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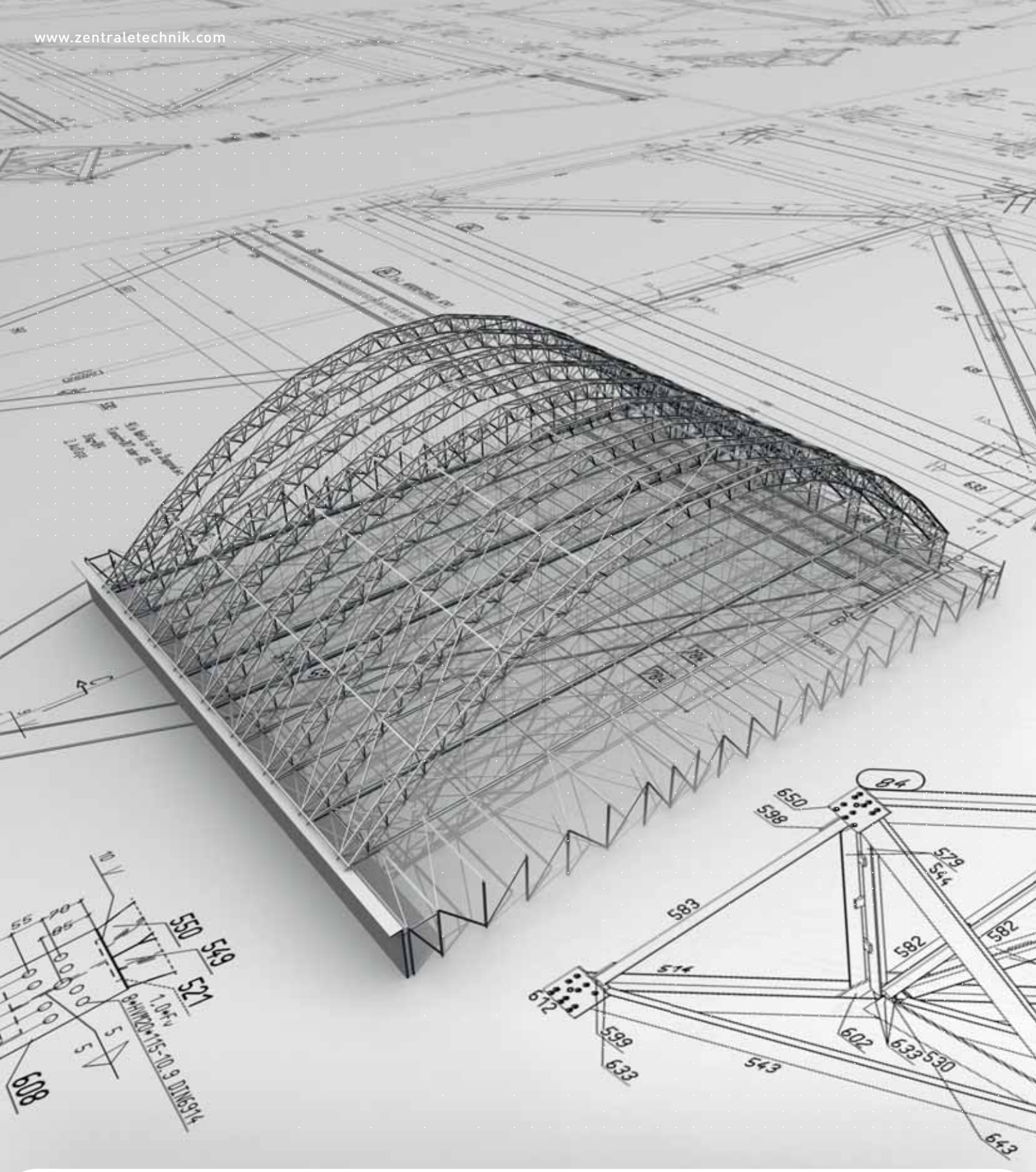


TECHNICAL HEAD OFFICE
ZENTRALE TECHNIK

ZENTRALE
TECHNIK

ZENTRALE TECHNIK

Cover: roof model for hazardous waste landfill Bonfol, Switzerland
1 Saadiyat Bridge, Abu Dhabi, UAE

CONTENTS

1 Christof Sänger
2 Dr. Rainer Bareiß
3 Dr. Christian Dehlinger
4 Dr. Thomas Voigt
5 Miklos Nikolics
6 Mario Rabitsch
7 Klaus Unger

ONE-STOP ADDRESS FOR TECHNICAL KNOW-HOW

The Technical Head Office (Zentrale Technik, ZT) is the Group‘s centre of technological competence. We support the Group‘s operating units in geotechnical engineering and tunnelling, structural engineering and turnkey construction. The services we render cover the entire construction process, from the early acquisition stage, through tendering and construction design, all the way to expert site management.

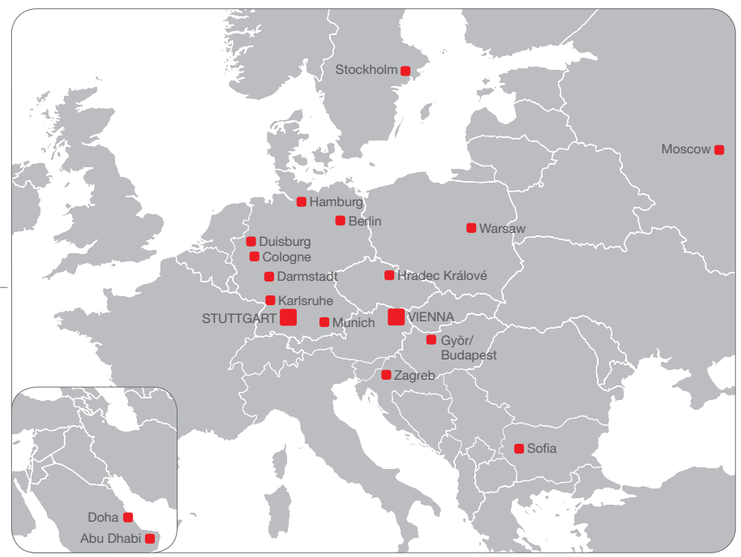
With a view to strengthening the company‘s future competitiveness, ZT also pursues specialised and interdisciplinary research, development and innovation. Other important tasks of ZT are to apply for, administer and research patents for the entire Group as well as to maintain and refine tools for efficient planning and construction such as software tools for design, cost estimation and construction site management.

Many young engineers start their careers at ZT to later assume operating responsibilities at one of our construction sites. University graduates can thus gain an overview of the entire range of our business fields and have the opportunity to immediately apply what they have learned. Apart from this practice-oriented training for young engineers we offer in-house training in all the individual specialties for all staff members of our Group.

Our contribution to the Group‘s PR activities includes lectures and presentations at national and international conferences and workshops, papers published in technical journals, and its expert committees.

LOCATIONS

ZT‘s potential can unfold on construction sites only if our engineers are present there. In order to serve our clients directly and swiftly, ZT has offices in 18 cities and has headquarters in Stuttgart and Vienna.



WHAT WE OFFER

Technical assistance for the operating units:
- acquisition
- tendering
- construction design
- design management
- expert site management

Main tasks:
- research, development and innovation
- maintenance and development of tools for design and construction
- patent office
- human resources development
- in-house training
- Corporate Social Responsibility-Management

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TEAMCONCEPT – THE GROUP‘S PARTNERING MODEL

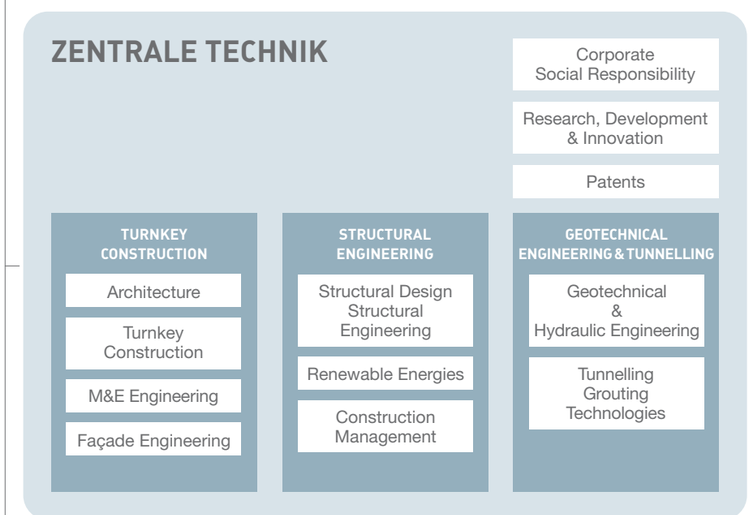
Price competition in the construction industry has not brought about the expected good price / value-ratio for the parties involved. Rather, the contrary has happened: product quality, client satisfaction, and the contractor‘s cost-efficient work execution have all suffered.

With new business models, the Group aims to achieve a high standard of competition. Only if all parties involved in a project collaborate as partners, i.e. work together in a constructive, open-minded and trustful manner, will we be able to reach our project goals and achieve for high quality, client satisfaction, and efficient project implementation. In this context it is essential to have a contractual environment that provides the general contractor with the opportunity to contribute its expert know-how at an early stage. Traditional approaches do not allow for an uninterrupted work flow from design to construction. Valuable information is lost at the various project interfaces.

The **teamconcept** approach provides for such an uninterrupted work flow, from the design and planning stages all the way through construction, thus keeping valuable information for the subsequent project phases. It is, in particular, the early contribution of technical know-how (e.g. by ZT), which allows for the optimisation of construction periods and costs to the highest-possible quality. The flexible and modular teamconcept approach enables us to accurately tailor our expertise to our clients‘ individual needs. A prerequisite for our Group‘s partnering model is that all project participants define the contractual, commercial and technical goals and time schedules together as equal partners. Especially during the preliminary planning phase, the design competence of ZT is of particular importance.

STRUCTURE

ZT draws its competence from over 600 staff working in one of the following three main business fields: Turnkey Construction, Structural Engineering, or Geotechnical Engineering and Tunnelling. These business fields are organised into divisions and corresponding departments as shown in the chart below.



TURNKEY CONSTRUCTION

TASKS AND OBJECTIVES

ZT‘s Turnkey Construction Department professionally supports the market presence and competitiveness of all the Group‘s operating units and thereby contributes to the success of construction projects. Our objective is to acquire, implement, and successfully complete construction projects by cooperation and pooling the available resources.

Turnkey Construction brings together the know-how of many divisions and departments of ZT. Experienced and highly competent staff members ensure that construction projects are carried out using a comprehensive approach considering several requirements, such as customer care, planning, technology, functionality, costs, and contract management.

The quality of our service is based on the constant upgrading and updating of tools and instruments to improve work flows and on the application of the latest computer software. To uphold this quality, it is necessary that we maintain high-performing personnel through continuous education and training.

WHAT WE OFFER

Tendering and cost estimation: Cost estimation in cooperation with internal and external teams of specialists and subcontractors. Tendering and contracting as well as assistance in procurement and award of contracts. General management of projects involving more than one department or large-scale projects.

Staff provision: Provision and posting of trained staff for operational tasks in tendering and contracting as well as expert site management and project management.

Staff training: Introduction of new colleagues to methods of turnkey calculation and tender with focus on national as well as international projects.

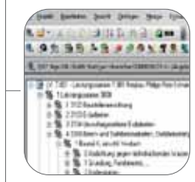
SPECIAL COMPETENCE

Guide price calculation: Short-term CAD-supported guide price calculation.

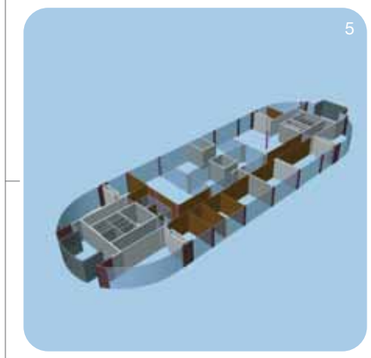
Digital calculation of quantaties: Execution of pilot projects for the implementation of digital quantity take-off for cost estimates.

ARRIBA / iTWO: Internal calculation of subcontracted works based on the calculation of material and wage costs using an advanced version of the ARRIBA tender calculation software.

Coordination of large international and national projects: Involving all necessary divisions and departments, national and international large-scale projects are executed and merged in the tendering phase.



1 Deutscher Herold, Bonn
2 Köln Triangle highrise, Cologne
3 ARRIBA calculation
4 Phillip-Reis School, Friedrichsdorf
5 3D model, guide price calculation
6 Waste incineration plant Yanino, St. Petersburg



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TASKS AND OBJECTIVES

Building is a complex process requiring cooperation and coordination. This includes planning and building laws, the first design development as well as construction drawings up to the technical execution of the project. We apply our know-how at all stages of architectural and interior design in order to find the best solution, both from a technical and an economical point of view.

Our main focus is to provide construction sites with coordinated and approved plans and designs in due time. This can only be achieved by transparent, clear-cut specifications of performance, deadlines and targets. Amongst other items, we focus on coordinating schedules and ensuring design quality, e.g. by using 3D design clash detection for specialist design check.

As coordinating part of the construction team we aspire to sustainable and energy-efficient designs and – in cooperation with the operative units – find efficient solutions for clients, to create a solid basis for a trustful, long-term partnership.

Staff training and continuous communication with the construction site team are the keys to a qualified and up-to-date consultancy in acquisition and execution.

Efficient design tools give us a competitive edge and enable us at ZT to contribute vitally to the development of an ‘intelligent‘ building model.

WHAT WE OFFER

Architectural design: As a service provider for a diverse construction company we use our creative potential to strike a balance between appealing, high-quality designs and economic solutions. In this spirit, we draft preliminary designs, building permit and construction designs in the architectural as well as the interior design fields. If clients provide us with preliminary layouts, we guarantee the source-conform translation into construction-site-adequate construction drawings.


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SPECIAL COMPETENCE

- hotel buildings
- shopping malls
- office buildings
- industrial buildings
- passive houses
- 3D CAD-approach

General planning: The close cooperation with experienced colleagues from the different specialised departments at ZT provides great benefits, as it enables us to offer coordinated fulfillment, allover planning across the board.

Design management: Design work is an interactive process. The communication and technical understanding between internal and external project participants defines both design pace and quality. Hence actively supporting design processes within a coordinated planning schedule is (only) one of our core tasks.

Cost minimising: A close collaboration with the construction units enables us to offer practical and cost efficient design solutions. Easy-to-implement and low-risk design details are an integral aspect of our cost reduction strategy.

Key accounts: For regular customers we provide standards such as national and international specifications for finishes and production requirements.

Client consultancy: We offer qualified support in teamconcept negotiations with potential clients by providing demand analyses, acquisition layouts, energy concepts and calculations of profitability.

Consultancy and procurement: For the interior finishing of objects.

Visualisations and animations: From tender presentations to construction site signs.

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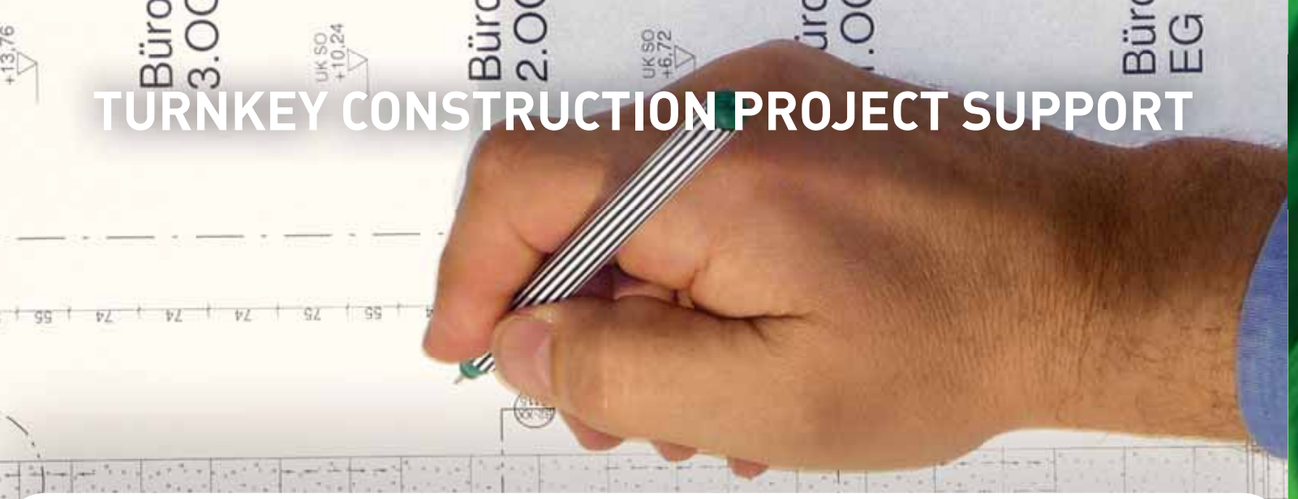
7

1 Multifunctional centre: Polus Centre, Bratislava
2 Multifunctional centre: Palladium, Prague
3 Hotel: Polonia, Warsaw
4 New office building Züblin Z3, visualisation, Stuttgart
5 District community centre of Stuttgart Killesberg, THINK K, visualisation
6 Façade of a religious building, Kiev
7 Office building: STRABAG headquarters, Vienna



TURNKEY CONSTRUCTION PROJECT SUPPORT

TASKS AND OBJECTIVES

Turnkey Construction Project Support gives technical and organisational assistance to improve the quality of design and planning, offers internal staff qualification programmes, and provides a wide range of other services for quality assurance.

WHAT WE OFFER

Risk assessment and design/planning review: Technically challenging and successful turnkey construction projects require complete, professional and timely planning. Such planning is, on the one hand, the basis for subsequent specialist designs (load-bearing structure, M&E engineering, façade, finishing and completion, etc.), and, on the other hand it helps to prevent mistakes and future damage.

We analyse and assess the risks in each phase of a project. We check and analyse our construction designs and those provided by the client with a focus on architectural and technical criteria, e.g. waterproofing. If necessary, other departments, such as M&E Engineering, are integrated in the design and plan checking.

Management tools, standards, technical rules and regulations: Project execution is supported by the development, maintenance and refinement as well as the dissemination of management tools such as the central template database, the project checklists, standard detail drawings for construction, and database of expert reports. The digital collection of standards and building regulations is continuously updated.

Workshops and training seminars for staff qualification: We offer basic training for new staff and organise seminars on engineering topics as well as design and planning review workshops. Our Turnkey Construction Working Group serves as a forum for the exchange of know-how and experience for the operating units. Often, issues are addressed which have turned out to be particularly critical during our design and planning review.

Additional services: Expert support in assessing defects, construction damages and technical solutions. Advice on design and planning details, also including their detailed examination and development. Assistance in reconstruction, conversion and refurbishment projects and in analysing the condition of existing buildings. Additionally we offer fire protection consultancy, design coordination, set-up of design management and coordination structures, assistance in digital construction deficiency and acceptance management, construction and project management, as well as technical assistance in warranty issues and lawsuits.

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TECHNOLOGY CENTRE FOR SUSTAINABLE CONSTRUCTION

TASKS AND OBJECTIVES

Given the rising energy prices and with the effects of the climate change becoming ever more noticeable, the construction industry has been witnessing a paradigm shift from investment-cost-optimised to life-cycle-cost-optimised buildings. Quality and resource efficiency are gaining priority.

The Technology Centre for Sustainable Construction audits its clients' buildings on the basis of well-established certification systems and thereby makes their features measurable and comparable. TNB accompanies and optimises buildings throughout their entire life cycle based on the principles of sustainability: Sustainable buildings are economic, environment-friendly, resource-efficient and sociologically sophisticated. They meet high standards in regard to functionality and design.

Our services are tailored to the needs of our clients and are, therefore, the ideal add-on to the integrated teamconcept approach. TNB is also actively involved in research and development and thereby contributes to the early introduction of resource-saving technologies and processes.

WHAT WE OFFER

Certification according to DGNB, breeam, LEED *
Regarding the certification process, our services range from the elaboration of quick and low-cost pre-assessments to detailed analysis and evaluations of designs or projects. They also include manuals for expert planners and builders as well as project assistance throughout the entire certification process.

Consultancy, project steering and management
Irrespective of the certification process, we offer our clients advice in all phases of design, construction and operation, with a focus on sustainability and resource efficiency.

Life cycle assessment
Detailed elaboration of environmental impact (CO_2, greenhouse gas emissions, etc.) through building materials during construction and operation of a building.

Life-cycle-cost analysis
Comprehensive calculation of a building's investment and follow-up costs over its whole life cycle.

* DGNB (German Sustainable Building Council), breeam (Building Research Establishment Environmental Assessment Method), LEED (Leadership in Energy and Environmental Designs)
** ÖGNI (Austrian Sustainable Building Council)

Member:

Founding member:

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M&E ENGINEERING

TASKS AND OBJECTIVES

Mechanical and Electrical (M&E) engineering makes buildings come to life. By expertly supporting all M&E engineering teams we assist the operating units in all phases of turnkey construction projects. Our job is to pool and constantly widen the expert knowledge in the M&E engineering areas of heating, ventilation, plumbing, fire protection systems, cooling systems, electrical engineering, building automation and conveyor technology, as well as integrate all decentralised operating units in charge of M&E engineering.

With our outstanding M&E engineering competence and the fact that we identify and minimise risks and optimise technological systems, we contribute to the Group's competitiveness. The range of services we offer spans from offering advice on individual issues for smaller projects to comprehensive M&E solutions in all phases of more complex construction projects. In order to be able to provide the operating units with optimum service, ZT observes the M&E market for new technologies, developments, and requirements.

WHAT WE OFFER

Tendering
- value engineering in the acquisition phase
- technical and commercial plausibility examination of tenders
- tender optimisation
- integration of innovative ideas and development of alternative concepts
- cost estimation
- cooperation within teamconcept projects
- assistance in PPP projects and project development
- assistance in contract drafting
- risk assessment

Innovation
- elaboration of alternative proposals for higher energy efficiency and sustainability
- services in the field of thermal and flow simulation for assessing the functionality of concepts
- daylight and artificial light simulation
- proposal of passive house projects
- energy saving computations (EnEV) for housing and non-housing projects
- participation in national and international R&D projects
- market observation, evaluation and integration of new technologies
- training and supervision of trainees, graduates and young engineers

Work Planning – Procurement
- planning of M&E installations based on in-house concepts and in cooperation with external planners
- tendering, bid examination, negotiations
- drafting of price comparison lists and recommendation of contractors
- preparation of contract documents for M&E subcontractors
- construction and/or project briefing
- drafting of framework contracts

Implementation
- M&E engineering projects and/or site management
- interface coordination
- quality surveillance
- examination of construction documentation, design controlling
- customer care
- claim management
- documentation
- assistance in commissioning, implementation of acceptance procedures and handovers
- subcontractor rating

Warranty
- checking of revision documents
- assistance in acceptance procedures and the prevention of defects
- remedial works management

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SPECIAL COMPETENCE

- thermal simulation of buildings and M&E equipment simulation of networked flow systems
- certificated tasks in reference to thermography (certificate currently in preparation)
- comprehensive planning of technical installations such as kitchen and swimming pool installations
- provision of diverse measuring instruments and respective supporting services
- fire protection with a focus on M&E installations
- stage engineering
- event engineering and presentation technology
- special data centre know-how (e.g. Injazat Data Centre, Abu Dhabi)

1 German air traffic control tower, Berlin
2 Geothermal energy distributor
3 Refrigerating machine (Dürr Campus)

FAÇADE ENGINEERING

TASKS AND OBJECTIVES

The central task of this specialist department of ZT is to pool the Group‘s façade engineering know-how, develop it further and to apply it whenever a construction project is acquired and conducted throughout the Group.

This includes detecting and minimising possible risks, identifying potential savings and optimising our approaches.

In close cooperation with the operating units and the Central Procurement Department we keep abreast of the market situation and the growing requirements and developments in the field of façade engineering. Hence we can support our clients using our comprehensive and up-to-date know-how during their construction projects.

In close cooperation with the operating units, every building project which generally poses technical challenges, provides us with additional experience and detailed knowledge.

WHAT WE OFFER

Comprehensive consultancy during all project phases on issues regarding a building‘s entire external envelope taking into consideration construction rules and regulations as well as architectural, energy-saving, and economical aspects.

Assistance in tendering, presentations and invitations to tender with own design details and technical solutions.

Key detail drawings for the building‘s entire external envelope in cooperation with architects and expert planners.

Cost estimates for the entire building envelope and checking and verification of prices tendered by subcontractors and partner companies.

Elaboration of alternative proposals with all the respective specifications and details for cost and quality optimisation.

Drafting of invitations to tender and preparation of contract awarding, including comprehensive technical specifications.

Coordination of construction design, workshop and assembly drawings for the building envelope rendered by architects, structural engineers, façade planners, authorities, inspecting institutions and subcontractors. This is done in close cooperation with the operating project team.

On-site coordination of work on the building envelope plus execution of the permanent installation and quality controls until final acceptance of the works, including the relevant schedule and cost control.

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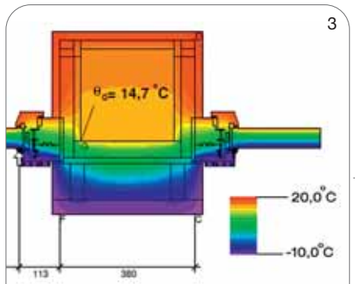

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SPECIAL COMPETENCE

teamconcept: Specifying of contracts within the teamconcept approach, also for subcontractors. Project-specific elaboration and implementation in cooperation with the Central Procurement Department.

Cost estimation: Detailed calculation of façade costs with all individual costs listed and divided into categories such as planning, materials, manufacture, installation, etc.

Overall planning consultancy: Optimisation of building concepts through a comprehensive examination of the interaction of structure, façade and M&E installations in cooperation with other departments of ZT.

Thermal simulation: Tests on the influence of façade design and shading devices on room climate and comfort using numerical simulation programmes.

Glass statics: Use of special software for testing glass compositions by simulating static and dynamic loads on glazing with linear or point-shaped supports.

Building physics: Preparation of energy performance certificates pursuant to EnEV (Germany‘s energy saving regulations) and construction parts catalogues, stationary thermal calculations, transient hygrothermal simulations, thermography, sound insulation, acoustics.

5

1 Tanzende Türme, Hamburg
2 Forum Mittelrhein, Koblenz
3 Isothermal computation
4 Thermal image
5 ADAC headquarters, Munich

STRUCTURAL ENGINEERING

SPECIAL COMPETENCE

- load-bearing structures of highrise buildings
- prestressing
- pre-cast construction
- long-span roofing
- noise barriers at transportation routes
- railroad construction
- free-cantilever equipment for bridges
- bridge construction

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TASKS AND OBJECTIVES

Structural Engineering is the backbone of sophisticated building construction and traffic infrastructure engineering and is thus, by tradition, an integral department of ZT. Well thought-through design and implementation-friendly planning of engineering structures and complex load-bearing structures of buildings are the basis for a successful project completion. Experienced, flexible, and high-performing staff see to these tasks. We provide them with constant training to always apply latest technologies in our projects.

The goal is to optimise loadbearing structures while adhering to maximum quality standards in order to simplify construction and to minimise costs. This allows the operational units to offer economical and premium solutions to customers. The department pools years of experience and technical expertise and concentrates on developing and continuously improving innovative solutions in the field of structural engineering. All divisions of the company profit from this know-how during project execution. Furthermore, our qualified specialist engineers have been involved in defining current technical standards for over twenty years through active involvement in standards committees etc.

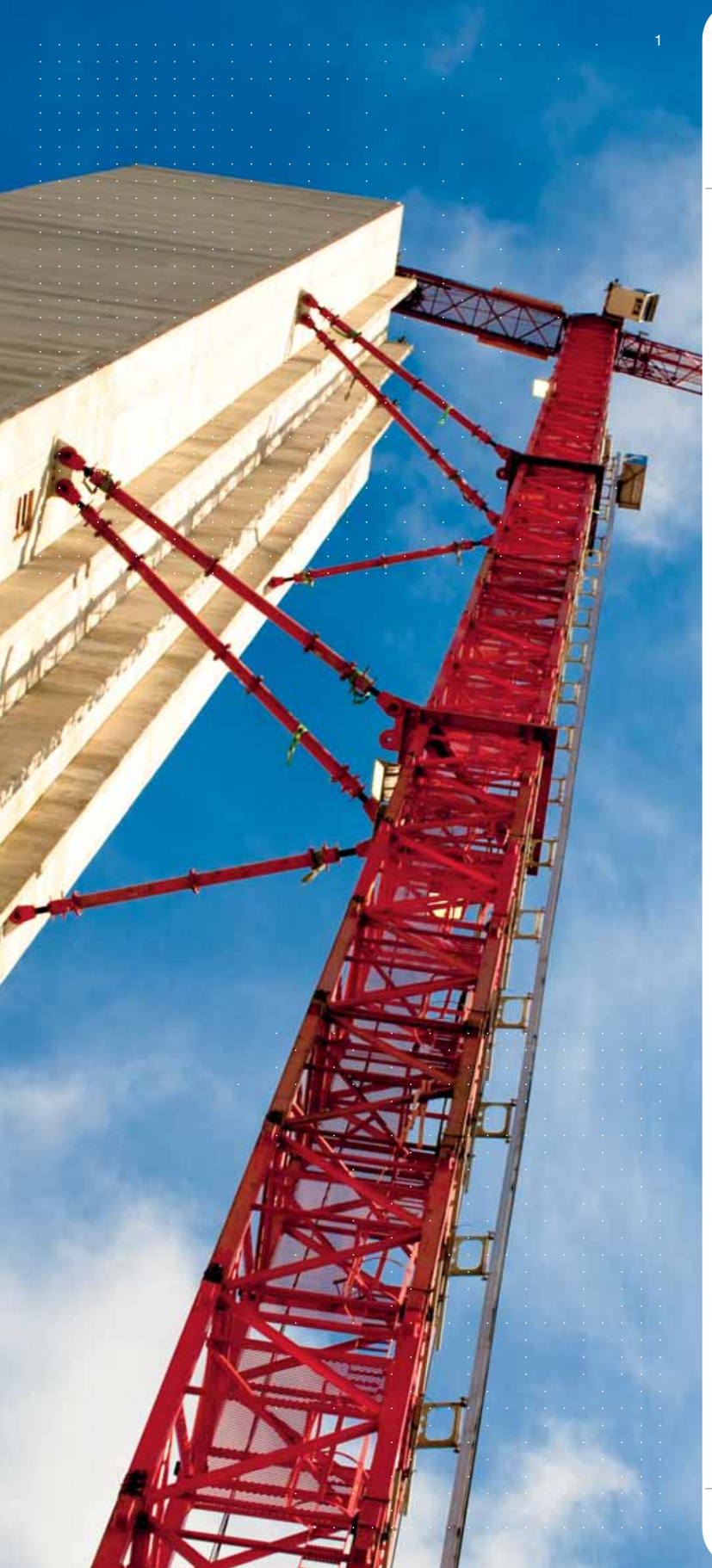
WHAT WE OFFER

Construction Bidding: We design and optimise load-bearing systems for engineering structures in building and bridge construction and choose suitable materials and construction methods together with the construction manager. By means of preliminary investigations (static and, if necessary, dynamic), optimised structures and dimensions are devised. In a subsequent step, bills of quantities and building specifications are created.

Implementation: Before starting the construction phase, we handle the final static and dynamic calculations and verifications. This is done in accordance with the construction schedule and illustrates the load-bearing structure in the structural drawings in a clear and comprehensive fashion.

Other services:
- estimation of construction shell costs
- estimation of production costs in building construction
- coordination of structural design planning
- design platform set-up (BuildOnline/Baulogis/Fusion Live)
- 3D drawings of structures as well as schedules for tenders, presentations and interface checks
- expert site management
- staff provision

1 Hazardous waste landfill Kölliken, Switzerland



1 Crane fixation, power plant Maasvlakte
2 Construction management workplace

CONSTRUCTION MANAGEMENT

TASKS AND OBJECTIVES

In order to execute a construction project successfully it is essential to consider and consequently implement all aspects of construction management. Construction management starts during the tendering phase with estimating the tender price and preparing time schedules and site installation concepts. During the execution phase, the team elaborates on and constantly updates the working estimation, as well as the time schedule, the formwork design, and the site logistics plans. Using our BIM-tools 5D, building models can be visualised, and linked to the schedule and the bill of quantities.

WHAT WE OFFER

ARRIBA/iTWO: National and international training seminars for tender and working estimation, quantity surveying and cost control. Telephone hotline support for the operating units. Temporary staff provision on site (national and international) for tasks such as preparation of the working estimation, quantity surveying, cost control and the handling of change orders (for more detailed information see page 20).

POWER PROJECT, PRIMAVERA, TILOS, MS PROJECT: National and international training courses are held in the Stuttgart offices and on site. Telephone hotline support for the operating units.

Civil engineering and bridge construction: Estimating the shell construction based on the client‘s bill of quantities and functional specifications in close cooperation with the other departments of ZT. Estimation of method-dependant civil engineering works, e.g. bridge, storage structure and power plant construction. Elaboration of alternative proposals in coordination with the operating units.

Work preparation: Preparation of site installation drawings as well as schedules for the tendering and execution phases. Elaboration of logistic concepts. Development of formwork and scaffolding concepts, and support for the operating units in obtaining quotations and awarding of the relevant packages. On-site consultancy and assistance concerning specialist construction methods (sliding or climbing formwork, bridge construction). Provision of temporary on-site staff (national and international) for tasks such as creating and updating of schedules and site installation drawings.

5D-planning: Creation of 3D building models, linking to schedule (4D) and representation of the construction process taking into account the scheduling requirements. Clash detection and creation of a model-based bill of quantities. Visualisation of construction processes in frames or even photo-realistic renderings. Development of the necessary software tools for the successful implementation of 5D® planning (see page 22).

Product coordination procurement: Cross-segment and international product coordination of STRAbis. Providing trainings in STRAbis for power users. Coordination of a steering group for the implementation of procurement processes in iTWO.

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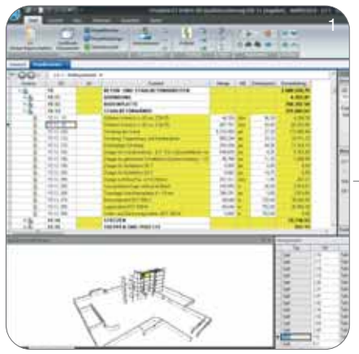
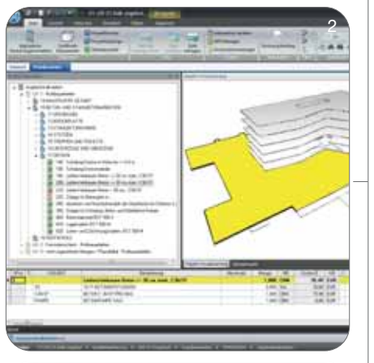
ARRIBA/iTWO





1 Bill of quantities with visualisation of 3D-models in iTWO 5D
2 Tender bid estimation in iTWO 5D
3 Evaluation of a building construction model

TASKS AND OBJECTIVES

The determination of estimation costs for a tender bid and cost monitoring within the context of project controlling are always based on the relevant building methods and processes used in the project concerned. They form the basis for the work execution estimate. For construction site controlling, the comparison between the estimated execution costs and the actual construction costs recorded in the commercial system provide the basis for a company-wide evaluation of the planning data.

As part of the specialist department 'Construction Management Services' the group 'ARRIBA-Construction Management' has the task of standardising and developing these processes within the tender estimation and the controlling activities for the whole company.

The core application for these tasks is the software program ARRIBA. During the next couple of years these tasks will be transferred to the program's successor 'iTWO'. This new software has been developed using the same technological basis as ARRIBA and fully covers the scope and performance of the original ARRIBA software. Furthermore, additional extensive new functions will be introduced step by step, allowing for 3D model-based operation, amongst others.

With the aid of ARRIBA/iTWO the centralised Controlling Software pro-CON is being developed for the entire company, covering all divisions national and international, to be used both on construction sites as well as a reporting program for the operational units of the various departments and divisions.

Furthermore, the group ARRIBA-Construction Management is responsible for the uniform development and implementation of the company-wide STRABAG trade codes (STC) used in the estimation, controlling, procurement and project organisation.

The results of the uniform standardisation are mirrored in ARRIBA/iTWO using a common access platform and authorisation system, standard systematic approach with master data and standard print templates as well as with a construction processes-relevant training program for both the bid and execution phases.

iTWO

5D® is a model-based procedure using various software tools.
iTWO is the principal software for the concrete application of 5D®.

iTWO is available in two versions:
- iTWO baseline is equivalent to ARRIBA with a new modernised user interface,
- iTWO 5D is equivalent to iTWO baseline, extended by further modules, capable of viewing and evaluating 3D models.

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The software developer RIB offers the new functions for iTWO 5D in several successive stages. The first stage covers the tender bid estimation for general building construction. It is now possible, amongst other functions, to determine the quantities directly from a 3D model and therewith to generate a bill of quantities and establish a tender bid estimation. Thereby iTWO supports the general development towards model-based working methods.

Further successive stages of the iTWO development will offer new functions, expanding the programmes scope to other business fields, such as model-based work preparation and program scheduling, cross-project procurement and model-based support for project execution as well as targeting methods for infrastructure projects.

The development and introduction of iTWO is managed by the ARRIBA Construction Management and the 5D Design groups within the specialist department 'Construction Management Services'. Apart from the continued development toward an optimised working procedure, supporting documentation is prepared and training courses in 3D CAD and iTWO 5D are organised and held.

WHAT WE OFFER

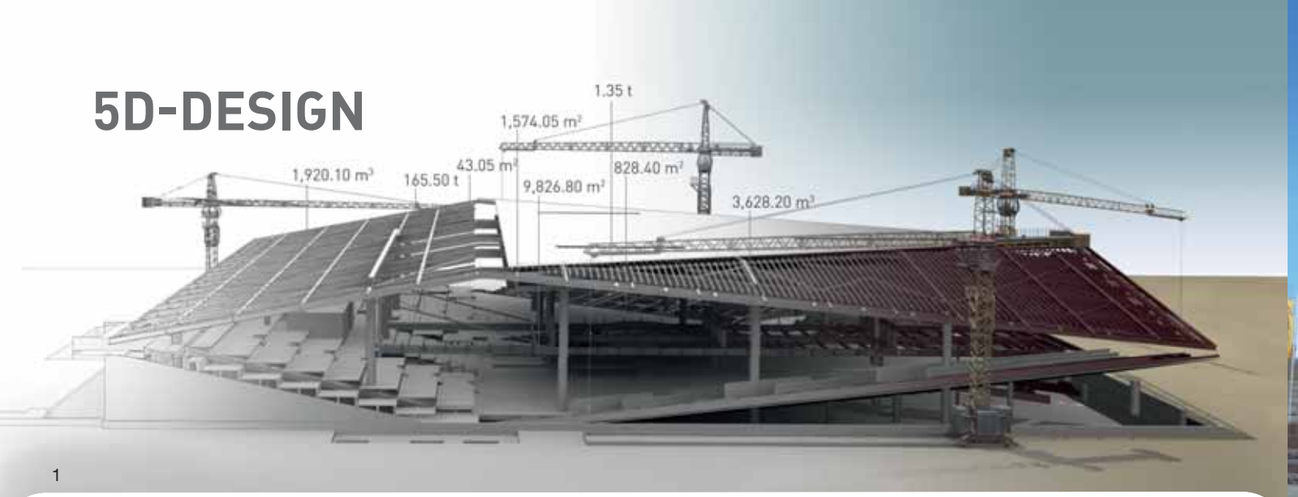
ARRIBA / iTWO company-wide application: Also included within the scope of responsibilities is the organisation and configuration of database structures as well as the management of access authorisation and establishment of the authorisation levels and project files for operational units.

Training courses include: ARRIBA / iTWO basic introduction, estimation structural works, estimation turnkey, estimation road construction, estimation specialist works, billing, controlling unit rate contracts, controlling lump sum contracts, controlling commercial, ARRIBA Light (in future: iTWO Light), interface with scheduling programs, training courses for the handling of project report and project monitoring, Autodesk QTO as well as individual workshops.

User support: Telephone hotline support is available for the operational units, tendering team consultation, joint ventures and operational units to assist them with methodology selection in estimation and controlling, preparation of the 1st working estimation, support for the monthly update as well as provision of temporary staff for on-site support (both national and international) for the preparation of the working estimation, billing, cost control and for the creation of change orders.

STRABAG trade code (STC): Central information center for questions regarding the trade code structure.

5D-DESIGN



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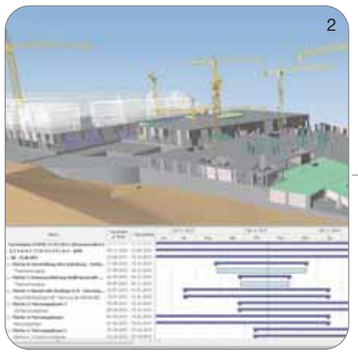

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TASKS AND OBJECTIVES

Efficient construction requires efficient tools and lean processes. ZT responds to this challenge with 5D®. The aim of this innovative solution is to provide a model-based system that integrates all parties involved in the project on a common basis, covering all phases and trades involved.

The 5D Design group introduces the necessary working methods, tools and templates into the company step by step on an ongoing basis:

- **Development** of the necessary soft- and hardware together with its partners
- **Provision** of support services for all available 5D® applications
- **Transfer** of knowledge: Consultation and training for the introduction of 5D®

WHAT WE OFFER

Supply of templates for iTWO 5D in accordance with the requirements of the STRABAG trade codes (STC) for general structural works. Templates for other trades within building construction and civil engineering as well as infrastructure works are at present being developed.

Model-based clash detection, trade coordination and scheduling: 5D Design linked to the construction time schedule supplied (ASTA power Project / MS Project / Primavera) with a 3D model of the building structure and a 3D model of the site installation plan.

Model-based quantity take-off: Provision of quantities or direct evaluation in iTWO 5D on the basis of a 3D model.

Model-based production planning / work preparation: The 5D Design group supports the production planning of the formwork and provides the necessary 3D planning for scaffolding and construction support works for complex forms in cooperation with the group 'Work Preparation'.

3D modeling capacity: Drafting of 3D models based on 2D drawings created by specialist planers or from the data provided by the client.

Building Information Model (BIM) Manager / 5D Project Management: Coordination of internal and external 3D planning.

Prequalification / proof of technical abilities: Issuing of reference data for proof of technical abilities within the 5D® field of expertise.

Visualisation: Presentation of both tender bid and technical solutions for execution, using all technically possible means, such as 3D pdf, pictures, photomontage, films, stereoscopy (3D Film).

1 Central Library, Doha/Qatar, Visualisation
2 Linking the construction time schedule with the 3D model
3 Quantities derived from the 3D model
4 Offshore wind energy plant, film clip

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TECHNOLOGY CENTRE FOR RENEWABLE ENERGY

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TASKS AND OBJECTIVES

Two drivers foster the use of renewable energy sources as the highest societal target: rising costs for fossil fuels, and the reduction of greenhouse gases necessary for futher mitigation of climate change. Due to the expected usable energy potential, the development of offshore wind power plants is at the very front of possible future technologies to provide eco-friendly power.

For years ZT has been involved in the design and development of foundation structures as well as developing concepts for the erection of offshore wind power plants. In summer 2011, specialists from the departments of TBK Structural Engineering Construction, TBT Geotechnical Engineering and BAV Construction Management have been merged into the Technology Centre for Renewable Energies. This multi-disciplinary team will be able to seamlessly cover the highly demanding and complex design processes required for offshore wind structures.

WHAT WE OFFER

The Technology Centre for Renewable Energies develops and designs the foundation structures for wind power plants. These include gravity based foundations using high-strength pre-stressed concrete and jacket steel framed structures. Feasibility studies for various types of foundations are carried out for designated wind farm locations. As part of the licensing process the Technology Centre for Renewable Energies provides geotechnical reports and coordinates external designers.

Ground engineering concepts are prepared and necessary steps are coordinated with external experts such as certifiers, consultants and authorities. Furthermore, the Technology Centre for Renewable Energies provides specifications and monitoring concepts as well as interpretation and evaluation of the monitored data in order to meet the quality requirements during and after the execution of the construction works. Joint research and development projects together with universities and research organisations ensure the application of the most recent technical standards and developments.

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1 Full scale model testing facility for offshore wind power plants in Cuxhaven, engineered by ZT
2 Jacket foundation for offshore wind power plants, designed by Technology Centre for Renewable Energies
3 Gravity foundation with scour protection, designed by Technology Centre for Renewable Energies

GEOTECHNICAL ENGINEERING

TASKS AND OBJECTIVES

By tradition, the Group‘s service portfolio also comprises civil engineering, ground engineering and geotechnical engineering at home and abroad. Hence, both the designing and consultancy of civil and geotechnical engineering projects are among the key tasks of ZT. The Geotechnical Engineering Department of ZT is based in Stuttgart and has further offices in Berlin, Duisburg, Munich, Hamburg, and Vienna, which allows for high quality service to be rendered to the operating units.

From acquisition to implementation, ZT technically supports the operating units in all phases of geotechnical engineering projects. Fair cooperation between ZT and the construction sites is the basis for a successful project execution.

Our objective is to plan projects to meet the requirements of the construction works. Creative yet economic solutions contribute to a successful project. We succeed due to our technical competence and high-quality user-oriented design services.

WHAT WE OFFER

Technical tender handling and construction design in civil engineering and geotechnical engineering at home and abroad:

- combined pile and slab foundations
- framed and trough structures
- cut-and-cover tunnel construction
- underground stations
- dewatering
- hydraulic engineering
- docks
- port construction
- locks
- dams
- construction pits
- foundation slabs
- deep foundations
- underpinnings
- soil improvement
- ground freezing
- grouting works
- measuring technique
- monitoring
- soil engineering

Elaboration of optimised alternative proposals and ancillary offers.

Design work for special construction methods, such as jacking or shifting of large-size building components and lifting of structures.

Geotechnical advice, design coordination, expert site management.

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SPECIAL COMPETENCE

Construction pits: Construction pit support and underpinning design including measuring and monitoring layout, dewatering and excavation concepts are among the core competences of ZT. The wide range of retaining options available stretches from soil-nailed pit walls to diaphragm and bored pile walls for deep urban construction pits.

Transportation engineering: Another core competence is the construction design of cut-and-cover tunnels, underground stations, and framed and trough structures. The construction method chosen depends on the available space, whether traffic may be disrupted or not, and the time frame.

Foundations: ZT covers all design aspects of this highly demanding engineering task. Depending on the respective conditions and requirements, we may choose soil improvement techniques or piled foundations using large-diameter bored piles, displacement piles or driven piles, or in frequent cases, combined pile and slab foundations.

Hydraulic engineering: Port and dock structures, locks and dams, hydroelectric power plants and land reclamation at home and abroad are designed and planned in coordination with the operating sub-divisions and by taking into consideration the relevant local particularities.

Special solutions: ZT exhibits particular competence in designing underpinnings for buildings and in relocating entire building components and structures.

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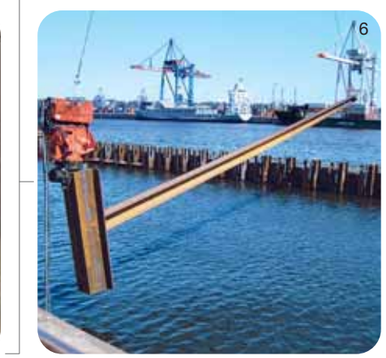

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1 Noise protection tunnel BAB 8, Gruibingen
2 Leipzig City Tunnel, Bayrischer Bahnhof
3 Rhine bridge power pole at motorway A44, Ilverich
4 Safety tunnel underneath Bahrmühlen-viadukt, Chemnitz
5 Underwater excavation of the construction pit for Desy XFEL, Hamburg
6 Flap anchor, Predöhlkai construction phase 2, Hamburg

TUNNELLING

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1 Alternative solution with steel segments in the crossover connection area, Randstad Rail Rotterdam
2 TBM arrival at Statenweg Station, Randstad Rail Rotterdam
3 Reinforcement works on inner lining, Cologne, Bechergasse
4 +5 Determination of a tunnel lining segment's load-bearing reserve using a 3D FE model with an explicit replication of the reinforcing cage

TASKS AND OBJECTIVES

Design and engineering services in tunnel and underground construction have been a special competence and core business of ZT for more than 30 years. The quality of our services and products is based on the know-how and ambition of our staff, who – on behalf of our operating units – have carried out the design work for the excavation process and the final lining of more than 20 tunnelling projects around the globe during the last five years alone.

Our special focus lies on:
- high customer satisfaction through technical competence and quality
- efficiency and innovation skills in all construction phases
- education and training of enthusiastic and ambitious staff for our company
- pooling of tunnelling know-how and its dissemination throughout the Group

WHAT WE OFFER

Planning in all fields of tunnelling, setting tunnel boring machines (TBM) operating parameters such as support pressure computation, segmental lining design, design of primary support and permanent lining in conventional tunnelling, pipe jacking, settlement prediction, buildung risk assessment (BRA), monitoring programmes, etc.

Design of special constructions such as emergency tunnels, pressure tunnels, crossover tunnels, cross passages and ventilation shafts as well as the design of temporary constructions in conventional tunnelling such as tunnel eyes and pipe umbrellas.

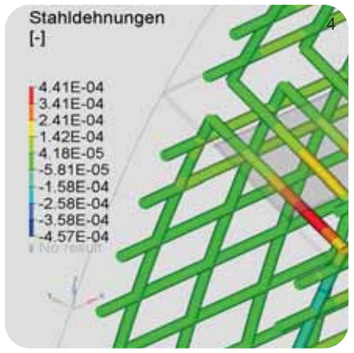
Design of launch and reception constructions for TBM and TBM transport through stations.

Design for low and high-pressure grouting works, e.g. jet grouting umbrellas or compensation grouting in urban tunnelling.

Ground freezing design including thermal calculations to elaborate freezing time and energy demand and in order to examine the influence of specific issues, such as high groundwater flow rates.

Compressed-air drives with all relevant special structures and estimation of compressed-air demand as well as blow-out safety.

Planning and design as well as production of dimensioning equipment for separation plants in slurry shield tunnelling.



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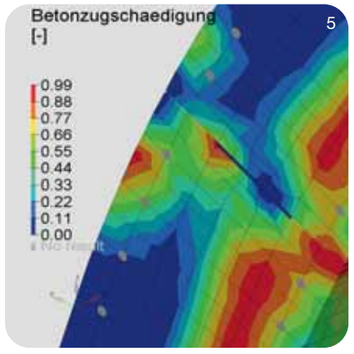

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PRODUCTS

SOFIA – software for grouting works: Design and monitoring of low-pressure grouting such as compensation grouting in urban tunnels or grout injections in tunnels through the ground.

Shield Transfer System (STS): Development of a special shield bearing structure used for the longitudinal transport in stations, where conventional longitudinal shifting is not possible for geometric reasons.

Energy tunnel lining segment (Energietübbing®): Tunnel lining segment equipped with geothermal technology to extract heat and cold from the soil.

RFB-tunnel lining segment: Steel lining segment allowing for free orientation of freezing and grouting boreholes.

Q-Bolt: Coupling bolt for the transmission of strong transverse forces in tunnel lining segments and other prefab concrete elements.

SPECIAL COMPETENCE

Geotechnical engineering and geology: Customised design of geotechnical longitudinal sections and interpretation of geotechnical data. Geothermal calculations for analysing and optimising heat and cold extraction from the soil.

Grouting and freezing technologies: In-house software solutions for designing, dimensioning and supervising grouting and freezing measures.

TBM excavations: Parameterised design of tunnel lining segments using 3D CAD-solutions. In-house software for optimised tunnelling-specific design tools including various, also international standards. Implementation of complex 2D/3D FE calculations to tackle specific problems. Software solutions for optimising the on-site management of technical data, e.g. customised database solutions in ground engineering and tunnelling.

Research and development: Energy self-sufficient radio systems for use in tunnels, compressed air energy storage units, constructions with special safety requirements, such as hybrid tunnel shells with pressure-absorbing properties, couplings of tunnel lining segments subject to dynamic loads, and fibre-reinforced concrete shells made of ultra high performance concrete (UHPC).

TASKS AND OBJECTIVES

Cost optimisation was the strategic guideline for competitiveness in the construction industry for a long time. In addition, the general perception of innovative thinking and operation seemed totally incompatible with the construction sector. However, construction engineering requires a wide spectrum of both technology and know-how and thereby can be regarded as an integrated platform with a widely diverse field of tasks, processes and construction techniques. In order to allow further development in these areas, the implementation of good ideas is essential. Together with the operational units, the specialist departments of ZT pursue the goal of further developing the competitiveness of the company. This is done using high quality solutions that are innovative, technically demanding, and also take into consideration a responsible use of the needed resources. The central unit Research Development and Innovation (RD&I) supports this work, concentrating on:

- the acquisition of externally funded research projects, that feature a significant overlap with our daily business,
- an effective and efficient support for internal project proposals of ZT,
- the continuous development of the innovation network ‘construction’, consisting of funding bodies, research institutions, universities, business enterprises and associations,
- consultation regarding cooperation with research related institutions or administrative aspects of i.e. publicly funded projects.

WHAT WE OFFER

Publically Funded Projects: We support both the operational business units and various specialist ZT departments in all matters regarding acquisition and administration of both European and National development projects.

Coordination and consultation: We coordinate RD+I projects, provide tools for controlling, check external project and cooperation ideas as well as proposals and approach possible cooperation partners from industry, research institutes and universities.

Innovative Network Construction: During recent years we have developed an extensive network including international organisations of the construction sector. Among the most important are ENCORD[1)] and ECTP[2)]. We then inform our colleagues about relevant seminars such as, for example, Best Practice Workshops regarding industrial safety, Building Information Modeling or Lean Construction. Therewith our specialist staff receives helpful information regarding where they stand among competitors, synergies are used and trends relevant to our sector are recognised at an early stage.

The Knowledge Platform for Innovation: In order for innovative ideas to effectively reach the construction sites, development projects conducted by the Central business units need to be closely coordinated with the company’s operative units. This decentralised approach is supplemented by compiling our new knowledge in a centralised location. Such a platform of knowledge offers synergies for the management, i.e. for prequalification process, and it allows an efficient exchange of experience and knowledge for our experts. This is manifested by the annual corporate brochure ‘Research, Development & Innovation – Projects’, which features our development projects according to topics.

1 Offshore wind power plant with gravity foundation
2 Adiabatic compressed air storage
3 Concrete heat accumulator test module for solar direct evaporation
4 Company brochure ‘Research, Development & Innovation – Projects’

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TOPIC OF THE FUTURE: ENERGY

By 2020 the portion of renewable energy from the German energy suppliers is to be increased from the current 15% to 30%. This ambitious target requires innovative solutions in numerous areas. As especially wind and solar energy are subject to weather fluctuations, future energy needs have to be met using flexible storage technologies. The subject of renewables is an opportunity for the construction industry to take up a leading role. ZT responds to these new challenges by systematically increasing its expertise in this field.

Offshore Wind: Offshore wind power plants are a substantial component of the company’s ‘renewable energies’ portfolio. However, there are still considerable technical challenges to be overcome, for example, the economic erection of offshore wind power plants. ZT has been covering this subject for several years now and has recently bundled the necessary expertise into the group ‘Centre of Technology for Renewable Energy’ (see page 23).

Energy Storage: The ‘battery’ takes a key role in the energy industry of tomorrow. Innovative solutions and corresponding knowhow are essential for the construction related activities in this complex field. ZT pursues various concepts in cooperation with strong partners. A heat storage system is being developed for power storage, from offshore wind plants, which substantially increases the efficiency of compressed air storage power plants. With a high temperature solid state accumulator, solar heat shall be stored in concrete cores, to be released for power as required. In contrast to this, thermal solar power is already being used in a seasonal low-temperature accumulator to supply energy to a school and a sports centre.

Resource Efficiency and Effectiveness: A more effective use of energy is nowadays essential. As one of the technological leaders in all areas of turnkey construction we must, therefore, place emphasis on sustainable construction (see page 11). Particular attention must be made to energy efficiency during a building’s life cycle, since it is generally determined during the predesign phase. Hence, a comprehensive solution is required. This is also relevant for existing buildings as these carry a substantial potential for a reduction of their energy consumption, and thus, also of CO_2 emissions. The energetic optimisation of buildings during their operational phase on the one hand, and new quality requirements by the customer on the other, have led to examine the company’s construction process with regards to its environmental impact (see page 31).

Building Information Model (BIM) – 5D®: The competitiveness in complex construction projects can only be secured with efficient and comprehensive design tools. A model-based development is being further advanced in the 5D Design group (see page 22) with the aim of comprehensively modeling all phases and trades. Thereby, all project participants can be integrated from the project start. Also, in the area of renewable energy, the BIM approach offers applications for modeling and simulation, as the location and structure of a building can, for example, influence the effectiveness of energy efficiency and energy generation measures.

1) European network of Construction Companies for Research and Development, www.encord.org
2) European Construction Technology Platform, www.ectp.org

PATENT DEPARTMENT

The Patent Department is in charge of managing all the group's Intellectual Property (IP) rights. In order to promote innovative strength and competitiveness, the Patent Department is responsible for the following tasks: It offers advice on all IP right issues (patents, utility models, registered designs, trademarks and brands) and supports the organisational units in all phases of obtaining IP rights (from drafting and submitting the application, through the awarding procedure, and all the way to a possible enforcement or defence of IP rights).

In addition, the Patent Department handles the administration of the granted IP rights, from the application up to the time the term of protection ends or to the abandonment of the IP right. This responsibility also involves the control of protection and payment deadlines as well as a regular assessment of the necessity of protection of individual IP rights. Market observation is yet another task of the Patent Department: By searching the weekly publications of the Journal of the German Patent and Trademark Office Journal (Deutsches Patentblatt), interesting innovations are detected and passed on to the respective units within the Group. Upon request, the Patent Department also conducts project-based IP right database searches in order to forestall violation of external IP rights.

HUMAN RESOURCES DEVELOPMENT

In various ways ZT contributes to the Group's human resources development. At ZT, new staff members can deepen their expert knowledge and have the opportunity to apply in practice and under expert guidance what they learned at university. Young engineers are trained for jobs such as construction or project management for their later work within the operating units. In addition, ZT also offers technical training for employees to specialise, for example, as expert site managers or design engineers.

ZT also provides training in all specialist fields for the entire Group staff. Seminars and working groups on diverse topics promote a Group-wide knowledge transfer.

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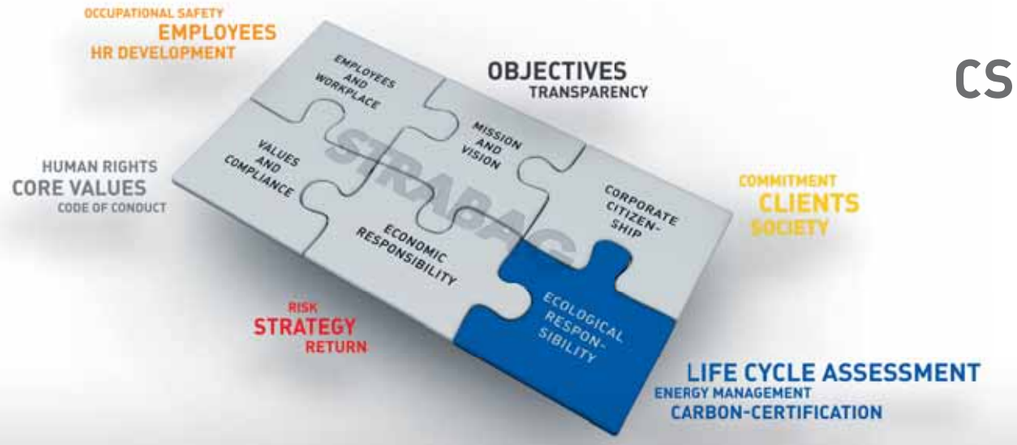
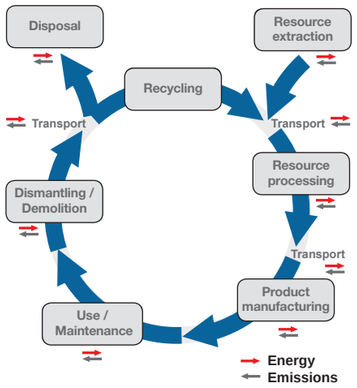


CORPORATE SOCIAL RESPONSIBILITY

The competitiveness of a company depends more and more on its ecological responsibility and social commitment, to such a degree that these aspects are benchmarked for the quality value of companies and their operative units – now often summarised under the term sustainability.

Corporate Social Responsibility (CSR) is a platform, which aims to systematically and comprehensibly advance the company's extended responsibility. By disclosing relevant information about company processes and products, a sustainable development for the company is sought. In some of STRABAG's market sectors the bidder's ecological commitment is already evaluated during the prequalification or tendering phase, respectively. This also includes, amongst others, the carbon footprint disclosure of the corporation and of the bidding company units. Also rating agencies and non-governmental organisations (NGO), such as the Carbon Disclosure Project (CDP) evaluate and publish this information for potential investors and customers.

At the instigation of the STRABAG SE board of directors, a CSR agenda has been created to meet these new external requirements. This comprehensive agenda aims to cover all relevant issues with six topical areas illustrated above. For a successful company-wide implementation, a close cooperation between operational and service units is essential. For this to work effectively, information and implementation measures particularly from the environmental management need to be coordinated with the internal accounting system, the revision, personnel administration, contract management, construction processes management, equipment and vehicle management as well as corporate communication. The concept, as well as high level coordination for these activities is the task of the CSR management assigned to ZT.



Life cycle approach

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WHAT WE OFFER

Early identification of societal changes and their possible impact on our core business.

Contact for internal inquiries regarding life cycle assessment of construction works and processes as well as for energy management issues.

Responsible for external inquiries regarding CSR related activities of the company, for example by NGO such as the CDP and the Global Reporting Initiative (GRI).

Development, coordination and monitoring during the implementation of the CSR agenda.

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