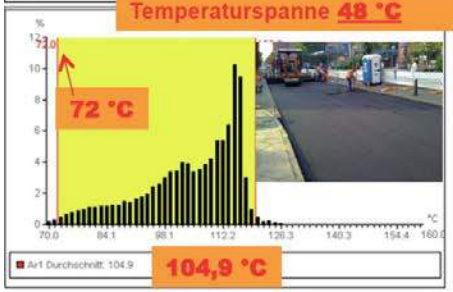
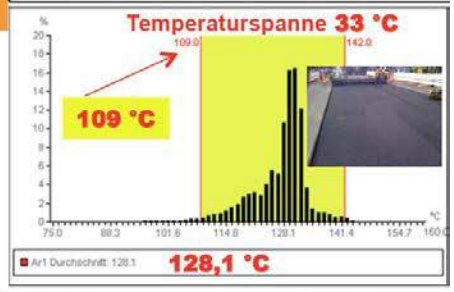
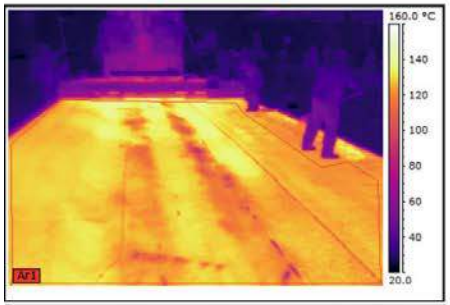
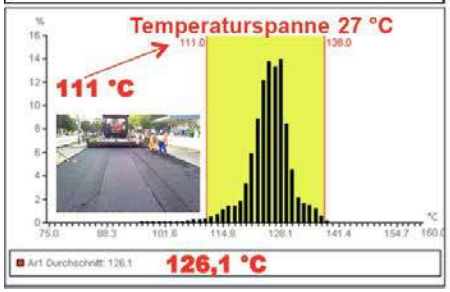


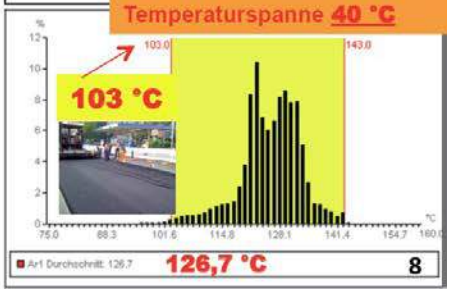










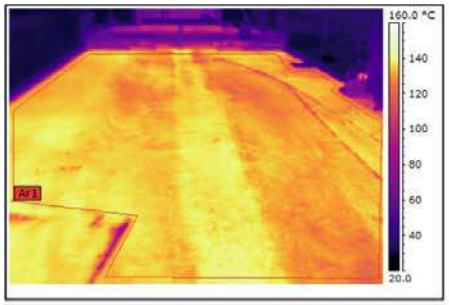


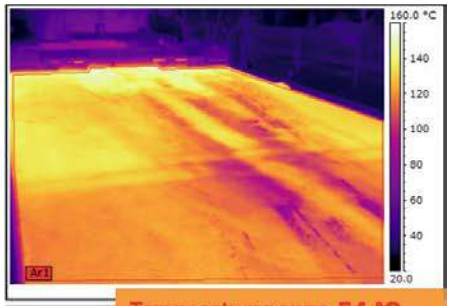
Temperature progression with thermal bodies – dumpers

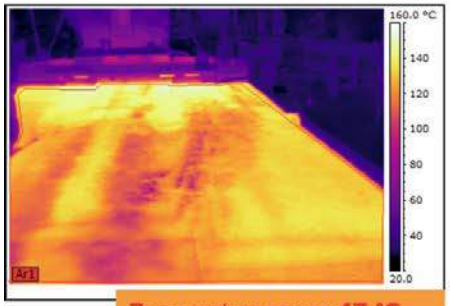
Berlin, B96-Residenzstraße_Einbau mit Thermomulden-Teil 2

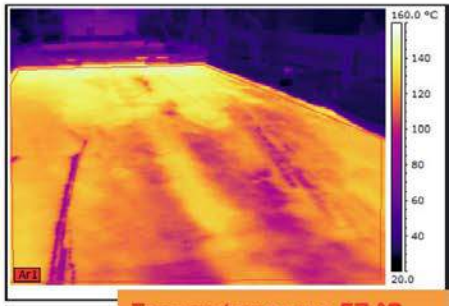
Witterung: Sonnenschein, windstill, ca. 28 -30 °C

Einbau von Binderschicht von ca. 9.15 Uhr bis 9.35 Uhr





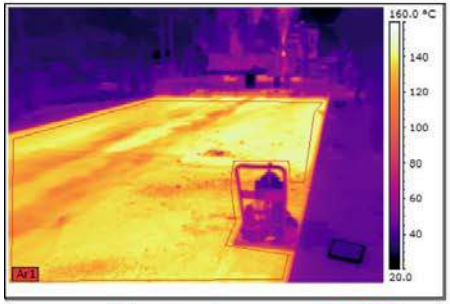


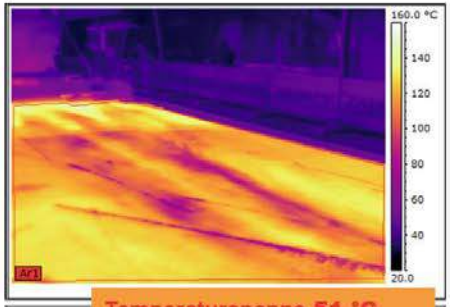


Berlin, B96-Residenzstraße_Einbau mit Thermomulden-Teil 3

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

Temperature progression with thermal bodies – push-off vehicles

Berlin, B96-Residenzstraße_Einbau mit Abschiebefahrzeuge

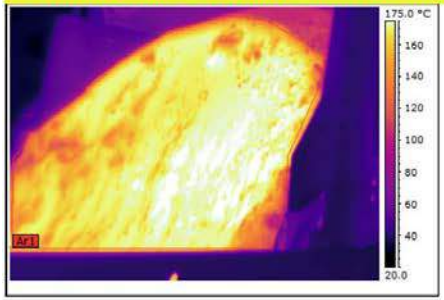
Temperaturverlauf beim Abschieben

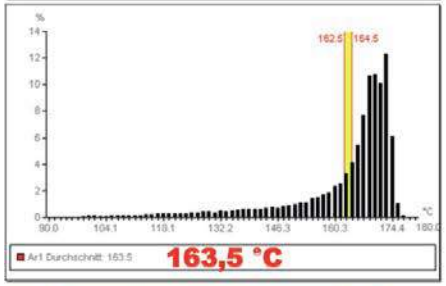
Nachfolgende 4 Aufnahmen entsprechen EINEM Abschiebevorgang

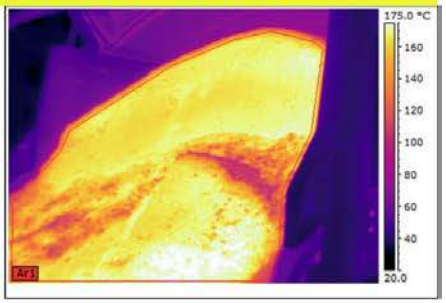
Berlin, B96-Residenzstraße_Einbau mit Abschiebefzg.-

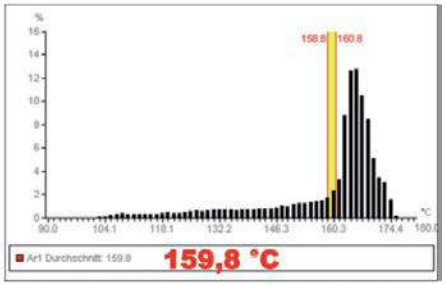
Temperaturverlauf beim Abschieben

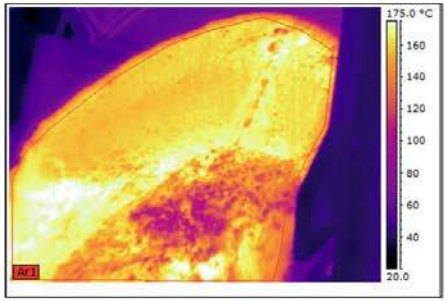
Nachfolgende 4 Aufnahmen entsprechen EINEM Abschiebevorgang

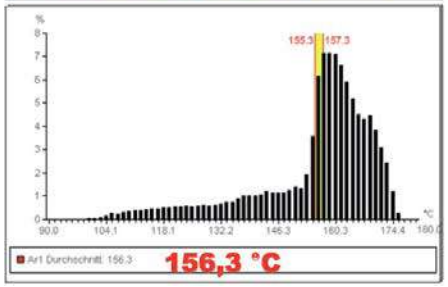


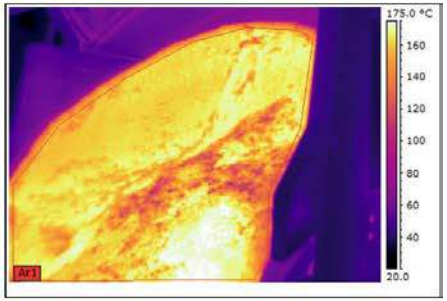


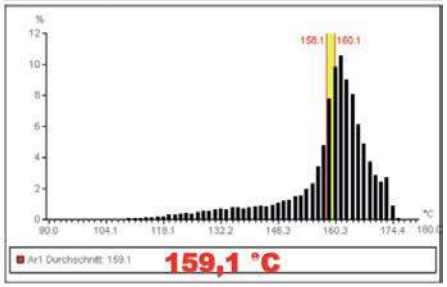






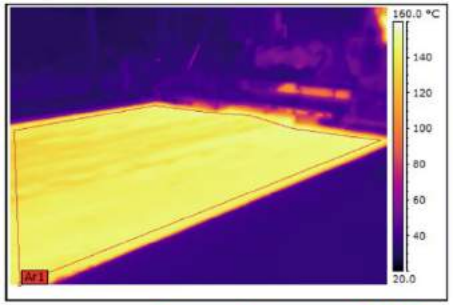


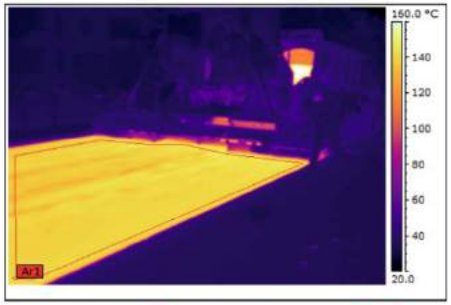


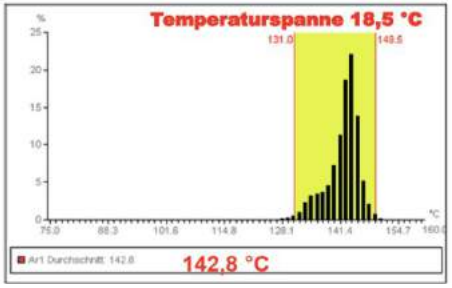


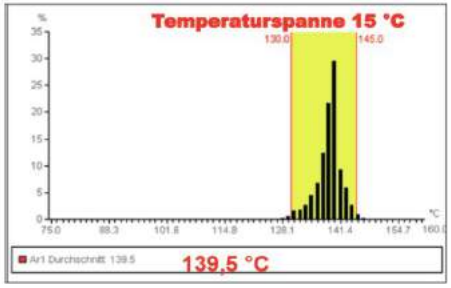
Temperature progression with thermal bodies – push-off vehicles

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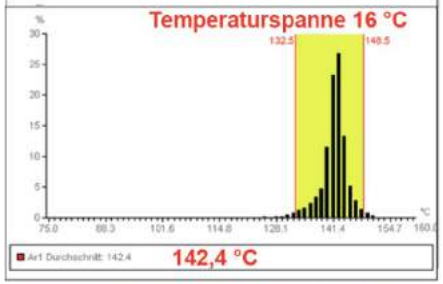
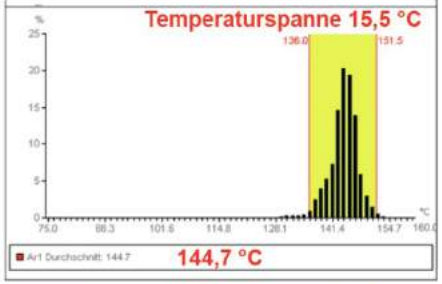
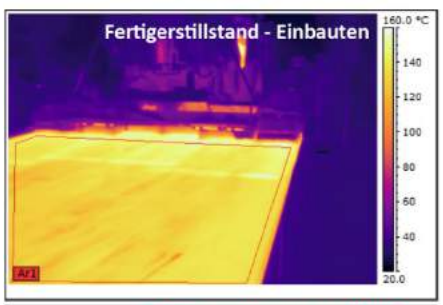
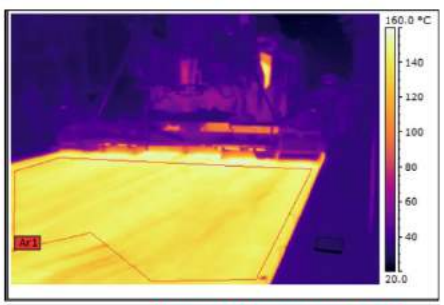
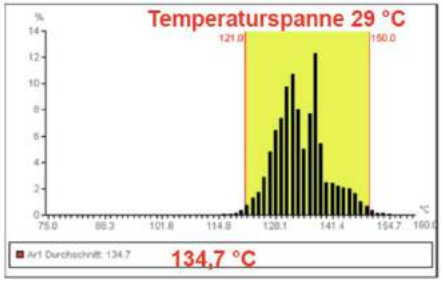
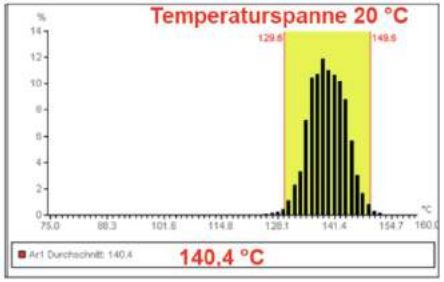








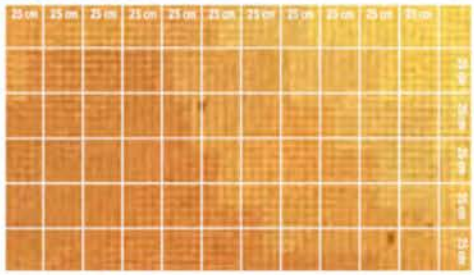




Thermal imaging systems that have proved themselves in practice
e.g. Vögle Road Scan

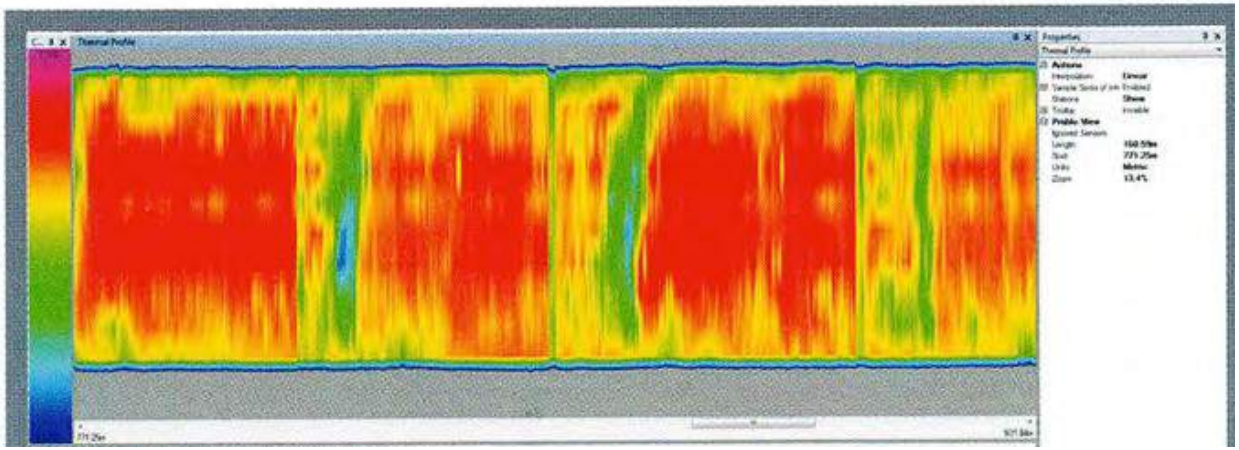
High-precision infrared camera with 100% measuring cover

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 ± 2°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."

For more safety at work

The Fliegl 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.


LIEBHERR
20

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)

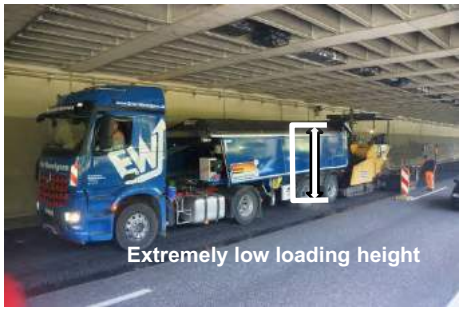
- Incorporate your transport company with push-off technology FIRMLY into the mix-material logistics and reduce costs in this way!!

- Ask your supplier of mix materials to transport them using push-off vehicles and so increase YOUR impact and competitiveness!!!

- Improves process reliability in asphalt road construction

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…
- Shorter circulation times as a result of significantly lower load centres on push-off vehicles (less braking ahead of bends…) and less cleaning effort even for PmB, OPA…



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**

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…**

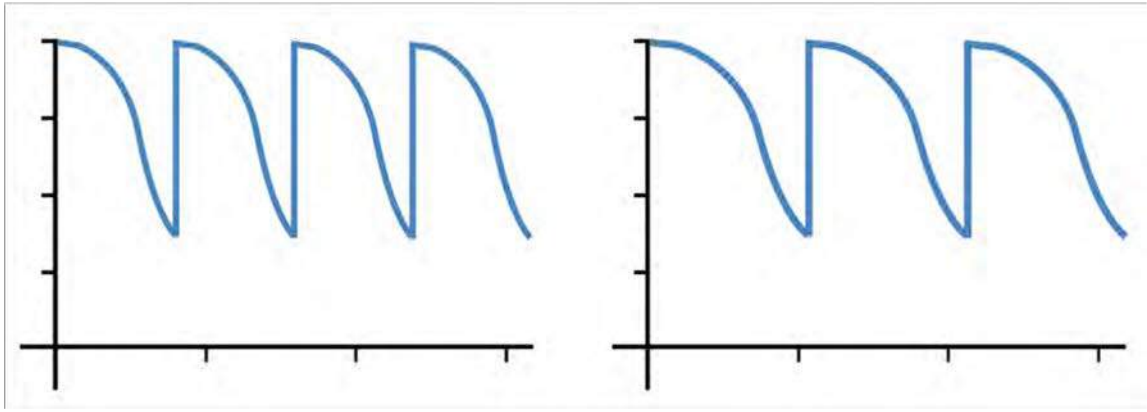
Costs / benefits for the consortium and for the contractor at airports

- **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**

Costs / benefits for the consortium

- **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

- **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 m²!!!)
- **It costs significantly more to build to a bad level of quality ! !**
- RVS and ASFINAG have already included included push-off technology as a best-bidder criterion and are demanding it in their specifications
- Vehicles with push-off function (recommended by the BMVI)
- Reduced asphaöt segregation in the silo
  Continous homogenisation of the material during unloading

Costs / benefits Enviormental Protection

Protecting the environment by reducing CO_2 emissions during asphalt production!

Production temperatures may be reduced in the mixing plant

è **while still achieving high and homogeneous installation quality**

è **fewer resources** – **less CO_2, less gas, oil, coal dust**

Vehicles also available regionally and nationally

Environmental Protection

Protecting the environment through low CO2 emissions during asphalt production≈

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 !!

Due to the more moderate production temperature, the bitumen is less stressed, resulting in less aging and embrittlement of the bitumen. -> This additionally improves the average service life of asphalt pavements.

Environmental Protection

Protecting the environment through low CO2 emissions during asphalt production≈

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

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??’

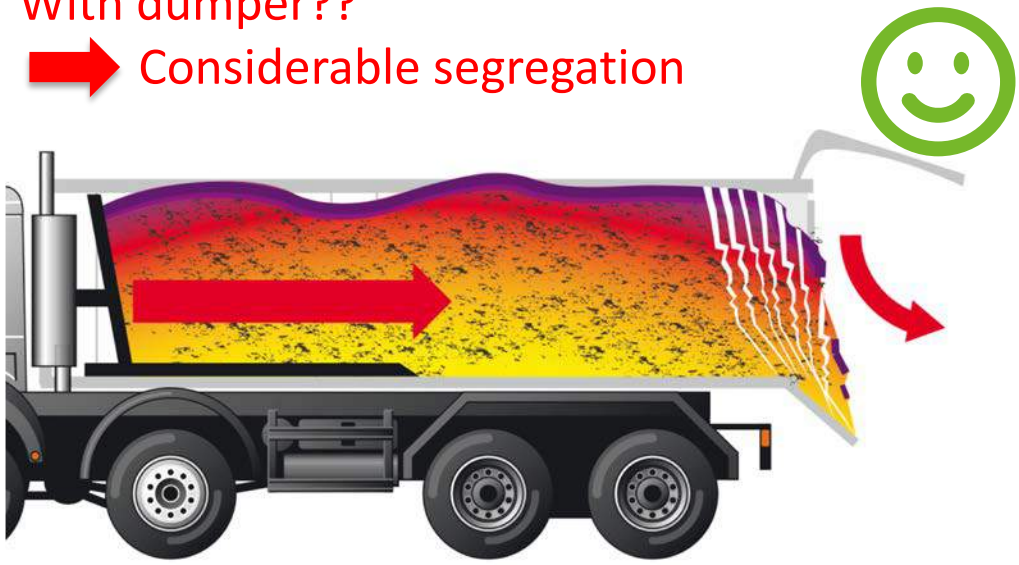
‘Quality has priority!!!’

How would you handle transportation?

With dumper??

➡ Considerable segregation

‘The main thing is that it's cheap??’



With push-off function!

➡ **CONTINOUS mixing during the unloading process with push-off vehicle!**