

SOUTHEASTERN ASPHALT USER / PRODUCER GROUP

2005 ANNUAL MEETING
NEW COMPACTION TECHNOLOGY
CHUCK DEAHL
BOMAG AMERICAS, INC.

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TOOL BOX TALKS PRODUCED BY
NATIONAL ASPHALT PAVEMENT
ASSOCIATION

1. ROLLING PROCEDURES
2. 4 FORCES OF COMPACTION
3. MTV EXCHANGE
4. TRUCK EXCHANGE
5. LONGITUDINAL JOINT
CONSTRUCTION

Longitudinal Joint Construction

Building a Sound
Longitudinal
Joint

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Steps in Making Good
Longitudinal Joints

- 1- Control Segregation at the Outside
Edges of the Mat
- 2- Steer a Straight Line
- 3- Compact Unconfined Edge
- 4- Maintain Correct Overlap
- 5- Place the Proper Depth for Roll Down
- 6- Do Not Lute the Joint
- 7- Compact the Joint for Density

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1

Control Segregation at the Outside Edges of the Mat



**Minimize
Segregation
at the
Outside Edges
of the Mat**

Properly Adjust
the Material
Sensors

Use Correct Length of Auger Tunnels

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2

Steer a Straight Line



Maintain Proper Overlap
A Must for Proper Joint Construction

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3 Compacting Unsupported Edge using Steel Wheel Roller

Option 1
Hang over 6"

Option 2
1st Pass 3"-6" inside
2nd Pass hang over 3"-6"

3 Compaction of Unsupported Edge using Pneumatic Tire Roller

6"

Recommended

Pushes out

Not Recommended

4&5 Maintain Proper Overlap and Matching Depth

Proper Roll Down – Start With 25% of the Depth

1/2 - 1 1/2" (13-35mm) Overlap

1st Pass (Cold) 2nd Pass (Hot)

Minimum Overlap for Compaction is 1/2 Inch (13mm)

Always Check Joint Roll Down Behind the First Roller

4&5 Maintain Proper Overlap and Matching Depth

If Your Joint is Set Up Correctly, Little or No Handwork Should be Required

6 Do Not Lute Joint

Move roller away from joint
Result: low-density zone at joint

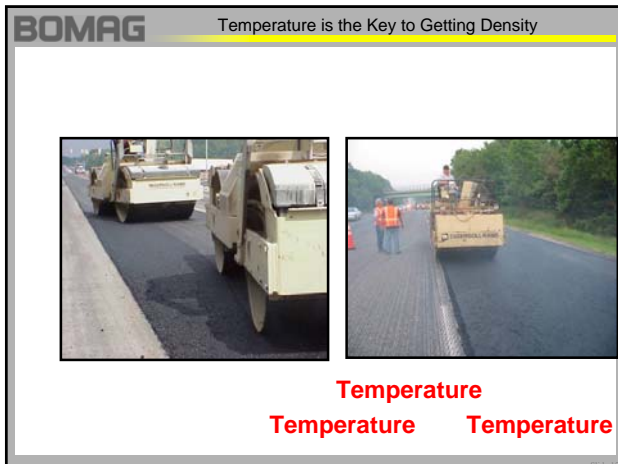
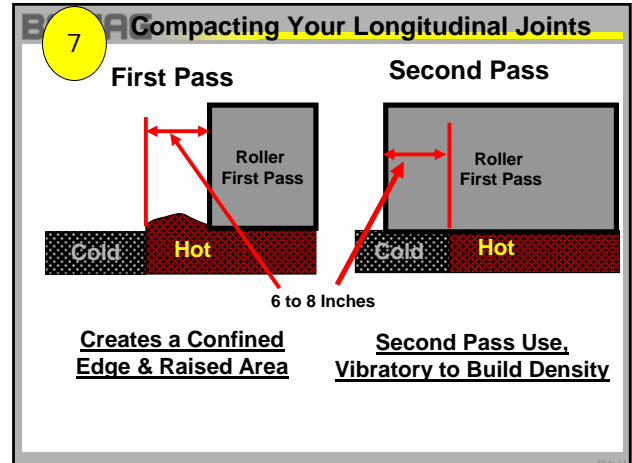
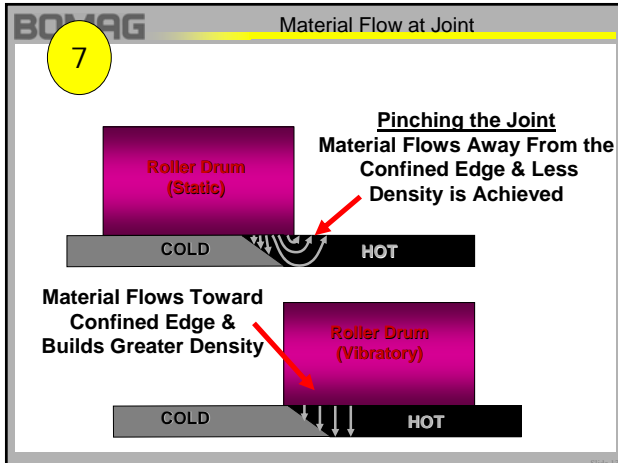
7 Compacting Longitudinal Joints

Hot Cold

6" - 8" Offset

Hot Cold

6" - 8" Offset




- Steps in Making Good Longitudinal Joints**
- 1- Control Segregation at the Outside Edges of the Mat
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Pocket Size Handout



Safety First

- Watch for overhead power lines
- Follow directions of dump person

Safety First

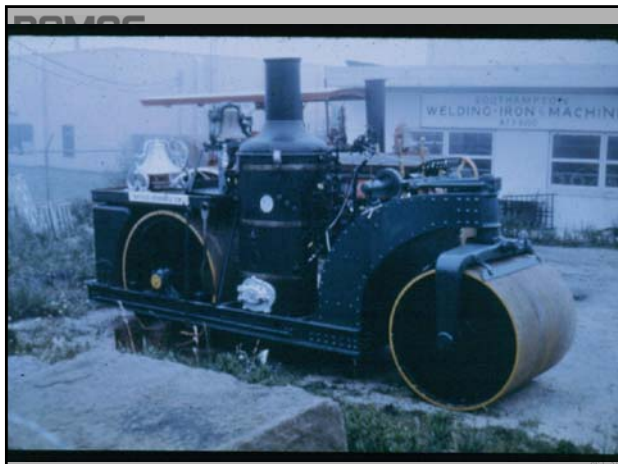
- Watch for overhead power lines
- Follow directions of dump person

Safety First

- Always be aware of the location of overhead obstructions and power lines.
- Marking these locations on the roadway using cones —or paint is a good idea, especially for night construction.
- Don't back up until directed by the dump person or other designated person.

INTELLIGENT COMPACTION

NEW INNOVATIONS IN COMPACTION EQUIPMENT



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Asphalt Manager
Intelligent Compaction



Best for
COMPACTION

BOMAG **INTELLIGENT COMPACTION**

- A SYSTEM FOR MEASURING THE STIFFNESS OF HMA ON THE ROLLER
- A RECORDING OF THAT STIFFNESS MEASUREMENT
- PROOF OF THE STIFFNESS OF THE HMA AS RELATED TO DENSITY
- PROVIDING INFORMATION FOR THE ROLLER TO MAKE DECISIONS

BOMAG **INTELLIGENT COMPACTION**

INTELLIGENT COMPACTION IS:

A SYSTEM FOR MEASURING THE STIFFNESS OF A GIVEN MATERIAL IN MEGA NEWTONS METERED SQUARED OR P.S.I. AND RECORDING THAT INFORMATION, TO BE UTILIZED AS A DOCUMENT OR PROOF OF ACHIEVING A GIVEN AMOUNT OF COMPACTION. THIS SYSTEM IS MOUNTED ON A MOBILE ROLLER TO RECORD THESE MEASUREMENTS AND THEN RELATE THESE MEASUREMENTS TO MEASURING DEVICES.

BOMAG COMPACTON GOALS

1. DENSITY
2. SMOOTHNESS
3. NOISE REDUCTION
4. BALANCED PRODUCTION



needed for **COMPACTION**

- mix confinement
- correct mix temperature

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8.4 Importance of Compaction

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation
- Reduce Moisture Penetration
- Improve Fatigue Resistance

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COMPACTION ACHIEVED BY..

PRESSURE

IMPACT

VIBRATION

MANIPULATION

BOMAG History

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 (E vib)
- 2004 Modular Measuring System with GPS support

BOMAG History

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;

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VARIOMATIC roller with directed vibration

Control unit

low dynamic energy

high dynamic energy

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

Applications: asphalt layers, granular bases and subbases.

Asphalt thin course
Asphalt base course
Gravel-sand

BOMAG Asphalt Manager

Worldwide proven design:

Several hundreds Tandem rollers

BW 151 AD-2

BW 174 AD

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Vibration Systems

Rotary exciter Oscillation directed

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Vibration Systems

Rotary exciter Oscillation directed

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BOMAG Rotary Exciter

Non Directed Forces:

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Vibration systems / Overview

	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	directed
Amplitudes	up to 8 up to 1,3 mm	2 fixed amplitudes ca. 1,3 mm	horizontally to vertically automatic variation 0 - 0,9 mm
Frequencies	35 - 70 Hz	33 - 42 Hz	35 - 50 Hz
Control system	manual	manual	automatic variation

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BOMAG Directed exciter system


Advantages vs. Rotary exciter:

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

BOMAG Asphalt Manager

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



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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

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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]

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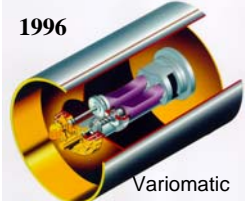
Comparison between conventional compaction concept and VARIOMATIC

	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

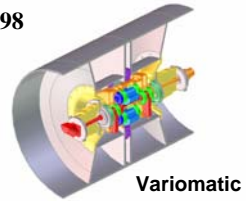
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1996



Variomatic

1998



Variomatic 2

advanced, more powerful
also for split drums !

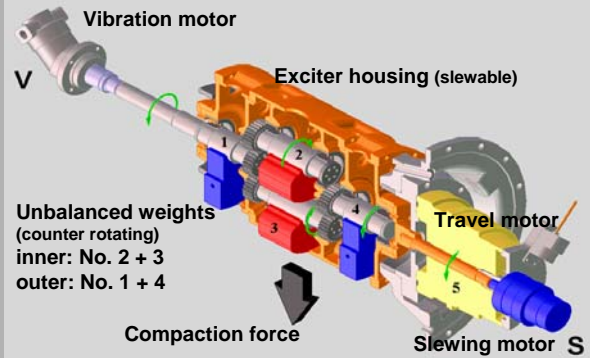
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Latest developments of compaction technology

- 1996 Variomatic for asphalt rollers
- 1998 Variocontrol for soil rollers
- 2000 Evib (MN/m²)
- 2001 **Asphalt Manager**

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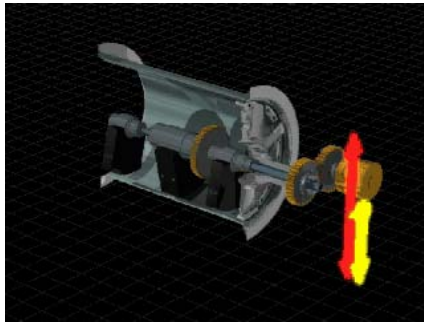
Directed Exciter System



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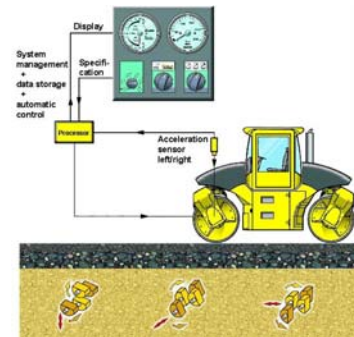
BOMAG VARIOCONTROL

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



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



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Acceleration meters



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Asphalt Manager

Benefits for Operators:

- No critical decisions required
- All operators achieve better results:
 - good and uniform compaction
- Continuous information on
 - asphalt temperature
 - compaction increase

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BOMAG The Operator

Asphalt Manager: Easy to understand



BOMAG Asphaltmanager

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	160	168	247 / 158	247 / 158
rear	kN	80 / 34	80 / 34	167 / 109	126 / 84

BOMAG Bomag Operational Panel

0 fixed	variable	
0,2 mm	0 - 0,2 mm	0,08 in
0,4		
0,6	0 - 0,6	0,24 in
0,7		
0,93	0 - 0,93	0,37 in
6 x	3 x	

**Manual - Auto
Compaction Modes**

BOMAG Bomag Operational Panel



PRINTER

- Start
- Stop
- Print out
- Delete

Test procedere:

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

BOMAG Bomag Operational Panel



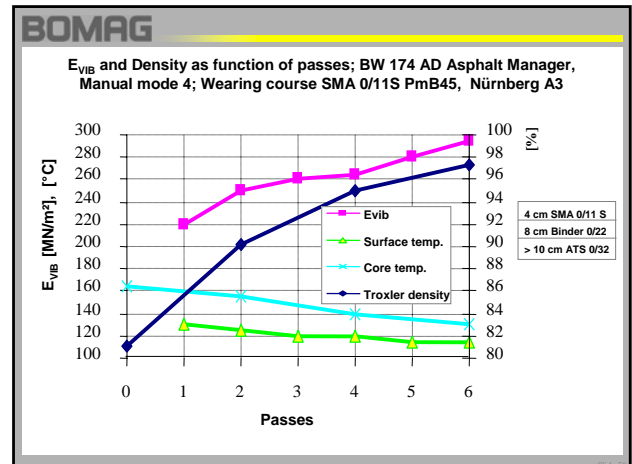
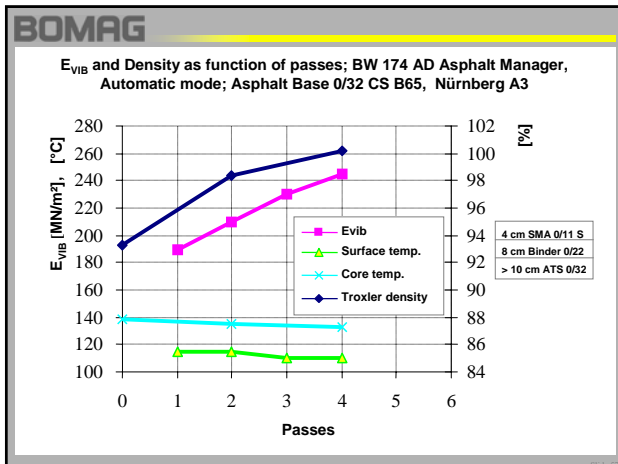
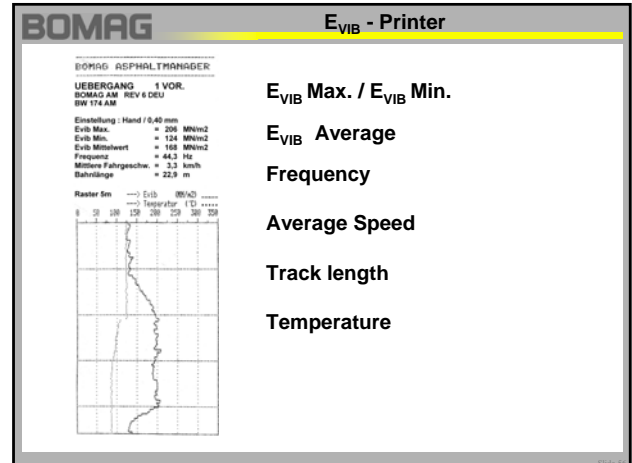
SETTINGS

- Escape
- Enter

BOMAG Bomag Operational Panel



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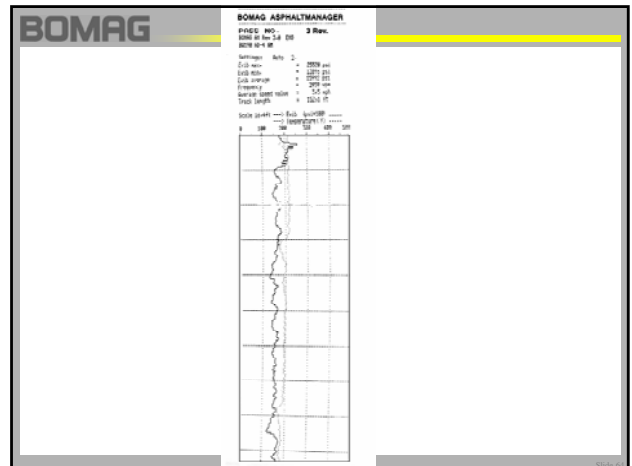


PATTERN DECISIONS:

1. How many passes?
2. How many repeat passes?
3. How to be sure mix is rolled at correct temperature?
4. How fast to roll?



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BOMAG Asphalt-Manager

Evib (MN/m²) Vibration modulus

Equivalent for dynamic Stiffness;

Directly picked up by the roller;

Physical value for compaction increase on asphalt.

BOMAG Asphalt Manager

Benefits for Contractors: Investment for Profit

Compaction

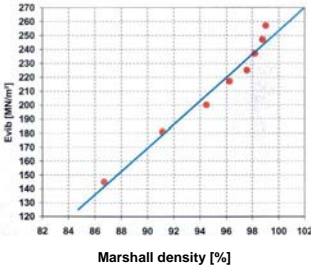
- Uniform and predictable results whilst rolling
- Avoids under / overcompaction
- Better evenness and roughness
- Eliminates drum bouncing

Economical and quality aspects

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

BOMAG E_{VIB} [MN/m²] vs. Marshall density [%]

Compaction test on asphalt wearing course (stone mastix asphalt)



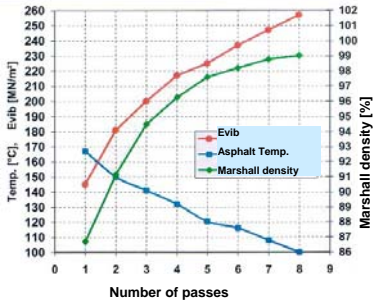
Perfect correlation:
Evib + Marshall density

Adequate conditions:

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

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Compaction test on asphalt wearing course (stone mastix asphalt)



Increase of Evib = Increase of compaction

BOMAG Application

Comfort + Quality:



Compaction of joints hot against cold

- avoids shock loads
- no bouncing
- better evenness

BOMAG Application

Leipzig:



“Augustusplatz”

Compaction on a parking roof top;

Alternatives:

- 15 t static roller - 15 cm layers
- With BVM - 40 cm layers

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BOMAG **Application**



Avoids shock loads on bridges and near buildings

Depth control via force adjustment

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

BOMAG **Investment Series4**

FEATURES **BENEFITS**

Modular Design Principle:

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

Less Expenses for Warehousing, Training, and Logistics;

BOMAG **Surface Quality**



Racing Course „Sachsenring“

Perfect Results:

- Roughness
- Eveness

BOMAG **CONCISE OPERATING INSTRUCTIONS ASPHALT MANAGER**


Application soil compaction
Support for compaction works and measuring paths on sub-grade, frost blanket layers and non-bonded bearing layers: the E_{va} 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_{va} will show the increase in compaction. A direct statement on the density is only possible after performing comparison measurements with an isotope probe (Trolox). 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

BOMAG **CONCISE OPERATING INSTRUCTIONS ASPHALT MANAGER**



Display: direction of vibrations
Eva display
Temperature gauge
Emergency switch

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

Eva display
Eva shows the dynamic stiffness of the material to be compacted in MN/m²

- Eva responds to changes in density. With increasing density the asphalt becomes firmer (stiffer). The E_{va} value increases.
- Eva responds to temperature changes. With dropping temperature the asphalt becomes firmer (stiffer), even if the end of compaction is not yet reached. E_{va} increases with decreasing temperature.
- Eva 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_{va} may remain low.

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.

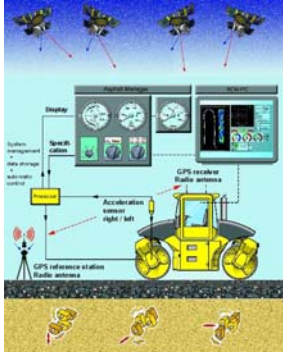
Emergency switch
In case of an electronics failure the emergency switch enables the selection of two vibration directions: horizontal (left) or vertical (right)

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

BOMAG **Current Developments**

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

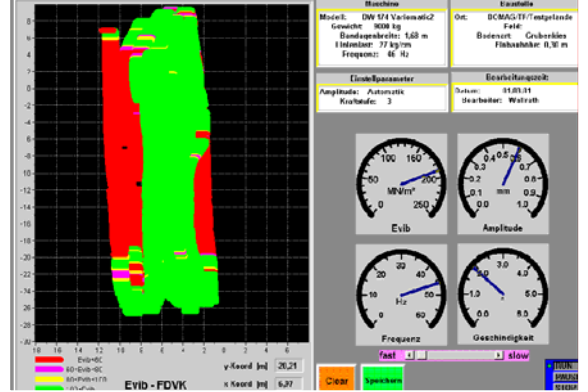
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Roller positioning with total station (Geodimeter) for continuous compaction control on asphalt layers



BOMAG Surface Covering Compaction Measurement



Maschine		Einheit	
Modell:	DW 5/4 Variomat2	Ort:	BCMAG-TF/entgeltende
Gewicht:	3008 kg	Feld:	Feld
Bauhöhenbreite:	1,08 m	Breiteart:	Grabenloos
Hubhöhe:	77 kg/m	Flächenhöhe:	0,30 m
Frequenz:	66 Hz		

Einstellparameter		Einsatzparameter	
Amplitude:	Automatik	Datum:	13.08.04
Rolle:	3	Steuer:	Wahlrad

Evid - FDVK
 y-Koord [m] 26,21
 x-Koord [m] 6,97

BOMAG Determination of roller positions with GPS

Reference station on the job site
 High accuracy: up to 5 cm

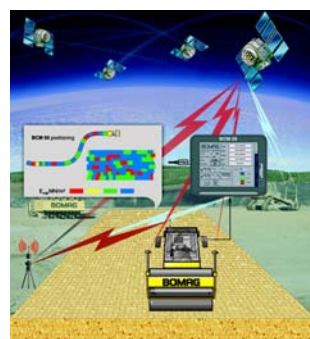
GPS Reference service with reference satellite
 Accuracy: up to 100 cm

- > 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)

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

BOMAG GPS / positioning with Reference Station



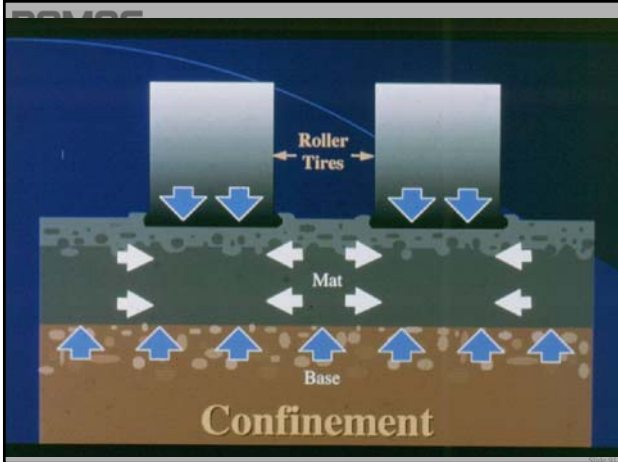
- Two GPS Antenna
- Reference station (Trimble)
- High accuracy (5cm)
- RTK (real time)
- BCM 05 positioning software



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QUESTIONS????
QUESTIONS????