

Job Report

Leipzig/Halle airport



Testing the unbound layer
on the South runway and taxiways
using SCCC



Leipzig/Halle airport

Authors:

Hans-Josef Kloubert, Ralf Thiele, Felix Dietl

Author's address:

Hans-Josef Kloubert Dip. Eng., BOMAG, Hellerwald, 56154 Boppard/Germany, Hans-Josef.Kloubert@bomag.com

Dr. Eng. Ralf Thiele, FUGRO CONSULT GmbH, Department of Geomonitoring, Hauptstraße 103, 04416 Markkleeberg/Germany, r.thiele@fugro.de

Felix Dietl Dip. Eng. (FH), FUGRO CONSULT GmbH, Department of Geomonitoring, Hauptstraße 103, 04416 Markkleeberg/Germany, f.dietl@fugro.de

Introduction

Following the construction of the North runway, Leipzig/Halle airport now has a new Southern runway. First the old runway originating from 1960 had to be removed. The original runway was subject to limited

use due to cracks, acidic reactions and a runway length of only 2500 m.

The first stage on the 3600 m long and 60 m wide new South runway began on 31.08.2005. The runway was designed for

24 hours/day operation and bad weather operation CAT IIIb for both landing directions. Approx. 5,000,000 m³ of soil had to be moved and approx. 1,200,000 m² of concrete surface had to be placed in order to construct the runway and aprons. Altogether, approx. 80 contractors with a total of approx. 1000 construction workers participated on the section. The total investment was around 290 million Euros. Figure 2 shows a site plan of the runway with taxiways, aprons and parking areas. The earthworks and concrete work were largely finished at the start of 2007. The South runway should be up and running mid-2007.

Bearing capacity and compaction requirements were specified for the South runway as well as taxiways, aprons and parking areas for the subsurface, subbase and unbound layers. This article is intended to report on tests on the bearing capacity and



Figure 1 – Herstellen des Erdplanums mit BOMAG Bodenstabilisierer MPH 122 und BOMAG Walzenzüge BW 226 PDH-4 und BW 226 DH-4.

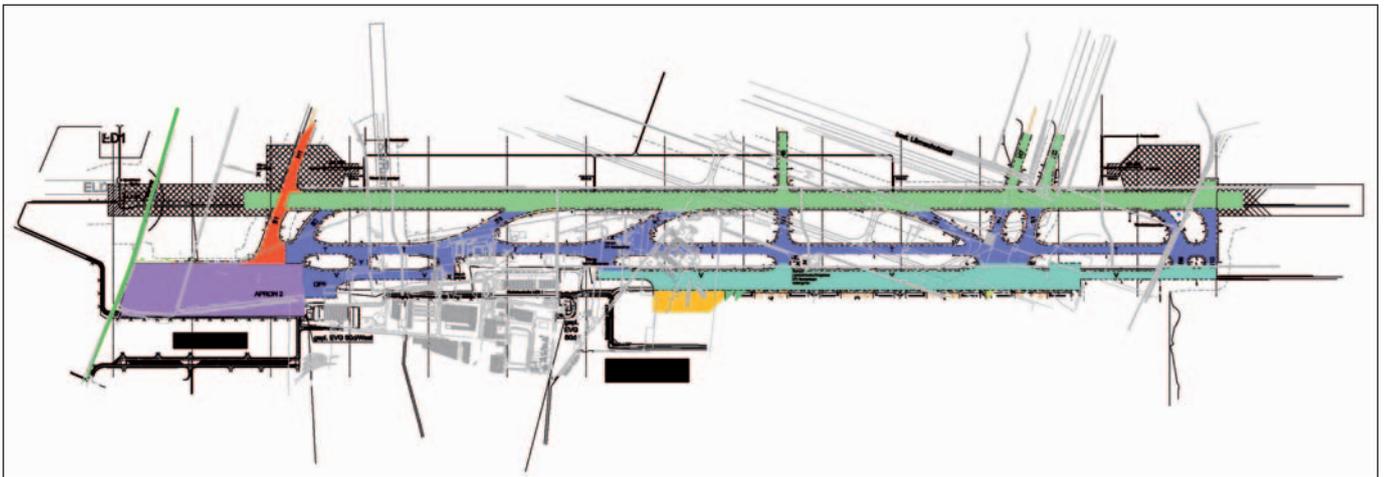


Bild 2 – Site plan of the South runway (green) with taxiways (dark blue) and aprons.

Leipzig/Halle airport

compaction levels in the unbound layer on the South runway and taxiways. These tests were put out for tender by the contractor as surface covering dynamic compaction control and additionally as work procedure tests.

Work on the South runway was carried out by ARGE Flughafen Leipzig/Halle (Heilit + Wörner Bau GmbH, Max Bögl Bauunternehmung GmbH & Co. KG, STRABAG Straßen- und Tiefbau AG) and on the taxiways by Bilfinger Berger Verkehrswegebau GmbH. Self-monitoring of both sections was executed by FUGRO CONSULT GmbH, department for geomonitoring. Control monitoring was carried out by BAUGEO – Ingenieurbüro für Baugrund und Geotechnik GmbH. The compaction equipment and test rollers used came from BOMAG. The following will first present the SCCC test method and then report on its use at Leipzig/Halle airport.

2. Surface covering dynamic compaction control

2.1 The measuring principle of the BOMAG Terrameter

A precondition for surface covering dynamic compaction control is that the compaction equipment is fitted with measuring and documentation systems. The BOMAG Terrameter (BTM) records data and uses a simple display. BOMAG Compaction Management (BCM) is a complex display and evaluation system. At different times during construction of the new South runway, 25 BOMAG single drum rollers in weight classes ranging from 13 to 26 t were used. 18 single drum rollers, primarily from the BW 213 DH-4 and BW 213 DH-4 BVC VARIOCONTROL range were equipped with the Terrameter BTM prof measuring system. The documentation system BCM 05 was also installed on six of the single drum rollers.

The measuring principle of the Terrameters BTM prof is based on determining the dy-

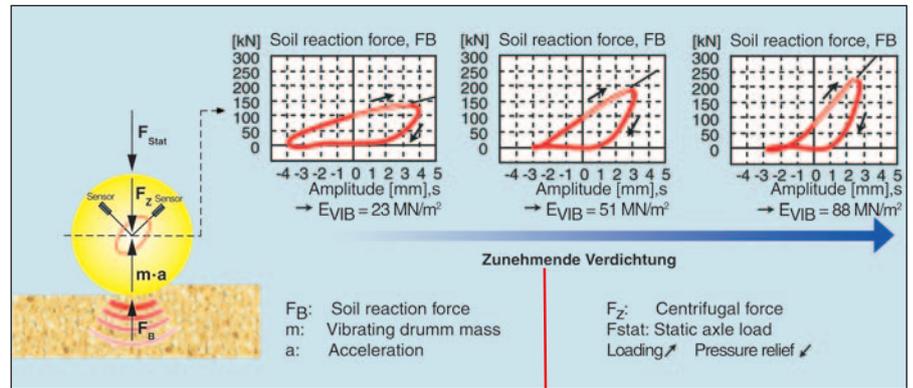


Figure 3 – Determining the E_{VIB} value.

engl. Übersetzung

namic stiffness of the soil. A force-travel diagram stemming from the vertical equilibrium of forces and the vertical oscillating path of

the drum is created for each eccentric revolution from the acceleration signals measured by the vibrating roller body.

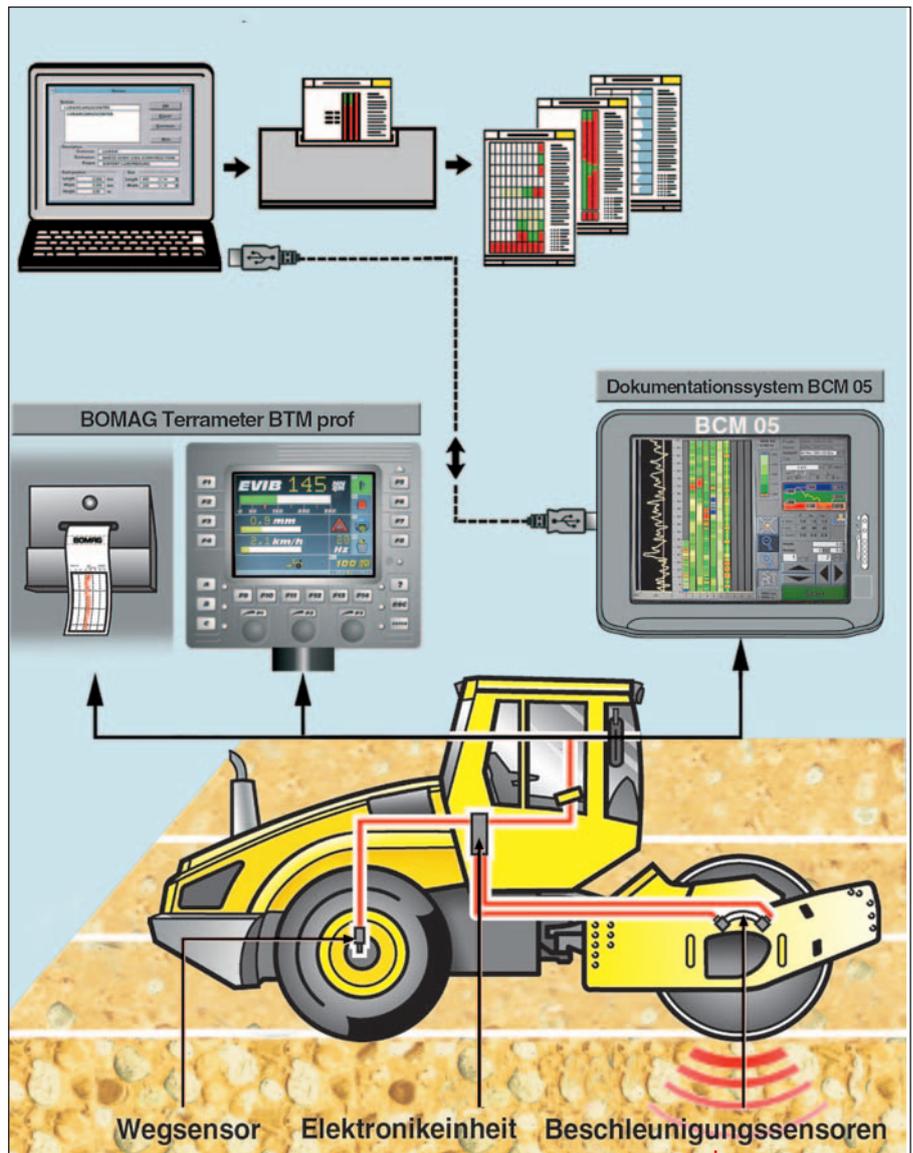


Figure 4 – BOMAG Terrameter BTM prof and the BCM 05 documentation system.

engl. Übersetzung

Einsatzmöglichkeiten von BOMAG BTM prof und BCM 05

The stiffness is calculated on the load axis of the force-travel diagram with $\Delta F/\Delta S$. Increasing levels of stiffness lead to steeper load curves. Taking the linear, elastic and isotropic relations as a basis, the dynamic stiffness module for the soil can be derived from the stiffness; this dynamic stiffness module is in direct correlation to the deformation module E_V of the static load plate test. The dynamic stiffness module of the soil which is designated with $E_{V\beta}$ describes the bearing capacity of the soil, similar to the deformation module E_V , but on the basis of the dynamic measurement of the vibratory roller (Figure 3).

Here we are dealing with a physically verifiable measuring variable which in contrast to the nondimensional dynamic measured values can be referred to not only for qualitative but also for quantitative evaluation of the compaction status and level of bearing capacity. Calibration between $E_{V\beta}$ and E_V is

necessary while taking into account different material behaviour under static and dynamic load on the soil.

2.2 Roller integrated measuring and documentation systems

The Terrameter BTM prof essentially consists of the recorder unit with two acceleration sensors (which are not arranged on the rotating part of the drum), the electronic unit, a travel sensor, the operating and display unit and a printer. The Terrameter display continuously shows the $E_{V\beta}$ value, the working speed, frequency and amplitude. The printer enables printouts to be made directly on-site for paths up to 150 m long. The paper strip documents the recorded $E_{V\beta}$ value as a continuous line record and also documents the operating parameters of the compaction equipment. The measurement printout is particularly helpful on smaller construction sites and for case-by-

case control of compaction on larger projects. Weak points and areas with a low bearing capacity can be precisely localized along the measuring route. By comparing the measurement printouts from several passes, you can also identify and document the compaction progress and the maximum compaction level possible with the equipment.

The BCM 05 documentation system is indispensable for surface covering measurement of the site and for exchanging data between roller and site office on medium-sized and large construction jobs, such as highways or preparing sites for commercial and industrial buildings and container terminals.



Figure 5 – Track-bound documentation with the BOMAG BW 213 DH-4 and BCM 05.



Figure 6 – BOMAG BW 213 DH-4 BVC with GPS receiver and BCM 05 display.

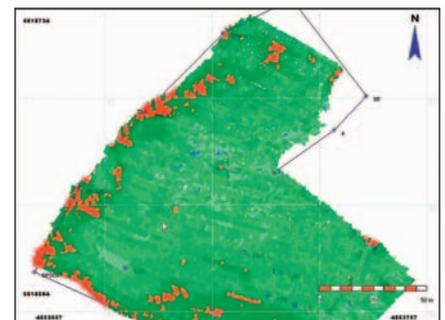


Figure 7 – Example of GPS based SCCC with colour allocations corresponding to the compaction level achieved.

During the compaction process, any measured data coming from the BTM prof is displayed graphically and numerically to the roller driver on the colour display of the BCM 05 system and is analysed, managed and documented on a PC using the evaluation program BCM 05 office. Data transfer between display and PC is by USB memory stick (Figure 4).

The BCM 05 software creates meaningful and detailed data summaries with calculations of areas and static examination of the $E_{V\beta}$ values for assessing compaction quality both on the BCM display for the roller driver and in the site office for the data evaluator (test engineer for self-monitoring). The graphic display can either be a top view with

Einsatzmöglichkeiten von BOMAG BTM prof und BCM 05

colour allocations or a 2D representation (Figures 13a and 13b) (E_{VIB} value over the measured length). In this respect, the 2D representation corresponds to the measured printout display of the Terrameters (Figure 5).

Without GPS, documentation is implemented on a track-bound basis using path lengths of 100 m. For this purpose, the area to be processed is subdivided into a roller path grid; grid size, positioning within the field by XY coordinates and other data important for describing compaction work are prepared in the site office using BCM 05 office and saved onto as USB stick.

The documentation system not only offers track-oriented documentation with manual positioning in the section but also a satellite

supported documentation solution with the software module BCM 05 positioning developed by BOMAG (Figures 6, 7).

This not only provides continuous recording and documentation of the E_{VIB} value, but also of the locational and height-related position of the roller, the operating parameters of the roller and the time of measurement. In principle, all conventional, differential GPS systems with correction signals from reference stations or with satellite supported reference services can be used. Depending on the system and receiver quality, positioning accuracies of 2-5 cm (RTK-GPS) or 10-30 cm can be achieved using a reference satellite. The BCM 05 positioning software transforms incoming satellite data into the Gauß-Krüger coordinate system or into another local system if the appropriate

transformation parameters have been entered. Axes and outlines can be easily incorporated for orientation within documented areas by recording special points in the construction measure.

2.3 SCCC applications

Since the introduction of ZTVE – StB 94/97 (additional technical specifications and guidelines in earthworks for road construction), roller integrated measuring and documentation systems can be used within the context of self-monitoring and external quality control of earthworks in road construction. In this case, special emphasis is on the application of SCCC (as a one hundred percent test based on calibration of the dynamic measured values of the roller) on the test features defined in the building contract, compaction degree and deformation module. The procedural method is laid down as the M2 test method in the ZTVE – StB 94/97 and in the technical test specifications for soil and field in road construction (TP BF – StB) SCCC method – Part E2. The application of SCCC as a one hundred percent test is explained in section 3 using the construction of the South runway and taxiways as an example.

In addition, SCCC offers a range of other application options which do not require calibration (Figure 8). A surface covering search for weak points carried out with the BCM 05 by proof rolling can be applied to all types of soil. Weak points with low E_{VIB} values can thus be identified and documented. Compaction can be assessed at these weak points in a targeted way using individual tests. The area can be assessed as a whole by combining the dynamic measured value of the roller and an individual test. Another important application is the documentation of compaction based on trial compaction and the related determination of a work instruction. To this end, the E_{VIB} values and position of the roller are continuously documented using the BCM 05 system and a GPS connection which consequently means

APPLICATION	Recommended compaction equipment	Examples	Benefits	Suitability
 Assesment of subbase and individual soil layers	Smaller works: Terrameter BTM prof Large projects: additional BCM 05	Foundation areas, subgrade and embankments	Location of soft spots (weak spot analysis / Proof Rolling) → targeted deployment of conventional test methods	All types of soil
 Proof of maximum possible compaction	Smaller works: Terrameter BTM prof Large projects: additional BCM 05	Embankments Frost blankets Unbound bearing courses	Comparison of results between passes Optimization of equipment use	All types of soil
 Scope of job instructions	BTM prof and BCM 05 und GPS		Documentation of passes and soft spots	All types of soil
 Proof of compaction by calibration	Smaller works: Terrameter BTM prof Large projects: additional BCM 05	Subgrade Frost blankets Unbound bearing courses Embankments	Surface covering compaction control	Rock fill Coarse grained soils Mixed soils Mineral mixes
 Control of compaction work	Smaller works: Terrameter BTM prof Large projects: additional BCM 05	Subgrade Frost blankets Unbound bearing courses Embankments	Efficiency Optimization of equipment use	All types of soil

Figure 8 – Application options of SCCC.

Verdichtungsanforderungen und Prüfplan für ungebundenen Oberbau

that the compaction passes are also controlled. The advantages of SCCC, for increasing compaction performance and improving compaction quality, can be summarized as follows:

- Non-uniform and poorly compacted sites are localized and documented
- The compaction process and the level of compaction achieved can be documented in a continuous line
- The risk of under- and overcompaction is reduced
- The use of compaction equipment is optimised
- The lower expenditure for compaction and compaction control lead to time and cost savings
- Testing efficiency can be increased considerably

surfaces and all test levels with SCCC was aimed for, whereby the expenditure for supplementary quality assurance tests was to be considerably reduced. Extensive test and calibration fields form the basis for this reduction in conventional tests.

3.2 Test plan

A test plan was prepared for both sections in graphic and tabular form by FUGRO CONSULT GmbH, department of geomonitoring, as self-monitoring supervisor. This plan was confirmed in agreement with the construction companies by quality control monitoring and by the contractor.

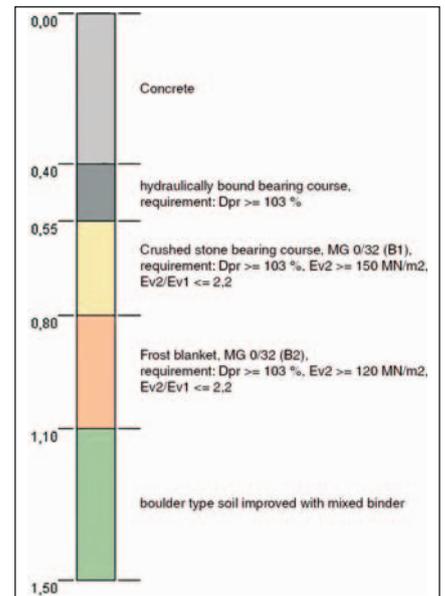


Figure 9 – Structural layout of the South runway and taxiways including test requirements.

3. Surface covering dynamic compaction testing (SCCC) as a test and control method on the South runway and taxiways

3.1 Structural layout and test requirements

The layout of the South runway and taxiways is shown in the following together with the bearing capacity and compaction requirements (Figure 9). Layout and test requirements for both construction areas are identical. The surface area to be processed per location is 280,000 m² on the South runway and 280,000 m² on the taxiways. According to site regulations, the subgrade is primarily made up of a mixed-grain soil in thicknesses of up to 4 m. Figure 9 shows the further layout of and requirements on the bearing capacity and compaction levels.

The contractor requested the surface covering dynamic compaction control method (SCCC) in addition to quality control within the scope of the M3 method for testing the bearing capacity and compaction of the unbound bearing layers (anti-frost layer and crushed stone subbase). Based on existing experience with SCCC, a 100% test of all

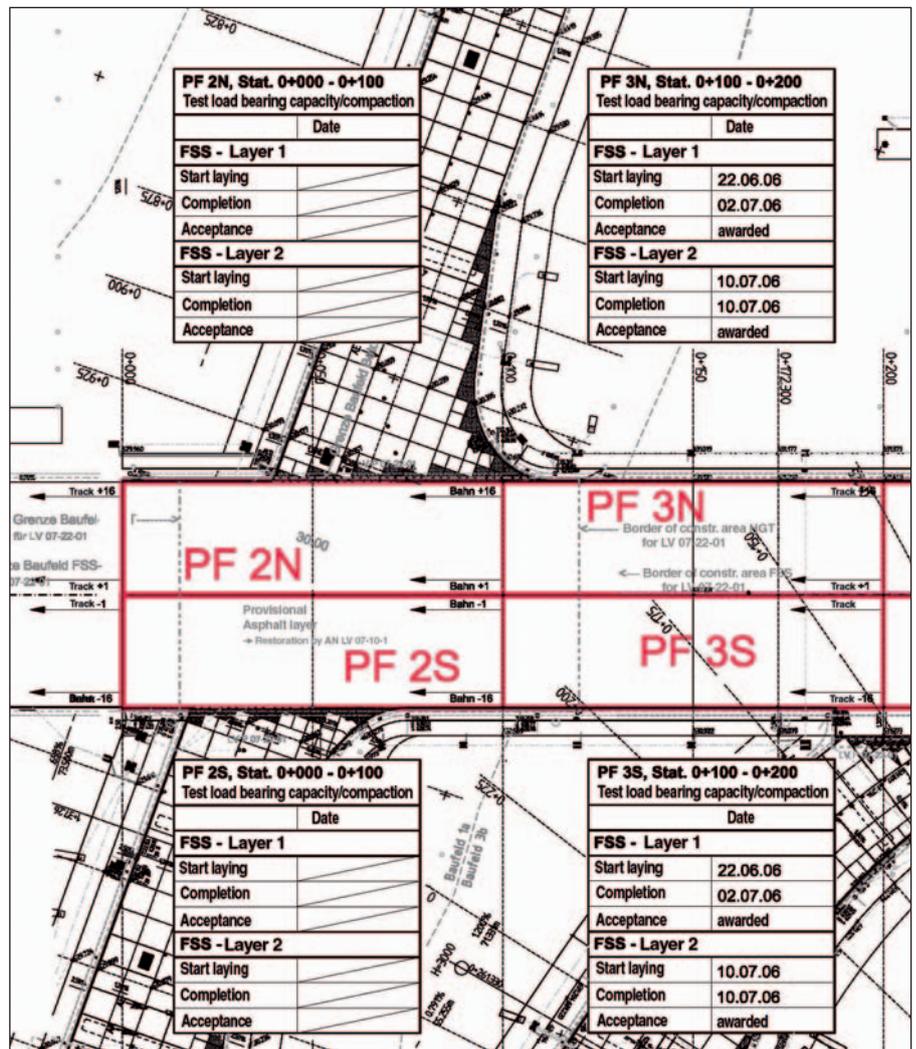


Figure 10 – An extract from the graphic test plan for the taxiways - the crushed stone subbase here is shown as a 2nd anti-frost layer.

Verdichtungsanforderungen und Prüfplan für ungebundenen Oberbau

Each test plot was checked over 100% of the area using the SCCC method. Testing was based on a calibration of the SCCC value E_{VIB} for bearing capacity and compaction. On each test plot, the bearing capacity was measured directly with the static load plate and the compaction level was measured directly using the sand substitution method or the Troxler probe in the area with the lowest recorded value (E_{VIB}) from the SCCC test. The scope of tests according to M3 was thereby reduced to one direct test each. In addition to the M2 method, a weak point search was still carried out with subsequent direct testing. This ensured that the targets were achieved across the entire surface area.

The results from the SCCC tests and the direct tests were evaluated and documented by the self-monitoring supervisors and then subsequently they were made available to quality control and the contractor within 24 hours.

In order to carry out self-monitoring, the section was subdivided into test plots. A test plot was established as having a width of 15 compaction paths and a length of 100 m. This resulted in 100 test plots for the South runway, each with an area of approx. 3000 m². Consequently a roller track oriented test scheme was selected. An extract from the graphic test plan is shown in Figure 10.

3.3 Test fields/evaluation

Calibration is always necessary for applying SCCC within the context of the M2 method. The calibration fields have been integrated into the layout of the South runway and taxiways. Preliminary tests showed that the number of passes recommended according to test specification M2 is only of limited suitability for the materials used. The material showed maximum compaction after 2 – 3 passes already. More than 4 passes led to a reduction in the display values. A measurement run directly following com-

action led to no applicable results. For this reason, the measurement run was carried out only 24 hours after compaction, likewise the static plate load tests and the direct density determinations. Then static load plate tests and direct density determinations were carried out within the calibration fields on at least 9 points. These tests were carried out in a targeted way in areas with low, medium and high E_{VIB} values. This meant that the test specification requirement for recording the largest possible measured value range could be taken into account.

The measured values for the dynamic compaction test (E_{VIB}) were correlated to the bearing capacity (E_{V2}) and the degree of compaction (D_{pr}). In this way, a functional dependency between E_{VIB} and E_{V2} or E_{VIB} and D_{pr} could be derived from the calibration diagrams. A smooth drum roller BW 213 DH 4 from BOMAG was used for the compaction work. The settings between compaction run and measurement run were not altered. The calibration fields were produced based on experience with the following equipment settings on the compaction roller:

- Travel speed: 1,5 – 1,7 km/h
- Amplitude: 0,9 mm
- Frequency: 36 Hz

Using the selected low amplitude, the E_{VIB} value is recorded roughly over a depth of 0.6 m as an integral value for a surface area measuring approx. 0.50 m². The E_{VIB} value corresponds to the average soil characteristic for this soil volume. The selected amplitude during SCCC leads to a measuring depth which corresponds to the testing depth of the static load plate.

In the calibration fields' result for the anti-frost layer and the crushed stone subbase, maximum compaction was usually reached after three passes and the fourth pass was implemented as a measurement run (> 24 hours after compaction). Identical material

¹ 1 Übergang = 1 Überfahrt in Vor- oder Rückwärtsbewegung

was used for the crushed stone subbase on the taxiways and on the South runway. According to expectations, both calibrations that were carried out show a concurring result for the bearing capacity calibration.

- $E_{V2} = 150 \text{ MN/m}^2 \sim E_{VIB} = 107$ or 110 MN/m^2

The anti-frost material was procured from different suppliers stating the same material requirements for both sections. The calibration curves of the two different materials supplied differed from each other.

- $E_{V2} = 120 \text{ MN/m}^2 \sim E_{VIB} = 80$ or 103 MN/m^2

This makes it clear that independent calibration is required for each material.

Using the result of the calibration tests, the test plan went on to define what test results were needed for a test plot to pass the requirements. In this respect, the following target values were defined:

- Weak point variable – smaller than 2.0 m in length and smaller than one track width
- Target value not met – lower than 20 % at the weak point
- Area evaluation – 10 % quantile value 10 % area proportion

This means that if the target E_{VIB} value is fallen short of by less than 20 % over a length of < 2.0 m, the test plot is considered to have passed still if a total of at least 90 % of the area has reached or exceeded the target E_{VIB} value. A colour illustration was derived from this definition. A distinction was made between:

- Target value achieved – blue
- Target value fallen short of by max. 20 % – green
- Target value fallen short of by more than 20 % – red

Kalibrierung und Auswertung mit BCM 05

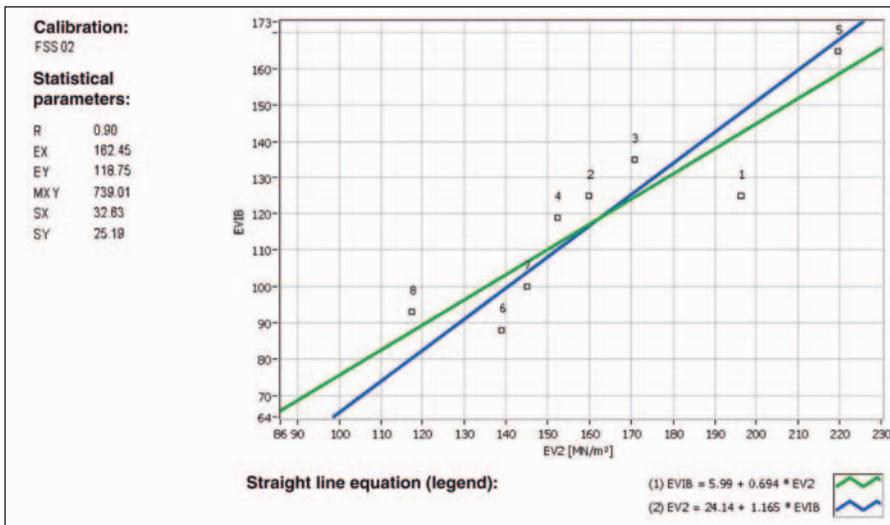


Figure 11 – Correlation diagram E_{VIB} v. E_{V2} .

In addition to this, the respective coloured area was determined as a % in relation to the overall area of the test plot. Figure 12 shows an example of this evaluation. The size of a single weak point can be measured using the true-to-scale representation of the tracks.

3.4 Daily working method

To implement SCCC, the data recording unit BOMAG Terrameter (BTM prof) and the documentation and display unit BOMAG Compaction Management (BCM 05) was installed in the measuring roller. Once the test plots were notified as having been com-

Saved Data	
Total area	2000 m ²
Processed area	1992 m ² 99.6 %
Passes	1 ... 2
documented from	13.7.2006 11:57:06
documented to	13.7.2006 13:15:22
	Mean Min Max
EVIB [MN/m ²]	174 0 350
Amplitude [mm]	0.9 0.9 0.9
Frequency [Hz]	36 24 59
Speed [km/h]	1.1 0.0 1.9
Evaluation and statistics	
EVIB > 110	99 %
EVIB :88 -110	1 %
EVIB < 88	0 %

Figure 12 - Extract from the SCCC documentation with colour selection corresponding to the definition of target variables.

pleted by the contractor, the self-monitoring supervisors (measuring engineers from FUGRO CONSULT GmbH) established and prepared these test plots in the office using the BCM 05 software from BOMAG. When doing this, the following values were defined alongside the original data for each test plot:

- Test plot number
- Coordinates
- Number of tracks and track reference
- Track length
- Target values for E_{VIB}
- Colour arrangement definition
- Calibration used

The prepared test plots were installed the next day on the BCM 05 display in the roller by the self-monitoring supervisors; this was followed by marking of the test plots and track arrangement over the grounds. During the measurement run, the roller driver was immediately able to read off areas with insufficient compaction and to see the rest of the entire test plot on the BCM 05 display right after conclusion of the measurement run.

The display is shown either as a function of the measured E_{VIB} value over the measured length (2D representation) or as a coloured area representation (top view). Both displays

(Figure 13) show the target value and a 20% undercut according to the test plot definition by colour selection.

If the measurement run was successful, the data was saved; if compaction was insufficient, self-monitoring determined further measures. The data from the measurement runs were outputted the next day. Subsequent evaluation was carried out by the technician on the office computer.

Documentation for a test plot comprises a cover sheet with the original data, a top view of the test plot with colour allocation of the achieved target variables including static evaluation as well as a 2D display for each measured track. This data was sent to the quality controller as a PDF document for their information and for inspection. Furthermore, the quality controller received a suggestion for the location of the direct bearing capacity and compaction tests on the test plot. These tests were then partially carried out in the presence of the quality controller or they were implemented parallel by the self-monitoring supervisor and quality controller. The balloon method, sand substitution method or the Troxler probe as well as the static load plate were used in this instance (Figure 14). The results of the direct tests were added to the PDF document from the SCCC test. This completed the concluding documentation for the test plot after approx. 24 hours. The test plot was entered and marked as complete in the graphic and tabular overall test plan.

Altogether, 95 % of all test plots achieved the test criteria during the first measurement run. Subsequent compaction led to all other test plots meeting the requirements. Calibration of the test fields was supplemented by the test results of the direct bearing capacity and compaction tests for each test plot. Consequently, with each test plot, another pair of values (E_{VIB} ; E_{V2}) or (E_{VIB} ; D_{PP}) were made available for correlation. Following conclusion of the construction measure, each correlation was based on

Kalibrierung und Auswertung mit BCM 05

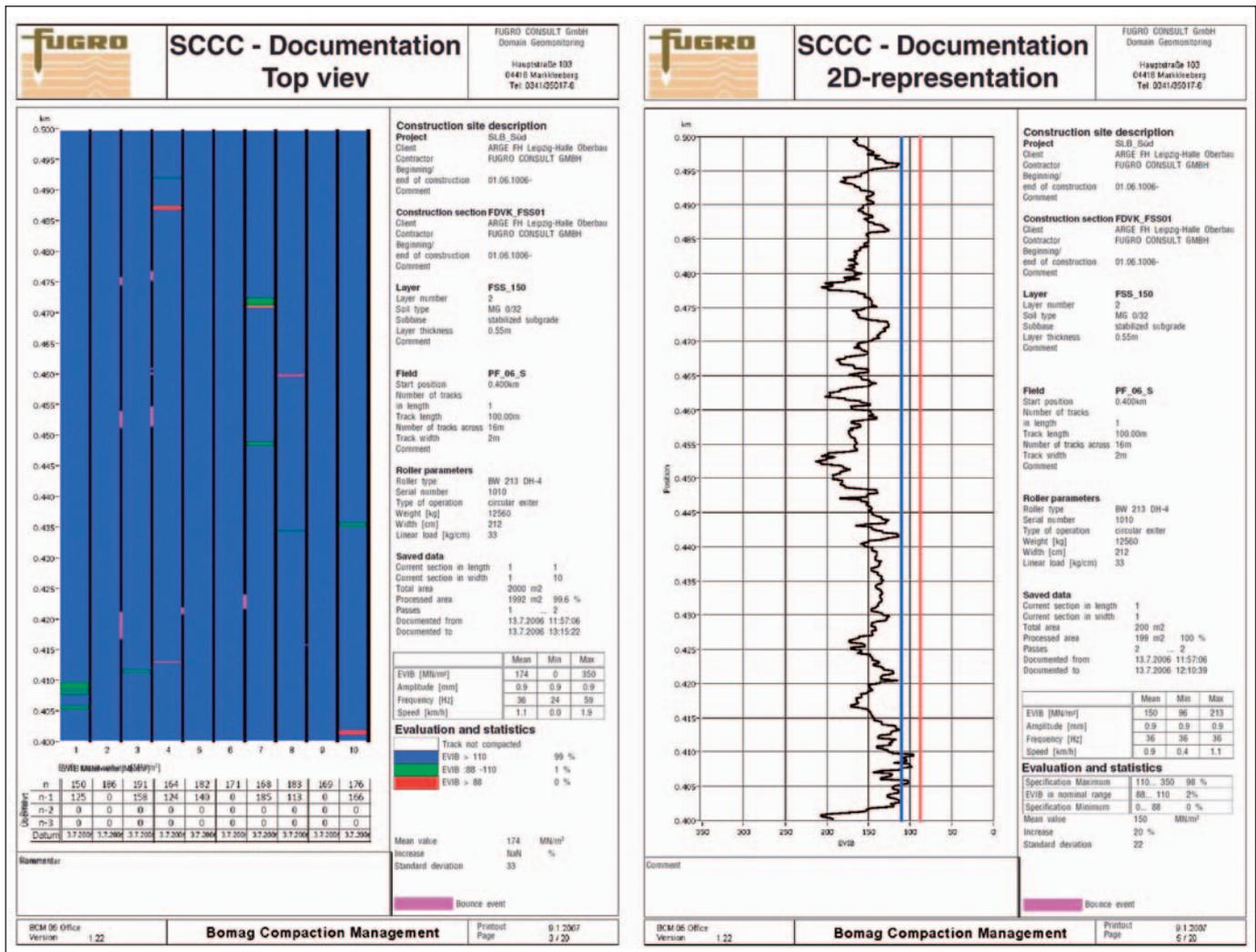


Figure 13 a - Display of the measured E_{VIB} value on the test plot denoted by colour markings (top view).

Figure 13 b - Display of the measured E_{VIB} value on a measured path of the whole plot as a 2D display.

over 100 value pairs. There were no significant changes to the correlations which were derived from the respective test fields.

applications, it can be successfully employed on all construction projects on earthworks and highway construction as well as preparing areas for building development.

suites. On the other hand, non-uniform results and lower correlations can be expected with soil conditions that change locally or within small areas and/or with fine grain soil conditions.

4. Summary

On evaluating these surface covering dynamic compaction and bearing capacity tests and based on experiences from other SCCC construction sites, the following summary has been drawn:

The SCCC application without calibration provides a work-integrated procedure for the technical and cost optimisation of compaction work and is suitable for all soil types.

Proof of compaction and bearing capacity by SCCC using the M2 method invariably requires calibration. By using the M2 test method (which is a 100 % test), a clearly higher test quality is achieved in contrast to the M3 method which works as a spot check test of the working procedure. The compaction status is displayed to the roller driver during the compaction process using the documentation system. Altogether, this leads to uniform, quality assured and cost optimised compaction. In addition, the

Surface covering dynamic compaction control offers the possibility, with and without calibration, to record and document information on the bearing and compaction status of the ground – online, cost effectively and comprehensively. With the various possible

When using calibration, SCCC is applied within the context of the M2 method. SCCC as an M2 method is particularly well suited for medium-sized to large sites with largely consistent material composition and the most uniform subsoil possible. Coarse grain and mixed grain soils with fine grain portions of 15 % and mineral mixes are usually well

Vorteile der flächendeckenden dynamischen Verdichtungskontrolle



Figure 14 a – Bearing capacity test with the static load plate.



Figure 14 b – Compaction test with a Troxler probe.

quality control tests demanded by the contractor can be carried out in a targeted way using the documentation functions of the BCM 05 system. For the client, this means higher reliability and for the contractor it offers cost optimised compaction.

This does not result in additional work for the technical personnel on the single drum rollers. The work of the test engineer changes significantly. It is recommended that the SCCC test is carried out from planning up to data management by an experienced self-

monitoring technician. Overall, this will mean no extra costs for self-monitoring in comparison to the M3 method.

It is mandatory to use a calibration area when applying the M2 method. The number of compaction passes should be determined by preliminary tests. The measurement run and direct tests are simultaneous but must only be carried out at least 24 hours after compaction. Results from direct quality tests should be used to update and qualify calibration.

If test plots are straight, calibration can be carried out geodetically or by manual GPS. A georeferenced creation of test plots is recommended on curves, multi-layered and offset test areas. This option is available on BOMAG rollers by optional GPS receivers and a GPS software module in the BCM 05 system.

Surface covering dynamic compaction control was successfully used at Leipzig/Halle airport for the South runway and for the taxiways to test the unbound layer. The selected test plot sizes and testing criteria have proven to be valid. The engineer's technical self-monitoring and external quality control work increased in scope and necessitated a greater proximity to the construction site as well as closer collaboration with the contractor and the client's project management department.

The sections were subjected to 100% testing density with additional direct, subsequent testing. All test plots passed; there were no weak points identified. An evenly compacted, unbound layer capable of taking the maximum load was produced. The targets set by the client were fully met. 100% testing density was achieved by applying SCCC while overall costs remained roughly the same for self-monitoring, and idle time for the construction equipment was lower. At the same time, the time and effort required for direct testing was reduced to 1/5 of the original plan. Consequently, using SCCC at

Vorteile der flächendeckenden dynamischen Verdichtungskontrolle

Leipzig/Halle airport, a higher test quality was achieved with lower total costs in comparison to the classic M3 test method.

The successful outcome was due not only to high quality and timely work but also the constructive collaboration of all participating contractors and engineers; all parties worked harmoniously sharing responsibility on a contract where deadlines were tight. The movement of material was huge and a large number of other companies were working on the site. We would like to thank all of those who participated in this project. Our special thanks go to the South project management department at Leipzig/Halle airport GmbH for the participation of many regional companies in the overall project; for their support in preparing SCCC and for the consistent and successful application of SCCC on the contract.

We wish Leipzig/Halle airport every future success.

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Workshop Flächendeckende dynamische Verdichtungskontrolle [workshop on surface covering dynamic compaction control]

VSVI (2006)

BV Leipzig, Mr Talkenberg, report on a professional excursion to Leipzig/Halle airport – new South runway



Figure 15 – Start- und Landebahn Leipzig Süd im Bau.

Zusammenfassung der Projektdaten

Project:	Leipzig/Halle airport in 2 sub-projects 1. New-build of South runway – length 3600 m, width 60 m 2. New-build of taxiways
Customer:	Flughafen Leipzig/Halle GmbH
Contractor:	1. ARGE Flughafenbau Leipzig Halle: Heilit + Wörner Bau GmbH, Max Bögl Bauunternehmung GmbH & Co. KG, STRABAG Straßen- und Tiefbau AG 2. Bilfinger & Berger Verkehrswegebau GmbH
Self-monitoring (internal quality control):	Fugro Consult GmbH, Speciality Geomonitoring, Markkleeberg
External quality control:	BAUGEO, Ingenieurbüro für Baugrund und Geotechnik GmbH, Leipzig
Compaction work: Earthworks/ non-bonded SLB:	Earthworks 5.000.000 m ³ 1. Anti-frost layer B 1: thickness 0.25 m: 69.000 m ³ Anti-frost layer B 2: thickness 0.30 m: 83.000 m ³ 2. Anti-frost layer B 1: thickness 0.25 m: 95.000 m ³ Anti-frost layer B 2: thickness 0.30 m: 114.000 m ³
Taxiways:	
Compaction equipment:	3 x BW 225 / BW 226 smooth drum and padfoot roller drums 4 x BW 219 smooth drum and padfoot roller drums 12 x BW 213 DH-4 and BW 213 DH-4 BVC with BOMAG Terrameter BTM prof 6 x BW 213 DH-4 and BW 213 DH-4 BVC with Terrameter BTM prof and BMC 05
Information:	BOMAG GmbH, Application Technology, H.-J. Kloubert Dip. Eng. Tel.: +49 6742 / 100350 Fax: +49 6742 / 3090

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BOMAG Service. Everywhere and for every need. Our branches and dealers are backed by BOMAG's Central Parts warehouse where about 40,000 parts are held against customer requirements. You expect top service from BOMAG. We aim to provide it.

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The machines illustrated may show optional equipment which can be supplied at additional cost. Specifications may change without notice.

- **Head Office/Hauptsitz:**
BOMAG, Hellerwald, 56154 Boppard, GERMANY, Tel.: +49 6742 100-0, Fax: +49 6742 3090, e-mail: info@bomag.com
- **BOMAG Maschinenhandelsgesellschaft mbH**, Porschestraße 9, 1230 Wien, AUSTRIA, Tel.: +43 1 69040-0, Fax: +43 1 69040-20, e-mail: austria@bomag.com
- **BOMAG (CANADA), INC.**, 1300 Aerowood Drive, Mississauga, Ontario L4W 1B7, CANADA, Tel.: +1 905 6256611, Fax: +1 905 6256670, e-mail: canada@bomag.com
- **BOMAG (CHINA) Compaction Machinery Co. Ltd.**, No. 2808 West Huancheng Road, Shanghai Comprehensive Industrial Zone (Fengxian), Shanghai 201401, CHINA, Tel.: +86 21 33655566, Fax: +86 21 33655508, e-mail: china@bomag.com
- **BOMAG FRANCE S.A.S.**, 2, avenue du Général de Gaulle, 91170 Viry-Châtillon, FRANCE, Tel.: +33 1 69 57 86 00, Fax: +33 1 69 96 26 60, e-mail: france@bomag.com
- **BOMAG (GREAT BRITAIN), LTD.**, Sheldon Way, Larkfield, Aylesford, Kent ME20 6SE, GREAT BRITAIN, Tel.: +44 1622 716611, Fax: +44 1622 713335, e-mail: gb@bomag.com
- **BOMAG Italia Srl**, Z.I. - Via Mella 6, 25015 Desenzano del Garda (Bs), ITALY, Tel.: +39 030 9127263, Fax: +39 030 9127278, e-mail: italy@bomag.com
- **BOMAG Japan Co., LTD.**, Oval Court Ohsaki Mark West Bldg. 8th floor, 2-17-1, Higashi Gotanda, Shinagawa-ku, Tokyo, JAPAN, 141-0022, Tel.: +81 3 5449 7560, Fax: +81 3 5449 0160, e-mail: info@bomag.co.jp
- **BOMAG GmbH**, 300 Beach Road, The Concourse, #38-03, Singapore 199555, SINGAPORE, Tel.: +65 6 294 1277, Fax: +65 6 294 1377, e-mail: singapore@bomag.com
- **BOMAG Americas, Inc.**, 2000 Kentville Road, Kewanee, Illinois 61443, U.S.A., Tel.: +1 309 8533571, Fax: +1 309 8520350, e-mail: usa@bomag.com

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