

Asphalt Manager Intelligent Compaction



Best for
COMPACTION

WHAT IS INTELLIGENCE

1) Collect Information

**2) Use the Collected Information
to Make a Decision**

3) Execute the Decision

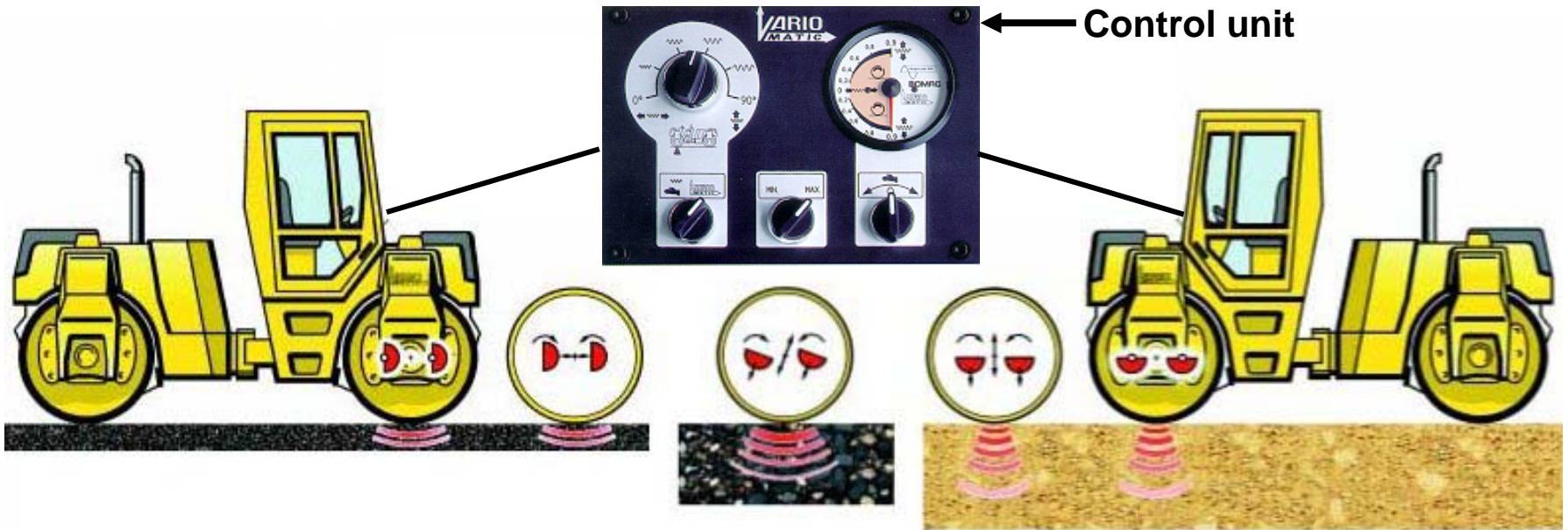
Surface Covering Compaction Measurement

- 1983 Terrameter BTM 01 (OMEGA)**
- 1993 Guidelines for Surface Covering Measurements
National Research Association**
- 1994 ZTVE / TP BF-StB 94, proof methods FDVK/ SCCC**
- 1996 Compaction Management System BCM 03**
- 1998 VARIOCONTROL**
- 2001 Measuring device for evaluation of stiffness (Evib)**
- 2004 Modular Measuring System with GPS support**

BOMAG Compaction Technology

- 1996** **Variomatic for asphalt rollers**
- 1998** **Variocontrol for soil rollers**
- 2000** **Evib (MN/m²)**
- 2001** **Asphalt Manager**
- 2004** **Research project of German DOT (BAST), Oct / Nov. 2004;**

VARIOMATIC roller with directed vibration






low dynamic energy

Compaction principle

static pressure and dynamic energy which is automatically adjusted to type of material, compactibility, layer thickness and base layer conditions.

high dynamic energy

-  Asphalt thin course
-  Asphalt base course
-  Gravel-sand

Applications: asphalt layers, granular bases and subbases.

Worldwide proven design:

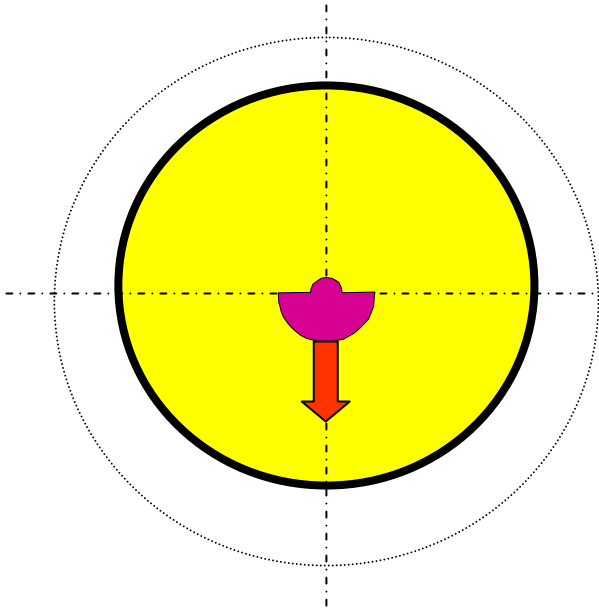
Several hundreds Tandem rollers

BW 151 AD-2

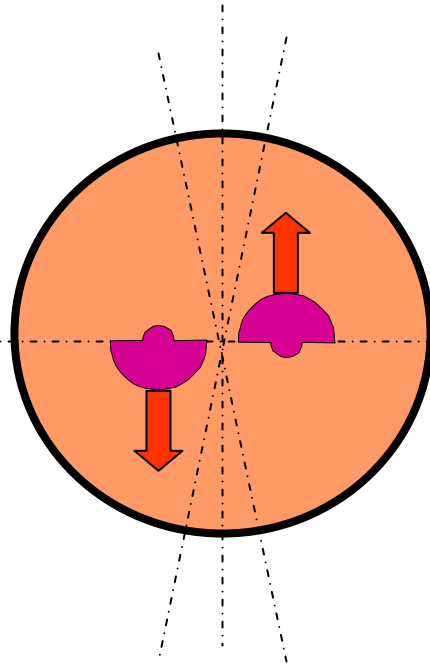


BW 174 AD

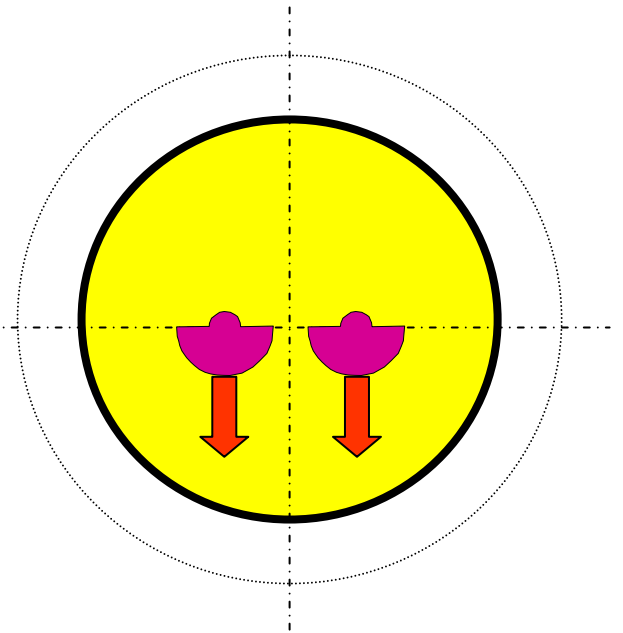
Rotary exciter



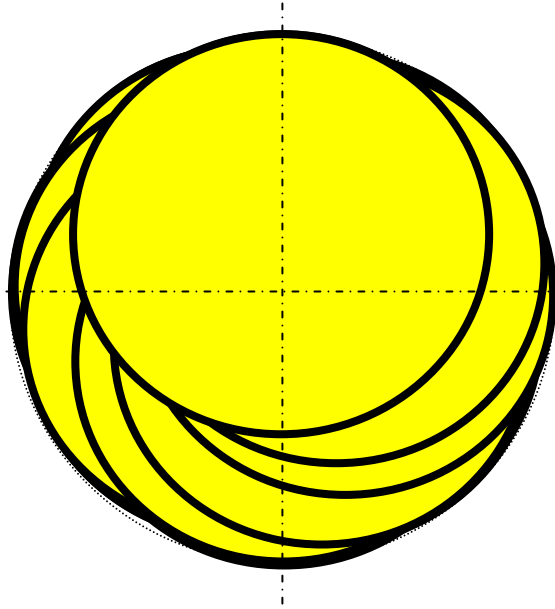
Oscillation



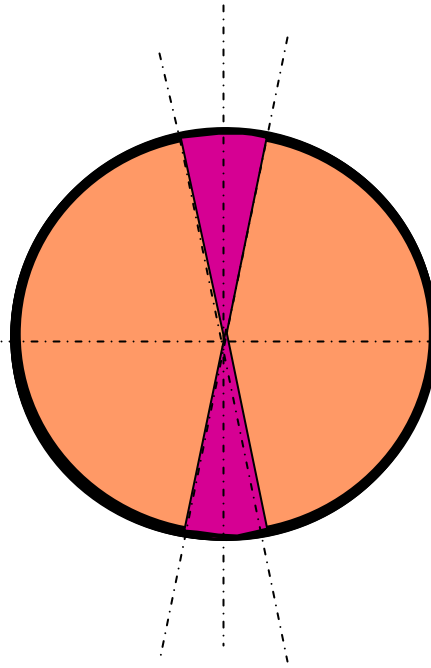
directed



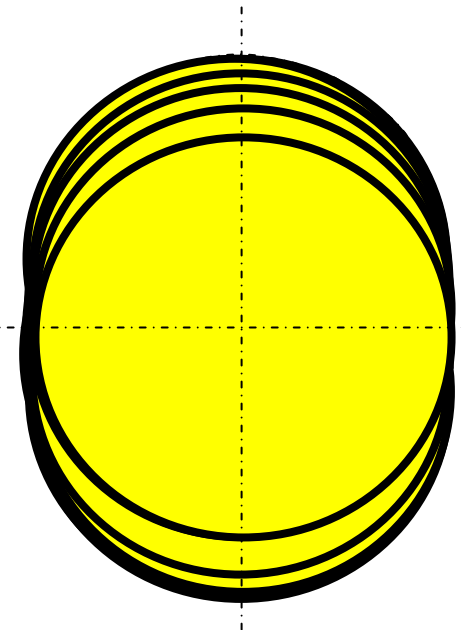
Rotary exciter



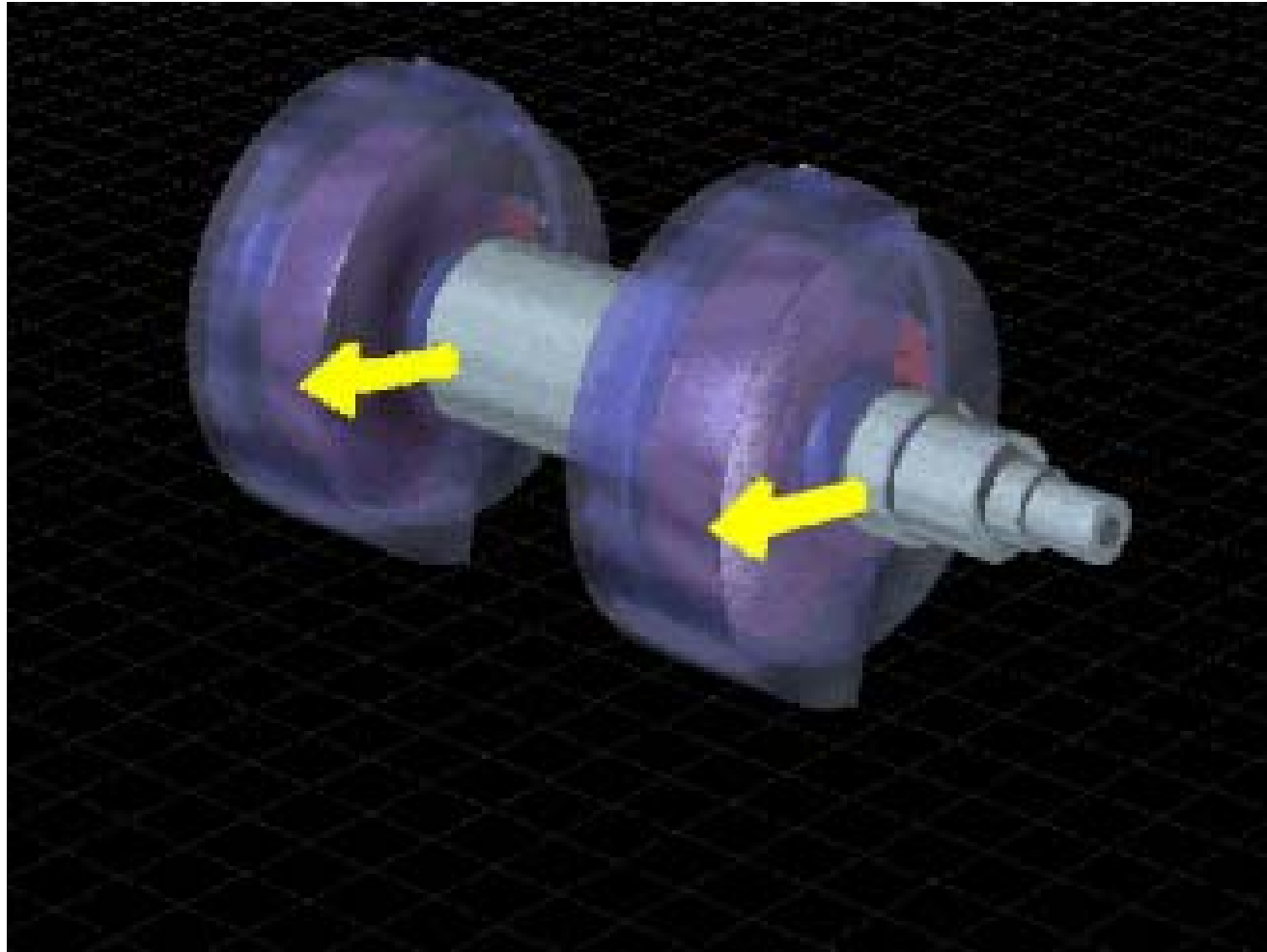
Oscillation



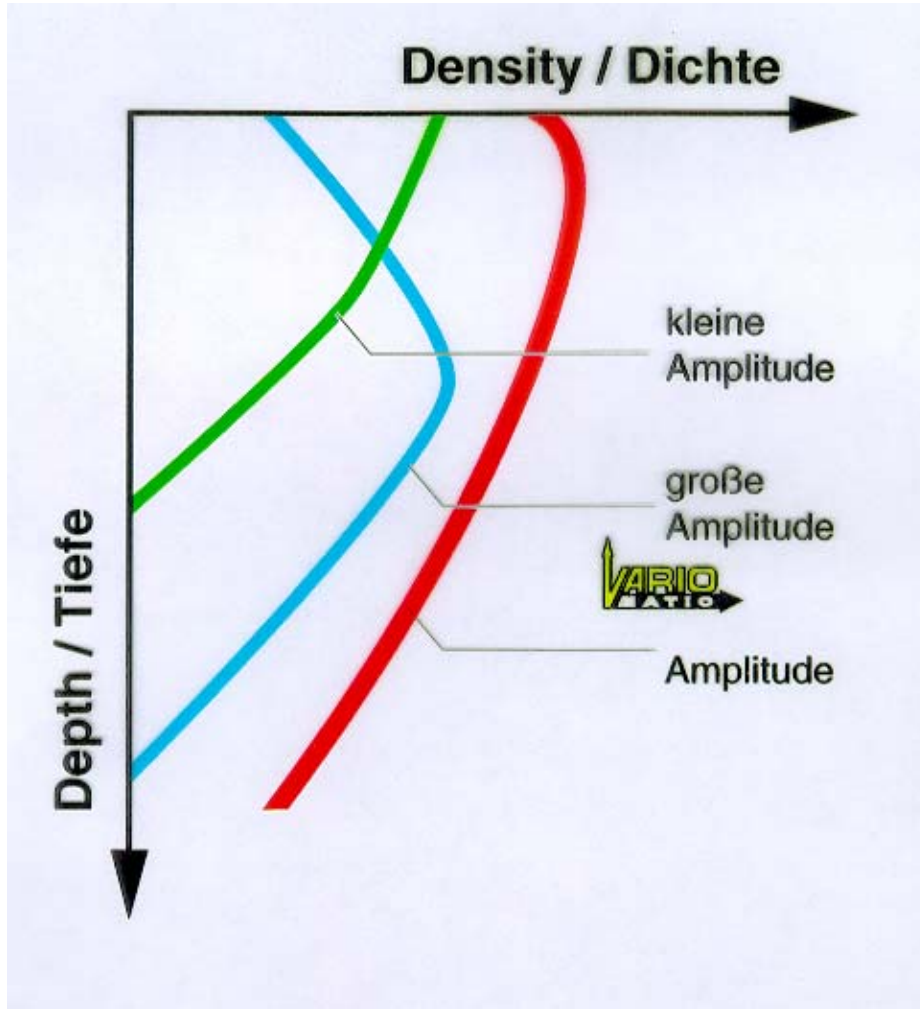
directed



Non Directed Forces:



| | Vibration | Oscillation | Variomatic |
|-----------------------|---------------------------------------|--|---|
| Principle | Rotary exciter with unbalanced weight | 2 rotary exciters with 2 unbalanced weight | 2 rotary exciters with 2 unbalanced weight counter rotating |
| Oscillation | non directed - | directed horizontally | directed horizontally to vertically |
| Amplitudes | up to 8 up to 1,3 mm | 2 fixed amplitudes ca. 1,3 mm | automatic variation 0 - 0,9 mm horizontal/vertical |
| Frequencies | 35 -70 Hz | 33 - 42 Hz | 35 - 50 Hz |
| Control system | manual | manual | automatic variation |



Comparison:

**Rotary exciter
(no infinite variation)**

**Variomatic
(automatic compaction)**

Advantages vs. Rotary exciter:

- **Better depth effect**
- **Excellent Asphalt surfaces**
 - **Evenness**
 - **Grip / roughness**

Benefits for contractors:



- **Universal use on**
 - Road base
 - Wearing course layers
 - Thin layers
- **Higher compaction performance**
- **Uniform compaction, even on sub-bases with inhomogeneous stiffness**
- **Better evenness and more uniform surface structure**
- **Low tendency to scuffing**

Compaction of 6 cm asphalt binder course 0/10, RN13 France Operating weight and compaction technique affect smoothness and evenness



15 t tandem vibratory roller

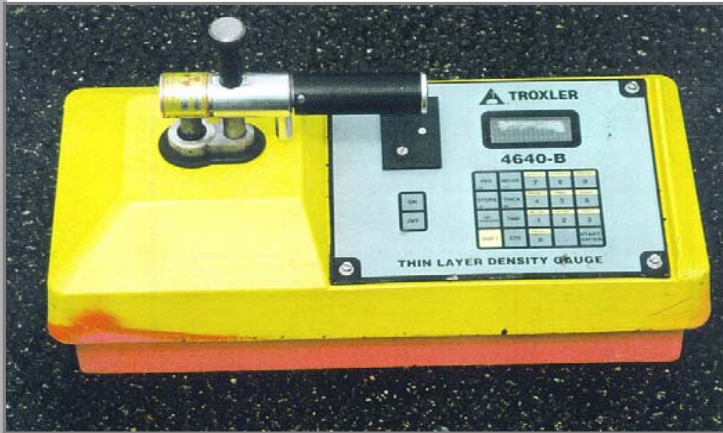
8 passes



8 t BOMAG VARIOMATIC BW 151 AD

8 passes

Density and roughness measurement on asphalt binder layer



Punctual compaction measurement with portable isotope probe



Continuous compaction measurement with mobile isotope probe
[1 measurement / 10 m]]

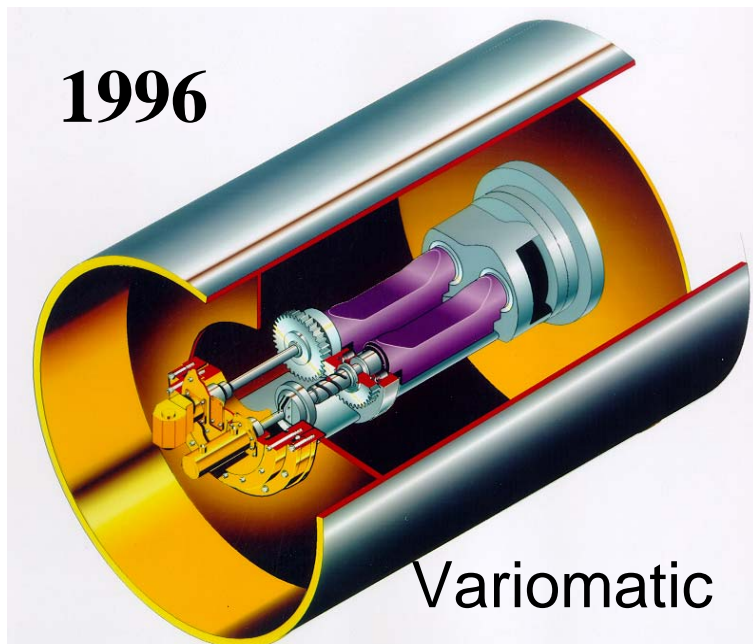


Comparison between conventional compaction concept and VARIOMATIC

| | Compaction | | | | | | Roughness | | |
|--|------------------------|--------|----------|---|--------|----------|------------------|---------|----------|
| | Portable isotope probe | | | Mobile isotope probe [1 measurement./10 m] | | | Sand spot method | | |
| | n | X1 | σ | n | X1 | σ | n | X2 | σ |
| 4 passes with 25 t rubber tire roller and 4 passes with 15 t tandem vibratory roller | 14 | 92,5 % | 1,22 | 59 | 94,6 % | 1,29 | 12 | 0,46 mm | 0,07 |
| 8 passes with BW 151 AD-2 VARIOMATIC | 14 | 92,5 % | 0,54 | 59 | 93,8 % | 1,06 | 12 | 0,60 mm | 0,05 |

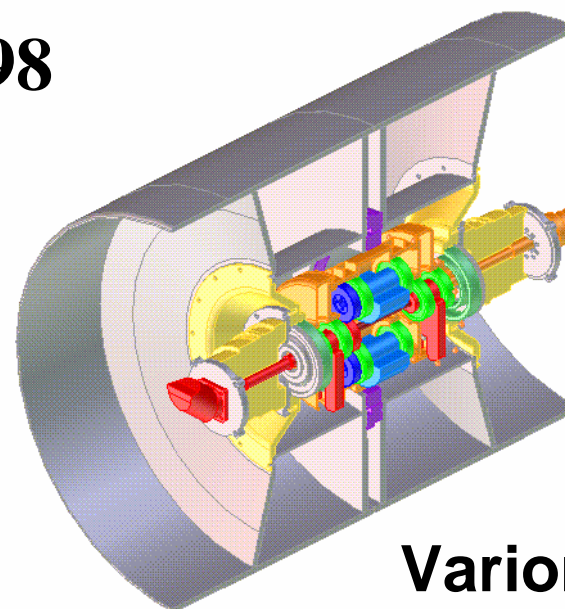
n = number of measurements, X1 = mean value of achieved Gyrator test compaction value (93% Gyrator value ~ 98% Marshall value), X2 = mean value of characteristic roughness value

1996



Variomatic

1998



Variomatic 2

advanced, more powerful

also for split drums !

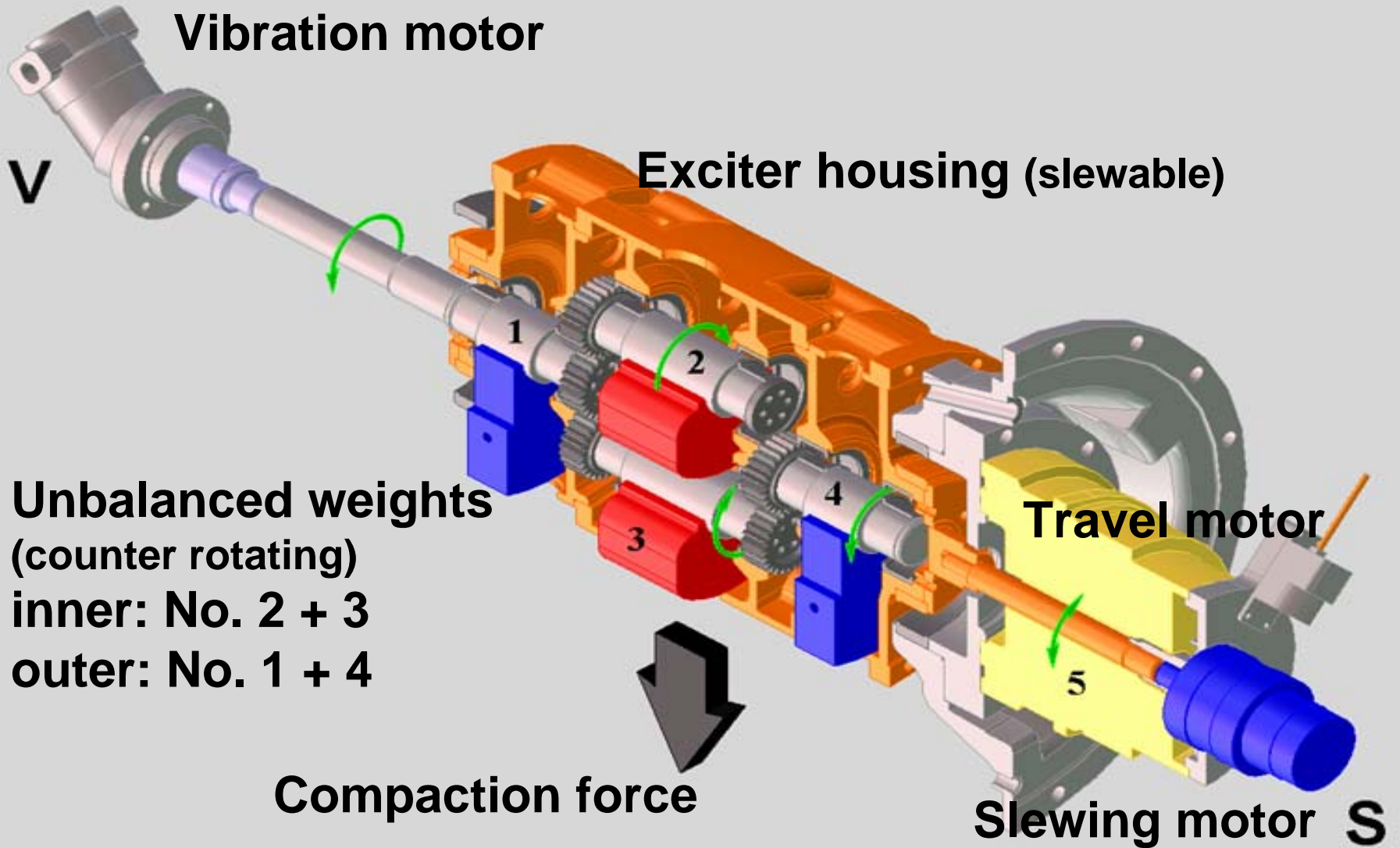
Latest developments of compaction technology

1996 Variomatic for asphalt rollers

1998 Variocontrol for soil rollers

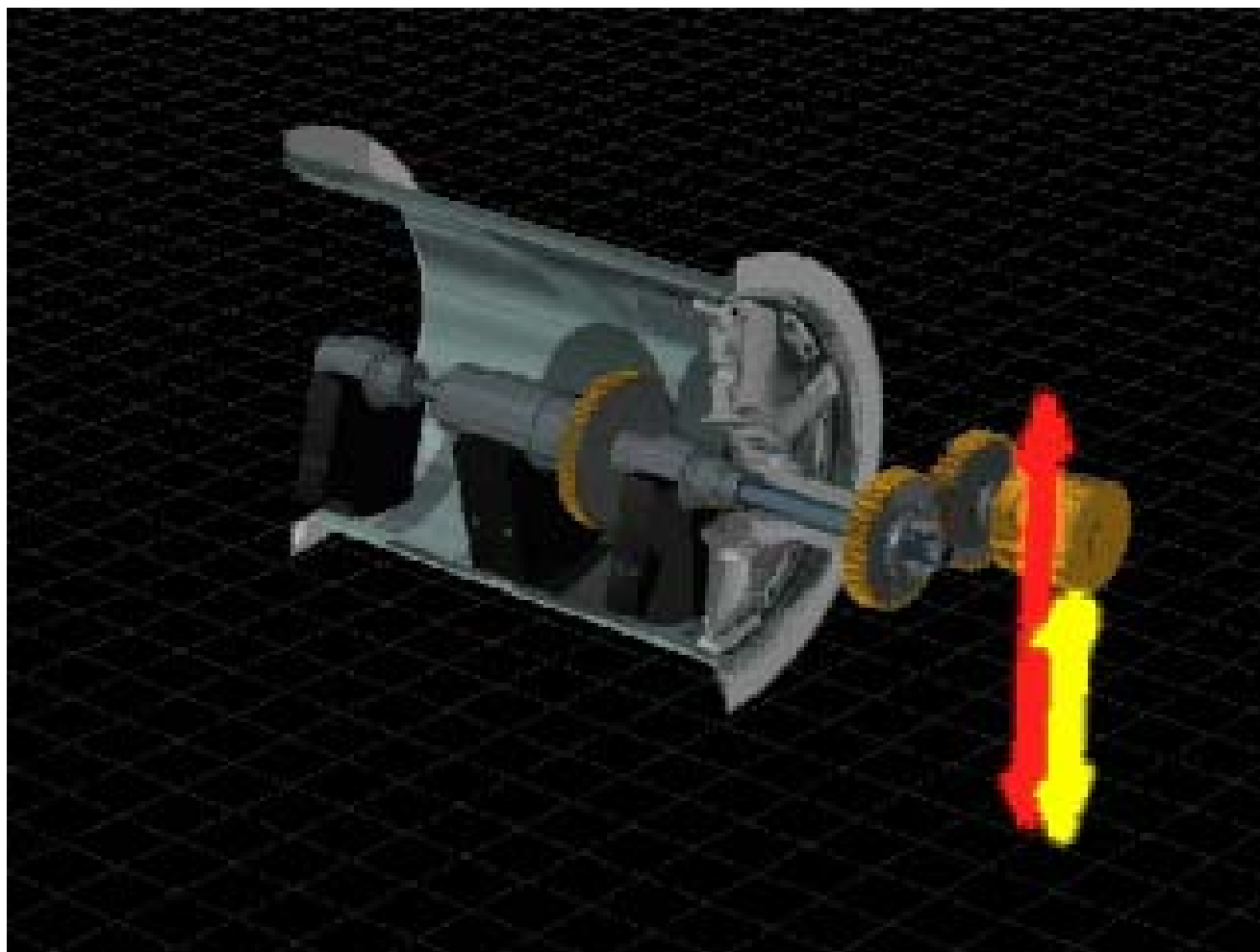
2000 Evib (MN/m²)

2001 Asphalt Manager

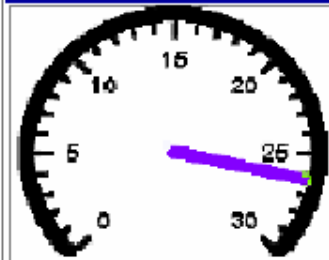


BOMAG VARIOCONTROL

**Force Direction
Control:**
Infinite adjustment
of exciter housing
from
horizontal to
vertical.

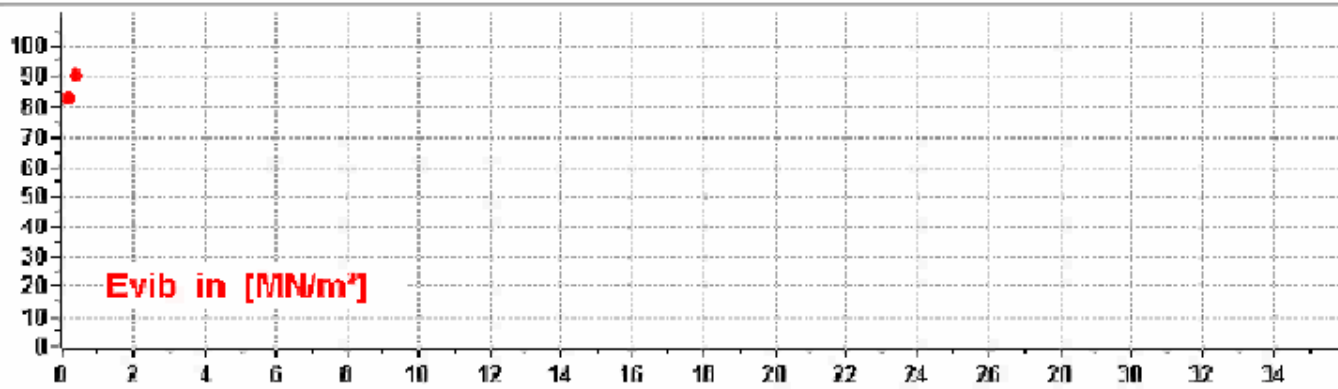
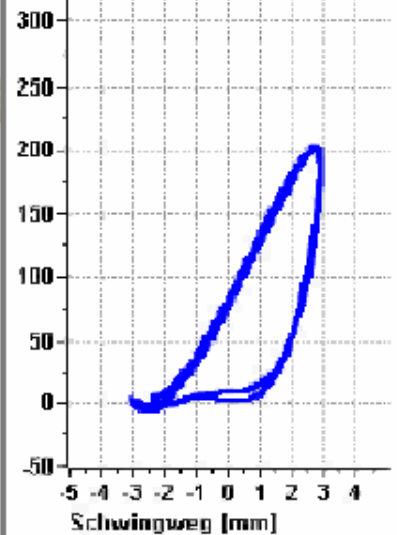


Dynamischer Steifigkeitsmodul "Evib" als flächendeckende Verdichtungskontrolle beim Fahren



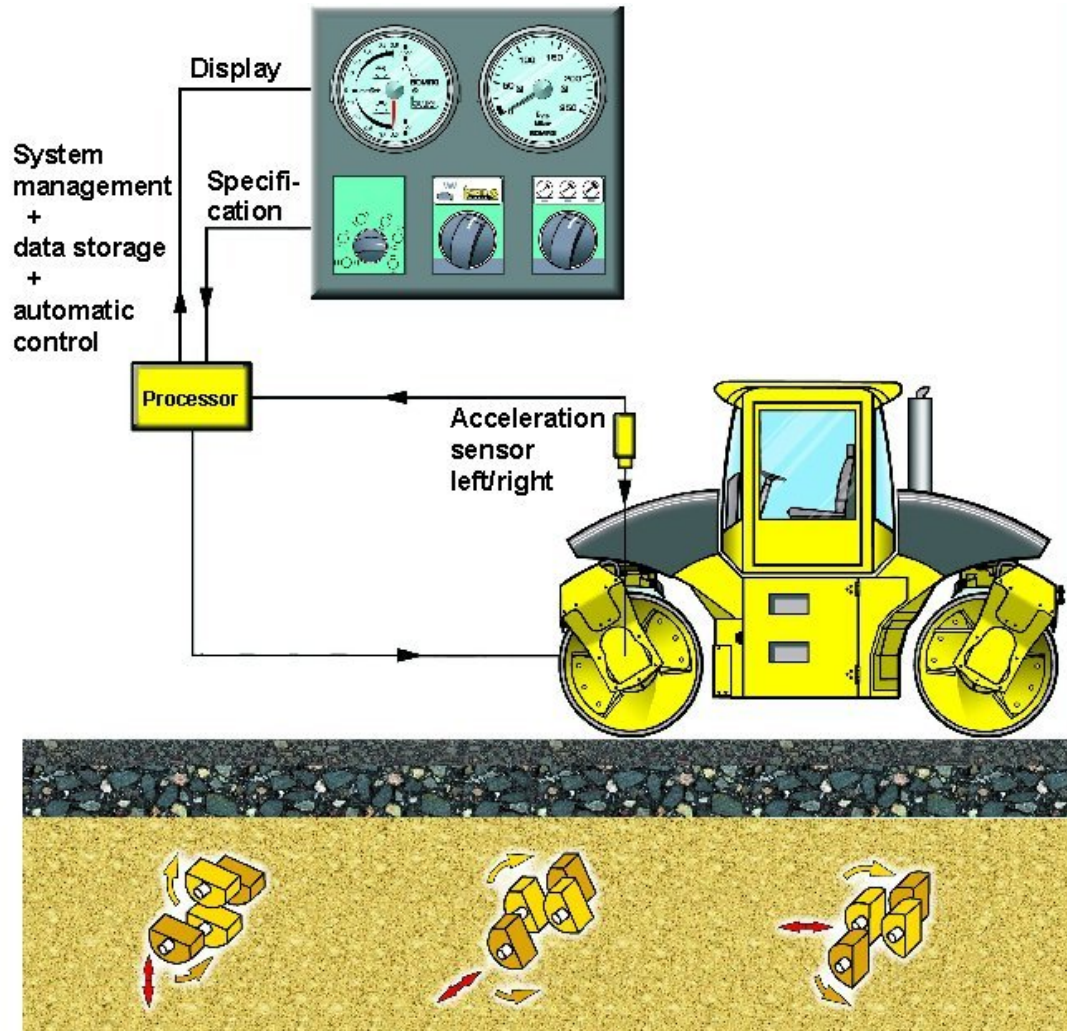
Indikatordiagramm

Bodenkraft [kN]

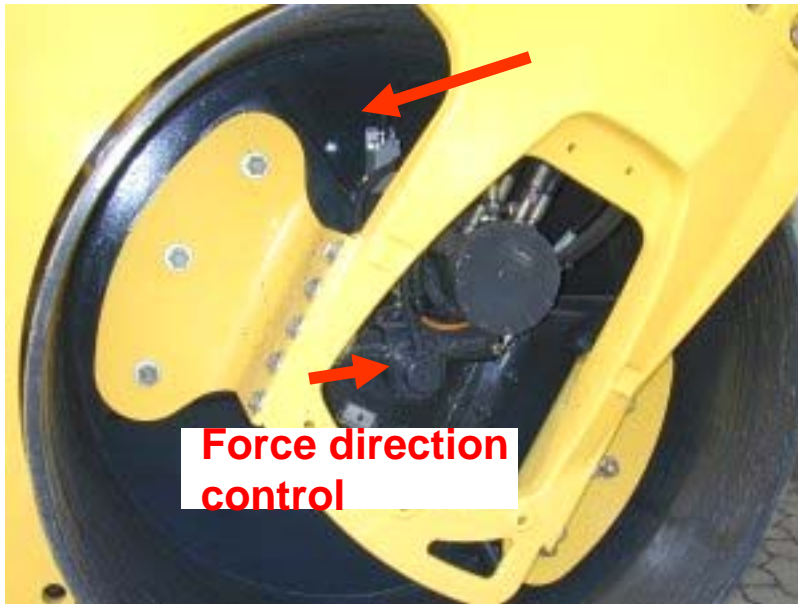


EVIB_DEU_800x600.avi

Asphalt Manager with new measuring value E_{VIB} [MN/m²] and temperature gauge



Acceleration meters



Benefits for Operators:

No critical decisions required

All operators achieve better results:

- good and uniform compaction**

Continuous information on

- asphalt temperature**

- compaction increase**



Asphalt Manager: Easy to understand



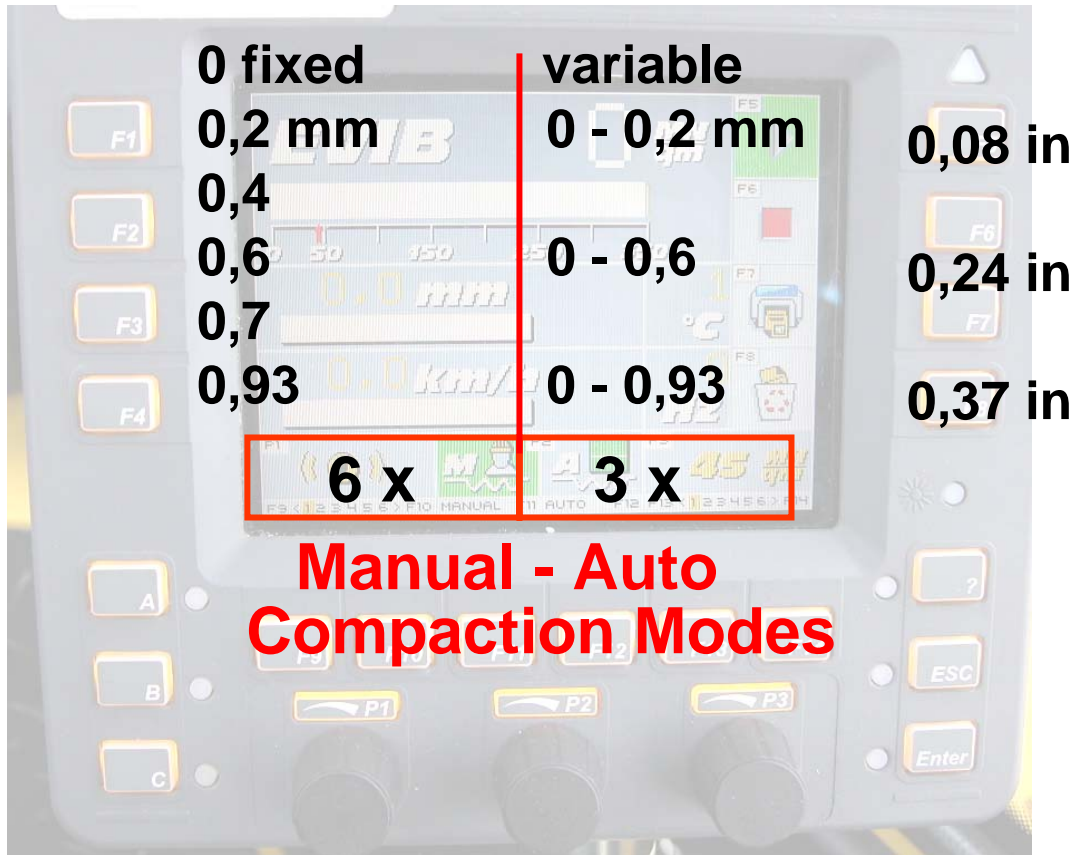
Technical Data

| PARAMETERS | BW 141 / 151 AD AM | | BW 190 / 203 AD AM | |
|------------|-----------------------|--|-----------------------|--|
|------------|-----------------------|--|-----------------------|--|

Front: AM

Rear: Std. Exciter

| | | | | | |
|---------------------|-----------|-------------------|-------------------|-------------------------|-------------------------|
| Oper.weight | kg | 8.000 | 8.400 | 12.000 | 13.100 |
| Drum width | in | 59 | 66 | 79 | 84 |
| Amplitudes | | | | | |
| front | mm | 0,96 | 0,95 | 0,93 | 0,73 |
| rear | mm | 0,64 / 0,27 | 0,6 / 0,25 | 0,86 + 0,37 | 0,7 / 0, 3 |
| Frequencies | | | | | |
| front / rear | Hz | 45 | 45 | 40 + 50 / 46+57 | 40+50 / 40+50 |
| Centr. force | | | | | |
| front | kN | <u>160</u> | <u>168</u> | <u>247 / 158</u> | <u>247 / 158</u> |
| rear | kN | 80 / 34 | 80 / 34 | 167 / 109 | <u>126 / 84</u> |





PRINTER

- ← - Start
- ← - Stop
- ← - Print out
- ← - Delete

Test procedere:

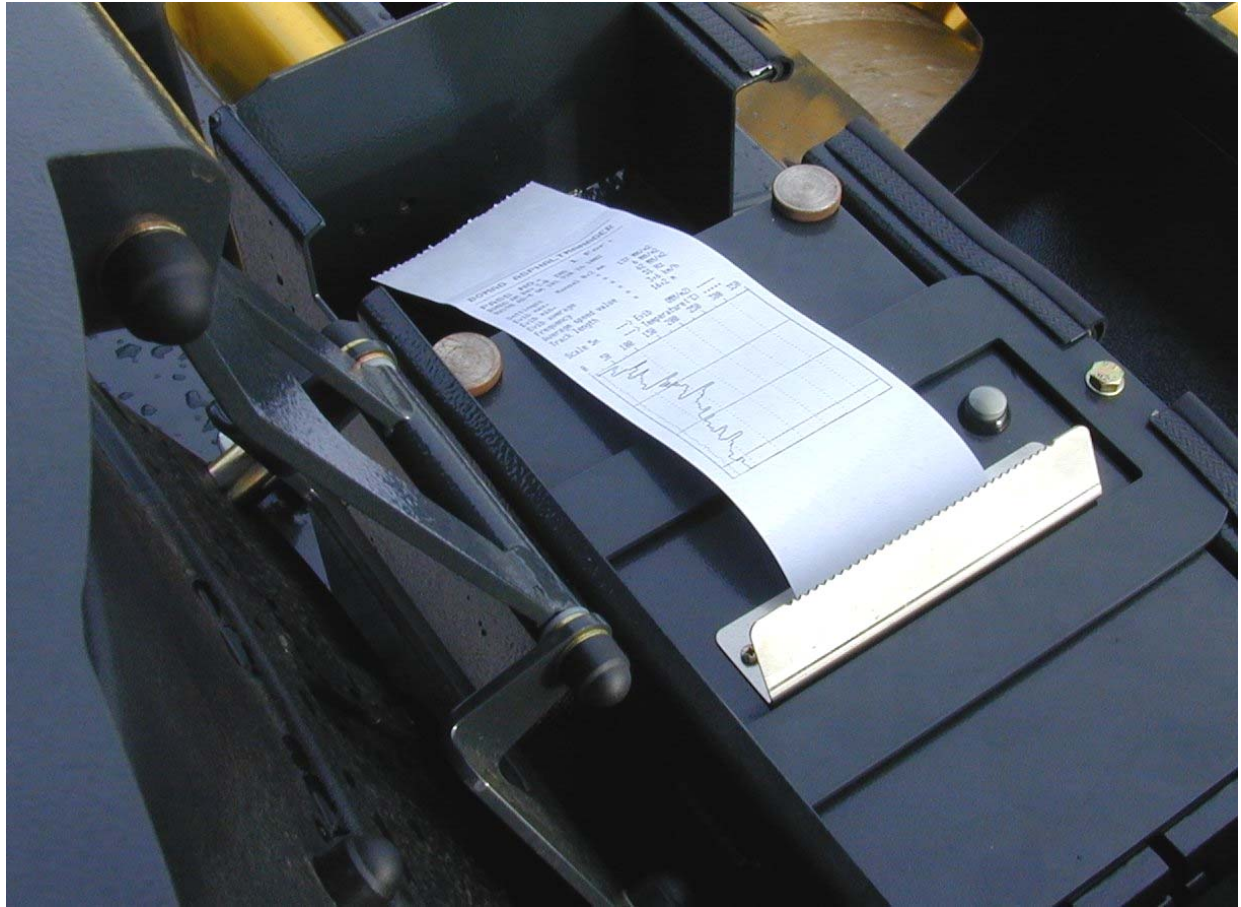
- Mark the track to be compacted
- „Manual operation mode“ with
- Fixed amplitude
- Fixed working speed



SETTINGS
- Escape
- Enter



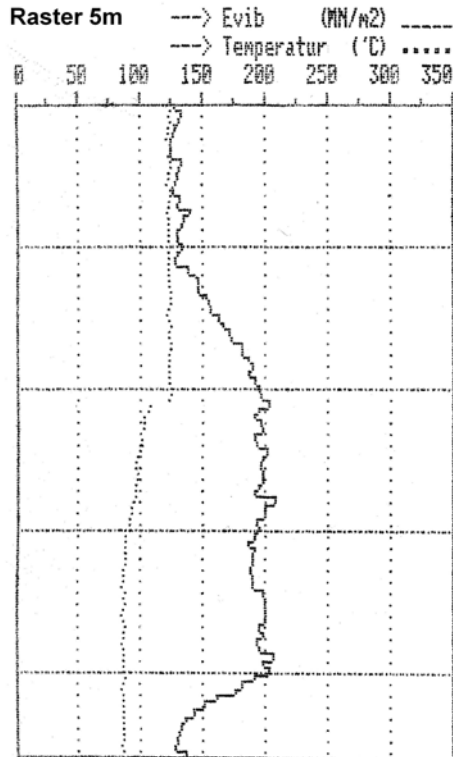




BOMAG ASPHALTMANAGER

UEBERGANG 1 VOR.
 BOMAG AM REV 6 DEU
 BW 174 AM

Einstellung : Hand / 0,40 mm
 Evib Max. = 206 MN/m²
 Evib Min. = 124 MN/m²
 Evib Mittelwert = 168 MN/m²
 Frequenz = 44,3 Hz
 Mittlere Fahrgeschw. = 3,3 km/h
 Bahnlänge = 22,9 m



E_{VIB} Max. / E_{VIB} Min.

E_{VIB} Average

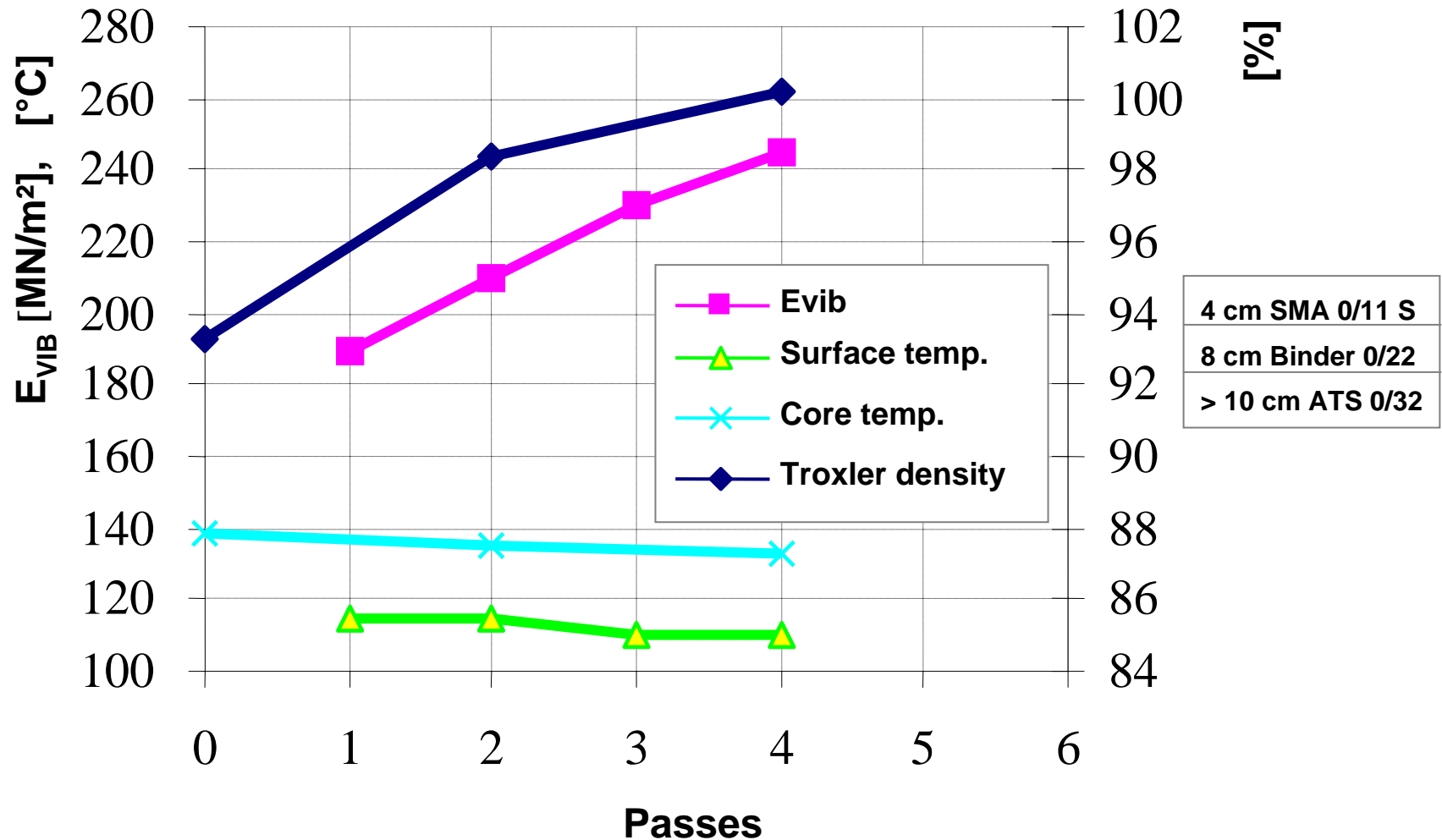
Frequency

Average Speed

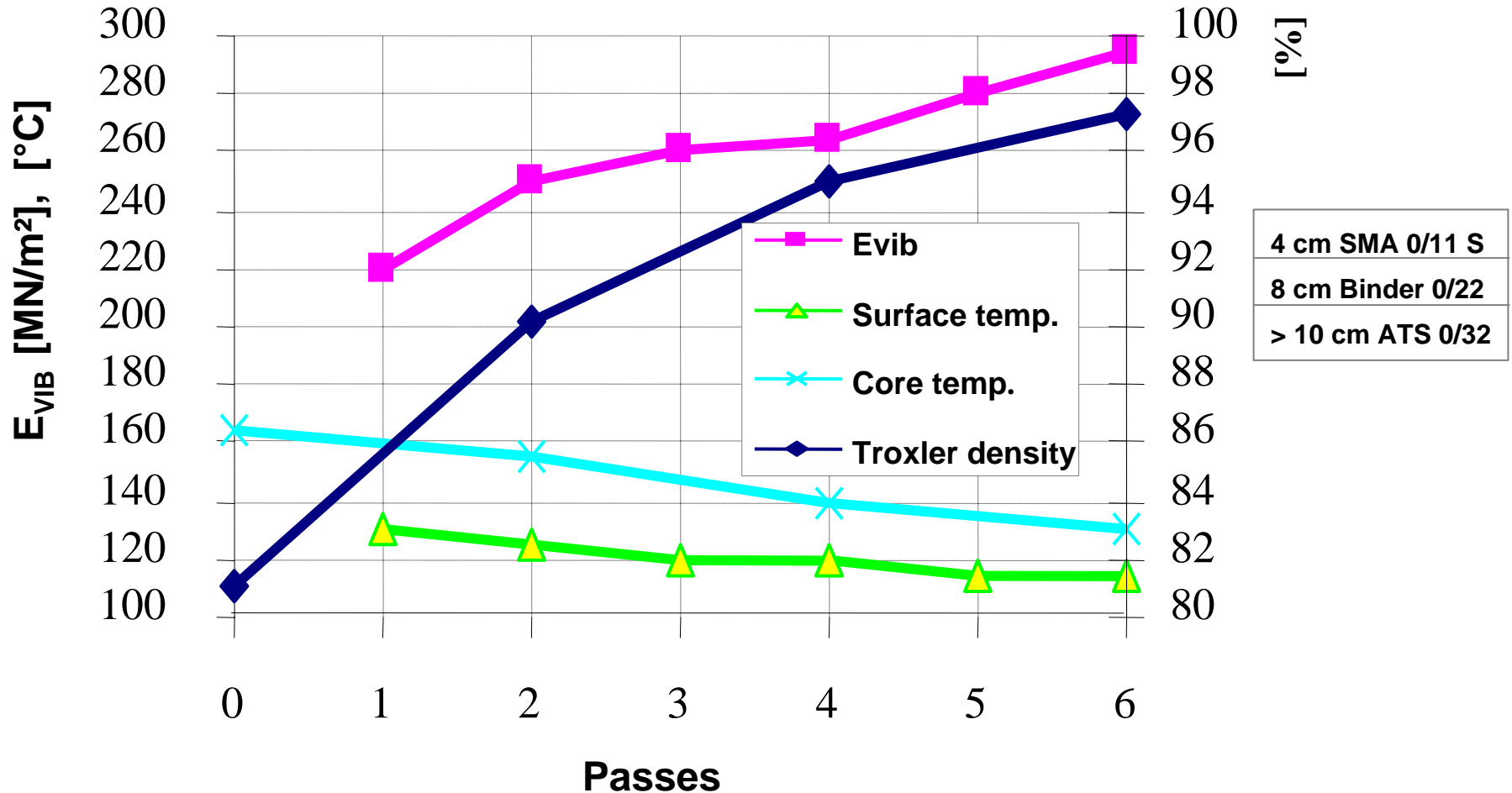
Track length

Temperature

E_{VIB} and Density as function of passes; BW 174 AD Asphalt Manager, Automatic mode; Asphalt Base 0/32 CS B65, Nürnberg A3



E_{VIB} and Density as function of passes; BW 174 AD Asphalt Manager, Manual mode 4; Wearing course SMA 0/11S PmB45, Nürnberg A3



Advantages:

- Immediate determination of dynamic stiffness in MN/m^2 (E_{VIB})
- E_{VIB} can be correlated with the increase of compaction
- E_{VIB} is widely independent from roller parameters
- E_{VIB} printouts for area covering compaction control

In Development:

- Target E_{VIB} values to be pre-selectable
- „Ready“ indication if target value is achieved (red light)
- „Ready“ indication if no further compaction is possible (red light)

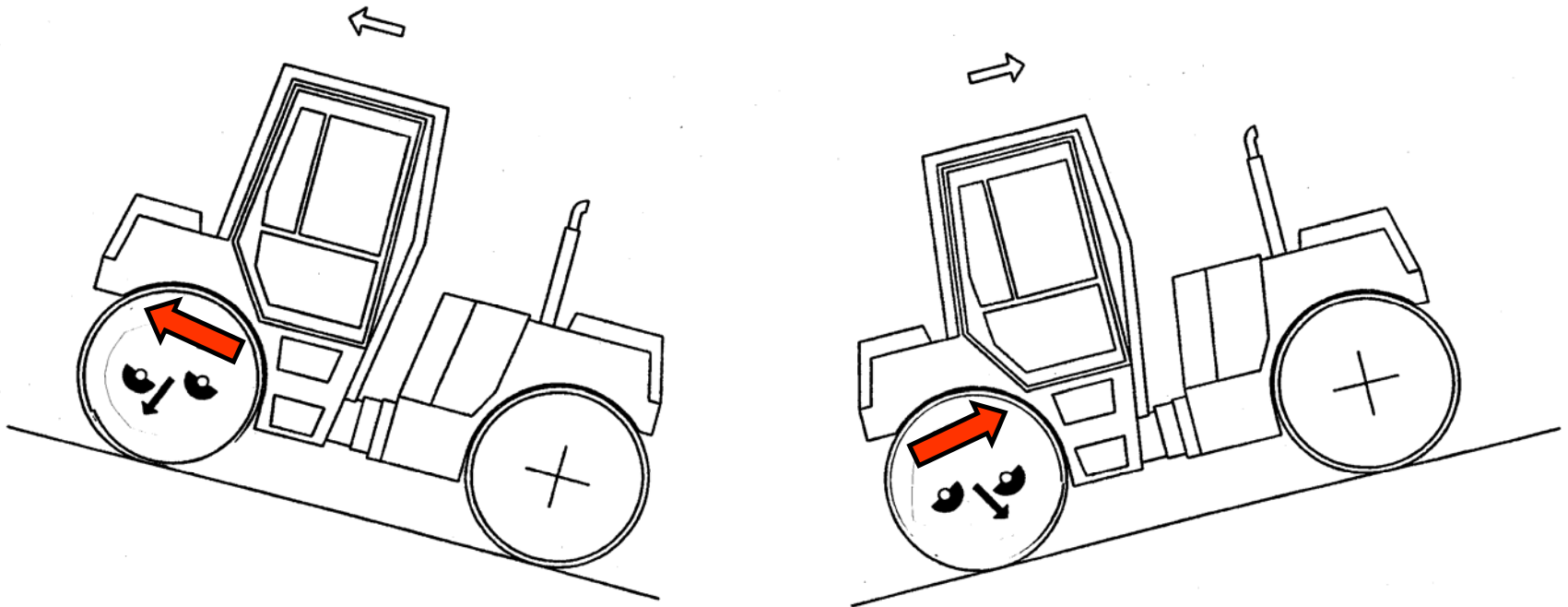
Recommended figures:

| Layer thickness d [cm] | | No. of passes with vibration of different tandem rollers | | |
|---------------------------|--------------|--|---------------------------------|---------------------------------|
| | | 3 t | 6 t | 9 t |
| 2 | | 2 - 4 | 1 - 2 (L) | 1 - 2 (L) |
| 4 | | 4 - 6 | 2 - 4 (L) | 2 - 4 (L) |
| 6 | | 4 - 8 | 4 - 6 (L) | 2 - 4 (L) |
| 10 | | 6 - 8 | 4 - 8 (L, H) | 4 - 6 (L, H) |
| 14 | | -- | 6 - 8 (H) | 4 - 6 (H) |
| 18 | | -- | 6 - 8 (H) | 4 - 8 (H) |
| SMA | d = 2 | -- | 1 - 2 (L) + stat. passes | 1 - 2 (L) + stat. passes |
| (Stone mastix) | d = 4 | -- | 4 - 6 (L) + stat. passes | 4 - 6 (L) + stat. passes |
| Porous asphalt | d = 4 | -- | 1 - 2 (L) + stat. passes | 1 - 2 (L) + stat. passes |

L = low amplitude, H = high amplitude
3 t = Machine with only the amplitude

Assumption: Compaction temperature > 100°C

**Further advantages:
better gradability- less shoving effect**



Automatic force adaption with travel direction

Evib (MN/m²) Vibration modulus

Equivalent for dynamic Stiffness;

Directly picked up by the roller;

**Physical value for compaction increase
on asphalt.**

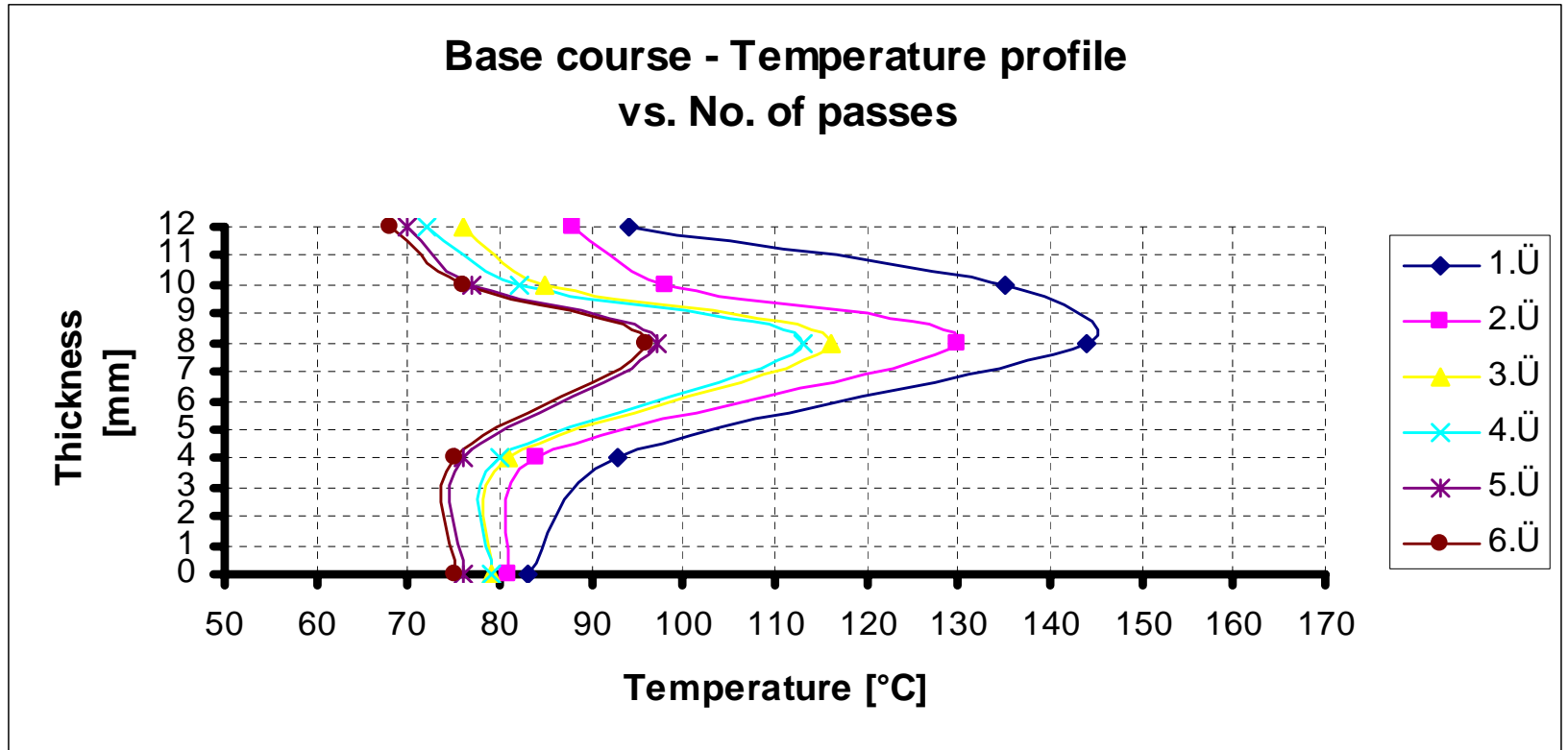
Benefits for Contractors: Investment for Profit

Compaction

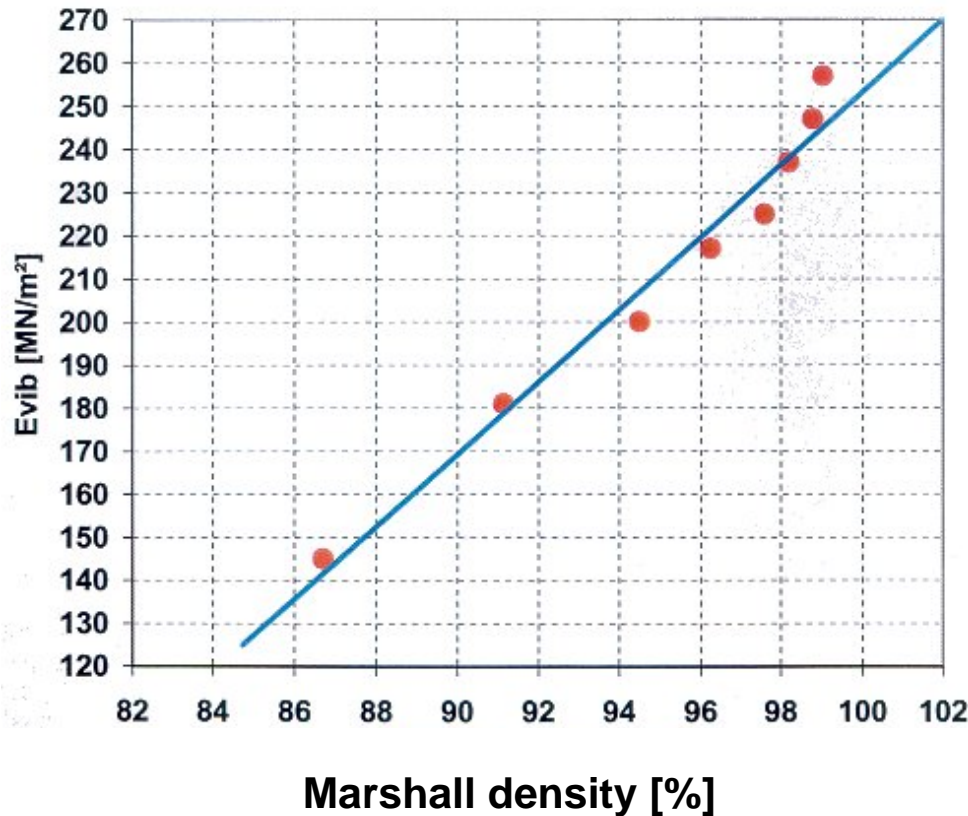
- **Uniform and predictable results whilst rolling**
- **Avoids under / overcompaction**
- **Better evenness and roughness**
- **Eliminates drum bouncing**

Economical and quality aspects

- **More efficient roller utilization with fewer passes**
- **Reduced shock loads in sensitive environment
e.g. buildings, bridges**
- **Area coverage method**



Compaction test on asphalt wearing course (stone mastix asphalt)

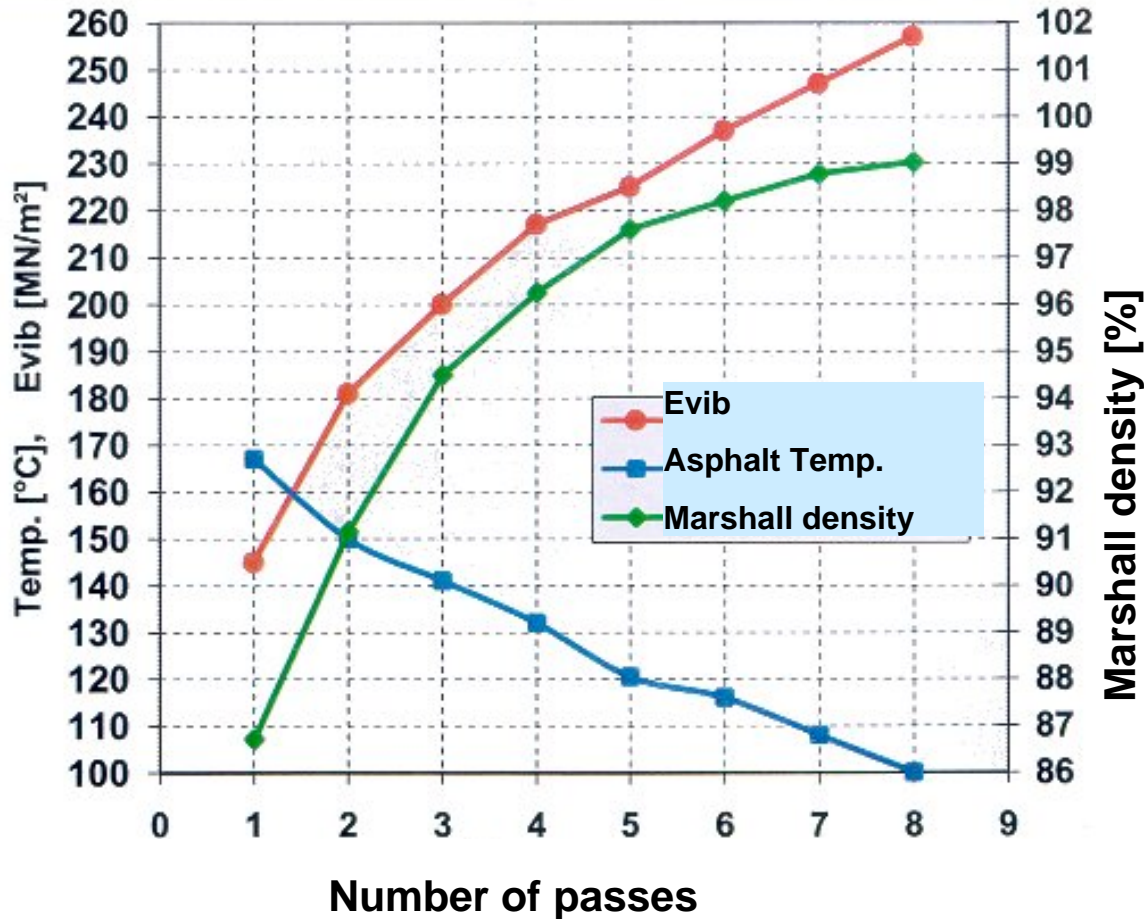


Perfect correlation:
Evib + Marshall density

Adequate conditions:

- Temperature between (170-120 °C)
- Asphalt layer on solid ground

Compaction test on asphalt wearing course (stone mastix asphalt)



**Increase of Evib =
Increase of compaction**

Comfort + Quality:



**Compaction of joints
hot against cold**

- avoids shock loads
- no bouncing
- better evenness

Leipzig:



“Augustusplatz”

Compaction on a parking roof top;

Alternatives:

**15 t static roller
With BVM**

**- 15 cm layers
- 40 cm layers**



Avoids shock loads on bridges and near buildings

Depth control via force adjustment

- **3 automatic control ranges**
- **6 manual force directions (fixed)**

FEATURES

Modular Design Principle:

- Operator Platform
- Central Electric System
- Travel- / Vibration Pumps
and Motors
- Support Legs

BENEFITS

**Less Expenses for Warehousing,
Training, and Logistics;**

Racing Course „Sachsenring“



Perfect Results:

- Roughness
- Evenness

Application soil compaction

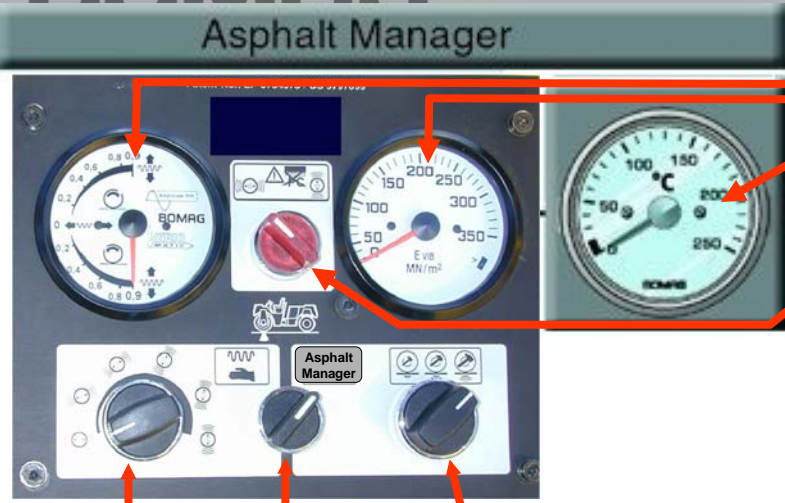
Support for compaction works and measuring paths on sub-grade, frost blanket layers and non-bonded bearing layers: the E_{VIB} value increases with increasing compaction. Weak spots are localized.

Application asphalt compaction

Support for compaction works on asphalt layers. If compaction is performed within a narrow temperature range (e.g. 120° – 150°C) and the sub base is of sufficient stability, E_{VIB} will show the increase in compaction. A direct statement on the density is only possible after performing comparison measurements with an isotope probe (Troxtler). Compaction force and depth effect can be adapted to the layer to be compacted and to the substrate (see matrix of recommended applications).

| Condition of the substrate | Setting | Asphalt bearing course | Asphalt binder | | Asphalt pavement | |
|----------------------------|--|------------------------|-----------------|----------------------|------------------|--------------|
| | | | Easy to compact | Difficult to compact | Asphalt concrete | Stone mastic |
| evenly firm (stable) | Automatic: Force level | 3 | 2-3 | 3 | 2 | 3 |
| | alternative: Manual*: Position | 6-3 | 4-3 | 5-3 | 4-2 | 4-2 |
| | Compaction temperature | > 80°C | > 80°C | > 100°C | > 100°C | > 120°C |
| yielding (soft) | Automatic: Force level | 2 | 1-2 | 2 | 1 | 2 |
| | alternative: Manual*: Position | 4-2 | 3-2 | 3-2 | 2-1 | 2-1 |
| | Compaction temperature | > 80°C | > 80°C | > 100°C | > 100°C | > 120°C |
| Layers on bridges | Automatic: Force level | 1-2 | 1-2 | 1-2 | 1 | 1-2 |
| | alternative: Manual*: Position | 3-2 | 2-1 | 2-1 | 2-1 | 2-1 |
| | Compaction temperature | > 80°C | > 80°C | > 100°C | > 100°C | > 120°C |

Temperature specifications related to the asphalt surface, * in manual mode start with higher level first, and reduce after



Display, direction of vibrations

E_{VIB} display

Temperature gauge

Emergency switch

Selector switch
Operating mode
Manual/Automatic

Manual mode

6 selectable amplitudes
each with constant
direction of vibration

Automatic mode

3 selectable force ranges
with amplitude control,
limited to compaction force
and depth effect

① Display of vibration direction and amplitude

shows the direction of drum vibration and the size of the vertical amplitude

② E_{VIB} display

E_{VIB} shows the dynamic stiffness of the material to be compacted in MN/m²

- E_{VIB} responds to changes in density. With increasing density the asphalt becomes firmer (stiffer). The E_{VIB} value increases.
- E_{VIB} responds to temperature changes. With dropping temperature the asphalt becomes firmer (stiffer), even if the end of compaction is not yet reached. E_{VIB} increases with decreasing temperature.
- E_{VIB} responds to deviations in the stiffness of the substrate (base layer). On a soft substrate and with a pre-selected high force level the E_{VIB} may remain low.

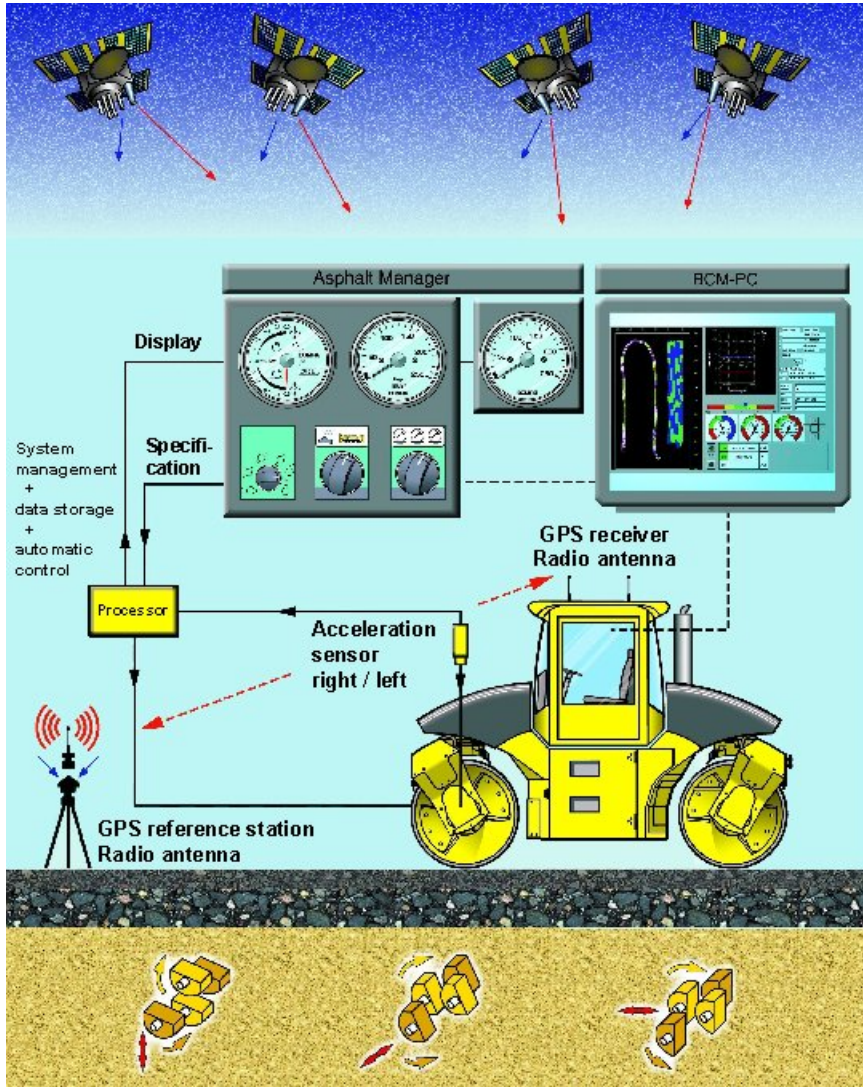
③ Temperature gauge

The temperature is permanently detected as asphalt surface temperature. Depending on layer thickness, ambient temperature and wind force the mix temperature inside the core of the layer may be up to 40°C higher. At a surface temperature of 80°C compaction should be completed.

④ Emergency switch

In case of an electronics failure the emergency switch enables the selection of two vibration directions: horizontal (left) or vertical (right)

Asphalt Manager + BOMAG GPS System



- **Surface covering compaction control on asphalt layers**
- **GPS receiver**
- **GPS reference station**
- **Roller PC for data managing and graphical representation of roller position and stiffness values**
- **Position accuracy: better than 10 cm**
- **CAD based evaluation program**

Roller positioning with total station (Geodimeter) for continuous compaction control on asphalt layers



A45 Asphalt / 1_Lage / Feld9_220501_vor Münzenberg / GPS - Fahrt [36] Verdichtungsvariante : EVIB Asphaltbau

Einstellungen Kalibrierung Prüfungen GPS v.06.07.01

2D CAD GeoCAD Menu A

| Bahnposition | Längs / Quer |
|----------------------|---------------------|
| x | 5.700042 |
| y | 11.470921 |
| z | 0.000000 |
| Bahn Länge | Gewalzt % |
| 0.0 | |
| EVIB | 84 |
| MW | |
| Zeit der Bearbeitung | |
| von : | 21.08.2001 09:29:29 |
| bis | |

Temperatur

GPS

Aufzeichnung AUS

Lenkhilfe AUS

Autopilot AUS

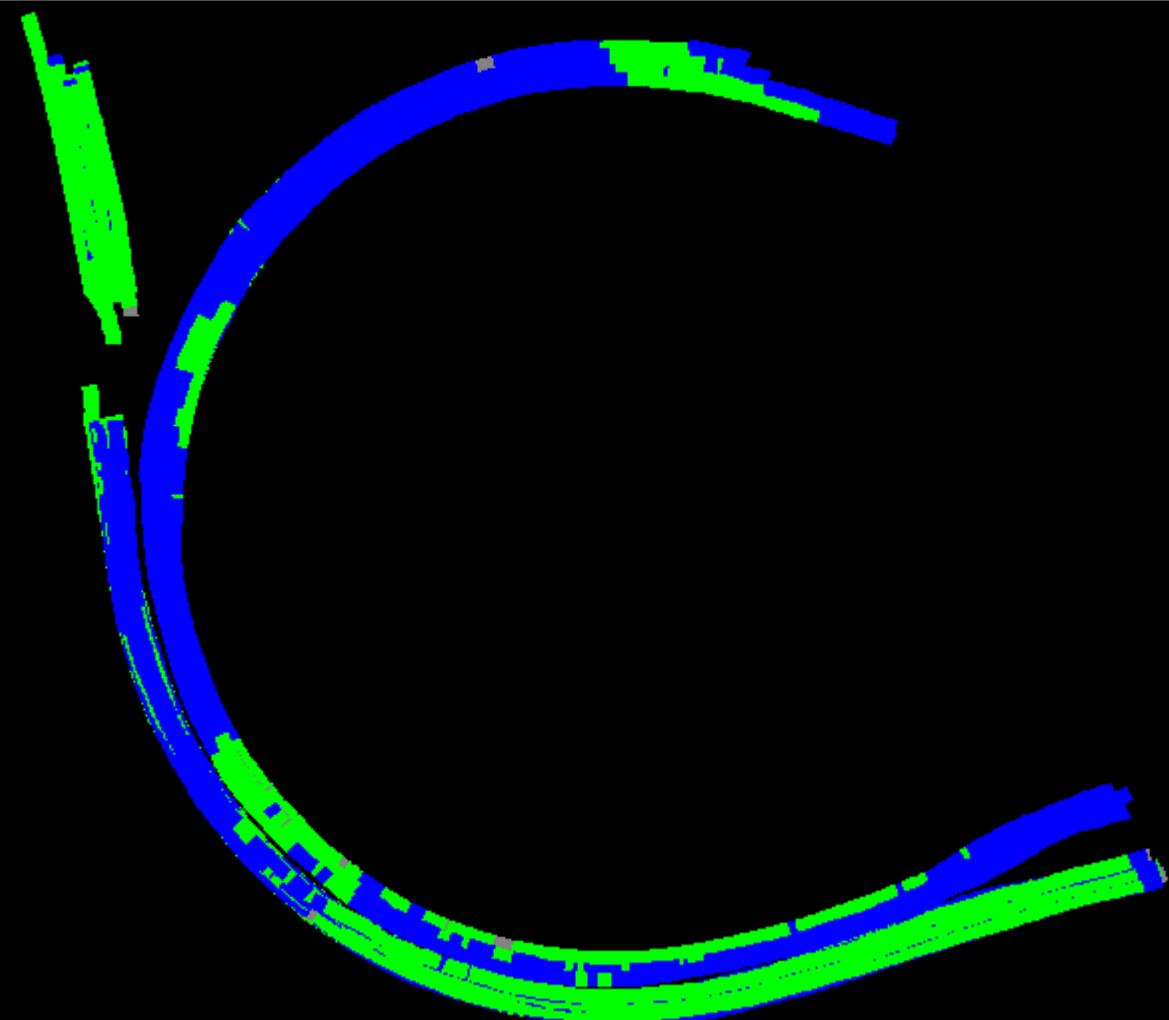
Zoom All

7.7141,9.5789,0.0000 0 BYLAYER BYLAYER SNAP GRID ORTHO ESNAP MODEL TABLET

Start Explorer - D:\OPneutso... Paint Shop Pro - [GPS...] LEADTOOLS 12.0 Speciali... A45 Asphalt / 1_Lage /... 08:29



| | | | | | | | |
|-------------|-----------|-------|--------|-------|---------|---------|------------------------------------|
| NurCAD | Obj.find. | Texte | Status | Layer | Maßstab | Planart | Datei |
| ocadop/feld | | X | Normal | 0 | 1:1000 | KARTE | C:\GeoCAD0p\FelduebersichtprgNoLeg |



| Name | Bedeutung | Epoche | Zustand | Material | DB-Rechts | DB-Hoch | DB-Höhe | Rechts | Hoch | Höhe |
|------|-----------|--------|---------|----------|-----------|---------|---------|-------------|-------------|------|
| | | | | | | | | 5414259.218 | 5935894.205 | |

wahl->Liste

Speichern Schliessen

Reference station on the job site

High accuracy: up to 5 cm

GPS Reference service with reference satellite

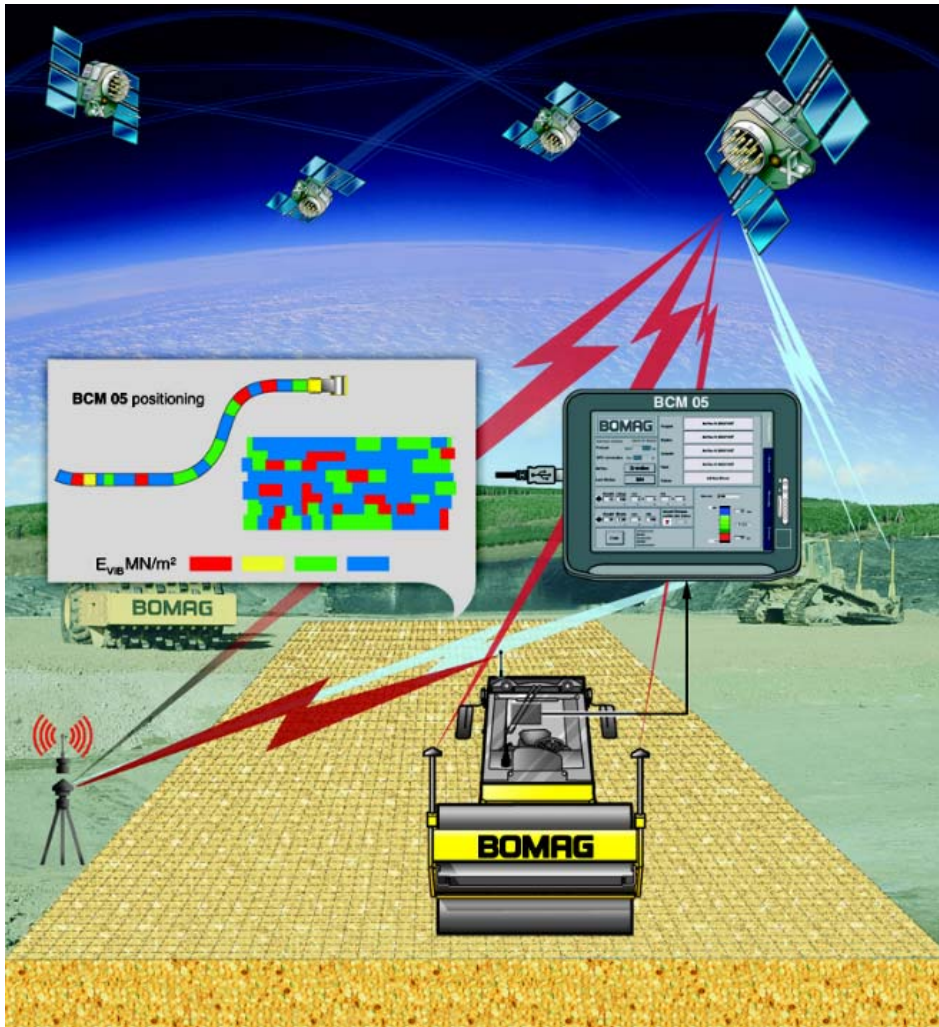
Accuracy: up to 100 cm

- > OmniSTAR (world wide) ~ 1500,- Euro annual charge**
- > EGNOS (Europe, not yet in operation) free of charge**
- > WAAS (North America)**

Local Reference network (reference service)

High accuracy : up to 5cm (depending on service)

- > Ascot (since 2001, Ruhrgas / Germany,
(only available in Rhine Area)**



- Two GPS Antenna
- Reference station (Trimble)
- High accuracy (5cm)
- RTK (real time)
- BCM 05 positioning software