BOMAG compaction measurement and documentation systems.

The transparent construction site up close.
„In an age of virtual communication, a customer can rightly expect that, as the global market leader, we will make available all significant data and parameters of the work carried out on call and at his disposal 24/7.“

Robert Laux, Vice President Engineering.
BOMAG $E_{\text{VIB}}$ measuring technology:
Reaching targets. Every time.

BOMAG $E_{\text{VIB}}$ measuring technology makes it possible to control compaction even during the compaction process. Surface covering and precise.

Quality requirements on earthworks and road construction are continually increasing. The aim is to meet quality standards and to optimise the use of compaction machinery. With this in mind, documentation of compaction processes and the compaction quality achieved are becoming more and more important.

BOMAG compaction measurement and documentation systems are used for continuous and surface covering compaction control. BOMAG measuring technology is based on the $E_{\text{VIB}}$ value. This is a value that calculates the soil stiffness in MN/m² during the compaction process. The $E_{\text{VIB}}$ value is a physical measured value that correlates directly with the plate-loading test used in earthworks and road construction.

It expresses the correlation between the ground contact force and the indentation of the roller drum. By changing the $E_{\text{VIB}}$ value, the roller operator is permanently informed of compaction progress.

The result:

The efficiency of compaction work is improved, as unnecessary passes can be prevented, weak spots discovered in good time, and time and effort carrying out inspections can also be reduced. The contractor will save time and money.
How exactly is the $E_{VIB}$ value created?

BOMAG compaction measuring systems use the interaction of the acceleration of the vibrating drum and the dynamic stiffness of the soil. In general, the soil stiffness will increase as compaction increases. If the soil becomes stiffer, the drum acceleration will also increase.

The measuring sensors record this acceleration and from this determine the effective contact force between the soil and drum and, at the same time, the oscillating path of the entire drum. If the contact force is then laid on top of the oscillating path of the drum, this results in a loading and unloading curve for every revolution of the eccentric weight in the drum. The surface included in this curve correlates with the compaction energy imparted. The $E_{VIB}$ value arises from the analysis of the load curve, as this correlates with the stiffness of the soil.

Unmatched precision

Only BOMAG uses two measuring sensors on the drum to optimise measuring accuracy. The measuring density is also unparalleled: The $E_{VIB}$ value is continuously measured with a measuring density value of up to 10 cm. This ensures that every weak spot is detected.
Different indicator systems
There are various instruments to choose from when it comes to indicating the \( E_{\text{VIB}} \) value. The BOMAG \( E_{\text{VIB}} \) meter BEM represents the starter device. In addition to the two acceleration sensors, the unit includes a distance gauge, an electronic unit and a circular instrument, the \( E_{\text{VIB}} \) analogue display, located with the driving instrumentation.

The advantages:
- Determination of the \( E_{\text{VIB}} \) value
- Indication of trend towards a compaction increase
- Detection of weak spots and inconsistencies.

And modules are available to upgrade to other measuring system versions.

The BOMAG Terrameter BTM is even more convenient to use. Instead of an \( E_{\text{VIB}} \) analogue display, it has a BOMAG Operation Panel (BOP), a convenient control unit.

Other advantages:
- The driver sees a message on the display when the target value has been reached or if further compaction is no longer possible.
- The results are displayed digitally and in the form of bar charts.
- The printer can be used to print out line diagrams and bar charts to document coverage of small and medium-sized sites.

The \( E_{\text{VIB}} \) value indicates the soil stiffness and evenness of compaction.

The compaction status can be printed out and documented as a bar chart or line diagram using the \( E_{\text{VIB}} \) value. The terrameter indicates the maximum compaction possible.
The complete solution: BCM 05 and BCM 05 positioning.

The optional BOMAG Compaction Management BCM 05 offers the most convenient solution for documenting results. Informative and detailed measuring records can be created easily for specific sites; this ensures comprehensive documentation complying with the rules and regulations* of Surface Covering dynamic Compaction Control (SCCC).

The BOMAG COMPACTION MANAGEMENT BCM 05 is used for large scale projects and at all sites where surface covering dynamic compaction control is required or recommended. BCM 05 is a tablet PC suited to use on construction sites; it determines, displays and saves the $E_{VIB}$ values of the entire construction site using the BCM 05 mobile software. This means no more hassle with printing. Compaction can be tracked in real-time, lane by lane, and location by location on the large display. The PC displays the entire surface to be compacted. The measured $E_{VIB}$ values are displayed as line diagrams and colour intervals. The colour intervals can be chosen as required, so that both compaction progress and weak spots can be clearly identified during work. With a USB-stick the data can be transferred to a stationary PC for analysis and documentation with the software product BCM 05 office.

The BCM 05 scope of delivery includes:
- Tablet PC with touchscreen
- USB memory stick
- Robust, lockable tablet PC holder
- BCM 05 software

*German regulations
ZTVE-StB 2009, ZTV SoB-StB 04, TPBF-StB Part E2, DB Ril 836
Austrian regulations:
RVS 85.02.6
Advantages

The BCM 05 documentation system is the basis of cost-effective compaction; it reduces the need for inspection and minimises the risk to the contractor:

- The roller operator is kept continuously informed of uncompactable or difficult to compact areas;
- Representation of the results in relation to the specified target
- Representation of variations in quality with interval observation
- Enhances comprehensive measured data management and clear construction site organisation
- Informative and detailed measuring records and comprehensive documentation complying with the rules and regulations of surface covering dynamic compaction control

The recording of these measured values is unique in its detail.

The colour display provides:

- High density of measured values: up to 1 measured value per 10 cm length of rolled track
- Real time display of the compaction and load capacity status in the form of diagrams and numbers
- Comparison of the current measurement curve with the measured values of the previous pass
- Visual and graphic warning when the measured values deteriorate
- Registration and display of local recompaction zones or bounce mode
- Documentation of the date and time

Once the data has been transferred to a stationary PC per USB stick, the BCM 05 software also offers:

- Project management
- Statistical analyses
- Archiving
- Convenient print manager
- Calibration program

The measurement records and calibration program contain and enable all of the data and diagrams required for the documentation of the SCCC according to regulations, incl. a regression diagram.
BCM 05 positioning – linking of $E_{VIB}$ measured values with position data.

BCM 05 positioning links the $E_{VIB}$ measured values with the position data of a differential GPS system. Documentation becomes even more user friendly: No fields need to be defined in advance and the roller driver does not need to assign his current position to the defined track. After all, the roller knows itself exactly where it is.

- Precise position determination to the centimetre with a reference station.
- Precise position determination to within 20 cm using a satellite-assisted reference service.
- For immediate use anywhere: BOMAG StarFire GPS receiver.
- BCM 05 display with BCM 05 mobile and office software
- BCM 05 positioning software
- GPS system with holder and wiring loom

BOMAG software is capable of interfacing with conventional DGPS systems with and without a reference station. However, the positioning accuracy depends on the chosen GPS system. The raw data supplied by the GPS system can be transformed with the aid of BCM 05 into construction site coordinates.

For additional orientation, points and/or axes can be easily read into the portrayed structure of the construction site.

The following systems are required in order to use satellite-assisted surface covering dynamic compaction control:
BOMAG uses the compact and simple to install Starfire iTC system as the DGPS solution; this works with a satellite-assisted reference service to achieve positional accuracy to at least 20 cm. This system does not require a reference station, as BCM 05 positioning can also be combined with any other conventional DGPS systems; an existing infrastructure on site can be used without difficulty.

The Starfire iTC system is extremely compact and can be installed quickly and easily. There is no need for specialist staff to commission the system.
BOMAG measuring technology – also used in asphalt compaction.

The $E_{\text{VIB}}$ measuring technology is also used for asphalt compaction. The basis is the self-regulating ASPHALT MANAGER rollers with integrated $E_{\text{VIB}}$ measuring technology and temperature sensors. When the rolling temperature is greater than 100 °C, the stiffness value determined by the roller can usually be used directly as a reference for compaction quality.

In conjunction with GPS applications, the technology helps the contractor to monitor and control asphalt compaction work. During compaction, the calculated $E_{\text{VIB}}$ values which are used as a reference value for compaction progress are continuously documented together with the number of passes, the asphalt temperature, amplitude and frequency, and all the associated construction site coordinates.

Calibration with a nuclear gauge to determine the correlation between $E_{\text{VIB}}$ and density.

Correlation between $E_{\text{VIB}}$ and density using the example of an asphalt base layer.

GPS-assisted, surface covering presentation of the compaction quality of an asphalt layer.

BCM for surface covering compaction control with GPS (optional).
BCM net – the transparent construction site up close: Seamless transparency for higher cost-effectiveness.

Networking several rollers on site provides an opportunity to create an overall picture of compaction over the entire site. With BCM net, not only the data from one machine, but data from all machines involved in the compaction work can be recorded and displayed on one screen.

For this, the rollers are equipped with GPS receivers and connected up via a wireless network. They permanently transmit their positions, the compaction results and other necessary parameters, such as the asphalt temperature or speed to the server.

The data is updated every 5 seconds and the server distributes the new „picture“ to all network users. This enables every roller operator to follow their own compaction progress and that of the other machines.

Overview of the advantages:
- Early detection of weak spots in the subsoil to minimisation risks
- Reduction in unnecessary passes once specified values have been reached.
- Reduction in time and effort on inspections
- Smooth documentation of compaction quality on asphalt construction and earthworks
- Support in terms of comprehensive measured data management – giving clear, cost-effective organisation of the construction site
- Easy and quick to install DGPS solutions that work independently of reference stations
- Recording and documentation of data from all machines involved in the compaction process via BCM net – for more efficiency on construction site

BOMAG compaction measurement and documentation systems provide the basis of cost-effective compaction. They provide high, uniform compaction quality, save the contractor time, effort and money, and increase protection against subsequent claims for remedials.