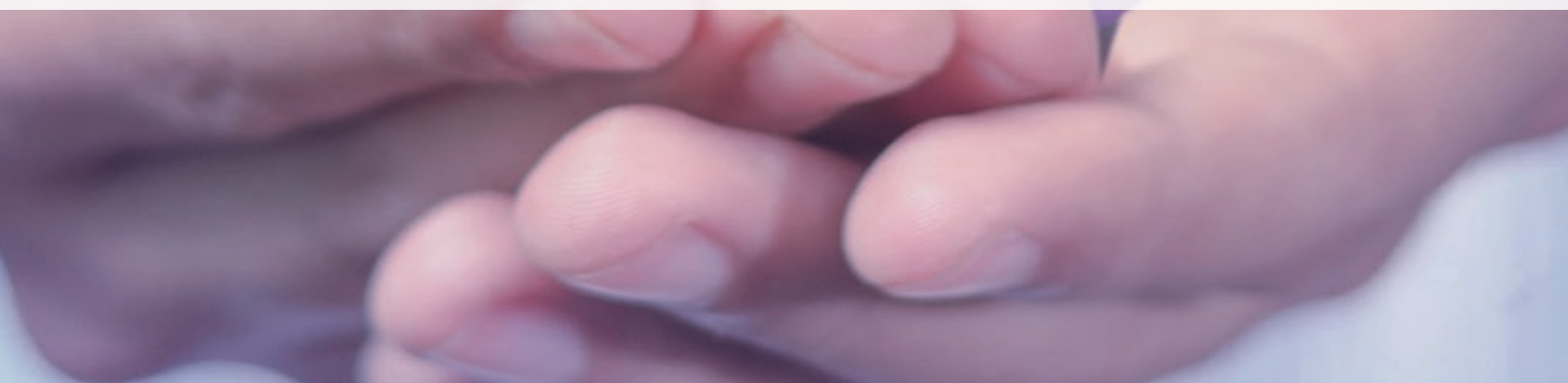




# How and where does the earth quake?

For More Functional and Structural Safety – Seismic Design of Plant Parts and Components by Calculation and Test | Earthquake-resistant Construction | Earthquake Verification According to International Standards | Seismic Monitoring

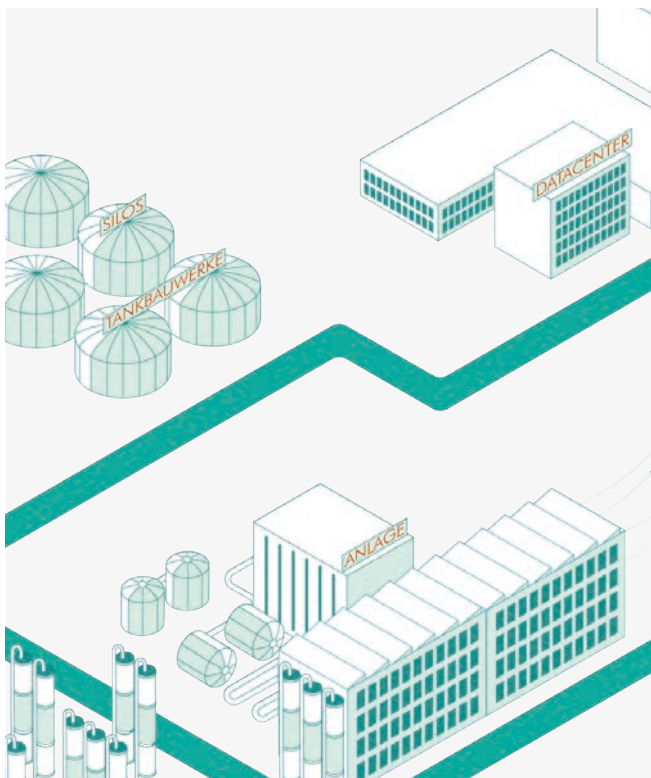




# Earthquake engineering at Wölfel: Earthquake-proof down to the last screw

Approximately 25 percent of global land surface is located in seismically active areas with a ground acceleration of more than 0.1 g, making them significantly vulnerable to earthquakes. Depending on the location, there are different requirements for a standard-compliant earthquake design of buildings, plants, machinery, components and infrastructure.

At Wölfel, we have been dealing with earthquake load cases worldwide for more than 50 years. We offer qualified services in the field of earthquake calculations and verifications, develop customer-specific solutions and conduct high-quality seminars.



## Our service portfolio:

Design of **structures** made of...

- steel
- reinforced concrete
- masonry
- ...

→ Learn more about our range of services in the field of **earthquake-resistant construction** on p. 7



Design of plants and mechanical as well as electrical components, e.g. ...

- tanks
- switch cabinets
- piping
- server cabinets
- turbines
- ...

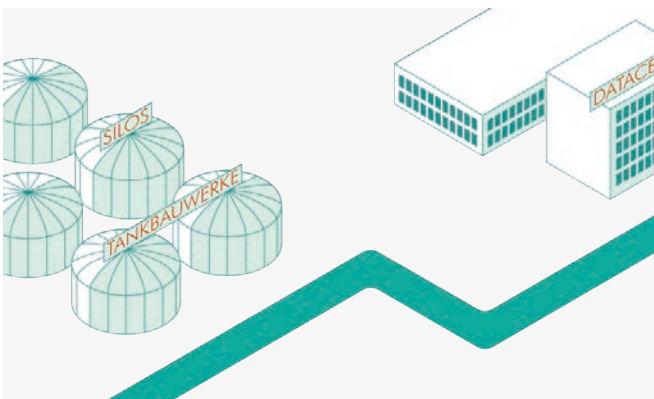
→ Learn more about our range of services in the field of **mechanical and plant engineering** on p. 8



Seismic monitoring of...


- power plants
- nuclear plants
- industrial facilities  
(e.g. chemical, oil & gas, hydrogen, plastics)
- dams
- buildings and other structures
- ...

→ Learn more about our range of services in the field of **Seismic Instrumentation** on p. 10



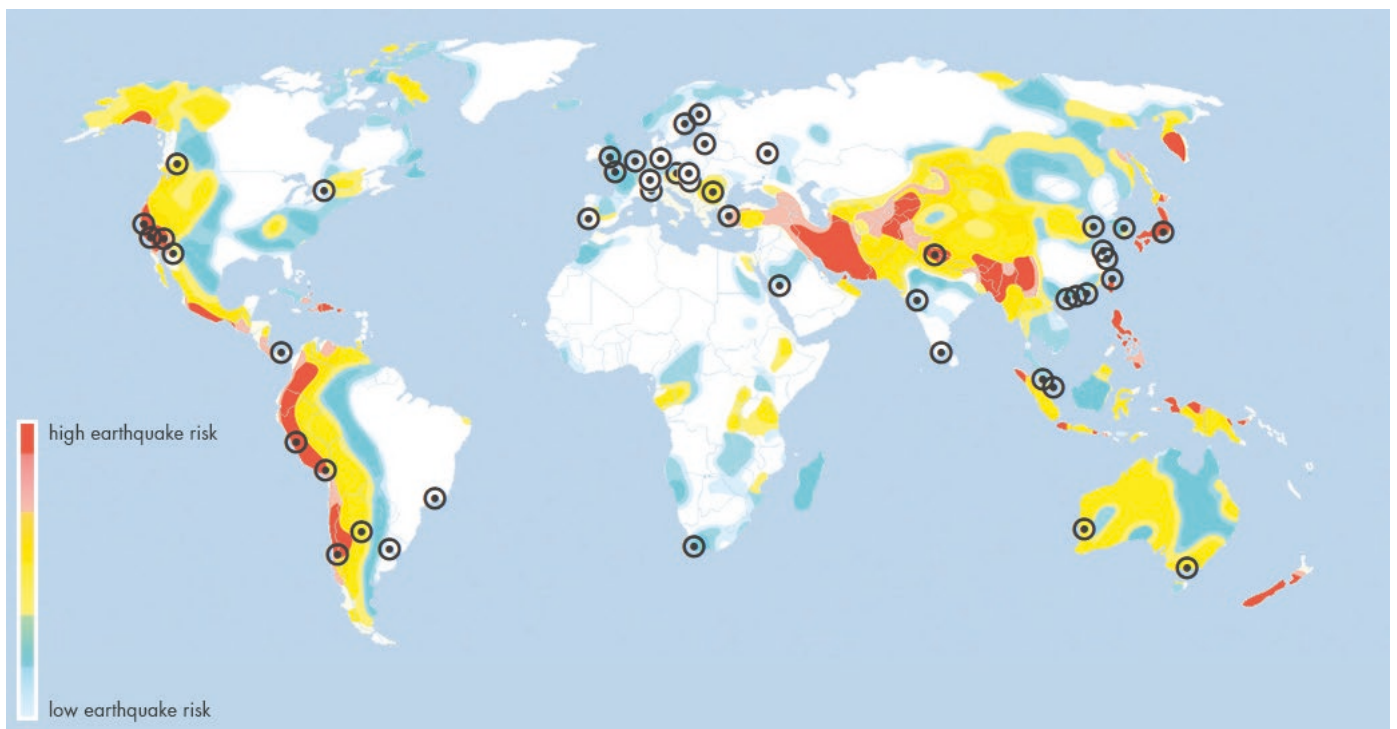


## What makes us earthquake experts – and how you can benefit from it

	<p>We do not only apply the relevant national and international seismic standards in numerous projects. We regularly communicate all new developments worth knowing about in our <b>seminars</b> and contribute our <b>specialized knowledge to standard and regulation committees</b>.</p>
	<p>In more than 50 years, our engineers have successfully completed over <b>1,400 projects</b>. This experience is reflected in our consulting services.</p>
	<p>Thanks to our <b>broad service portfolio</b> – we perform verifications, for example, by calculation, testing or similarity considerations – we can find and implement the optimum solution according to your requirements.</p>
	<p>The central aspect of earthquake engineering is at least the stability of your plant or component, but we also never lose sight of <b>economic efficiency</b>. Therefore, we closely coordinate with your design department and keep an eye on your manufacturing possibilities. This has proven itself in practice.</p>
	<p>In addition to earthquake verifications, we can also support you beyond this, e.g. by <b>training your employees</b> or by <b>providing advice</b> on integrating the load case „earthquake“ into your sales and design process.</p>



## Our projects: Equipped for earthquake load cases worldwide



**50+**  
Years

**1 400+**  
Projects

**200+**  
Customers



**All requirements met: On the safe and economical side with customized services and systems**

Our solutions for conventional as well as nuclear plant construction, which is characterized by higher requirements, are just as individual as your projects. Depending on your demands, we offer a complete package or support you with individual services:

<b>Earthquake verification and seismic design</b>	<b>Earthquake testing and specification</b>	<b>Assessment and retrofitting</b>
<b>Documentation and communication</b>	<b>Earthquake monitoring systems</b>	<b>Seismic switch</b>
<b>Recurring inspection</b>	<b>Consulting</b>	<b>Seminars</b>

→ [Link to the Seminars](#)



## Earthquake-resistant construction – Earthquake design of structural systems

One of the greatest dangers during an earthquake are collapsing buildings. This is precisely why many countries now have numerous standards and guidelines that make earthquake-resistant or earthquake-compliant construction mandatory – to protect people, to minimize damage and to limit any consequential damage.

*Earthquakes don't kill people,  
buildings do.*

From an adaptation of the floor plan to basic insulation to active or passive vibration mitigation using absorbers and dampers: There are numerous concepts to make large and small structures earthquake-resistant in the event of an emergency and to avoid failure of the supporting structure. At Wölfel, we have been dealing with this issue for decades and will provide you with advice on all aspects of earthquake-resistant and earthquake-compliant construction – both for new buildings and for recalculation and retrofitting.

### **In this field we would like to highlight the following services we offer:**

- Preparation and review of specifications on the subject of earthquakes
- Design of structures made of reinforced concrete, steel and masonry for the earthquake load case according to European and international standards such as DIN EN 1998-1 and ASCE 7
- Verification of the load-bearing capacity and serviceability of structures and components made of reinforced concrete, pre-stressed concrete, steel and masonry
- Analyses by means of static or dynamic calculation methods as well as time history calculations
- Design of earthquake protection systems such as seismic isolation, dampers or absorbers





## Standard-compliant earthquake qualification of plant parts and mechanical as well as electrical components

The German mechanical and plant engineering industry sells its products worldwide, increasingly also in seismically active areas. Depending on the product and its classification, and on the (country-specific) regulations, at a minimum the stability of the anchorage of a component under seismic action must be verified. Further requirements may extend to integrity (leak tightness) and functionality (especially for electrical components) during and after the earthquake event.

### Earthquake simulation: Numerical or experimental

Which method is used for verification is determined by numerous factors. Depending on the regulations and requirements, the proof of functionality can be provided, for example numerically using an FE model (earthquake calculation) and/or experimentally by means of a vibration test, as is often required. In the following overview you will find our range of services for mechanical and electrical components – we provide you with advice to develop the optimal verification concept for your specific application in close cooperation.

### Mechanical components

Which mechanical components (e.g., piping, tanks, coolers, LNG-, hydrogen tanks/lines) must be considered as part of the earthquake design depends, in particular, on the overall protection goal for the machine or plant.

Depending on the requirements, the verification can be done by calculation (quasi-static equivalent method, response spectrum method, time history method), experimental methods (earthquake test) and/or alternative methods (similarity, plausibility). Internationally, the ASCE/SEI 7 set of rules is frequently used for mechanical components; for detailed verifications, there are additional component-specific sets of rules.

### In this field we would like to highlight the following services we offer:

- Consulting for the determination of input data, the adaptation of designs as well as for the development of a verification concept
- Consulting with regard to internationally recognized standards
- Design of components for the load case earthquake
- Support in the introduction of a uniform procedure for you and your suppliers
- Support in clarifying customer questions on the subject of earthquakes and in representing you vis-à-vis authorities and TÜV testing bodies





## Electrical components

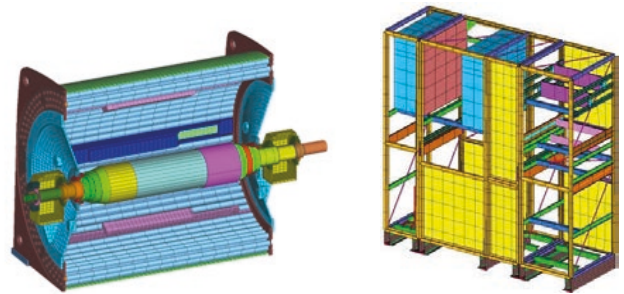


The use of electrical components (e.g. switch cabinets, electric motors, generators, transformers, gas-insulated switchgear (GIS), gas-insulated piping, valves, pumps, ...) may be subject to compliance with country-specific earthquake requirements, both at home and abroad. If this is the case, the seismic safety of the respective components has to be verified according to the local regulations.

### In this field we would like to highlight the following services we offer:

- Advice on the determination of earthquake input data
- Verification by calculation  
(usually FE calculation: linear/non-linear, quasi-static/dynamic with time-history method or RSMA calculation)
- Verification by vibration test  
(uni- or multi-axial, electric or hydraulic vibration table)
- If the boundary conditions allow it:  
Verification by plausibility/similarity considerations  
(lowest time and cost expenditure)
- Advice on design optimization
- Representation vis-à-vis inspectors and authorities
- Creation of customized software for processing/analysis of (earthquake) signals: Time histories, response spectra

In this context, we consider project-specific requirements resulting from (inter)national conventional and nuclear regulations. An overview of the most important standards can be found on our [website](#).



FE models for detailed verification of a motor and a switch cabinet

### Our know-how covers earthquake standards worldwide

In order to be able to offer high quality earthquake engineering for our customers with projects all over the world, we intensively and continuously deal with earthquake standards worldwide. To name a few project examples:

- Control cabinet in Chile (NCh2369)
- Brewery boiler in California (ASCE 7)
- Packaging facility in Australia (AS 1170)
- Nuclear interim storage facility in Germany (KTA 2201)
- Data center in Turkey (DBYBHY 2007)
- Substation in the USA (IEEE 693)
- Switch cabinet in China (IEEE 344)



## Seismic instrumentation and seismic switch – Permanent protection of your plant through earthquake monitoring

If an earthquake hits an industrial facility, a building, a power plant or other infrastructure, it can immediately and reliably be detected by installing seismic instrumentation. This opens up the possibility of initiating protective measures very quickly. If certain limit or design values (e.g. response spectrum) are exceeded, alarms are automatically triggered or entire plant sections are automatically shut down. This reduces or even prevents the occurrence of secondary damage such as explosion, fire and release of substances as well as their consequences.



Seismic instrumentation on a liquid gas plant in explosion-proof design

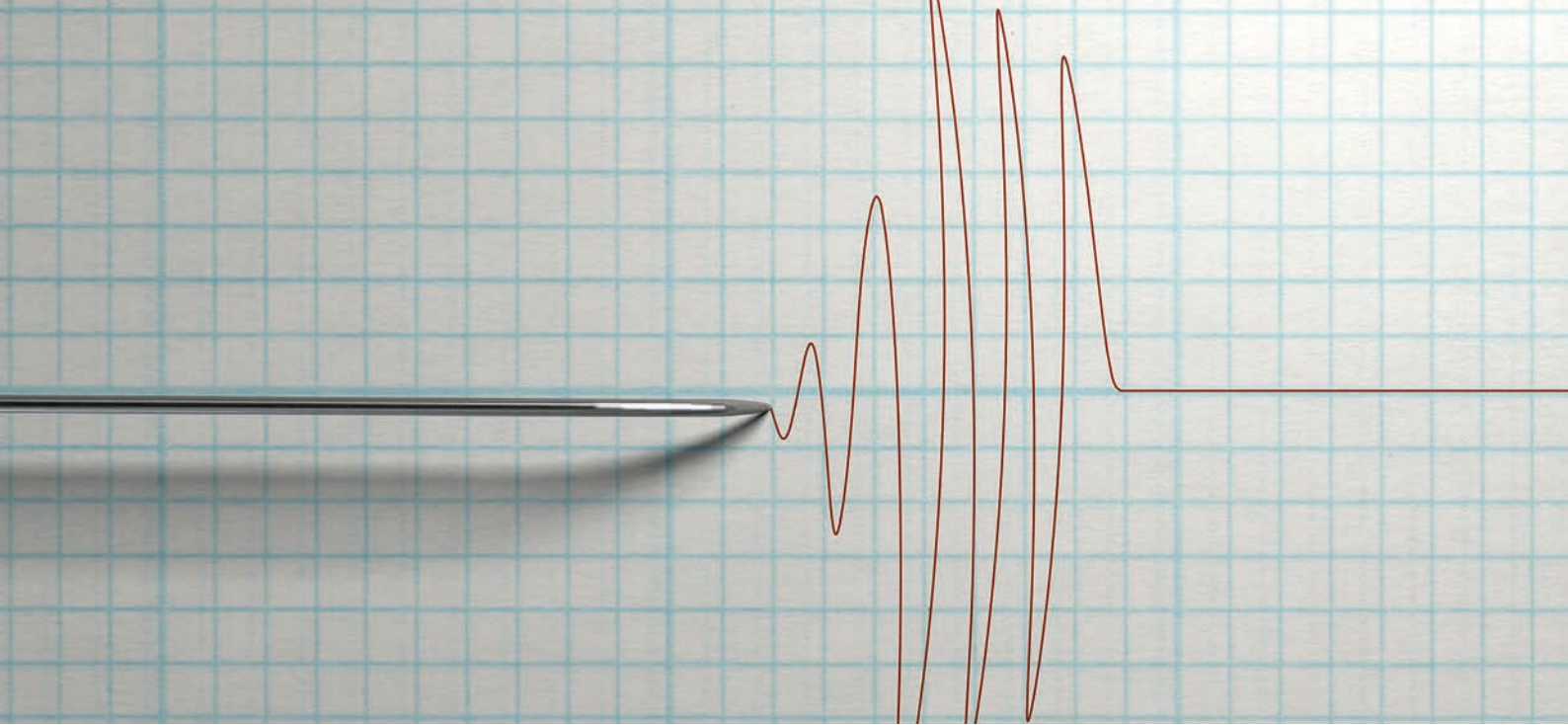
Our portfolio ranges from the so-called „seismic switch“ for monitoring buildings or for shutting down machinery and equipment to certified systems, e.g. for monitoring power plants. We use equipment technology from the renowned Swiss manufacturer SYSCOM.

### Together with SYSCOM, we can demonstrate the following core competencies:

- Instrumentation of power plants
- Instrumentation of nuclear plants
- Instrumentation of industrial facilities with potentially hazardous substances (e.g. chemical, oil & gas, LNG terminals, hydrogen, plastics)
- Instrumentation of dams
- Instrumentation of buildings and other structures

### We accompany the entire process with the following service portfolio:

- „Seismic switch“ for building monitoring or for shutting down machines and plants
- Detailed conception of a seismic instrumentation including possibly required computational verifications and determination of possible measuring points



- Delivery and installation of the seismic instrumentation, if required according to relevant regulations such as KTA 2201, IEC 61508 (SIL 2 and 3), IEC 60780, IEC 61226 (CAT A and C), IEC 61225 or IEC 60880 (CAT A)
- Concepts for exchanging existing (third-party) instrumentation
- Support in the official approval process and in coordination with experts
- Creation of any necessary certificates
- Creation of preliminary test documents and complete project documentation
- Implementation of the factory acceptance test with the participation of an expert
- Installation, commissioning, training, service and system maintenance

### **Safe operation of geothermal plants through seismic instrumentation**

Geothermal energy generation is the extraction of energy from the very high temperatures that exist below the earth's surface in rock layers as well as in underground water reservoirs. It is a renewable way of energy production that does not cause harmful emissions and provides a continuous source of energy.

Geothermal wells can drill deep into the ground and change the stress state underground, which in turn can lead to artificial or induced earthquakes. Through the use of seismic instrumentation, soil and nearby structures are monitored closely. Signs of change can then be detected early and action taken to minimize earthquake-induced risk. It also ensures a safe, efficient operation of geothermal plants.



### **Please contact us personally**

Our earthquake expert Marcus Ries will be happy to advise you on any questions regarding your earthquake engineering project:

**Dr.-Ing. Marcus Ries**

+49 931 49708-370  
ries@woelfel.de



# What moves Wölfel?

Vibrations, structural mechanics and acoustics – this is the Wölfel world. Here we are experts, this world is our home. More than 120 employees daily do their best for complete satisfaction of our customers. For more than five decades we support our customers with engineering services and products for the analysis, prognosis and solution of tasks in the fields of vibrations and noise.

Are vibrations really everywhere? Yes! That's why we need a wide variety of solutions! Whether it is engineering services, products or software – there is a specific Wölfel solution to every vibration or noise problem, for example

- simulation-based seismic design of plants and power stations
- measurement of acoustic emissions of wind turbines
- universal measuring systems for sound and vibrations
- expert reports on noise immission control and air pollution forecasts
- dynamic occupant simulations for the automotive and aviation industry
- and many other industry-specific Wölfel solutions ...

## **Wölfel-Group**

Max-Planck-Straße 15 / 97204 Höchberg

Phone: +49 931 49708 0 / Fax: +49 931 49708 150

info@woelfel.de / [www.woelfel.de](http://www.woelfel.de)

