

# Vibration reduction at industrial machinery

VICODA Your global partner for vibration and bearing technology



structural engineering and bridge construction sectors.

The comprehensive range of products, consisting of spring elements, dampers, structural and bridge bearings as well as the global positioning of the group of companies are the basis to develop and provide efficient on site advice and the optimum and individual solution for the client.





VIBRATION REDUCTION SUPPORTING ACCORDING TO SPECIFICATIONS VIBRATION CONTROL INNOVATIVE TECHNOLOGIES COMPREHENSIVE RANGE OF PRODUCTS OPTIMUM, TAILORED SOLUTIONS INTERNATIONAL STANDARDS COMPREHENSIVE MANUFACTURING EXPERTISE INDEPENDENT QUALITY MANAGEMENT ١Q١ Ρ )BA G HIGH EFFICIENCY

The VICODA group of companies does not only focus on one product technology but incorporates all important manufacturing and engineering methods within the group

for the damping, limitation or isolation of unwanted vibrations.

#### Engineering and service

## Vibration control at industrial machinery

#### From the problem analysis ...

To secure the ideal solution for a vibration problem a detailed engineering evaluation is necessary. As well as general consulting, VICODA offers the on-site measurement of vibrations through which the type and cause can be determined.

#### ... to the definition of the solution and manufacturing of the products ...

The core competence of VICODA lies in the conceptual and detailed design of protective measures mitigating vibrations. Complex, static design calculations customized installation manuals and product manufacture complete our performance package.

#### ... the installation and commissioning and ...

In addition to the provision of the necessary hardware, VICODA offers expert installation supervision or a complete installation service. Experienced engineers are available for the commissioning of all VICODA products performing on site result monitoring and final adjustments if necessary. Installation report, confirming "as built" characteristics, can be provided on request.

#### ... the continuous control of operations.

The permissible range of operation of an industrial plant can be efficiently controlled through a monitoring system. For this purpose the applied products will be supplied with a corresponding sensor technology. This ensures early recognition of any change or damage to the system. Consequently service and maintenance programs can be planned and implemented based on the actual condition of the system.



Analysis



Solution finding process



Product delivery



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WORKFLOW







### CONTINUOUS DEVELOPMENT OF TOP QUALITY SERVICES AND PRODUCTS



#### Quality management

### Technological expertise and product quality a constant focus

#### Further development of innovative techniques

The continuous development of the product range is the essence of the VICODA corporate philosophy. This is ensured through a close collaboration with universities, design consultants, end users and the commitment of the VICODA experts in national and international committees.

#### In house testing expertise

Order related verifications or testing of new product developments can be performed in our own test laboratory. This is continuously enhanced according to developments in technical requirements. This asset ensures that functionally tests and material verifications can be rapidly completed.

#### Quality management in accordance with international standards

The global market requires compliance with a variety of different standards. This has been recognized in the development of the quality management system, thus ensuring that the appropriate documentation is always readily available.

The VICODA quality management system incorporates recognized procedures which comply with the quality requirements of the following established standards and technical codes:

- DIN EN (EU)
- VGB and KTA (DE)
- RCC-M (FR)
- MSS, ASME and ANSI (US)
- MITI and JEAG (JP)
- SPIR-0 2008 (RU)
- DIN EN ISO 9001
- ASME III Div. I Subs. NVA + NF
- KTA 1401
- RCCM-H

Comprehensive technical documentations can be provided upon request, e.g.:

- Certificates of compliance according to EN 10204-2.1
- Material documentations according to EN 10204-2.2
- Inspection certificates according to EN 10204-3.1/3.2
- Certificates of conformity
- Load calibration certificates





Industrial machinery

## Industrial machinery produces vibrations and structure-borne noise

During the operation of industrial machinery vibrations can occur. They may disturb surrounding machines, the environment and have harmful effects on personnel.

Consequently, it is important for the machine manufacturer and the plant operator to make due consideration at the design stage. Occupational safety, emission protection & the efficiency of operation are all factors that can be influenced in a positive manner.



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#### Vibrations

When considering the significant numbers of machines and industrial applications, a targeted approach to vibration reduction considering the specific case is most appropriate. Whereas some machines emit vibrations, others are sensitive towards vibrations from the surrounding areas.

Typical vibration sources are e.g. forging hammers, metal forming presses, rock crushers and diesel generators. Particularly sensitive to vibrations are e.g. high precision machine tools or measuring devices. A combination of a vibration source and a recipient can typically be found in a machine shop. Some machines, with their characteristic vibration excitation and damage symptoms are described in the following examples.



#### ... by forging hammers

With forging hammers the forming energy is mostly imparted by the hammer falling off onto the workpiece. They can be distinguished into drop hammers, double acting hammers and counterblow hammers. With drop hammers the forming energy is the result of the mass of the hammer and the height of fall. Double-acting hammers achieve higher forming energies and impact velocities through an extra acceleration of the hammer. With counterblow hammers the hammer is paired kinematically or hydraulically with the lower hammer and the impact velocities increase as well. What they all have in common is a primarily vertical shock excitation or shock sequence. Distinctive are the deformation stokes as well as the final rebound impact, with which there is no further deformation of the workpiece and the whole impact energy is transferred to the foundation.

#### ... by forming presses

Forming presses can be divided by the functional principle and the excitation. In hydraulic presses a vertical, impulsive deformation force is provided by the hydraulic medium and the inertia of the ram. With crank, eccentric and screw presses the movement of the ram is given through a gear. The deformation energy is often provided by a flywheel, which is engaged in the deformation process and decelerated through that. In modern servo presses flywheels may partly be dispensed and the ram movement is freely programmable.

Superimposed impact force and torque excitations are typical for presses. The resulting vibrations can lead to an overstress of the foundation. In addition to vertical vibrations, tiliting and rotation can also occur.

Dynamic decoupling of heavy duty machines



Reducing vibration emissions from forging hammers and forming presses

Vibration sources







#### Vibration sources

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#### ... by gas and diesel generators

Gas and diesel generators are often used as a local energy provider. They consist of an engine and a generator for the power generation, typically positioned on a structural framework. Vibrations occur e.g. through unbalance forces or through a generator short circuit as a fault load condition. Diesel generators are often used for emergency backup in hospitals or in the maritime sector on ships, where high requirements are placed on vibration protection and structureborne sound isolation. For these cases a vibration isolated support is common. Diesel generators are often located in seismic active regions and have to be fully functional after an earthquake.



#### ... by testing machines

Dynamic testing machines like resonance and hydro pulsers or an unbalance exciter are e.g. used for fatigue strength testing of components and can produce large harmonic loads in a predefined frequency. Hydro pulsers can also generate shock type or random exciting forces through the hydraulic control. Vibrations can spread, with a firm foundation, through the subsoil into neighboring buildings.

#### ... at high precision-manufacturing machines

High precision and finishing machine tools need to be protected from vibrations from the surroundings in order to maintain the component tolerance and the surface quality e.g. in a pressing plant or with the installation on a floor slab.

#### ... at measuring machines

Multi-coordinate-measuring machines clearly react more sensitive to outside vibrations. In such highly sensitive scenarios vibrations from the surroundings need to be reduced by means of elastic supports.

#### ... in machine shops

In machine shops a number of machines work together, often in a row or arranged parallel to each other. Critically, they may exhibit the same excitation frequency. For example, the operation of a transfer press line can lead to unwanted vibrations, when all presses work on the same cycle. The vibrations in such a case can intensify (beat). Further examples are deep drawing presses, used for the production of beverage cans working synchronously with a high throughput or machine centers, cutting many identical parts. A vibration analysis is recommended especially with the setup of several similar machines on a floor slab because the floor slab together with the machine forms an oscillatory system.

#### ... by centrifuges

Centrifuges are mostly used to separate liquids from solid substances, using the principle of centrifugal forces. Thereby high rotational speeds generate high centrifugal forces. Vibrations occur when, through an unequal distribution of the centrifugation material, the rotor is operated with imbalance. These imbalances are intensified through settlement effects. The unbalance forces can lead to bearing damage in the centrifuge or even rotor failure.

#### ... by crushers

Crushers can be e.g. crushers for the coarse grinding and mills for the fine grinding. Crushers and mills are often used to process stone, coal or similar goods. There are many types of crushers; e.g. cone crushers, roller crushers, impact crushers and hammer crushers. Whereas cone crushers and roller crushers work according to the principle of pressure crushing, working typically with low rotational speed, impact crushers and hammer crushers generate high velocities of the crushed material respectively of the tool. Mills intermediately shred the ground material and can be carried out e.g. as a roller mill or a disc mill. Excitation forces with crushers and mills are random and shock type excitations. The vibrations lead to severe abrasion of the bearing and potentially to damages of the foundation.



Optimized solutions for various load cases

Significant vibration isolation of engines and generators





### The solution: vibration isolation of industrial machinery

The transfer of the dynamic loads into the foundation is reduced to a high extent through vibration isolation, so that less vibrations are transferred to the surroundings and damages, such as cracks in the foundation and bearing damages can be avoided. This is suitable for source isolation of heavy machinery, which emit vibrations, as well as for the recipient isolation of sensitive manufacturing and measuring machines. Depending on the applications, additional damping should be provided. The choice of the damping is of particular interest since this has a direct influence on the isolation effect.

#### A comprehensive product program for vibration isolation and damping

In general spring elements are used for vibration isolation of machinery. Specific series are available for a variety of different scenarios. These are adjusted, manufactured and delivered according to the specific requirements. For example they are used for the foundation isolation of precision machinery against vibrations from the surroundings.

In many applications the spring elements will be equipped with a viscoelastic damper to sufficiently absorb the vibration energy during the operational processes. By this means, resonances can be avoided and there are no unwanted movements of the machinery. Especially with impact processes (forging hammers and presses), rapid dissipation of the movement is ensured and for example the press comes to a rest before starting the next operation cycle. The natural spring frequency is specifically damped as well to ensure an isolation effect over a wide frequency range. Depending on the application viscoelastic or solid dampers are used. Separate dampers are always used whenever high system damping for specific individual modes or special load cases is necessary.

#### Product parameters

- Wide load range: 1 kN bis 2,700 kN
- Fatigue strength in accordance with EC3
- Low natural frequency (1.0 Hz to 8 Hz) of the system and thereby the highest vibration isolation
- Horizontal spring rates from 20% to 130% of the vertical rate
- Can be prestressed to block so that a replacement is always possible
- Surface coating for corrosion categories up to C5 according to DIN EN ISO 12944
- Individual damping resistance with built-in dampers according to the intended purpose
- Three kinds of viscoelastic medium for different damping and temperature ranges

#### Case study

Vibration isolation of a forming press	
Customer	Gräbener Pressensysteme GmbH & Co. KG
Country Year	Germany 2016
Technical details	Medal press GMP 360 Diameter of the coins 50mm Stroke rate 80 strokes/min Ejector force 50 kN Engine performance 15.9 KW
VICODA solution	4 spring/damping elements Degree of damping > 10% Load capacity max, 130 kN

Achieving the most efficient and cost-effective solutions

Targeted use of damping for high vibration reduction

#### Reference project





#### Case studies

Vibration isolation of a knuckle-joint press

Customer	BSH Hausgeräte GmbH
Country	Germany
Year	2006
Technical details	Press capacity 8000 kN Stroke rate 20-25 strokes/min Total weight approx. 225 t
VICODA solution	4 spring elements Vertical frequency 4.2 Hz Load capacity per spring element 600 kN



#### Vibration isolation of a gas engine

Customer	Kawasaki Heavy Industries, Ltd.
Country	Japan
Year	2016
Technical details	Gas engine and generator on a steel frame m = 106 t
VICODA solution	10 spring elements Degree of damping 11 % Load capacity per spring element max. 147 kN



## Isolation of vibrations through elastomeric bearings

In some applications, where an average isolation effect is sufficient elastomeric bearings are a cost-effective variant to solve a vibration problem. VICODA is using only reinforced elastomeric materials like natural rubber (NR), polychloroprene (CR) and also ethylene propylene diene M-class rubber (EPDM) of the subsidiary company Calenberg Ingenieure GmbH. The weather resistance of the bearings makes a maintenance free installation possible. The high load capacity allows compact bearing dimensions. Other than spring elements elastomeric bearings have always a minimal internal damping, which leads under dynamic stress, unlike spring elements, to a lower stiffening of the material.

Due to that the dynamical stiffness should be taken into account with the dimensioning of the vibration isolation effect. They are used e.g. with an emergency generator of a hospital, which is located in the basement of a building. The internal damping of the elastomer ensures that no inadmissible movements occur with the start of the generator.

#### Product parameters

- Natural frequency > 8 Hz
- Assorted variety of designs
- Mechanical dissipation factor up to 0.2
- Admissible compression up to 15 N/mm<sup>2</sup>
- Dynamical stiffening: c (dyn) / c (stat): 1.2 1.4
- Maintenance-free during the operating life (visual inspection recommended)
- Low creep behavior

#### Case study

#### Vibration isolation of a BHKW module

Customer	Brenner & Sampels GmbH
Country	Germany
Year	2012
Technical details	BHKW module
VICODA solution	Elastic bearing on CIBATUR® Tuning frequency approx. 11 Hz

#### Longer service life of the machines



Safe vibration isolation for sensitive industrial machinery







### Seismic protection - a demanding task

Industrial plants located in earthquake areas require special protective measures, otherwise in case of a seismic event there is the possibility of impairment or even the destruction of the plant and the plant components. For effective protection and to prevent an expensive malfunction of the plant, VICODA has developed a technical solution preventing seismic impacts on the foundation. Customized solutions are designed, manufactured and installed depending on the application.

The advantages of these solutions are:

- A passive, permanent seismic protection
- The durability and an almost maintenance free system
- The effectiveness in all directions in space

#### Reference projects (summary of the reference list)



Spring elements, viscoelastic dampers and elastomeric bearings for vibration isolation

Industrial machinerv

- Roller mill, Poland, 2001, customer: EW Warsaw Heat and Power Station
- Cement mill, Nigeria, 2002, customer: Bilfinger SE
- Fan, Germany, 2005, customer: EVG Lufttechnik GmbH
- Gas cooler, Switzerland, 2008, customer: Calorifer AG
- Gas cooler, China, 2008, customer: Shenyang Blower Works Group Company Ltd. (SBW Group)
- Steam condenser, Switzerland, 2012, customer: Caliqua AG
- Axial fan, Spain, 2015, customer: Howden Group Limited
- Diaphragm compressor, Germany, 2015, customer: SERA GmbH
- Gas engine, Japan, 2016, customer: Kawasaki Heavy Industries, Ltd.
- Fan, Hungary, 2017, customer: thyssenkrupp Industrial Solutions AG

Presses

- Forming press, press capacities: 6,3 10 14 and 20 MN, France, 2005, customer: Schuler Pressen GmbH & Co.KG
- Forming press, press capacity: 20 MN, Brazil, 2007, customer: Schuler Prensas S.A.
- Forming press, press capacity: 16 MN, Brazil, 2009, customer: thyssenkrupp Automotive Systems do Brasil Ltda.
- Forging press, press capacity: 10 MN, Bolivia, 2014, customer: Maxiforja Componentes Automotivos Ltda.
- Excenter press, press capacity: 20 MN, Poland, 2015, customer: Schuler Pressen GmbH
- Transfer line, press capacities: 25 16 and 12 MN, Mexico, 2017, customer: Schuler Prensas S.A.



Efficient safety concepts to resist seismic loads

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