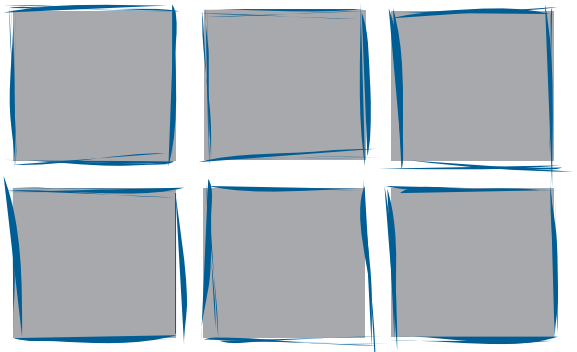

SDA
ENGINEERING

DETAILED FIRM BROCHURE

About us

SDA-engineering GmbH was founded in August 2006 by Prof. Dr.-Ing. Christoph Butenweg and Dr.-Ing. Philippe Renault after many years of collaboration at the Chair of Structural Statics and Dynamics of RWTH Aachen University. The gained experience of the partners during that time still forms the basis of the professional competence and the continuous development of the SDA-engineering GmbH. The main application areas are the execution of static and dynamic analyses in structural engineering, earthquake engineering and the development of innovative software solutions for complex structural problems.

Since 2009 SDA-engineering GmbH is quite active in the working area "Engineering Seismology and Soil dynamics". The collaboration with the „Center for Wind and Earthquake Engineering" guarentees, that SDA-engineering GmbH is always able to apply the most recent design concepts in these application areas. Moreover the employment of Prof. Dr.-Ing. Christoph Butenweg at FH Aachen - University of Applied Sciences enhance the expertise in plant engineering and plant component design.

The leading team of SDA-engineering GmbH was completed in 2010 by Dr.-Ing. Christoph Gellert, a well experienced senior engineer in the field of Structural Dynamics and responsible for project management. The team currently consists of five doctoral civil engineers, two graduate civil engineers and is complemented by a mathematician, responsible for software development and measurement techniques.

Team

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Activities in Code Committees and Associations

The members of the SDA-engineering GmbH are engaged in different committees and associations. The activities expand the expertise of our company and result in close contacts to approving authorities, international research institutions and representatives of code committees.

Furthermore, we are collaborating closely with the Chair of Structural Statics and Dynamics of RWTH Aachen University, where Prof. Dr.-Ing. C. Butenweg was working as Chief Engineer for 15 years, scince he changed to the Faculty of Energy Systems at FH Aachen - University of Applied Sciences. The close coopperation with RWTH Aachen University will be continued within the Center of Wind and Earthquake Engineering (CWE) and teaching assignments.

Activities in commitees and associations (Prof. Dr.-Ing. C. Butenweg)

- Code committee construction engineering NA 005-51-06 AA, Technical committee earthquake, special problems (Preparation of the earthquake codes DIN 4149 and Eurocode 8 with National Annex for Germany)
- Code committee construction engineering NA 005-06-37 AA, Technical committee „Earthquake safety of masonry structures“
- Former President of the German Society of Earthquake Engineering and Structural Dynamics (registered association)
- National contact person of the International Atomic Energy Agency (IAEA)
- Member of the Executive Committee of the European Association of Earthquake Engineering (EAEE)
- Board Member of the Center of Wind and Ewrthquake Engineering (CWE) at RWTH Aachen University

Fields of Activity

Static and Dynamic Analyses

- Structural Design
- Plant Engineering
- Tanks and Vessels
- Machine Foundations
- Masonry Buildings
- Pipeline Construction
- Existing and Historical buildings
- Retaining Structures

Engineering Seismology and Soil Dynamics

- Seismic hazard Assessment
- Soil Dynamics Aanalysis
- Soil-Structure-Interaction

Dynamic Measurements and Vibration Insulation

Probabilistic Analyses and Fragility Curves

Short-Term Dynamic Analyses for Extreme Loading

Software Development

- MINEA
- VLoad
- SVBS
- Easy Silo
- SEISPRO

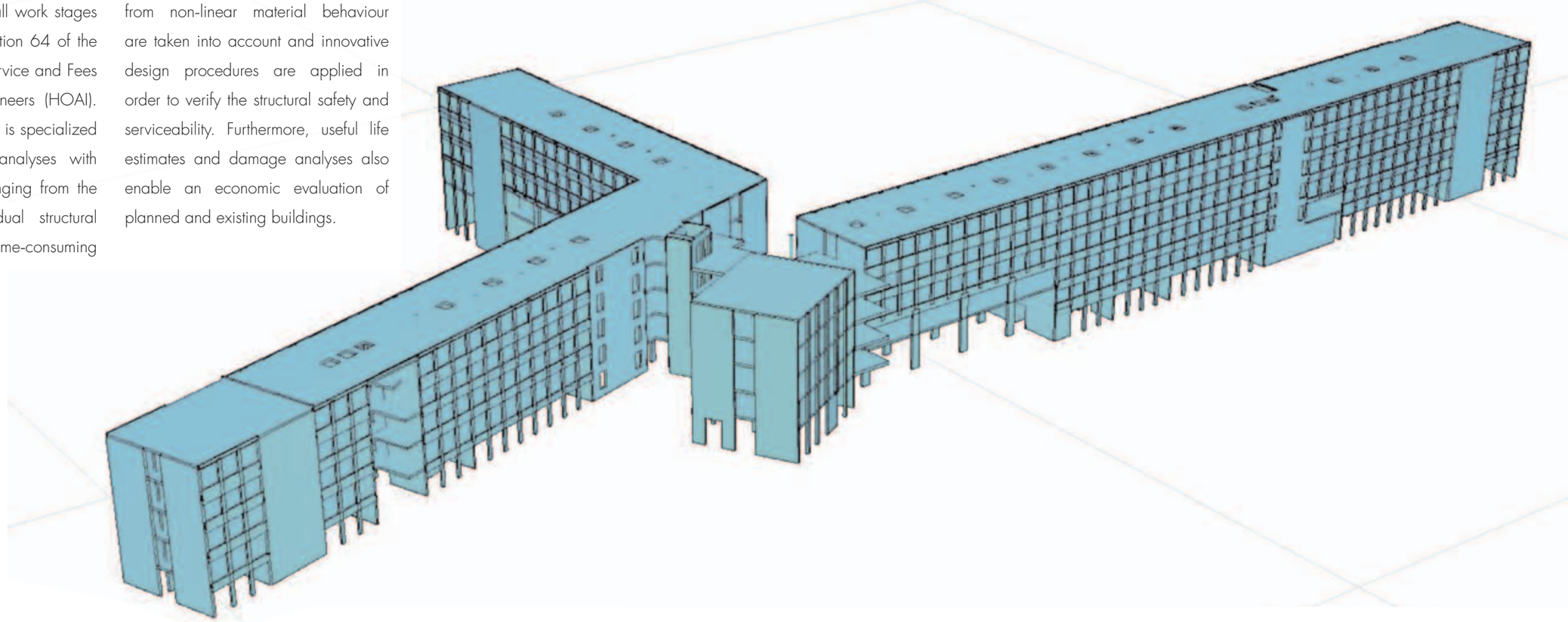
Product Development

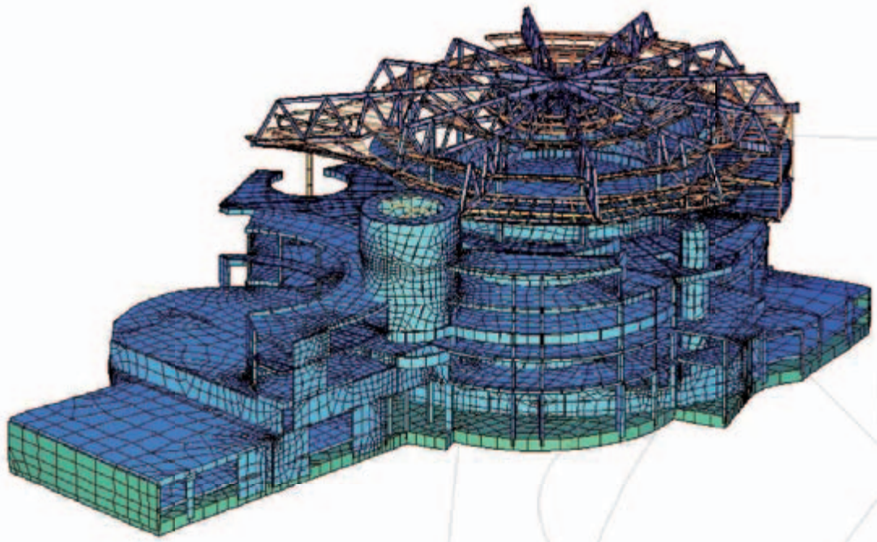
Engineering Expert Reports

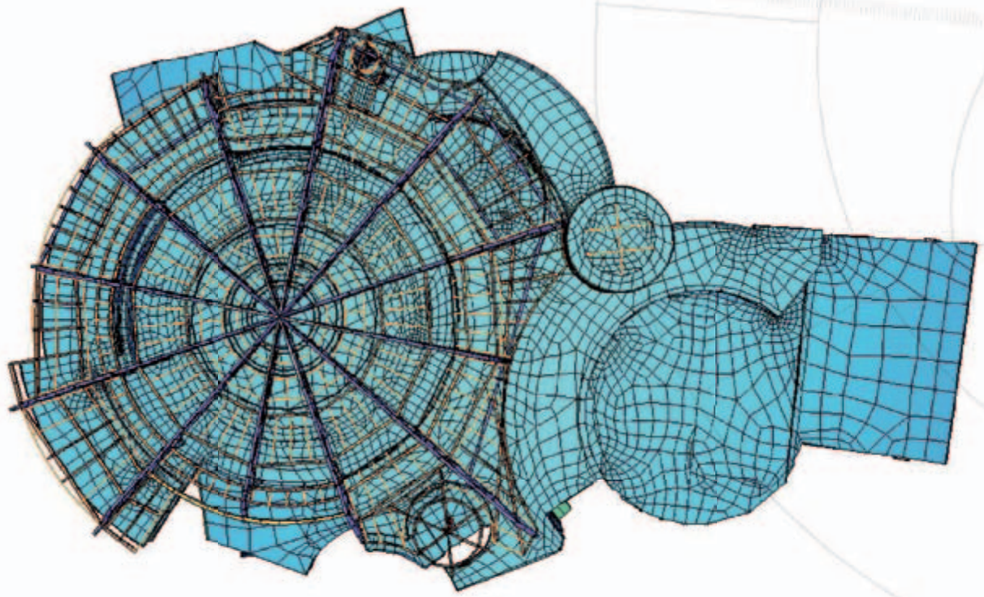
Static and Dynamic Structural Analyses

We conduct structural analyses for all kinds of simple and complex problems and can create calculation models using the entire software range from easy-to-use small software design packages to highly sophisticated finite element programs such as INFOCAD and ANSYS. The main objective is the calculation and structural design of load-bearing structures as the basis for the structural planning that we carry out in cooperation with our partner in Stolberg (El Deib: Engineering Office for Structural Planning) for all work stages in accordance with Section 64 of the German Schedule of Service and Fees for Architects and Engineers (HOAI). SDA-engineering GmbH is specialized in dynamic structural analyses with a scope of services ranging from the investigation of individual structural components to the time-consuming simulation of load-bearing structures subjected to dynamic loads as a result of earthquakes and induced vibrations. One of the core competencies of SDA-engineering GmbH is the earthquake-resistant design of common buildings and special structures of all kinds. We are able to provide you with economical solutions for structures under planning and with upgrading strategies for existing structures conform to European or International Standards. If necessary, load-bearing reserves from non-linear material behaviour are taken into account and innovative design procedures are applied in order to verify the structural safety and serviceability. Furthermore, useful life estimates and damage analyses also enable an economic evaluation of planned and existing buildings.

- STRUCTURAL DESIGN
- PLANT ENGINEERING
- TANKS AND VESSELS
- MACHINE FOUNDATIONS
- MASONRY BUILDINGS
- PIPELINE CONSTRUCTION
- EXISTING AND HISTORICAL BUILDINGS
- RETAINING STRUCTURES







Structural Design

Structural design is offered for all building types, ranging from standard residential buildings to multi-storey buildings. In case of more complex structural systems and geometries, three-dimensional models are applied, which are also necessary for the seismic design of structures. The import of CAD-files into the calculation software ensures an efficient generation of the structural calculation models. The design is accomplished automatically based on the calculation results. INFOCAD and MINEA are the main software packages that are used for the calculations.

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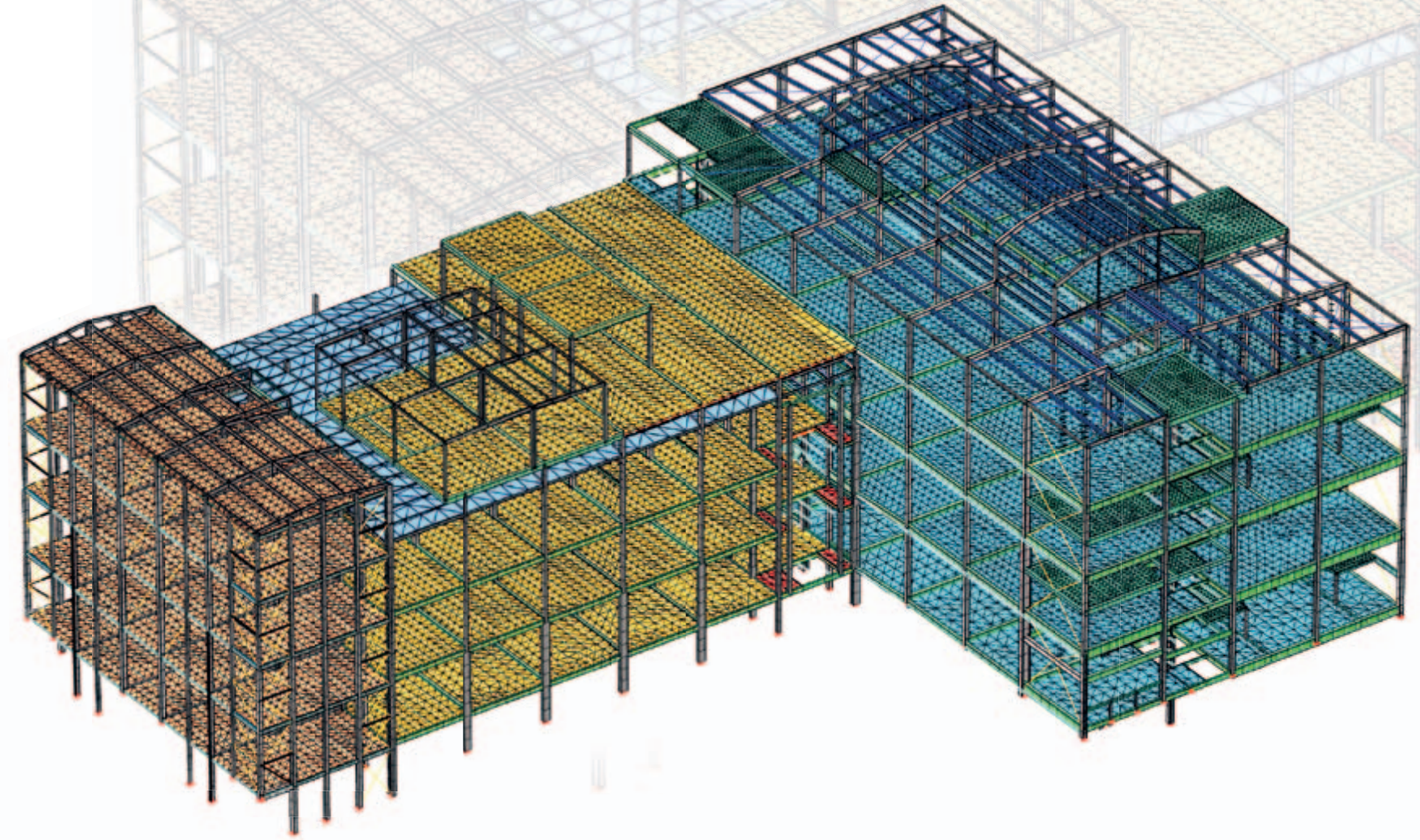
Plant Engineering

Plant engineering is characterized by continuously changing conditions due to modifications of the production processes. In the case of reconstructions, a reassessment of the construction might be necessary taking into account the modified static system of the structure. This represents a major challenge, especially in the question of earthquake safety. SDA-engineering GmbH has many years of experience in the assessment of plants and the estimation of their earthquake safety. SDA-engineering was involved in the compilation of the VCI-Guideline, in which special rules regarding the consideration of earthquake loads in plant engineering are provided. An evaluation procedure for the assessment of earthquake safety of the structural system with respect to the interaction of the plant components and the load-bearing structure was developed and continuously improved in close cooperation with plant engineers. Within the context of a transfer project, financed by the German Science foundation, new approaches for the assessment of the seismic vulnerability of existing plants are compiled by SDA-engineering GmbH in cooperation with RWTH Aachen University and the Chemical Industry. This knowledge is integrated into the further development of the seismic safety evaluation procedure.



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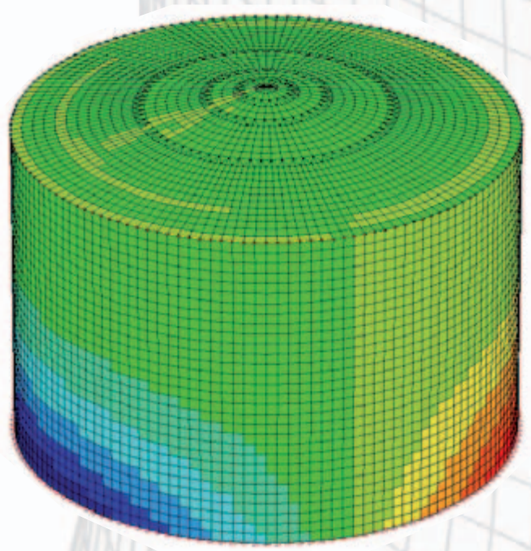

Tanks and Vessels

The analysis of storage tanks and vessels according to national, European and international Standards has been for the last few years an integral part of the activities of SDA-engineering GmbH. With a cost-effective and earthquake resistant design as an objective target, an automated design tool based on a three-dimensional finite-element model has been developed. Soil-structure interaction effects that are particularly important in case of seismic actions are optionally considered within the scope of the model generation. The application of seismic loads is achieved by means of an iterative procedure, according to which equivalent pressure components representing the dynamic behavior of the tank are taken under consideration. Base isolations can be applied in case of high seismicity levels, above which wall thicknesses resulting from conventional design appear uneconomic.

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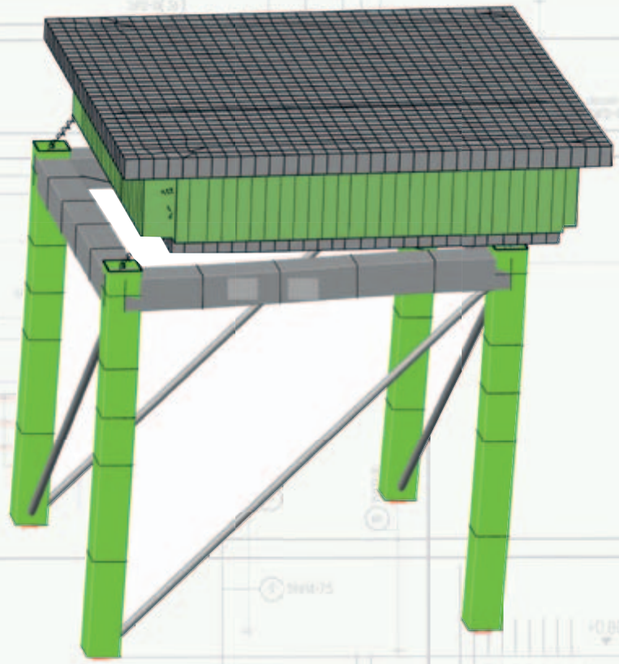

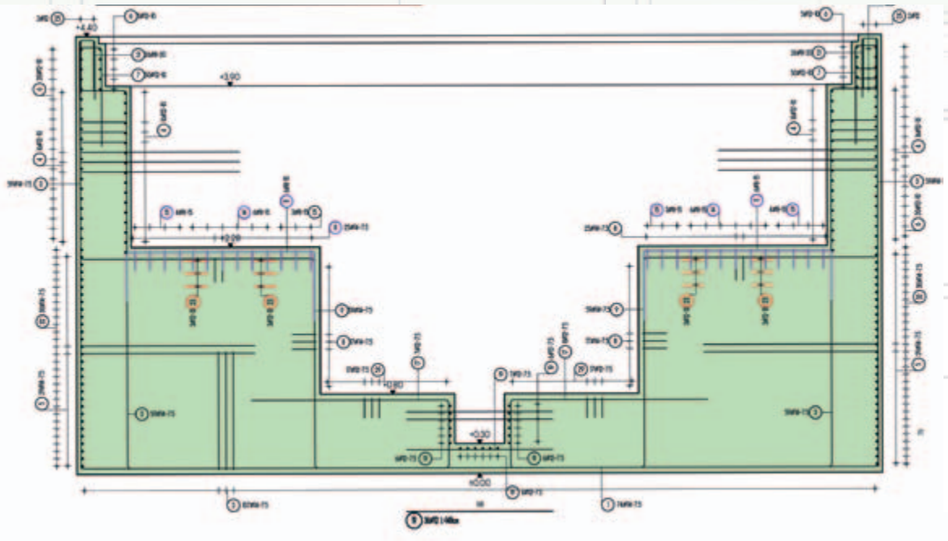

Machine Foundations

Machine foundations have to be designed as vibration resistant in order to ensure the continuous and safe operation of machines. Appropriate design measures securing operational stability under cyclic loading are therefore required. For this purpose, fatigue analysis has to be carried out accordingly. Technical and economic factors necessitate in many cases the application of isolation measures. An ''active isolation'' prevents vibration effects induced by the machine to the surrounding structure, whereas a ''passive isolation'' minimizes disturbance effects induced by the machine to the surrounding structure. A sufficiently designed isolation can generally achieve active as well as passive isolation effects.

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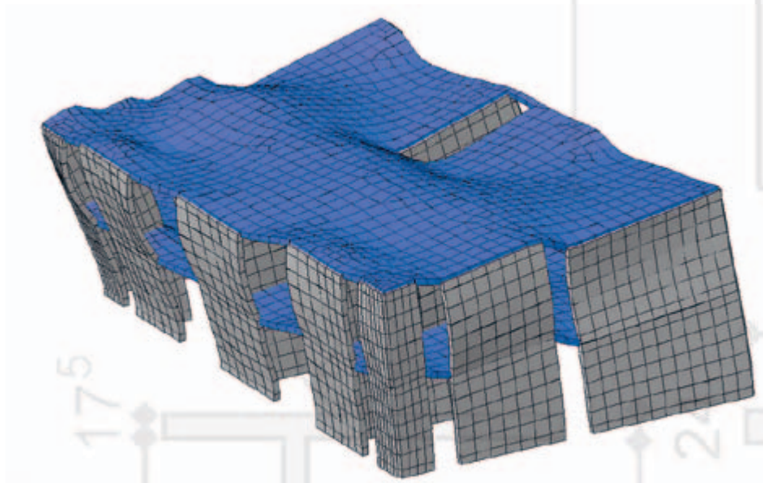
STATIC AND DYNAMIC STRUCTURAL ANALYSES

Masonry Structures

The safety verification of unreinforced masonry structures under horizontal loading due to seismicity or wind is rather complex, if traditional design methods in combination with increased loads as indicated by the new code generation are applied. In doing so, the structural safety cannot be verified even for traditional ground plan configurations, which already have shown their resistance in past events. Therefore, SDA-engineering utilizes nonlinear bearing reserves by using state-of-the-art deformation-based verification procedures considering the nonlinear material behaviour with its post-peak capacity. The procedure is based on the load-deformation curves of single masonry shear walls depending on material combination, wall geometry and vertical loading. The curves are approximated by means of a bilinear idealization using the initial stiffness, the maximum shear capacity and the ultimate drift capacity according to relevant European standards. The approximation is based on results of more than 60 cyclic shear wall tests which were carried out within the framework of European research projects. The deformation-based verification procedure was successfully applied to prototype and real buildings and verified by independent experts and the building authorities in Germany. The application of the innovative verification procedure allows again the realization of complex buildings in earthquake regions satisfying modern architectural demands at the same time.



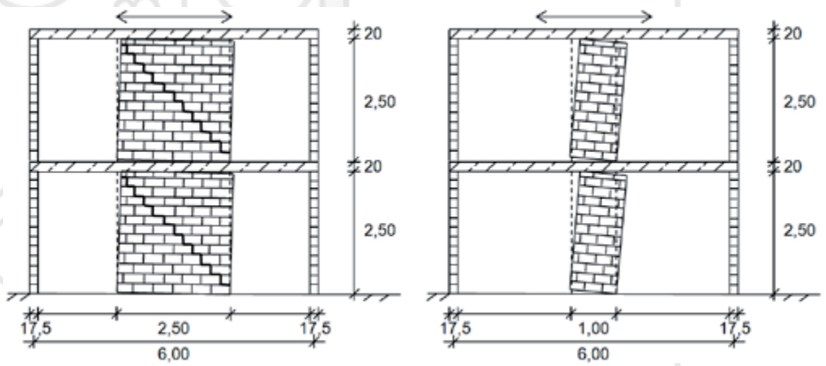



Photo: Wienerberger · Thomas Büsching

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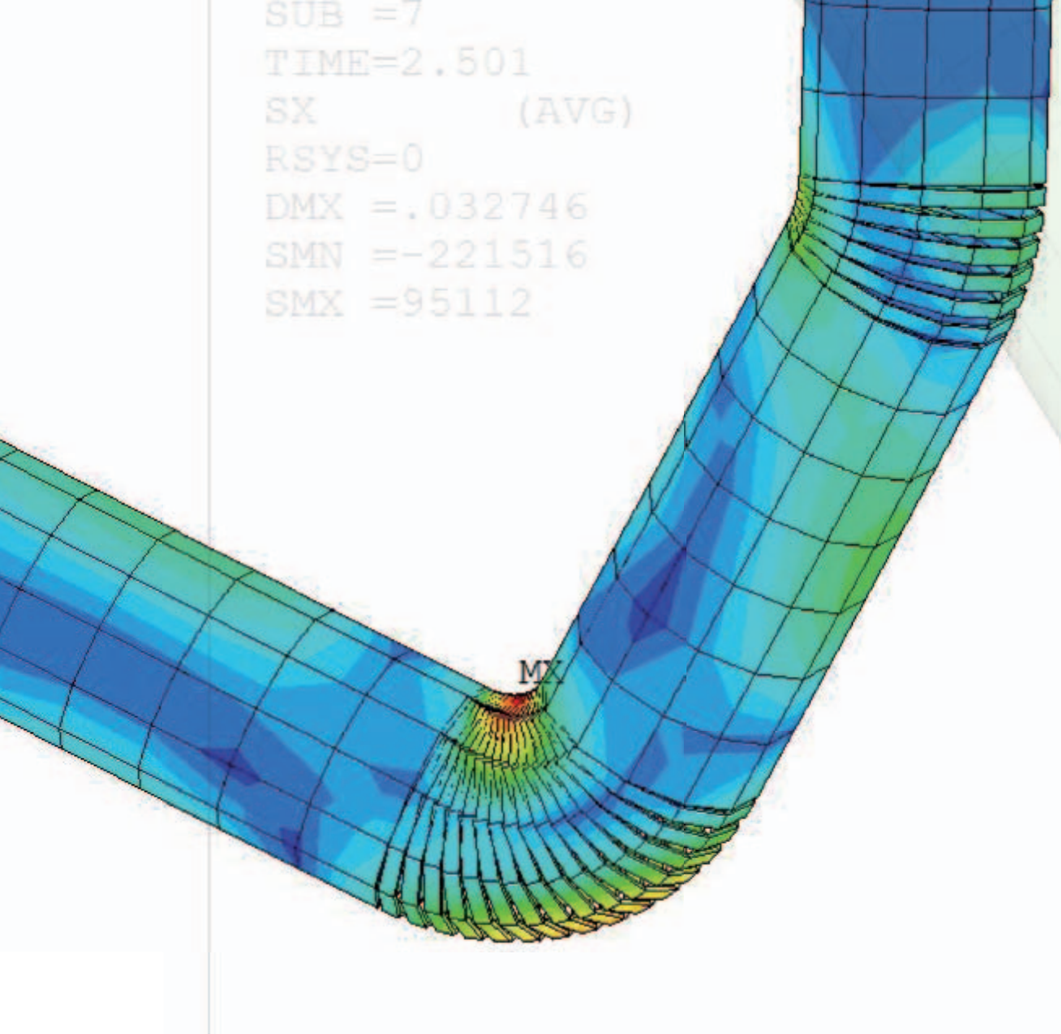

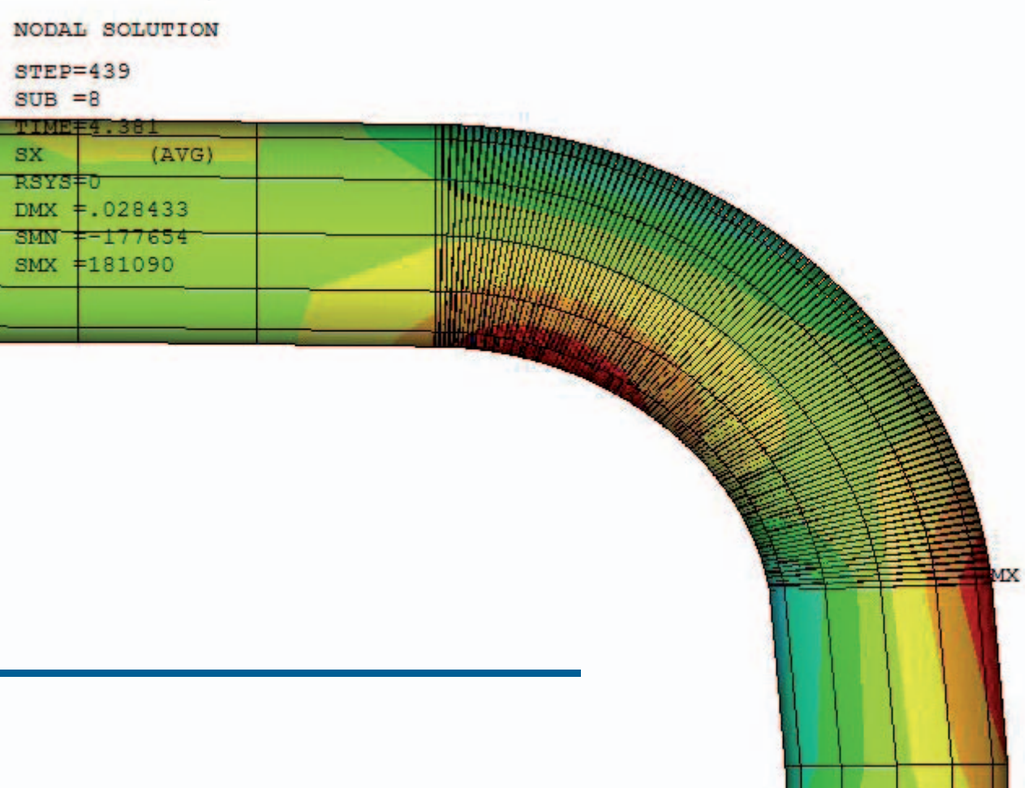

STATIC AND DYNAMIC STRUCTURAL ANALYSES

Pipeline Construction

The analysis of pipelines in industrial facilities is a complex task, because of the interactions with the surrounding structural system. For a sufficient design, these interactions shall be taken into account according to the current codes and guidelines. Furthermore, especially the calculation and design of buried pipelines is a challenging task, as the interaction effects between the pipeline and the surrounding soil plays an important role and is rather difficult to simulate. We solved this problem through the development of sophisticated three-dimensional simulation models, in which the pipeline is represented by nonlinear beam elements and the contact to the surrounding soil is captured by springs with nonlinear empirical load-displacement curves acting in axial, torsional and vertical direction. The seismic ground motion is caused by shear waves, which propagate orthogonally to the propagation direction of the earthquake and exhibit higher amplitudes in comparison to the compression waves. The calculations of pipelines are carried out on the safe side for a horizontally propagating seismic wave with a low wave velocity. SDA-engineering GmbH possesses extensive experience in the calculation of pipelines and will provide you with reliable and economic design solutions. Please contact us for innovative pipeline designs.

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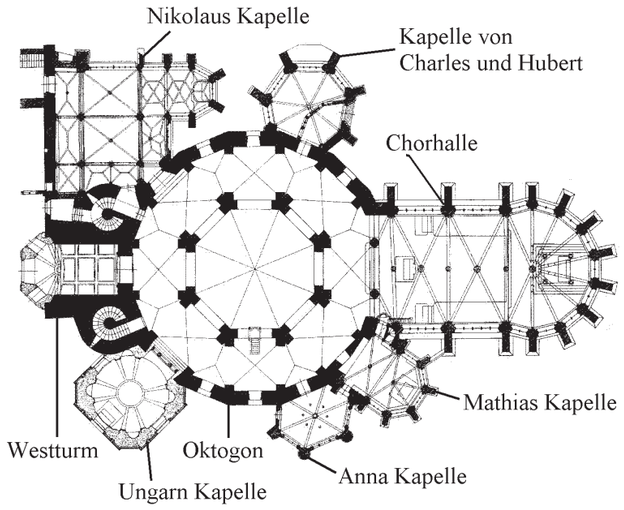

Existing and Historical Buildings

The earthquake safety of existing buildings and famous historical buildings plays an important role for the culture and the society. The verification of the seismic safety requires extensive surveys of existing documents and collection of available data like structural drawings, static calculations and geotechnical reports. Thereafter, a structural analysis with safety factors in dependence on the state of knowledge can be carried out. Extensive experiences were gained during the investigation of the famous and well-known Aachen cathedral, which can be easily transferred to other historical buildings.

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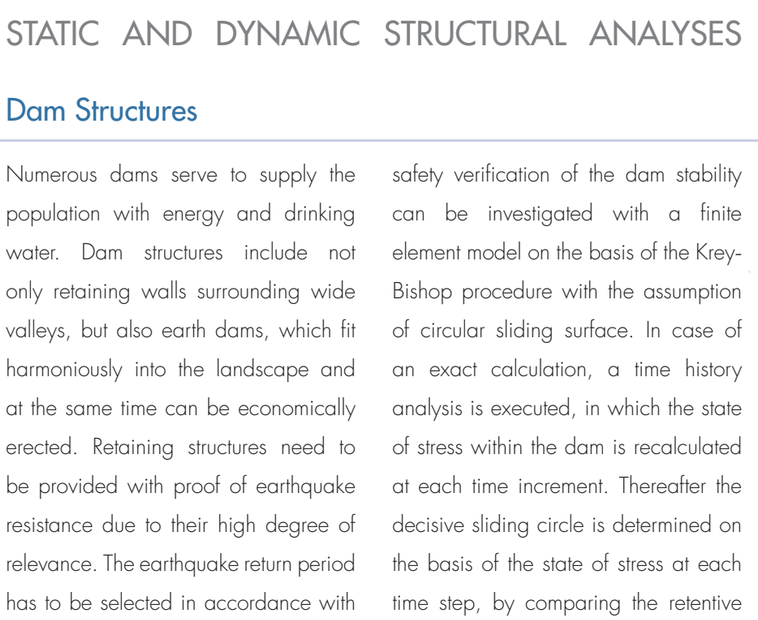
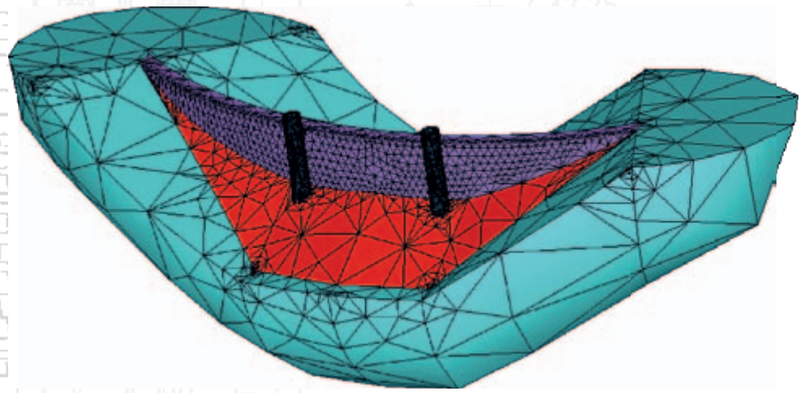
STATIC AND DYNAMIC STRUCTURAL ANALYSES

Dam Structures

Numerous dams serve to supply the population with energy and drinking water. Dam structures include not only retaining walls surrounding wide valleys, but also earth dams, which fit harmoniously into the landscape and at the same time can be economically erected. Retaining structures need to be provided with proof of earthquake resistance due to their high degree of relevance. The earthquake return period has to be selected in accordance with the existing dam structure class. The safety verification of the dam stability can be investigated with a finite element model on the basis of the Krey-Bishop procedure with the assumption of circular sliding surface. In case of an exact calculation, a time history analysis is executed, in which the state of stress within the dam is recalculated at each time increment. Thereafter the decisive sliding circle is determined on the basis of the state of stress at each time step, by comparing the retentive and impulsive forces along the sliding circle. The forces are calculated by integrating the stresses from the finite element model along the regarded sliding circle. Pseudo-static procedures can also be applied as an alternative. When calculating dam structures, one can work with two-dimensional calculation models as long as the curve of the dam wall is only moderate. Otherwise, three-dimensional models need to be taken into account. In some cases, the soil-structure-interactions effects must be considered in order to avoid the occurrence of wave reflection in the models. SDA-engineering GmbH gained extensive experience with safety verification of dam structures in the scope of diverse former projects.





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Engineering Seismology and Soil Dynamics

Earthquakes belong to the most destructive natural disasters. Engineering seismological studies enable the evaluation of site-specific seismic loads (response spectrum, strong motion duration etc.). This is important especially for constructions with higher safety requirements like dams, industrial facilities or nuclear power plants. For the calculation of the earthquake hazard, usually probabilistic analyses are used under a systematic consideration of uncertainties. Upon request, deterministic hazard analyses are conducted as well. For the refinement of the site-specific accelerations soil dynamic calculations are performed. SDA-engineering is working as a technical reviewer in the PEGASOS Refinement Project regarding the seismic hazard assessment of Swiss nuclear power plants and participates in the development of codes and guidelines for nuclear facilities in national and international working groups. The networking with colleagues worldwide and the cooperation with RWTH Aachen University in research projects ensures that the high expertise in this field considers the current state-of-the-art.

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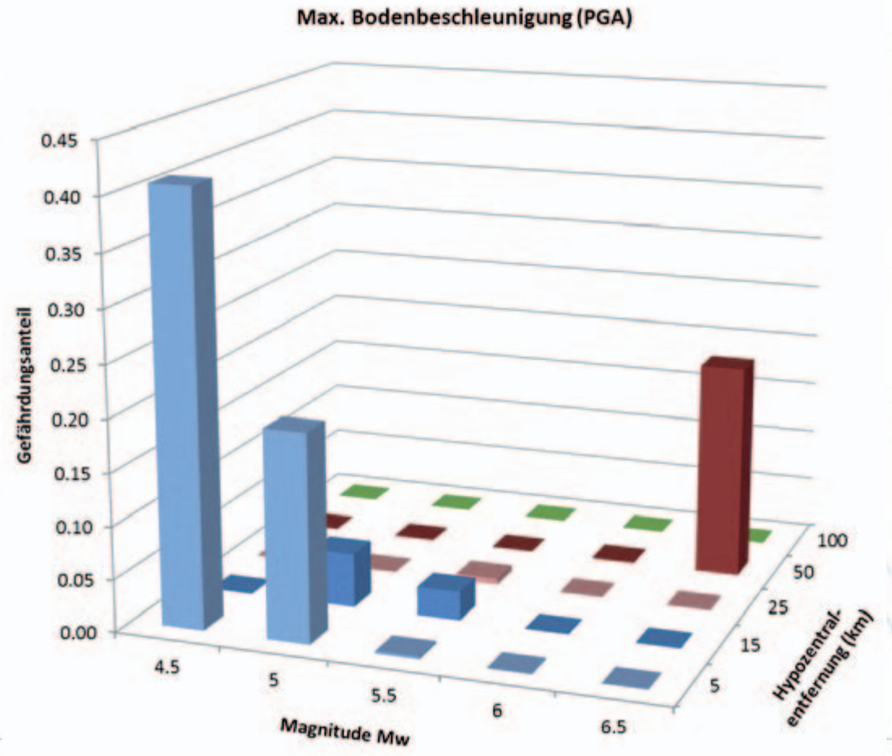
- SEISMIC HAZARD ASSESSMENT
- SOIL DYNAMIC ANALYSES
- SOIL-STRUCTURE-INTERACTION



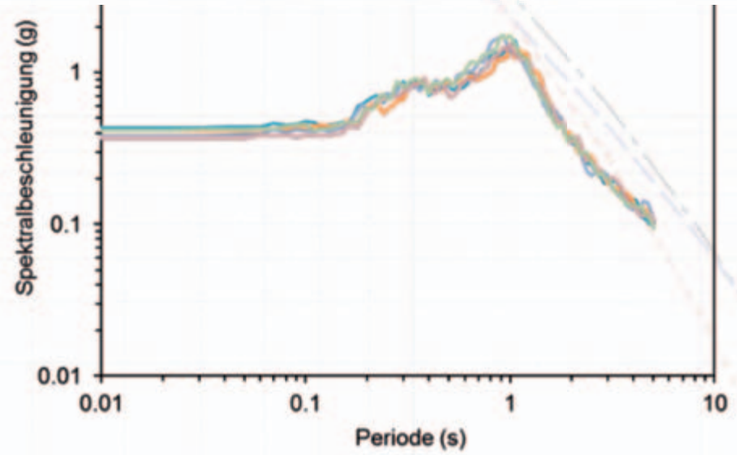
Seismic Hazard Assessment

Seismic design loads for standard buildings are given in seismic building codes. Special engineering constructions like dams or industrial facilities are out of the scope of standard building codes and require higher safety levels and longer earthquake recurrence periods. Seismic loads based on generalised code response spectra can only very roughly incorporate regional seismicity and local soil conditions.

SDA-engineering GmbH performs site-specific seismic hazard analyses and calculates seismic loads for the requested earthquake recurrence periods. Therefore, a probabilistic model is used that incorporates the surrounding seismicity in a large-scale and allows the consideration of parameter uncertainties. Soil dynamic calculations are used to further specify the local soil conditions. The cost-benefit and the accuracy of the seismic hazard assessment are matched to the safety requirements. A high level of comprehension and accuracy regarding the seismic hazard analysis is demanded for the evaluation of seismic loads for nuclear facilities. The analyses have to consider the current state-of-the-art and to incorporate uncertainties in a broad range. A modern and powerful software package is available for probabilistic hazard analyses. On request, an assessment of the soil liquefaction potential is conducted under consideration of peak ground acceleration, structural loads and local soil properties.

Soil Dynamic Analyses

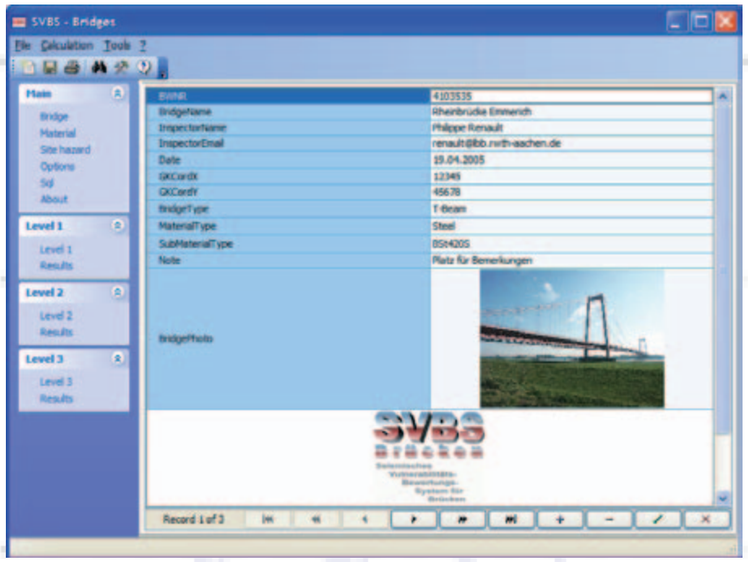
The seismic impact at a site is strongly influenced by the local soil- and subsoil conditions. Resonance effects, which lead to an amplification in the response spectrum, are not captured by generalised code spectra. In order to account for site effects and for an accurate specification of the seismic loads, we conduct soil dynamic analyses. Therefore, the soil layers are modelled with their dynamic properties. Based on an input seismic motion at engineering bedrock - given by a code spectrum or out of a site specific seismic hazard study - the motion and response spectra at the free-field level or at any other level at depth (e.g. foundation level) is calculated.

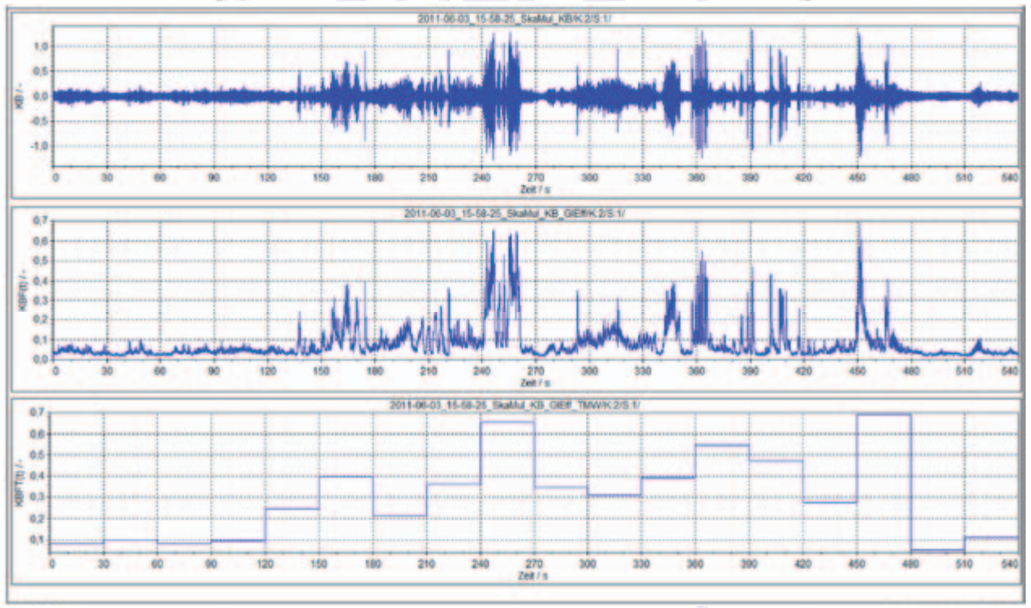


Soil-Structure-Interaction

The interaction between the soil and the building construction influences the transmission of the seismic waves from the free-field to the foundation of the building and modifies the response spectrum. The direct application of the free-field motion at the building foundation is not always conservative. For the calculation of floor response spectra combined models with soil layers and building structure are used.

Besides the application in the nuclear industry, accounting for soil-structure-interaction leads to a more optimised and more efficient design also for other constructions. For instance, for the design of wind turbines soil-structure-interaction has a considerable influence on the calculated results and has to be taken into account under certain circumstances.





Measurements and Vibration Isolation

The assessment of the vibration behaviour of existing buildings and the calibration of numerical models can be carried out based on structural dynamic measurements. The necessary technical equipment, including several geophones and highly sensitive velocity- and accelerometers are readily available. Powerful professional and in-house software packages are used for evaluating the measurement results for short- as well as long-term measurements. Typical applications are vibrations induced on buildings by the following sources:

- Machine induced vibrations
- Rail- and road traffic
- Construction works
- Bell ringing
- Explosions

The analyzed measured vibrations are utilized for the development and suggestion of appropriate active and passive vibration control measures. Vibration measurements are also used for checking the efficiency of isolation measures applied for instance in buildings with highly sensitive machines or equipment. In this case unascertainable vibrations for humans can be already unacceptable perturbations, which have to be avoided for an undisturbed operation. The serviceability of such buildings with highly vibration sensitive equipment must be investigated, since the requirements lie in the sub-micrometer range. A verification of the code and guideline requirements within this measurement range is only possible by means of vibration measurements.

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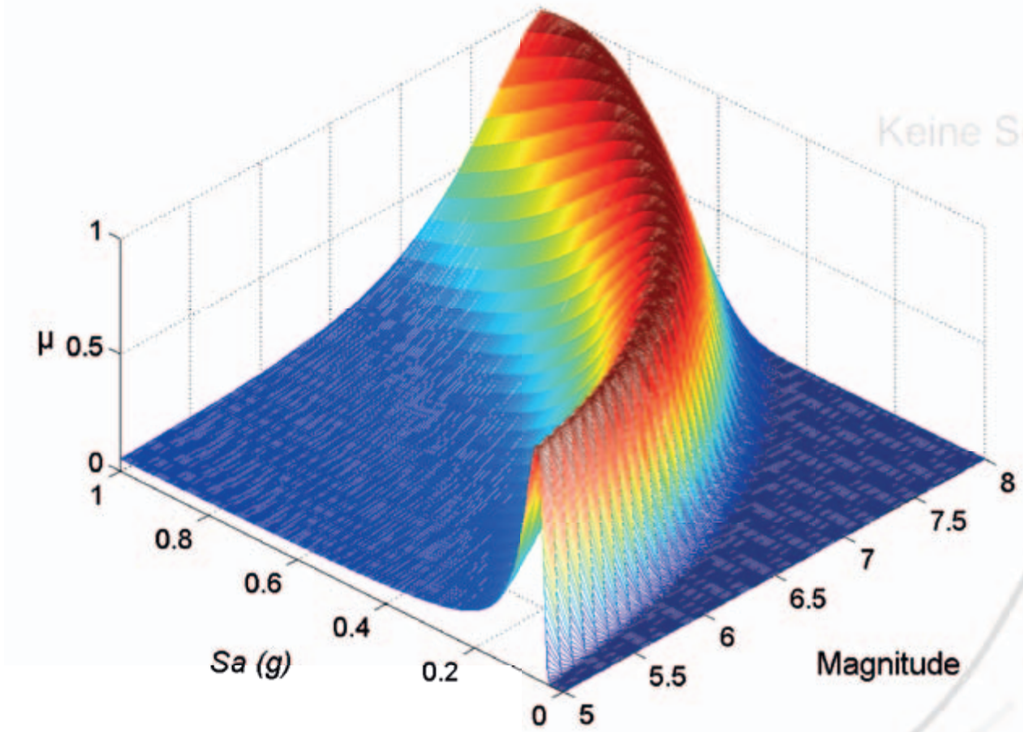
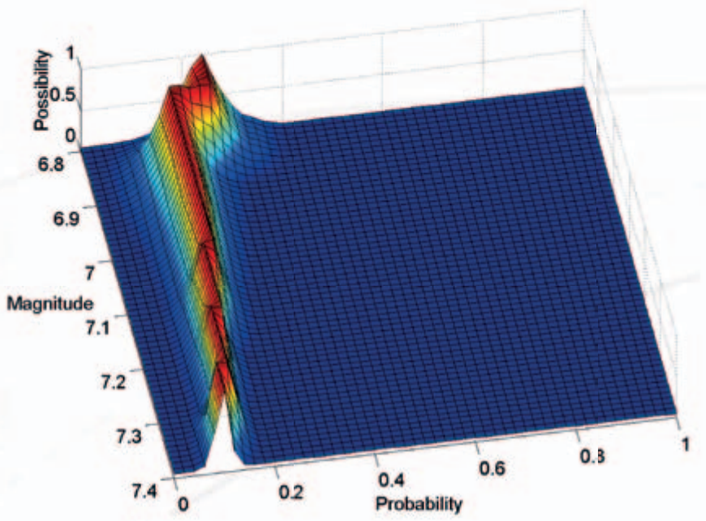
Probabilistic Analyses and Fragility Curves

Fragility curves are cumulative distribution functions, which are used to describe the relationship between the acting loads and the probability of failure. The simplest way for deriving fragility curves is the empirical compilation of fragility curves based on damage assessment and engineering knowledge. A more precise prediction can be obtained with fragility curves based on experimental investigations or simulations. A typical example for a traditional simulation approach is the application of Monte-Carlo simulations, which consider both the stochastic characteristic of the seismic input and the variation of the resistance in terms of distribution functions or random fields.

A reduction of the computational time can be achieved by using „Response surface models" (RSM - „Meta-Model"), which can be developed for each level of loading based on the principals of „Design of experiments" (DOE). The response surface models deliver a mathematical description of the dependency between the significant input parameter and the structural response. These so-called meta-models enable an efficient evaluation of fragility curves. The probabilistic analysis is executed with the finite element software ANSYS, for which SDA-engineering GmbH developed special program modules using the ADPL-programming language.





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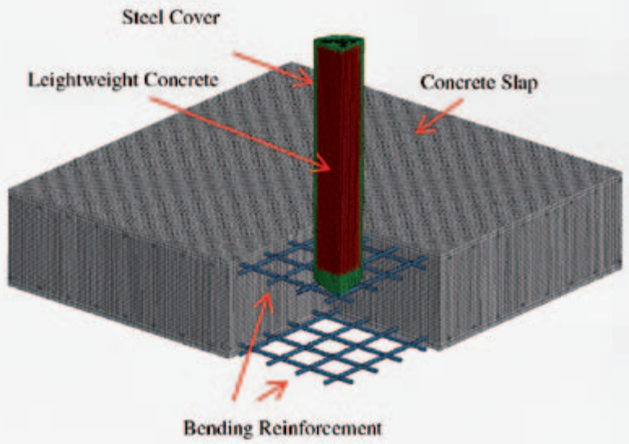

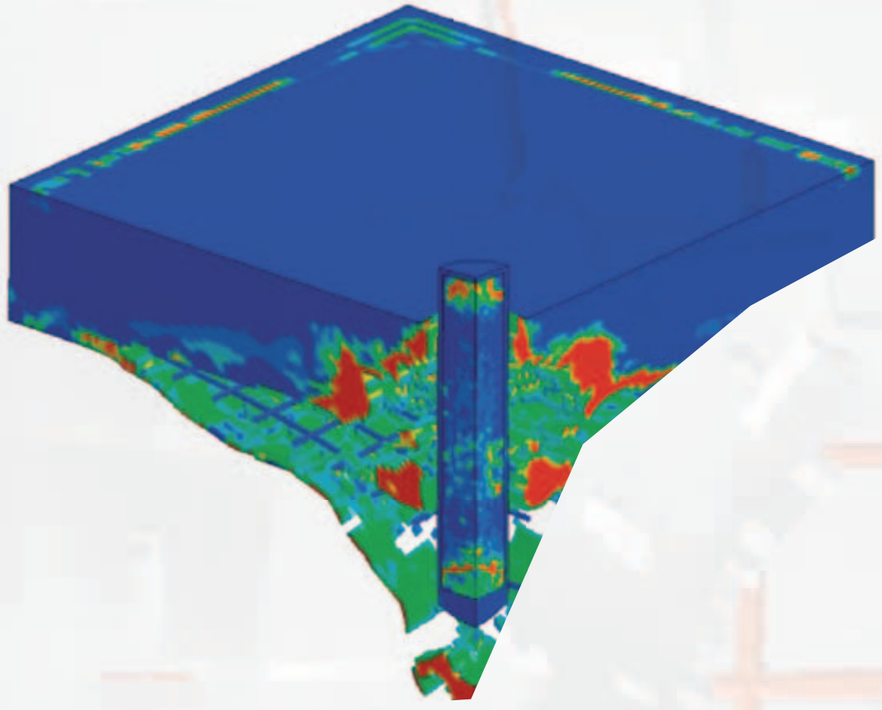

Short Term Dynamic Analyses for Extreme Loadings

The design of safety relevant structures and components requires the consideration of highly dynamic loads as result of actions like explosions, air plane crashes or missile impacts. The investigation of these exceptional load cases is getting more and more important since the attacks of 11 September 2001 at the World Trade Center in New York. An adequate structural design against impact loads is fulfilled, if the failure of single elements is compensated by force redistribution without a total structural collapse. The specified loads are extreme dynamic impacts, which affect structures or structural components within the time range of milliseconds. The analysis and design of structures under impact loads is a challenging task for the responsible engineers. A realistic estimation of the impact is quite complex and not sufficiently regulated in the relevant design codes and guidelines, so that experimental tests or time consuming simulations are unavoidable. The SDA-engineering GmbH is well experienced in executing short term dynamic analyses and offers highly dynamic calculations on request.

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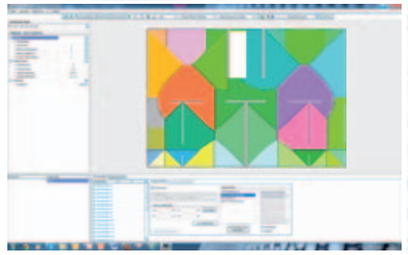
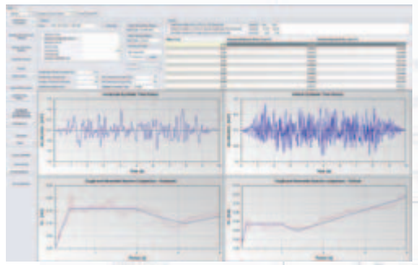


MINEA

Verification of Masonry Structures

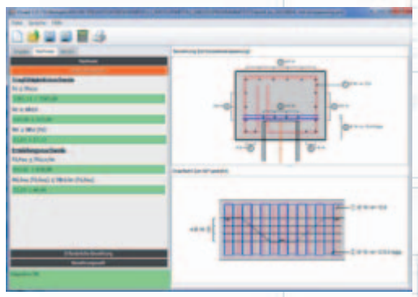


SEISPRO

Signal Processing Software

SVBS

Seismic Vulnerability-Benchmark-System for Bridges



VLOAD

Verification of Knife-Edge Bearings for Arcelor-Mittal Sheet Pile Wall Profiles

Software Development

SDA-engineering has a strong background in software development, combined with expertise in structural engineering consultancy. This combination guarantees the development of software packages for optimized design procedures, which fully meet the demands of the engineering practice. In the development process special attention is paid on intuitive handling and detailed documentation. SDA-engineering has already developed software packages for silos, signal processing, risk and vulnerability assessment and seismic design of structures. All packages are successful introduced into the engineering practice and reflecting the current state-of-the art. Moreover we offer the development of highly specialized software packages for user-related problems.

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Product Development

Another field of activity of SDA-engineering GmbH is the transfer of recent research results into the engineering practice, by means of extensive activities in the interface between research and practise. SDA-engineering GmbH collaborates with universities and is an active partner within collaborative projects of industrial partners and universities. The results of this fruitful cooperation are innovative product developments with short-term introduction to the market. The obtained project results and products are introduced to professional circles within the framework of advanced training seminars and further educational courses.

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Engineering Expert Reports

SDA-engineering GmbH offers the preparation of engineering expert reports in the application fields of Structural Statics and Dynamics and Engineering Seismology. The expert reports represent the state-of-the-art and if necessary, investigations beyond the state-of-the-art are carried out based on our experience and research activities. Furthermore, SDA-engineering GmbH exhibits extensive experiences in approval procedures for building products and conformity procedures of products on national and European level.

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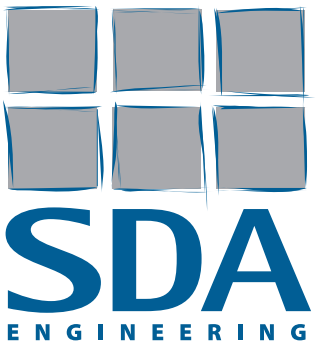

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