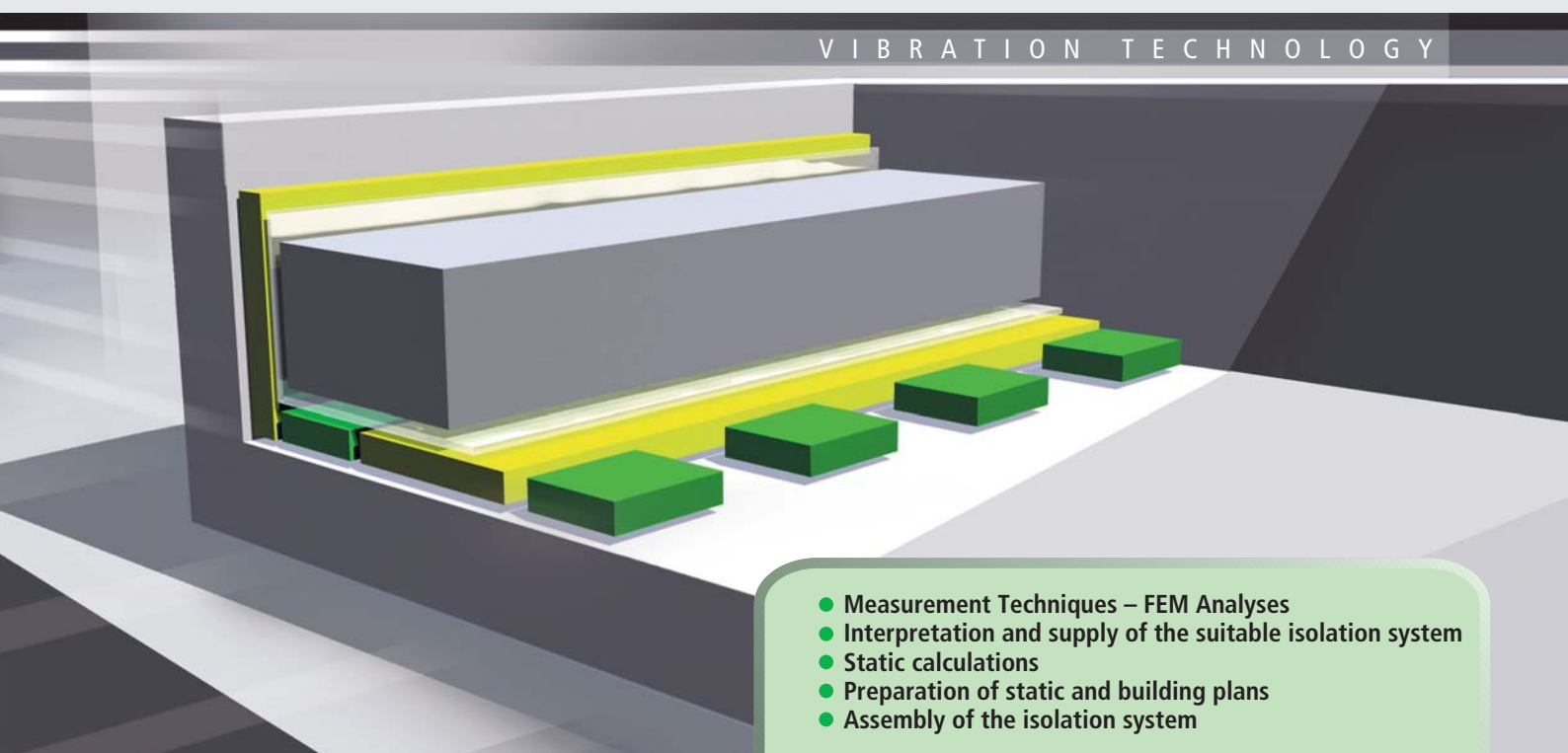


VIBRATION ISOLATION OF FOUNDATIONS AND FRAMEWORKS

V I B R A T I O N T E C H N O L O G Y



- Measurement Techniques – FEM Analyses
- Interpretation and supply of the suitable isolation system
- Static calculations
- Preparation of static and building plans
- Assembly of the isolation system

General Information on Vibration Technology

Today the reduction of vibration emission and vibration immission play an important part in the operation of plant and machinery, etc. The constant improvement in machine performance over recent years has generally been accompanied by increased speeds and cutting rates, as well as an increase in impact power in the field of forming. This means an increase in the vibrations transmitted to the surroundings, which must be efficiently controlled.

Matching up the important factors

Insulation of sinusoidal vibrations

The efficiency of vibration insulation depends to a large extent on the relationship between the machine speed/stroke rate and the natural vibration frequency of the insulator (matching ratio). In general, it can be said that the lower the natural vibration frequency of the insulator, i.e. the greater the ratio between forcing frequency and natural frequency, the greater the efficiency of the insulator. The diagram below shows that vibration insulation does not take effect until the matching ratio (η) is greater than $\sqrt{2}$.

It follows that: Efficiency of vibration insulation

$$f_0 = \text{natural frequency of isolator} \\ f_m = \text{forcing frequency of the machine} \quad J_S = \frac{\left(\frac{f_m}{f_0}\right)^2 - 2}{\left(\frac{f_m}{f_0}\right)^2 - 1} \cdot 100 \%$$

Transmissibility by taken dampening factor D into consideration is:

$$V_p = \sqrt{\frac{1 + 4 D^2 \eta^2}{(1 - \eta^2)^2 + 4 D^2 \eta^2}} ; \quad \eta = \frac{\text{forcing frequency}}{\text{natural frequency of isolates}}$$

Impact insulation

The physical properties of impacts are their duration, direction and magnitude. The object of impact insulation is to change the forcing frequency consisting of a high kick into an impulse of longer duration accompanied by small residual forces. Different from periodically excited vibrations, the system provided with springs vibrates in the

So, the efficiency factor of an impact insulation is:

$$J_S = 100 \times \left(1 - \frac{1}{\eta_S^2}\right) \% ; \quad \eta_S = \frac{\eta_b}{\eta_e}$$

Types of Vibration Insulation

We differentiate between active and passive insulation. If the objective is to prevent spreading of the vibrations caused by a machine (vibration emission), we talk of active insulation. If, on the other hand, precision

Important Definitions

Damping = the physical property of an insulator to limit resonance vibration to the permissible level. During this process, mechanical energy is converted into heat.

Isolation = insulating of an actuating force.

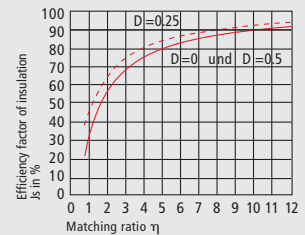
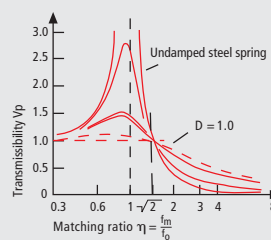
The basic principle of vibration isolation

The objective of using insulating devices for machine mounting is the reduction of pulsating (repetitive), or sinusoidal vibrations. The task is to keep the motion (amplitude) of the flexibly mounted machine within permissible limits for operation. The vibration insulators selected must have sufficient dampening capacity!

No insulating effect can be expected at frequency ratios of less than $\sqrt{2}$. Quite the opposite: an increase in (excessive) vibration must be anticipated.

As a rule a matching ratio (η) between 3 ... 4 is attempted, with 3 being taken as the technical minimum and 4 the economic maximum.

A bigger matching ratio (η) than 4 cannot be justified for economic reasons, as the material expense would increase out of proportion to the insulating effect.



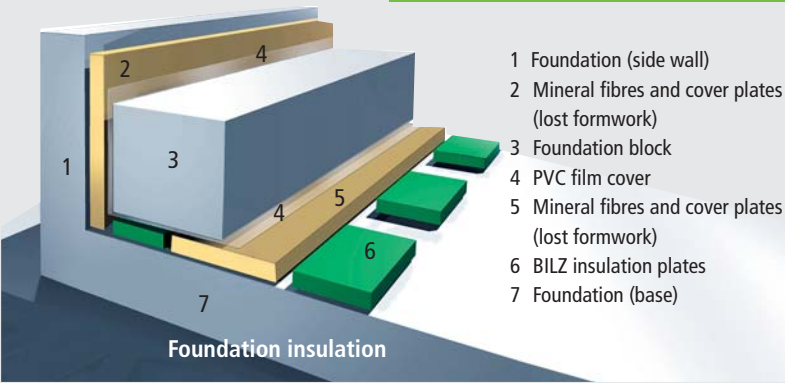
excited natural frequency of the insulated system, not according to its number of strokes. The residual forces transferred via the insulators become increasingly smaller, the longer the natural vibration period lasts and therefore the smaller the natural frequency of the system sitting on a foundation equipped with springs.

η_b = natural frequency of the system rigidly secured to the ground
 η_e = natural frequency of the system when placed on insulators containing springs

machining equipment which is extremely sensitive to vibrations is to be protected from vibration immission, this is described as passive insulation.

Vibration emission = vibration created by the machinery that is propagated to the surroundings.

Vibration immission = vibration present in the surroundings that is propagated to the machinery.



BILZ insulating plates are ideally suited for vibration suppression of foundations and baseplates

The main purpose of the foundation is to stabilize the machine as well as to increase the moment of inertia. The foundation thus positively influences machine vibration by reducing the amplitude of oscillation. It is wrong, however, to assume that any foundation large enough would eliminate all vibration problems. It is important that as much information as possible be supplied regarding the machine to be isolated, this will include machine size and weights, any dynamic features of its operation, location including ground type, condition where optimal performance is required and a vibration analysis of the machine and site conditions. A correct isolation between machine foundation and the surrounding area will result in trouble free operation.

As a result of years of experience we have the necessary experience in this field. At your request we can offer all other related services including measuring of vibrations, planning and construction design.

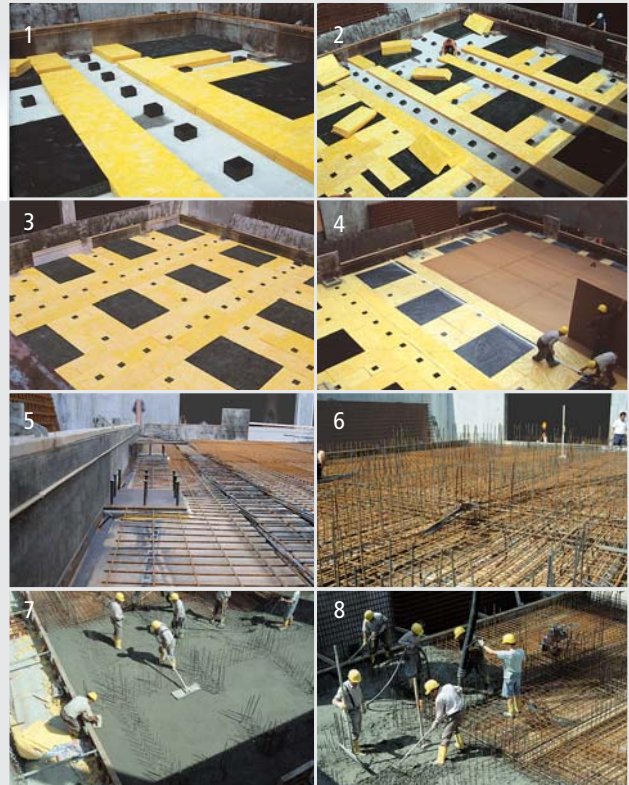
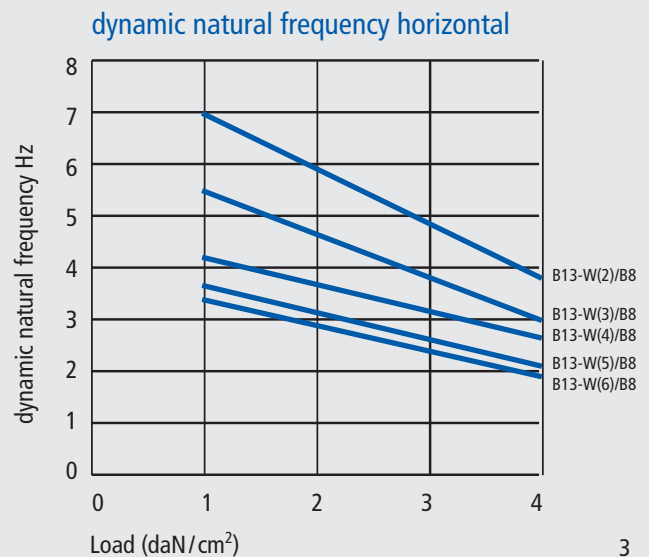
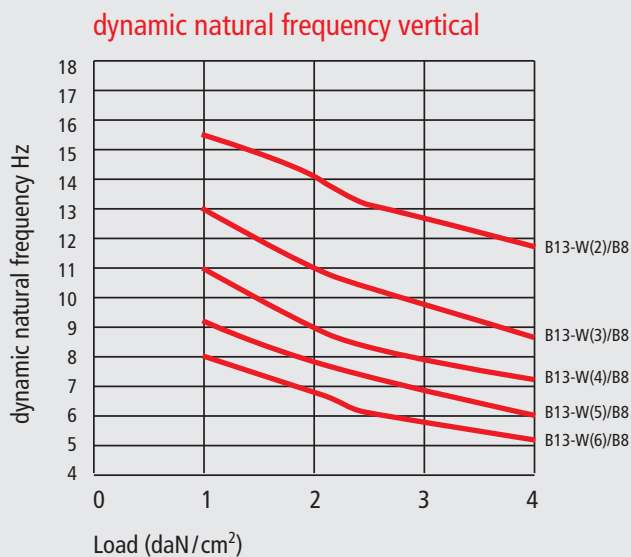


Illustration 1, 2, 3: Depositing of BILZ insulation plates (green) and padding of the spaces with mineral fibre insulation plates (sacrifice formwork). Illustration 4: Covering of the entire area first with PVC sheeting as used for construction work, and then with mineral fibre cover plates. All joints must be pasted/glued together. Illustration 5, 6: Mounting of reinforcement. Illustration 7, 8: Filling in of concrete.



Application example in the plant of a major automobile manufacturer. Passive insulation protection of a Waldrich-Coburg portal milling machine from the pressing mechanism sector. Total mass: approx. 1200 to.

Precast form, steel mould



FAEBI®-HD



Combined Rubber-Airspring-Insulator

FAEBI®-HD with adjustable dampening

Rubber air-spring insulator FAEBI®-HD is made of a combination of high-grade elastomer and metal with an enlarged sidewall. In order to obtain as high a dampening effect as possible, the air space is split into two chambers (load / dampening volume) linked by an air pipe. By the adjustable valve the dampening can be changed easily from outside. Due to the friction caused by the air-stream passing through the bypass valve, it is possible to adapt the dampening to each application.

Because of the very high dampening, the resonance amplitude is much smaller and therefore you are able to achieve less machine movement. (see graph 1a + 1b) Furthermore the increased transformable energy takes effect on the production quality of your machinery.

Note:

In contrast to viscous dampers, the air dampening is absolutely wear-resistant and free of maintenance. Furthermore it is possible to change the dampening from outside.

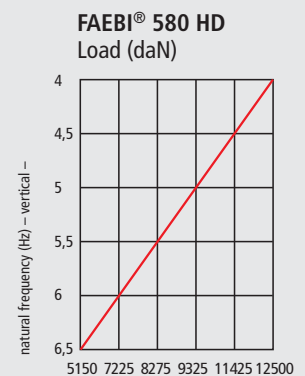
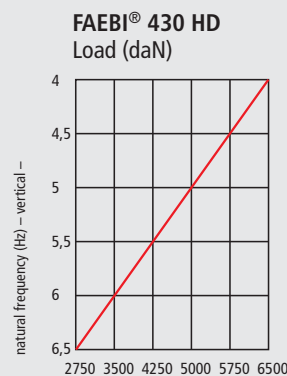
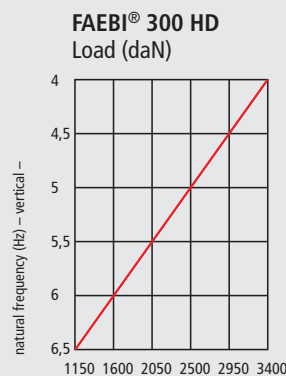
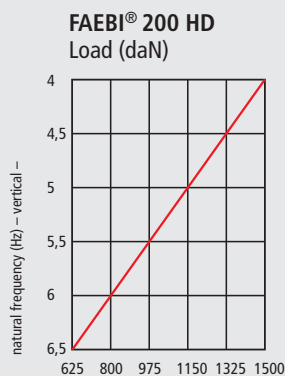
FAEBI® mechanical-pneumatic control valves

The mechanical-pneumatic relief valves are a simple yet effective solution. The level is constantly scanned by a plunger. The plunger position in transmitted to a slide valve. Depending on the slide valve position, pressure is applied to the air spring or the inside pressure is reduced. The level can be maintained at an accuracy $\pm 1/10$ mm.

Principally three control valves are used. A pressure control valve to limit system pressure to a maximum of 6 bar, water trap to remove vapour and an air filter to remove dust and any foreign bodies from the air supply.



type	FAEBI® 200 HD	load daN/pc.	625 - 1500	max. pressure / bar	6	A mm	260	D mm	236	H approx. mm = workheight	90	d mm	130	M	M 16
	FAEBI® 300 HD		1150 - 3400		6		370		340		90		200		M 20
	FAEBI® 430 HD		2750 - 6500		6		500		480		90		315		M 20
	FAEBI® 580 HD		5150 - 12500		6		680		650		136		380		M 24





Example: Stamping Machine Type PIVATIC PCC80 TTI + HT

Machine weight incl. work piece app. 23 to. Dynamic vertical forces app. 60 KN, horizontal forces app. 30 KN, Foundation block: app. 5,1 x 3,5 x 1 m, weight app 40 to.

Equipment: 8 x Bilz FAEBI type 580-HD with mechanic level control system LCV and following services:

- foundation design
- static foundation calculation
- formwork plans
- steel- and bending schedule list

Special request:

Target: loss of production not longer as 3 weeks. Small space from the revision channel trough to foundation block.
Very low horizontal movement of the machine was expected. Efficiency of the isolation of more than 80 % was requested.





BiAir®

BiAir®

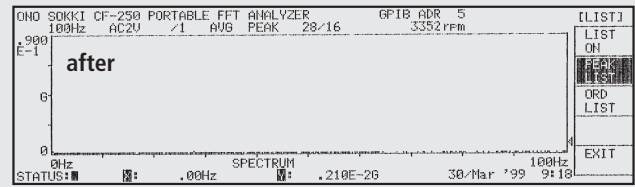
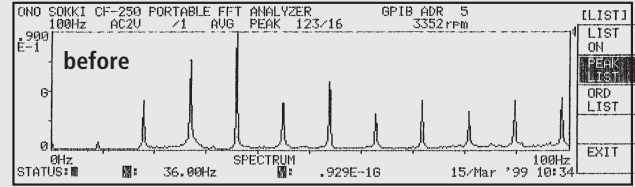
Product Description

The Air-Spring Insulator **BiAir®** consists of a cast aluminum body whose air volume is enclosed by a thin-walled, flexible and pressure-resistant rolling diaphragm. The piston is seated on this diaphragm and is pushed into the air volume.

This design causes highly effective vibration insulation. In order to obtain as high a dampening effect as possible, the air space is split into two chambers (load/dampening volume) linked by air pipe. By the adjustable valve the dampening can be easily changed from outside. Due to the friction caused by the air-stream passing through the bypass valve, up to 20% dampening can be effected. Additional safety valves will protect the roller diaphragm from getting damaged by over-inflation.

Range of Application

Highly effective vibration insulation of sensitive measuring and testing machines, fine-machining plant, as well as optical and electronic equipment. Another important range of application is the vibration-insulated foundation of vehicle, motor and other performance testers. **BiAir®** Air-Spring insulators are extremely well suited for the insulation of foundations e.g. equivalent machine loads.



Advantages compared with conventional steel springs

BiAir® Air-Spring insulators with level control are an active system. The machine/foundation level consistency will always be preserved! Automatic leveling/adjustment!

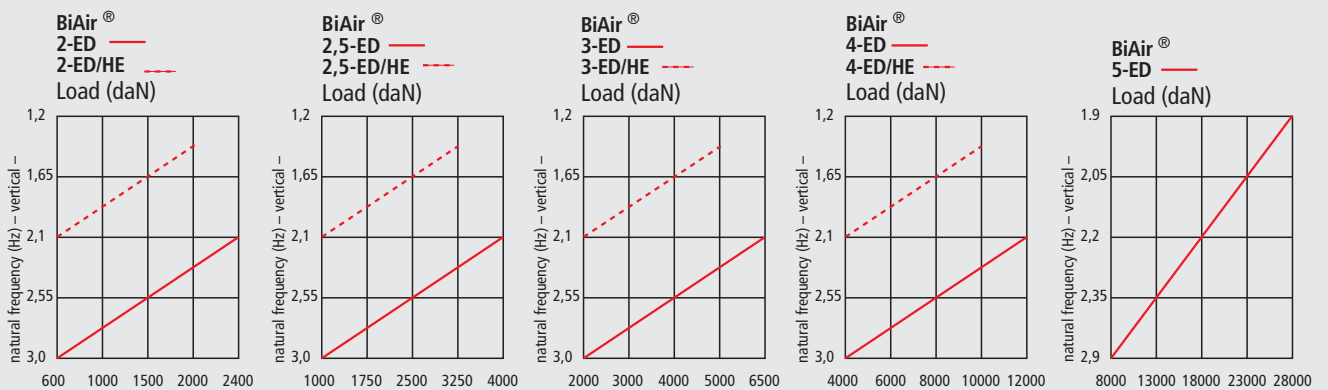
Control circuit

The circuit consists of at least three air springs. If more air springs are needed for structural or loading reasons, the system must always include 3 position pickups, e.g. three controlled components in order to avoid statical overdefinition. This is achieved by connecting sets of air springs in parallel.

BILZ level controller systems

Level control is an important part of an optimally functioning air spring system. The automatic level controller can be utilized to overcome the problem associated with load changes in air-spring insulated machines, which can result in tilting of the machine.

The height of the specific elements **BiAir®** or **FAEBI®** can be controlled by changing the air pressure in the air-spring insulators. Quick inflation or deflation will hold the machines level even if their center of gravity keeps changing.



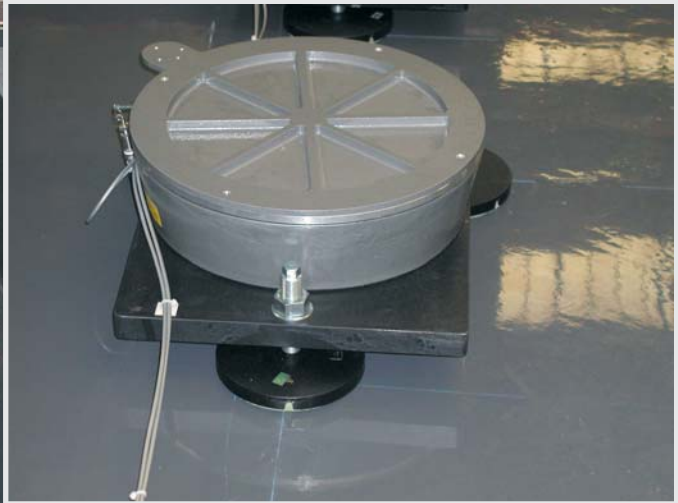
Example: Grinding machine Type GLEASON PFAUDER P 1200 G

Equipment:

Vibration isolated Inertia Block app. 20 to. On Bilz Membrane –
Airspring
System BiAir4 – ED with mechanic pneumatic level control system
MPN-LCV-HF

Special request:

Because of surrounding machines, crane runaway etc. installation of an isolation system is difficult. Workpieces with app. 10 to. Creates a large change in loading on the isolation system. To compensate this, a high flow level control system with level accuracy of 0,1 mm is needed.





Measurement-technological vibration analysis

Tasks

The measurement-technological coverage of oscillation emissions e.g. immissions as a basis for vibration technological measurement to observe legally laid down limit values (see graph 1).

As can be seen from graph 2, different limit values must be observed, depending on the location of the machine. This standard aims at laying down principles according to which mechanical shocks can be measured in buildings, enabling the determination of effects of vibrations on human beings and building construction.

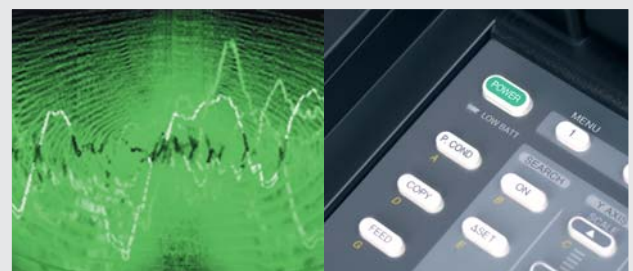
Another relevant example for the necessity of a vibration analysis is the mounting of high-precision coordinate measuring machines as well as of other testing, measuring or grinding machines. As a rule, measurement-tests must be carried out on proposed locations for such machines to ensure that local ground oscillations do not exceed permissible values.

To this end oscillation accelerations within a given frequency spectrum (1–100 Hz) are taken down, because a simple summation value measurement would give only an approximate indication of the exact environmental conditions. The evaluation of the power-path signals takes place with a Fast Fourier analyser, indicating the measured value for each frequency of the spectrum (vibration acceleration in g). Should the interferences (vibration magnitude) be outside the admissible range, a suitable insulation can be worked out with the assistance of our computer calculation programs.

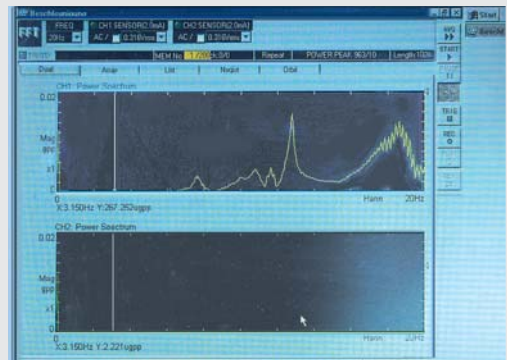
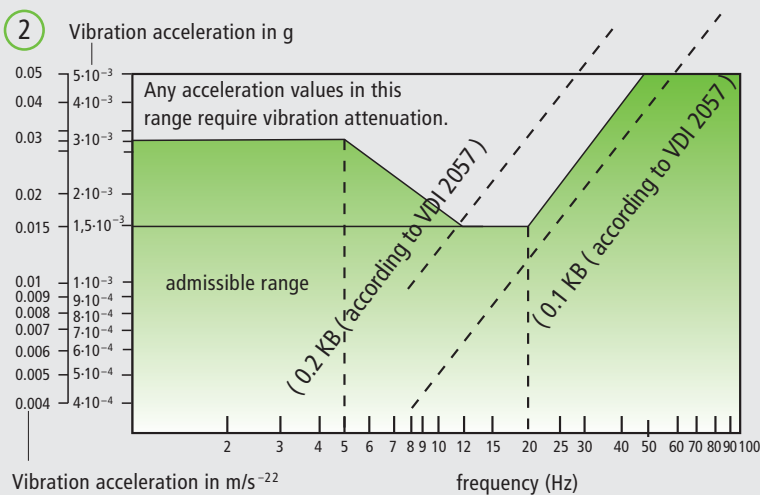
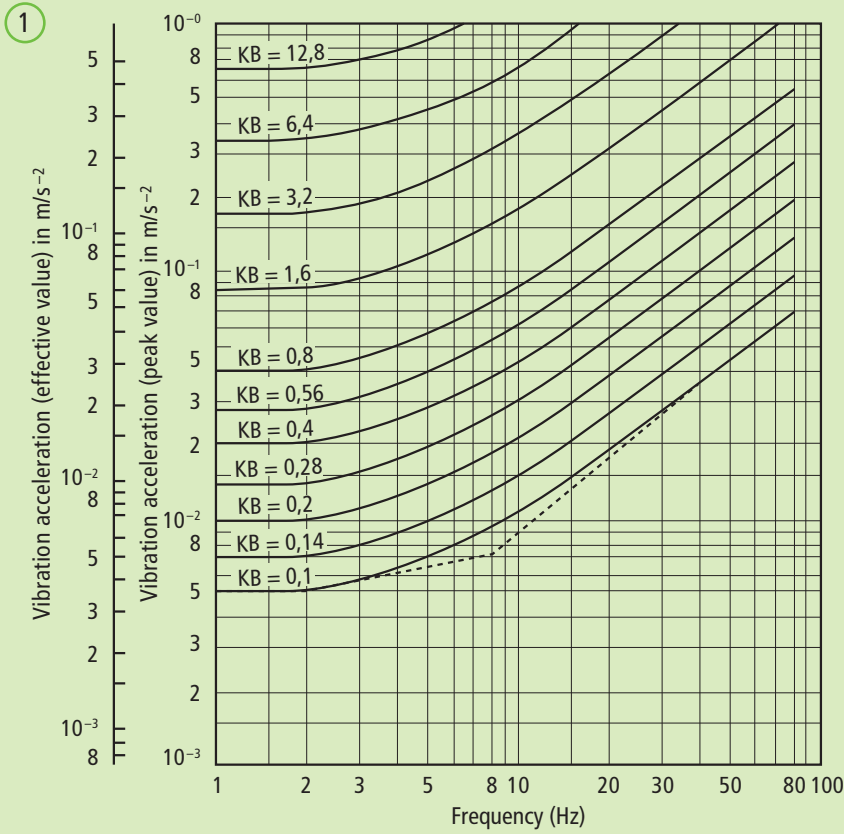
Very accurate and sensitive vibration analyses at low frequencies are carried out with a high-tec Geophone. With the Geophone it is possible to measure vibration amplitudes from $0,01 \mu\text{m/s}$ at frequencies from 0,2 to 30 Hz. Especially in the nano-tec and semiconductor industry as well as in the field of cutting edge 3D metrology absolute accurate vibration measurements is of great importance to achieve optimal and customer specific vibration isolation.



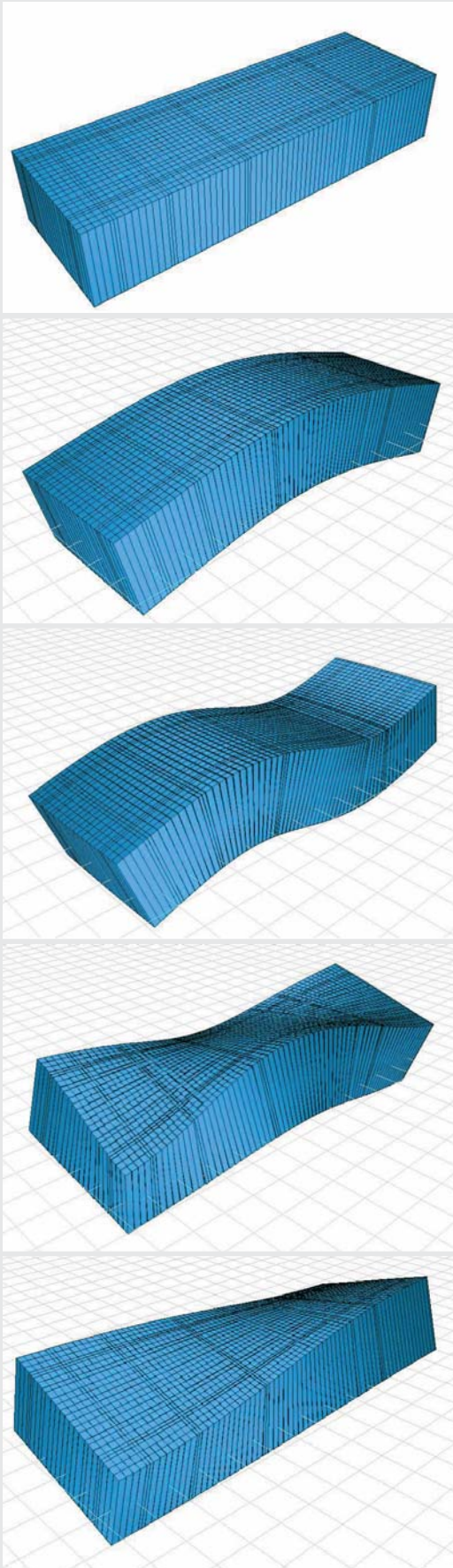
BILZ test bench (1600 Newton X-Y-Z Shaker)



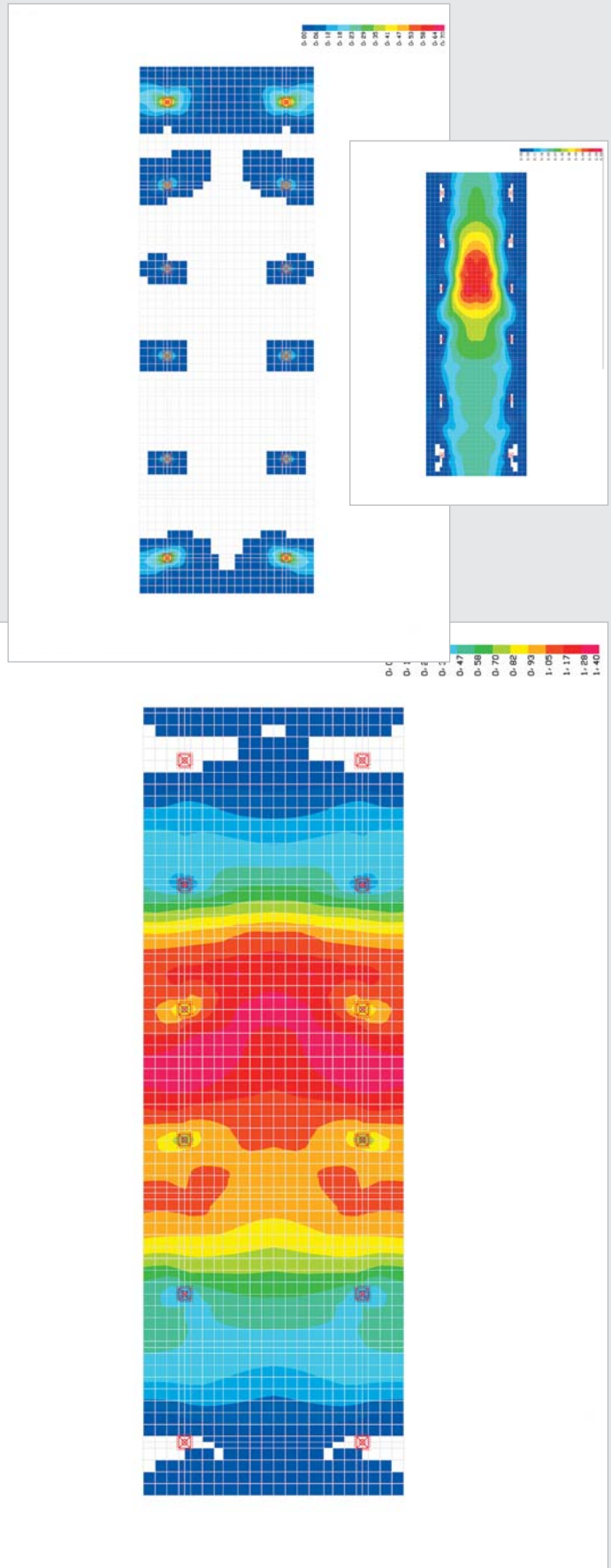
Measurements of vibration and mechanical shocks. We use the most modern measurement equipment (FFT-Analyser + PC calculation programs). Our decades of experience in the field of vibration technology guarantees technically and economically reliable solutions for your problems.



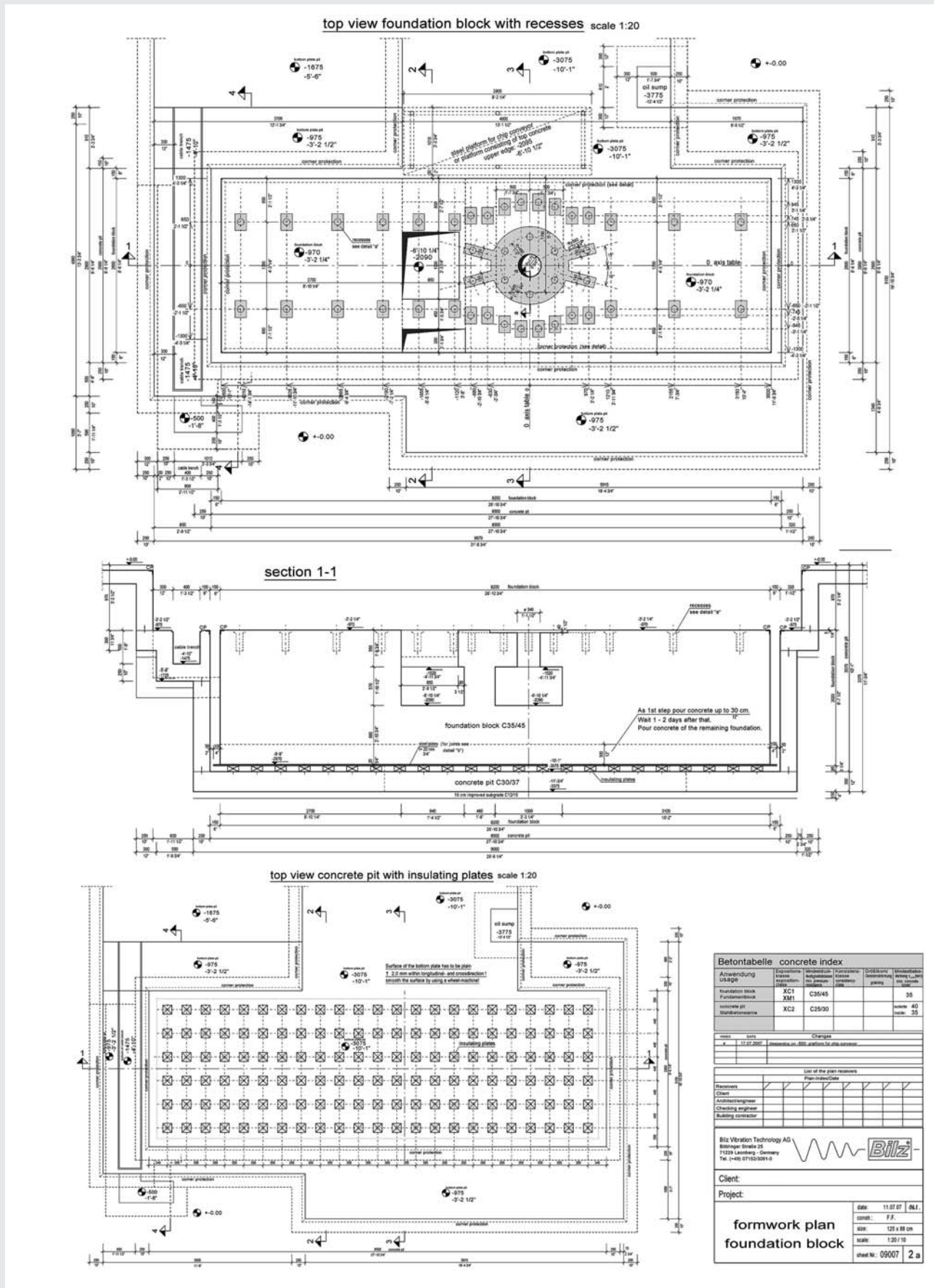
Example: FEM representation of Foundation Block / natural forms

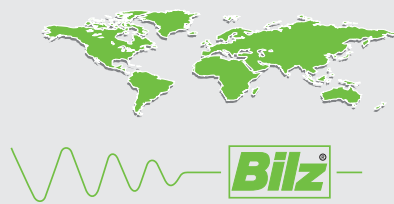


Example: FEM representation. Bend reinforcement in nodal points.



Example: construction plan for foundation isolation with insulation plate sets





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